24 April 2007

Mr. Nicholas Sabatini, AVS-1
Associate Administrator for Aviation Safety
Federal Aviation Administration
800 Independence Avenue
Washington, DC 20591

Dear Nick:

The PARC is pleased to submit the enclosed report entitled, *Implementation Plan for RNP Parallel Approach with Transition (RPAT).* The PARC recently completed this report that articulates the operational concept for RPAT in terms of the approach application, its benefits and future concept extensions. The PARC considers the implementation of RPAT a priority milestone for achieving higher capacity during marginal weather conditions at airports with closely-spaced parallel runways. The PARC recommends that the FAA adopt the enclosed *Implementation Plan* which was carefully developed through a collaborative government-industry coordination process within PARC.

Furthermore, the PARC is recommending that the FAA identify sites for implementation of RPAT, publish an FAA Order specifying the procedure design criteria, develop training and guidance for pilots and controllers for using RPAT, modify FAA Order 7110.65 Air Traffic Procedures as necessary for using RPAT, and modify the Aeronautical Information Manual appropriately. The FAA should endeavor to complete these activities by the end of calendar year 2007. As identified in the FAA's Operational Evolution Plan, RPAT is planned for implementation within the next two years.

Having completed the RPAT concept and implementation planning process, the PARC is refocusing the RPAT work group to develop a concept and implementation plan for RNP parallel approaches without transitions. This will enable higher benefits by allowing for simultaneous independent approaches during IMC where not possible today.

PARC appreciates your continued support of our activities and invites you to join us in a discussion of these recommendations at your convenience. I would also like to acknowledge the significance of this RPAT working group effort led by Don Porter. Please call me if you have any questions or would like to set up a discussion.

Regards,

David Nakamura
Chairman, PARC

Cc: J. McGraw
J. Williams
D. Porter

## Required Navigation Performance (RNP) Parallel Approach Transition (RPAT) Operational Plan (DRAFT)

### Background

Over the past two decades, air traffic growth has outpaced airport and airspace capacity. To meet this growth, the Federal Aviation Administration (FAA) has committed to developing and implementing performance-based navigation airspace and procedures throughout the U. S. National Airspace System (NAS). To this end the FAA, in collaboration with the aviation industry, is defining concepts and applications based on performance standards rather than specific technologies and aircraft equipage configurations. Among these performance-based concepts are Area Navigation (RNAV) and Required Navigation Performance (RNP). The aviation community is broadly adopting RNAV and RNP as key components of performance-based navigation. RNP takes advantage of an aircraft's onboard navigation capabilities to fly a predictable flight path with a specified performance level. By adopting RNP and leveraging existing and emerging cockpit capabilities, the FAA will be able to improve airspace utilization and instrument flight procedure design, leading to increased capacity and improved efficiency.

For example, a number of major US airports have runway configurations that restrict simultaneous operations to closely-spaced parallel runways during marginal weather conditions. Part of the FAA's "Flight Plan" strategy is to improve marginal weather landing capacities at major US airports with challenging runway configurations. In 2005, the FAA began conducting RNP Parallel Approach Transition (RPAT) safety studies as part of these capacity improvements at airports with closely spaced parallel runways. Closely spaced is defined as runways with less than 4300 feet between runway centerlines. The first airport studied was San Francisco International Airport (SFO), with parallel runways spaced 750 feet apart. The first phase of this study was conducting human-in-the-loop (HITL) evaluations on RPAT feasibility and implementation issues using the FAA's full flight, Level D Boeing 737-800 simulator, located at the Mike Monroney Aeronautical Center, Oklahoma City, OK. Following this simulator safety study, the FAA allowed company-specific, limited flight trials at SFO. The results of these simulations and flight evaluations have been summarized in two reports generated by the FAA's Flight Operations Simulation and Analysis Branch, AFS-440. These reports are titled "Safety Study Report on Required Navigational Performance (RNP) Parallel Approach Transition (RPAT) Operation Concept Flight at San Francisco International Airport (Feb 2006)", and "Safety Study Report for San Francisco International Airport (SFO) Required Navigation Performance (RNP) Parallel Approach Transition (RPAT) Operation using FAA B737-800 Simulator (Nov 2006)", and are available on request.

Based on data collected and lessons learned from these two trials, the Performance Based Operations Aviation Rulemaking Committee (PARC) created the RPAT Action Team (AT) to formalize the RPAT concept into a draft RPAT Operations Plan to be proposed to the FAA. In addition to the HITL evaluations discussed above, this draft plan is now being used in other RPAT safety studies. These studies will further assess and evaluate pilot and air traffic controller human factors issues such as cockpit workload and training under tighter performance requirements, improved surveillance and communications, and lowering weather conditions. These are discussed in the "Future RPAT Enhancements" section of the paper. Once this plan is formally accepted by the FAA and in order to further validate this plan, additional trials involving "lead operators" at several locations will be pursued while the FAA completes the required safety studies.

This RPAT Operational Plan defines initial implementation requirements for the RPAT operation and as such, its purpose is to enable benefits as soon as possible by utilizing current standards and guidance for RNP Special Aircraft and Aircrew Authorization Required (SAAAR), specifically Advisory Circular (AC) 90-101 and FAA Order 8260.52. The plan also recognizes the opportunity for future developments and applications of RNP approaches as more and more operators become equipped, and with advancements in new technology and automation that will provide additional benefits well beyond the initial implementation of RPAT.

**Benefits of Initial Implementation of RPAT**

Enhances Airport Acceptance Rate during Marginal Weather Conditions: The RPAT Operational Plan is intended to make better use of existing parallel runways at airports with high traffic demand. RPAT will allow an increase in the amount of time that visual separation rules are applied to parallel streams of traffic, allowing for sets of parallel runways to be used for arrivals when lowering ceilings or reduced visibility would otherwise force reduced or discontinued use of one of the parallel runways. When forced into a single runway configuration, an airport acceptance rate (AAR) can be reduced by as much as half. San Francisco's AAR, for example, drops from 60 arrivals per hour to 30 when forced to a single runway operation. With RPAT operations, the marginal weather AAR could be sustained at a level higher than 30 (but lower than 60). Studies are underway to determine AARs achievable with RPAT operations for airports with closely-spaced parallel runways, and with varying levels of aircraft capability.

Leverages Aircraft Capability: The initial implementation of RPAT defined in this plan requires that an RNP approach, designed and flown in accordance with applicable RNP SAAAR approach procedure design criteria, be used in parallel with an ILS approach. The benefits of using RNP SAAAR criteria is that this criteria (FAA Order 8260.52) allows for maximum path-keeping accuracy in turns (i.e., radius-to-fix path terminators) as well as vertical guidance to the runway threshold. Maximum path-keeping accuracy is intended to reduce pilot workload as well as reduce the need for controller intervention.

Supports Mixed Equipage: In the near term, the benefits of using RNP SAAAR in parallel with ILS enables mixed equipage operations. In the example of (SFO), rather than holding an aircraft on the ground, or delaying an aircraft en route waiting for a slot on the ILS runway, SAAAR equipped aircraft could continue to operate to the RNAV (RNP) runway.

Minimizes Ground Infrastructure Needs: The initial implementation of RPAT minimizes the need for additional ground infrastructure. For instance, it requires that centerlines of the RNP and ILS approach paths in the intermediate parallel segment be separated laterally by a minimum of 5,000 feet. Aircraft may be delivered to parallel runways with centerlines spaced as close as 750 feet, up to 4,300 feet, laterally. However, this requirement for the two approach path centerlines to be spaced at least 5,000 feet apart in the parallel segment, avoids the requirement for high-update radar. The only surveillance requirement for ATC during RPAT operations is an ASR-9 terminal radar system. In addition to minimum surveillance infrastructure, RPAT is also intended to eliminate the need for additional ground-based NAVAIDs (e.g., offset localizers) by leveraging RNAV capabilities based on GPS.

Maximizes Safety of Operations: To ensure maximum safety during initial implementation, the plan requires sufficient visibility for the use of the operation. While the standalone RNAV (RNP) approach may have Category 1 minima associated with it, the RPAT operation is not designed to be used unless the weather (ceiling and visibility) conditions are such that the crew of the RNP aircraft can visually acquire and maintain visual separation from the ILS aircraft before turning toward that aircraft's approach path. Furthermore, the visibility requirement is intended to ensure that the crew of the RNP aircraft visually acquires the airport environment early enough to gain the necessary visual perspective of its landing runway and the position of the ILS aircraft prior to rolling out on final.

Effectively Mitigates Wake Encounters: To aid in preventing an aircraft upset due to an encounter of wake turbulence, the RPAT plan requires that a heavier weight group aircraft be the trailing aircraft in a given ILS/RNAV pair. Furthermore, the plan requires that the straight-in, less maneuverable ILS aircraft be in the lead position so that the RNAV aircraft, which has the better vantage point, can maintain or increase in-trail spacing as needed. Combined with ATC's in-trail spacing range of 1 mile-or-less at touch down, the RPAT approach design (RF turns) and speed adjustments by the crew all aid the RNAV aircraft in wake encounter mitigation while remaining on FMS lateral and vertical guidance to the approach end of the runway.

## RPAT Operational Description

*Intermediate Segment*

Design - The RNAV (RNP) approach for the RPAT plan is designed in accordance with FAA Order 8260.52 and requires GPS and a navigation accuracy of RNP-0.3. The parallel segment is designed in accordance with FAA Order 8260.3B Change 19, Terminal Instrument Procedures (TERPS), Appendix 2 – Simultaneous ILS Procedures.

The Operation - ATC operations in the parallel segment are performed in accordance with the *separation requirements* of FAA Order 7110.65 *Air Traffic Control*, paragraph 5-9-7, "Simultaneous Independent ILS/MLS Approaches – Dual and Triple." NOTE: Simultaneous RNAV operations have yet to be approved with ILS/MLS. Currently, a waiver to conduct these operations is required. However, the FAA is conducting studies that are near completion and preliminary results appear to enable this operation.

Both aircraft must be established on and cleared for the approach, and directed to change to tower frequency prior to losing 1000 feet vertical separation. Each runway must have its own assigned tower frequency. Both aircraft are monitored by parallel approach monitor controllers from that point until reaching the PFAF. The use of monitor controllers is required for simultaneous independent instrument approaches and is a function of the approach control facility. The monitor controllers operate on, and have override capability of, their runway's tower frequency by way of the parallel approach monitor system (PAMS). The monitors are responsible for radar separation of the aircraft and resolving No-Transgression Zone (NTZ) penetrations (aircraft blunders). The monitors are responsible for the airspace from the point vertical separation is lost on the approach (approx. 15 miles from the runway) to the PFAF, where visual separation is applied. If it appears that an aircraft will penetrate the NTZ, the monitors will break the threatened aircraft off of its approach path and away from the blundering aircraft.

To enhance capacity, especially with runway thresholds separated by less than 2500 feet, ATC should have the RNAV aircraft in position by the PFAF so that it will be within one mile (0 – 1.0 mile facility specific) in-trail of the ILS aircraft as it crosses its runway threshold. NOTE: Not having a required interval *at* the PFAF leaves flexibility for ATC to adjust for varying conditions and aircraft performance so as to better attain the desired interval at the runway threshold.

*Final Approach Segment with Transition*

Design – The final approach segment (FAS) of the RNP approach is designed in accordance with FAAO 8260.52. The RNP aircraft will fly a laterally and vertically guided flight path that transitions from the PFAF to the waypoint that identifies the runway threshold. The transition initiates at the PFAF with a turn toward the ILS approach path followed by a second turn that rolls out on the RNAV runway's extended centerline. These turns, for the initial implementation, are designed as radius-to-fix (RF) path terminators in order to ensure maximum path-keeping accuracy while transitioning to the landing runway.

For the purposes of the RPAT operation, the waypoint that defines the beginning of the second RF turn is designated as the "RPAT abandon approach waypoint", the waypoint where the crew must have the airport in-sight. The RPAT Abandon Approach Procedure (AAP) is described below and is separate from the standard "Missed Approach Procedure".

RPAT AAP – Since RPAT is an instrument approach procedure that requires the use of visual separation in the FAS, it requires an additional egress procedure that can be flown:

1). From the PFAF, if visual acquisition of the ILS aircraft cannot be made, and

2). Anywhere between the PFAF and RPAT abandon approach waypoint if visual separation with the ILS aircraft cannot be maintained

3). If the airport is not in-sight by the Abandon Approach Waypoint.

The RPAT AAP will consist of heading and altitude instructions, "lost comm" instructions, and will remain consistent regardless of aircraft position in the FAS. Those instructions are intended to be depicted on the approach plate as well as contained in an "Attention All Users Page" (AAUP). The instructions will consist of a climb to at least the Minimum Vectoring Altitude (MVA), and a heading that diverges from the ILS course by *at least* 15 degrees. The heading and altitude will be site specific and determined during the development of the procedure.

The Operation - At some point prior to the PFAF, the RNAV aircraft shall locate and visually acquire the ILS traffic. The RNAV pilot must have the ILS traffic in sight prior to passing the PFAF and beginning the transition to the runway. ATC maintains separation responsibility until the PFAF at which time the pilot assumes visual separation responsibility from the PFAF to the runway. The pilot of the RNAV aircraft shall contact the tower when passing the PFAF and report the traffic in sight e.g., "Tower, N123 is at the PFAF for runway 28R, traffic in sight". NOTE: While an ATC response is not required to continue the approach, an acknowledgement should be expected. The crew should continue as long as visual separation is maintained and the airport is in sight by the RPAT abandon approach waypoint. The tower controller should respond very soon, if not immediately, after the check-in is made e.g., “N123, cleared to land”.

Weather Conditions - The plan requires that officially reported weather conditions at the airport served by the approach be a ceiling of at least 500’ above the PFAF, and a visibility value determined by the greater of:

- 4 miles, or
- The straight-line distance from the waypoint that begins the second RF leg (this waypoint being the RPAT Abandon Approach Waypoint) to the runway threshold waypoint.

Figure 1 depicts an overview of the RPAT procedure showing the ILS and RNP courses, and Figure 2 depicts the vertical attributes of the RNP course.

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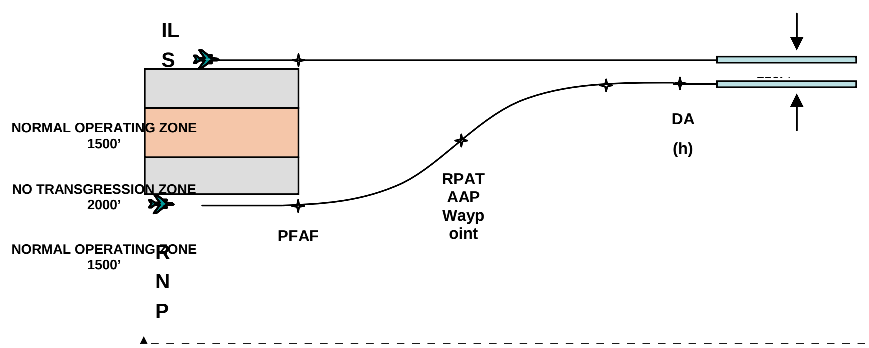


Figure 1. RPAT Overview

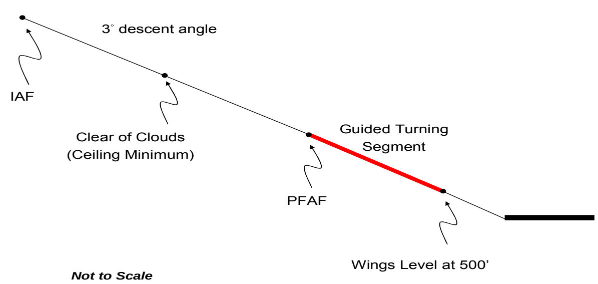


Figure 2. RNP Course Vertical Attributes

Table 1. Key Aspects of RPAT

| | |
|---|---|
| **Type of Approach** | Instrument Approach. |
| **Pilot Visual Separation Requirement** | RNAV pilot: Must have the ILS aircraft in sight and advise ATC prior to proceeding beyond the PFAF. The airport environment must be in sight no later than the waypoint that begins the second RF leg. The RNAV pilot shall report passing the PFAF with traffic in sight e.g., "Tower, N123, over "PFAF" for runway 28R, traffic in sight. ATC *will not* instruct the pilot to maintain visual separation. The RNAV pilot accepts aircraft separation responsibility at the PFAF. If the RNAV pilot fails to acquire the ILS traffic before reaching the PFAF, the pilot executes the RPAT AAP at the PFAF and advises ATC. |
| **ATC Requirements** | Approach Control: Issues approach clearance to the pilot of the RNAV aircraft, advises the position of traffic on the ILS and instructs the RNAV pilot to report it in sight *when able*. Then, in accordance with FAAO 7110.65 para. 5-9-7, approach instructs the aircraft to change (either monitor, or contact – site specific) to tower frequency and report the PFAF.<br>Monitors: Standard Operating Procedures for simultaneous operations.<br>In the event of an RPAT AAP:<br>Prior to the PFAF, the monitor controller shall assume control from the time the pilot reports executing procedure. Inside the PFAF, ATC (tower or tracon [site specific]) shall assume control from the time the pilot reports executing the procedure. In the event of "lost comm", the pilot will proceed via the "lost comm" procedure.<br>Tower: Standard Operating Procedures for parallel runway operations. Acknowledge the RNAV pilot check in at the PFAF. In the event of an RPAT AAP, assume control or instruct the pilot to contact the appropriate radar controller (to be determined on a site specific basis).<br>Lost Comm: If the RNAV aircraft loses radio communication: Prior to PFAF with the ILS aircraft in sight, the aircraft is expected to continue past the PFAF to landing. If traffic is not in sight, the pilot shall execute the RPAT AAP at the PFAF with standard "No Radio" procedures.<br>Inside the PFAF but before the RPAT AAP waypoint, ATC can expect the aircraft to execute the RPAT AAP per the "Lost Comm" procedures that are contained in the RPAT AAP The "Lost Comm" procedure will include a point to which the pilot can navigate exclusive of headings e.g., direct-to a waypoint. |
| **NavData Coding** | The RPAT operation requires a RNP SAAAR Approach that is coded from Initial Approach Fix through the termination of the MAP |
| **Visibility** | 4 miles, or the straight line distance between the waypoint that begins the second RF turn and the waypoint that depicts the landing threshold, whichever is greater |

**Future RPAT Enhancements**

Transfer of Communication

Since RPAT requires the crew to provide visual separation with the ILS aircraft from the PFAF to the runway, there is no need for the aircraft to be put on the tower's frequency for NTZ monitoring.  The required ATC separation services can be provided by the Tracon in its own airspace, which ends at or in the vicinity of the PFAF.  This would also aid in RPAT implementation at facilities where current operations do not include simultaneous independent instrument approaches by eliminating the requirement for additional tower staffing and equipment.

Increasing RPAT Participation

Aircraft capability for flying RF legs, especially inside the PFAF, is limited at the present time.  To increase participation in RPAT operations, the RNP approach path design along the FAS could be modified to include segmented legs using track-to-fix (TF) path terminators.  TF legs with fly-by and fly-over waypoints have been successfully used in RNAV SID and STAR design, and therefore may be considered in the design of future RPAT procedures.

Another future design possibility focuses on the use of a converging intermediate segment followed by a single turn onto final. This would have the affect of allowing a straighter path, smoother turns and shallower bank angles.

Leveraging Future Aircraft Capability

As the number of aircraft capable of RNP less than 0.3 increases sufficiently, the design of the RPAT operation may be enhanced to allow closer intermediate segments.  The intent of this change would be to reduce airspace requirements, minimize environmental impacts, and potentially allow straight-in RNP approaches (i.e., without requiring the offset path and RF turns).

Today, due to current FAAO 8260.52 requirements and FMC database limitations, the RPAT AAP is not coded and has to be flown manually.  To help reduce cockpit workload, in addition to the standard missed approach procedure required for today's Instrument Approach Procedures, the RPAT AAP could also be coded and executed by aircraft with the capability (which is currently very limited).  The intent of this future requirement would also be to enhance safety and predictability by leveraging lateral and vertical guidance using RNP during the execution of this procedure.

A more advanced capability that is expected to exist in the future is enhanced ground-based surveillance through Automatic Dependent Surveillance - Broadcast (ADS-B).  A companion capability that allows for Cockpit Display of Traffic Information (CDTI) would enhance traffic awareness and potentially lead to improvements in separation assurance, thus reducing or eliminating the need for air traffic monitors and the NTZ.  An added benefit to this enhancement would be cost savings to the service provider.

Enhancing Airport Capacity:

Once RNP SAAAR capability is prevalent at busy airports with closely-spaced parallel runways, the opportunity arises for a parallel approach application involving two or more straight-in RNP approach paths. The plan of RNP Parallel Approaches (RPA), depicted in the graphic below, enables higher AARs even in reduced weather such as Category 1 (ceilings of 250’ and visibility of ½ mile) weather minimums. One advantage of the RPA operation is that visual acquisition of traffic is no longer required, thus eliminating the need for the RPAT AAP.

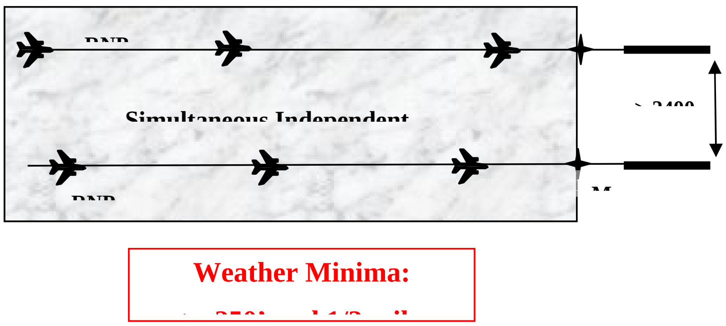


Figure 3 RPA Overview