MEMORANDUM

SIMULATION OF SIMULTANEOUS APPROACHES TO A HIGH-ALTITUDE AIRPORT

1.0 Introduction

The Multiple Parallel Approach Program (MPAP) Technical Working Group (TWG) conducted two real-time air traffic control (ATC) simulations at the FAA Technical Center in September and November, 1992, respectively. The simulations were designed to examine ATC procedures for simultaneous instrument landing system (ILS) approaches to three and four parallel runways at a high-altitude airport. In the September simulation, final monitor controllers used ARTS IIIA displays, whereas in the November simulation, they used FMA displays.

High-altitude airports are airports that have field elevations of greater than or equal to 1000 ft mean sea level (msl). Aircraft performance is affected by air density which generally decreases as altitude increases. Thus, for a given indicated airspeed, true airspeed increases proportionally with increases in altitude. An empirical examination of the effect of high-altitude was important for the development of the new Denver International Airport (DEN).

During the simulations, final monitor controllers staffed three and four final approach monitor positions. They monitored the flight paths of the aircraft on their assigned runways and their task was to ensure that aircraft maintained the required separation. Aircraft blunders were initiated to measure the ability of the system to maintain adequate separation between aircraft on final approaches during critical situations. A blunder occurred when an aircraft, already established on the final approach course, made and unexpected turn towards another aircraft on an adjacent approach. All blundering aircraft executed 30 degree turns towards adjacent approach courses. To simulate worst-case scenarios, blundering aircraft simulated an inability to comply with controller 'breakout' instructions in a majority of the conflicts.

1.1 Multiple Parallel Approach Program Test Criteria

The MPAP TWG established the following criteria to evaluate the proposed operations:

- The number of blunders resulting in miss distances of less than 500 ft relative to the total number of blunders initiated;
    - ◊ Blunders that resulted in miss distances of less than 500 ft were considered test criterion violations (TCVs). The MPAP TWG determined that a TCV rate (number of TCVs/number of blunders) of greater than 2 percent would be unsafe.
- The frequency of No Transgression Zone (NTZ) entries and the frequency of nuisance breakouts (NBOs);
    - ◊ NTZ entries occurred when aircraft entered the NTZ, not including aircraft that were directed to blunder. NBOs resulted when aircraft were broken out of the final

approach for reasons other than a blunder, NTZ entry, loss of longitudinal separation, or lost beacon signal. NTZ entries and NBO occurrences can affect the efficiency of a procedure. The MPAP TWG assessed the NTZ entry and NBO frequencies to ensure there would be no reduction in efficiency.

- An operational assessment from MPAP TWG members, based on their expertise and judgment, regarding the feasibility of implementing the procedure in the operational environment.

2.0 Simulation Using ARTS IIIA Displays

2.1 Design

The purpose of this simulation was to provide an operational evaluation of high-altitude simultaneous ILS approaches to both triple and quadruple parallel runways. Final monitor controllers used ARTS IIIA displays and a simulated ASR-9 radar with a 4.8-second update rate. The field elevation of the airport was 5431 ft. The triple approaches were to runways spaced 7600 and 5280 ft apart. The quadruple approaches were conducted to runways spaced 5348, 7600, and 5280 ft apart, with the 7600 ft spacing between the two inner runways.

Indicated airspeeds of 180 kts were assigned to turbojets, 150 kts to turboprops, and 120 kts to twin engine piston aircraft prior to ILS intercept. Aircraft decreased speed and descended according to normal operating procedures.

2.2 Results

Over the course of the simulation, a total of 746 blunders were initiated, 376 for the triple configuration and 370 for the quadruple configuration. Approximately 74 percent of all blundering aircraft did not respond to ATC instructions. Preliminary data analyses indicated that the number of TCVs exceeded the 2 percent criterion.

Thirty-three NBOs were observed, and no NTZ entries occurred. The number of NBOs and NTZ entries was acceptable based on the criteria set by the TWG.

Controllers indicated in post-simulation questionnaires that using the ARTS IIIA display made it “very difficult to perform the monitor controller task”. None of the controllers thought that the triple or quadruple independent IFR approach procedures could be conducted safely with the displays and runway spacings tested in this simulation.

2.3 Conclusions

After reviewing the simulation data and controller opinions, the Air Traffic Procedures Division (ATP-100) decided that a new high-altitude triple approach simulation should be conducted using Final Monitor Aid (FMA) displays. FMAs are high-resolution color displays that are equipped with controller alert systems and expandable horizontal and vertical axes. FMAs provide controllers with tools for recognizing and resolving aircraft course deviations, a task which is critical when monitoring simultaneous approaches.

It was also decided that the simulation would be site-specific to the new Denver International Airport (DEN); a high altitude airport with a field elevation of 5431 ft.

3.0 Simulation Using FMA Displays

3.1 Design

In order to simulate Denver's final approach procedures, information about air traffic and airport operations was requested from representatives from the Northwest Mountain Region. Assigned aircraft speeds for this simulation were set at 170 for all turbojet and turboprop aircraft. Additionally, twin-engine piston aircraft were assigned a 150 knot IAS.

Initially, for two days, November 16-17, 1992, monitor controllers used FDADS displays to monitor the triple simultaneous approach procedure. The FDADS, as was anticipated, did not provide adequate resolution to resolve blunder situations. Therefore, the simulation using the FMA displays commenced on November 18 and concluded on December 15, 1992. Controllers monitored traffic using the FMAs and a simulated radar with a 4.8-second update rate. The field elevation of the airport was 5431 ft. The triple approaches were to runways spaced 7600 and 5280 ft apart.

Indicated airspeeds of 180 kts were assigned to turbojets, 150 kts to turboprops, and 120 kts to twin engine piston aircraft prior to ILS intercept. Aircraft decreased speed and descended according to normal operating procedures.

3.2 Results

Over the course of the simulation, 186 blunders were initiated that would have resulted in aircraft miss distances of less than 500 ft had controllers not intervened (i.e., at-risk blunders). Of those 186 at-risk blunders, 2 resulted in miss distances of less than 500 ft between aircraft with controller intervention. Thus, the blunder resolution success rate was 98.9 percent, which exceeded the 98 percent success rate criterion set by the TWG.

Seventeen NBOs occurred out of 8927 non-blunder-related approaches (0.2 percent), and no NTZ entries occurred. These numbers were acceptable based on the criteria set by the TWG.

The results of the simulation indicated that the proposed simultaneous triple approach operation to runways spaced 7600 ft and 5280 ft apart with an airport field elevation of 5431 ft could be conducted safely with the use of FMA displays. The results of the November 1992 simulation are fully documented in DOT/FAA/CT-94/36.

3.3 Conclusions

Based upon the findings of the generic high-altitude and the DEN simulations, FMA displays were installed at the Denver International Airport for monitoring triple simultaneous approach operations. Denver International Airport opened successfully in February, 1994, conducting simultaneous ILS approaches to three parallel runways.