Federal Aviation Administration

Office of System Capacity and Requirements

VOLUME 2

Capacity Initiatives

- Independent Parallel Approaches Using Precision Runway Monitor (PRM)
- Independent Parallel Approaches Using Final Monitor Aid (FMA) (4.8 Second Update Rate)
- Independent Parallel Approaches To Triple and Quadruple Runways Using Current Radar Systems (4.8 Second Update Rate)
- Simultaneous Operations On Wet, Intersecting Runways
- Improved Operations On Parallel Runways Separated By Less Than 2,500 Feet
- Independent And Dependent Approaches to Three Parallel Runways
- Simultaneous (Independent) Converging Instrument Approaches
- Traffic Alert and Collision Avoidance System (TCAS)/Cockpit Display of Traffic Information (CDTI) for Separation Assistance

U.S. Department of Transportation

Federal Aviation Administration

FORWARD

This is the second in a series of pamphlets detailing capacity initiatives that offer solutions for improving the Nation's aviation system capacity. Based on the application and refinement of new systems and procedures, these initiatives promise an increase in capacity with relatively little financial investment or systems development. Users can look forward to benefiting from these procedures without the requirement for extensive certification of new airborne and ground-based systems.

Two terms which are used in describing some of the procedures need clarification. They are "independent" and "dependent" procedures. "Independent" procedures are so-called because aircraft arriving along one flight path do not affect arrivals along another flight path. "Dependent" procedures place restrictions between two arrival streams of aircraft because their proximity to each other has the potential for some interference.

This pamphlet offers the reader a description of capacity initiatives, their intended purpose, an indication of which airports may benefit, and where possible, the target implementation dates. Initiatives discussed in prior pamphlets in the series are not repeated unless there has been some change in their status or refinement in their application.

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CAPACITY INITIATIVES

One of the major challenges facing the aviation industry in recent years has been the increase in the number and duration of flight delays. Aviation experts have been seeking ways to keep pace with increasing operational demand while minimizing delays that can quickly have a domino effect throughout the national airport and airspace system.

While substantial increases in capacity can best be achieved through construction of new airports and new runways at existing airports, programs of this type require extensive long-term planning. In an effort to meet the increasing demands on the airport and airspace system, the FAA has initiated capacity enhancement programs designed to provide additional capacity at existing airports, while maintaining or improving the current level of safety in aircraft separation.

These capacity enhancement programs include improvements in air traffic control procedures, radar systems, high-resolution color displays for controllers, and increased utilization of multiple runways.

The testing of these initiatives has been thorough, involving various validation methods including real-time simulations and live demonstrations at selected airports.

The gains realized from these enhancements range from three additional arrivals per hour to as many as 26 arrivals per hour. Forecasts suggest that, in the absence of capacity improvements, delays in the system will continue to grow. In 1992, 23 airports each exceeded 20,000 hours of flight delays. Assuming no improvements are made, 33 airports are forecast to each exceed 20,000 hours of flight delays by the year 2002.

This pamphlet describes capacity initiatives that have recently become available for use or are targeted to become national procedures within the next five years. These new procedures continue to be tested thoroughly and are an example of the collective effort within the FAA to enhance operations and improve system performance.

Independent Parallel Approaches Using Precision Runway Monitor (PRM)

Objective:

Use the Precision Runway Monitor (PRM) to allow independent ILS approaches to parallel runways separated by 2,500 feet to 4,299 feet.

Concept:

Where closely-spaced parallel runways exist, the proximity of arrival paths precludes independent parallel approaches when the weather is less than the required minimum for visual approaches. Significant capacity gains can be achieved through use of a PRM system.

The PRM system consists of an improved monopulse antenna system that provides high azimuth and range accuracy and higher data rates than the current terminal Airport Surveillance Radar (ASR) systems. The PRM processing system allows controllers to monitor the parallel approach courses on high resolution color displays and generates controller alerts when an aircraft blunders off-course.

There are two versions of the PRM system. One system (E-SCAN) utilizes an electronic scanning antenna which is capable of updating an aircraft's position every half second. This update rate is an order of magnitude greater than the current airport surveillance radars. The other system (MODE-S) utilizes two mechanically rotating antennas mounted back-to-back and provides an update of an aircraft's position every 2.4 seconds.

Status:

Demonstrations of PRM technology were conducted at Memphis, TN, and Raleigh-Durham, NC, in 1989 and 1990, and have resulted in the publication of procedures for independent parallel approaches to runways that have centerlines separated by 3,400 feet to 4,299 feet. Application of these procedures is contingent upon the use of PRM technology. The first PRM system (E-SCAN) was commissioned in Raleigh-Durham, NC, in June 1993. Additional systems are scheduled for delivery starting in the latter part of 1994.

Additional simulations are being conducted at the FAA Technical Center to determine the minimum runway spacing (below 3,400 feet) for independent parallel approaches utilizing a PRM. The box below lists those airports that have or plan to have parallel runways separated by 2,500 to 4,299 feet and the average capacity gain expected from the use of these approaches.

Candidates Among Top 100 Airports
Average Capacity Gain 12-17 Arrivals/Hour

Atlanta †	Indianapolis	Philadelphia
Baltimore †	Long Beach	Phoenix
Columbus	Lubbock	Pittsburgh
Dallas	Memphis †	Portland
Denver (DIA)	Milwaukee	Raleigh-Durham †
Detroit	Minneapolis-St. Paul †	Salt Lake City
Ft. Lauderdale	New York (JFK)	Tampa
Harlingen		

† Selected for installation.

Note: Some candidates are based on the assumption that proposed runways will be constructed. Other deciding factors include traffic and weather demands.

Independent Parallel Approaches Using The Final Monitor Aid (FMA) (4.8 Second Update Rate)

Objective:

Allow independent parallel approaches to runways separated by as little as 4,000 feet using current radar equipment (4.8 second update rate) and a Final Monitor Aid (FMA).

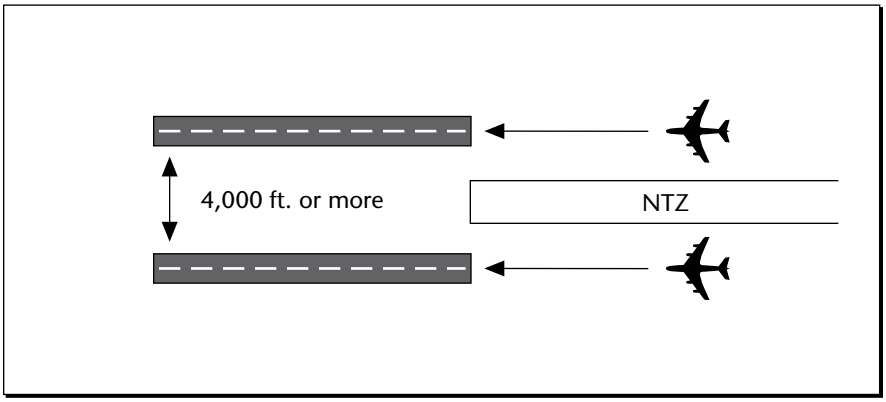
Concept:

The FMA is a high resolution color display that is equipped with the controller alert system hardware/software that is used in the PRM system. The display includes alert algorithms providing aircraft track predictors, a color change alert when an aircraft penetrates or is predicted to penetrate the no transgression zone (NTZ), a color change alert if the aircraft transponder becomes inoperative, and digital mapping.

Studies revealed that use of the FMA with current radar systems (4.8 second update rate) would improve the ability of controllers to detect blunders, thereby allowing a reduction in the minimum centerline spacing for independent parallel approaches.

Status:

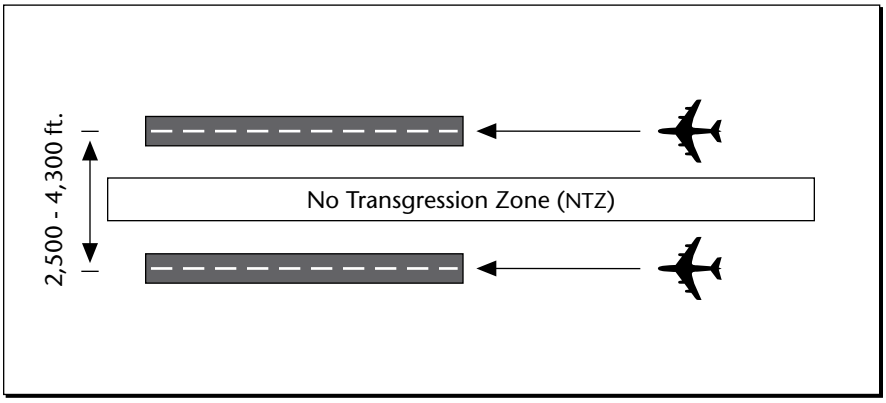
Real-time simulations were completed at the FAA Technical Center for dual and triple parallel runways spaced 4,300 feet apart. Data from these simulations are being analyzed, and, if the results are favorable, procedures could be published in calendar year 1994. Further simulations will be conducted for parallel runways spaced 4,000 feet apart.



Parallel Instrument Approaches Using FMA

Candidates Among Top 100 Airports
Average Capacity Gain 12-17 Arrivals/Hour

Denver (DIA)	Memphis	Pittsburgh
Detroit	Nashville	Salt Lake City
Grand Rapids	Orlando	Spokane
Little Rock	Phoenix	



Parallel Instrument Approaches Using PRM

Independent Parallel Approaches To Triple And Quadruple Runways Using Current Radar Systems (4.8 Second Update Rate)

Objective:

Allow triple and quadruple parallel approaches to runways separated by as little as 5,000 feet using current radar systems at airports having a field elevation of less than 1,000 feet.

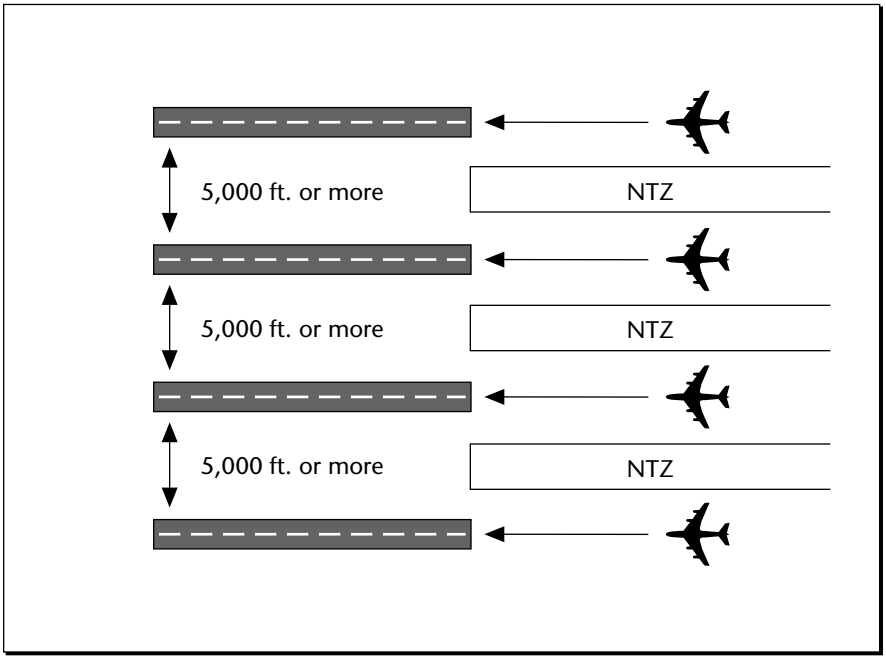
Status:

Procedures allowing triple independent approaches to parallel runways separated by 5,000 feet at airports with field elevations of less than 1,000 feet were published in May 1993. Simulations for development of procedures for quadruple approaches are tentatively planned for 1995.

Concept:

A major factor influencing National Airspace System Capacity has been the number of aircraft that can land at an airport during periods when the ceiling and/or visibility is below visual approach minimums. Any increase in the number of approaches under these conditions would significantly increase airport capacity and improve traffic flow throughout the national airspace system.

Several airports, such as Dallas-Fort Worth and Pittsburgh, are planning on building parallel runways that will give them the capability of conducting triple and quadruple independent parallel approaches. This could result in as much as a 50 percent increase in arrival capacity for triple parallel arrivals, and a 100 percent increase for quadruple arrivals.



Triple and Quadruple Parallel Approaches

Candidates Among Top 100 Airports
Average Capacity Gain 30 Arrivals/Hour

Dallas-Ft. Worth
Nashville
Pittsburgh

Simultaneous Operations On Wet, Intersecting Runways

Objective:

Establish a national standard for allowing simultaneous operations on intersecting wet runways.

Concept:

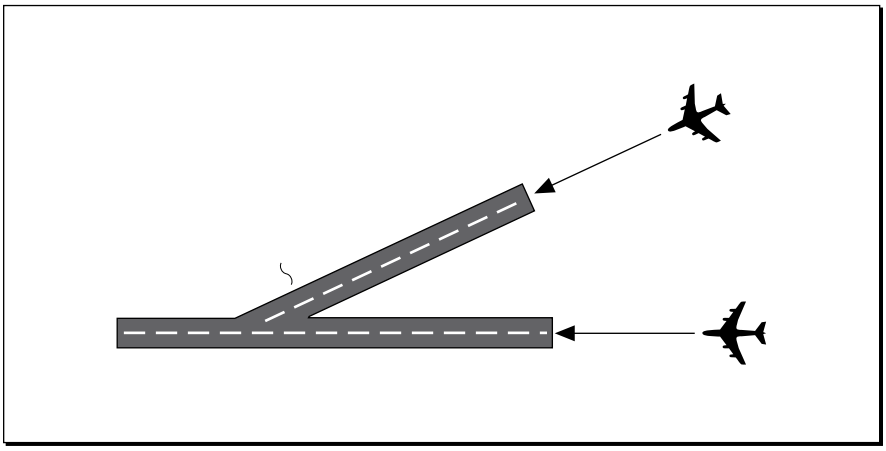
Currently, simultaneous operations on intersecting runways require that the runways be dry. Over the past several years, demonstrations have been conducted at various airports utilizing simultaneous operations on wet runways. Due to the success of these demonstrations, the FAA has initiated action to establish a national standard for allowing simultaneous operations on intersecting wet runways.

Of the top 100 airports, 60 currently conduct simultaneous operations on intersecting runways.

Status:

Demonstrations have been ongoing at Boston, Pittsburgh, Chicago O'Hare, Kennedy, Philadelphia and Miami. At O'Hare, increases of up to 25 percent have been experienced during wet runway operations.

An FAA team is in the process of formalizing procedures for these types of operations. The target implementation date is the last quarter of FY94.



Simultaneous Operations on Wet Intersecting Runways

Candidates Among Top 100 Airports
Top 13 Candidate Airports

Boston	Maimi	Philadelphia
Charlotte/Douglas	Minneapolis-St. Paul	Pittsburgh
Chicago O'Hare	New York (JFK)	San Francisco
Detroit	New York (LGA)	Washington National
	St. Louis	

Improved Operations On Parallel Runways Separated By Less Than 2,500 Feet

Objective:

Reduce the separation standards for arrival and departure operations to parallel runways separated by less than 2,500 feet.

Concept:

Current procedures consider parallel runways separated by less than 2,500 feet as a single runway during IFR operations. Simultaneous use of these runways for arrivals and departures is prohibited. This imposes a significant capacity penalty at numerous high-density airports. A recent MITRE analysis determined that airports such as Boston and Philadelphia could achieve delay savings of over 80,000 hours per year if they were able to run dependent parallel arrivals.

Status:

The FAA's Wake Vortex Program has been redefined to focus directly on the safety requirements for operations to parallel runways separated by less than 2,500 feet. It is anticipated that, among other things, the program will provide evidence supporting a reduction in the 2,500 foot requirement under most meteorological conditions. A program plan identifying specifics will be published in the second quarter of FY94.

Candidates Among Top 100 Airports

Atlanta	Las Vegas	Palm Beach
Austin	Long Beach	Philadelphia
Boise	Los Angeles	Phoenix
Boston	Memphis	Pittsburgh
Chicago Midway	Midland	Providence
Cincinnati	Milwaukee	Raleigh-Durham
Cleveland	Nashville	Reno
Dallas-Ft. Worth	New Orleans	San Antonio
Denver (DIA)	New York (JFK)	San Francisco
Des Moines	Newark	San Jose
Detroit	Norfolk	Santa Ana
El Paso	Oakland	Seattle-Tacoma
Houston Hobby	Oklahoma City	St. Louis
Houston Intercont'l	Omaha	Tucson
Islip	Ontario	Washington Dulles
Knoxville	Orlando	

Independent And Dependent Approaches To Three Parallel Runways

Objective:

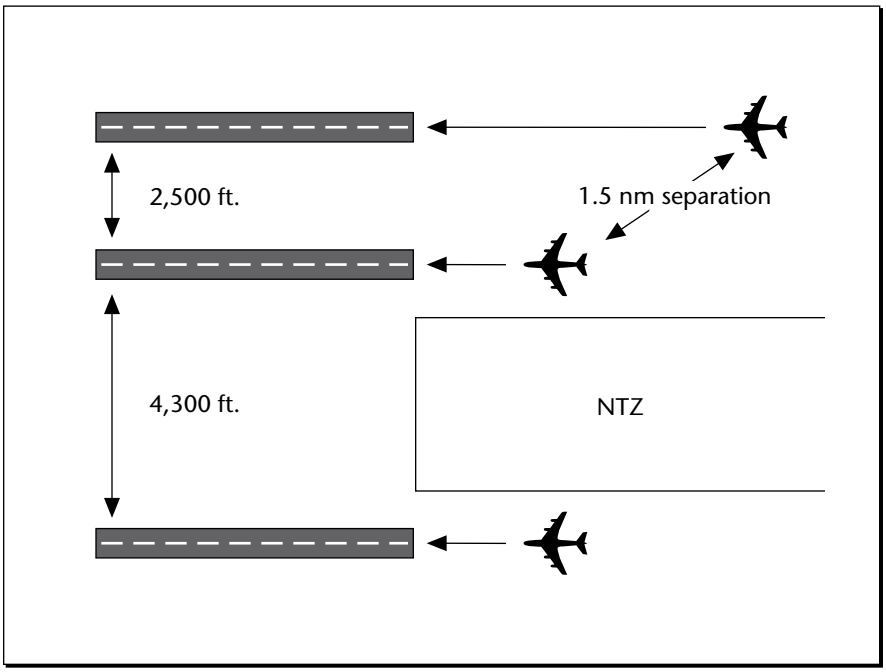
Establish procedures allowing approaches to three parallel runways when two may be operated independently of each other because of sufficient spacing and the third is dependent upon one of the others because of insufficient spacing.

Concept:

Currently, procedures allow simultaneous approaches to runways with centerlines spaced at least 3,400 feet apart, provided a Precision Runway Monitor (PRM) is available. However, those airports with spacings from 2,500 to 3,400 feet between one set of runways and 3,400 or 4,300 feet or more between the other set are limited to dual runway operations. This concept will allow triple operations utilizing dependent operations between one set of parallels and independent operations between the other set.

Status:

Real-time simulations will be scheduled in the future.



Independent and Dependent Parallel Approaches

Candidates Among Top 100 Airports
Average Capacity Gain 15 Arrivals/Hour

Charlotte/Douglas	Detroit	Pittsburgh
Chicago O'Hare	Houston Intercont'l	Salk Lake City
Dallas-Ft. Worth	Orlando	Washington Dulles

Simultaneous (Independent) Converging Instrument Approaches

Objective:

Develop procedures which allow independent converging approaches to near category one minimums.

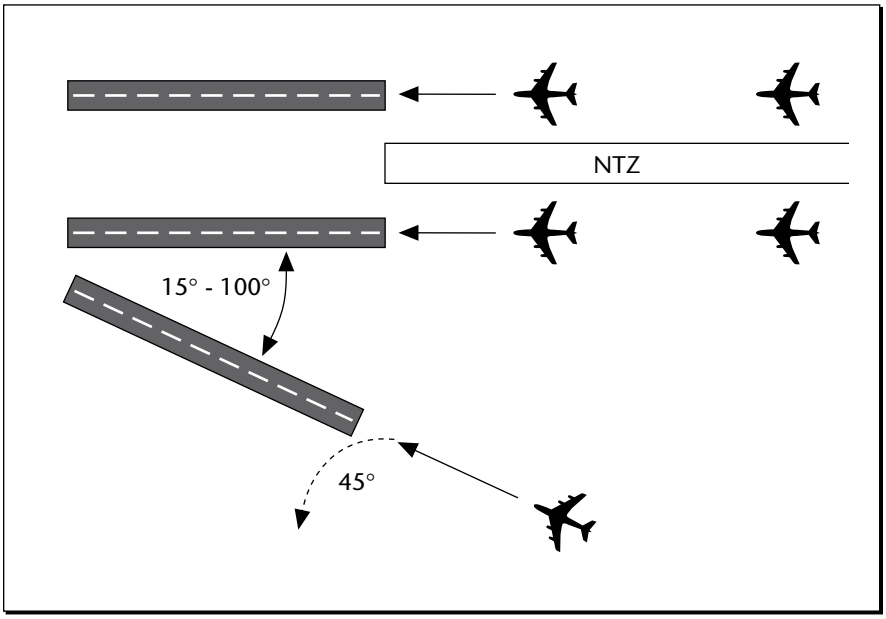
Concept:

Procedures governing independent converging approaches require that the distance between the missed approach points be 3 nm apart and that the Terminal Instrument Procedures (TERPS) surfaces not overlap. Because of these restrictions, minimums are high, thereby limiting the number of airports that could benefit from the procedure.

In an effort to refine the independent converging approach procedures a multi-disciplined work group has been formed. This group is analyzing various concepts that would result in a lowering of minimums to near category one.

Status:

Data is being collected using various types of flight simulators to establish and/or validate required TERPS surfaces. Following the data collection and analysis, real-time simulations with controller and pilot participation may be conducted using radar laboratory and flight simulator demonstrations for further validation. Preliminary analysis indicates that several high-density airports will benefit significantly from this refined independent converging approach procedure.



Triple Approaches: Dual Parallels and One Converging

Candidates Among Top 100 Airports
Average Capacity Gain 30 Arrivals/Hour

Baltimore	Houston Intercont'l	Oakland
Boston	Indianapolis	Omaha
Charlotte	Jacksonville	Philadlephia
Chicago Midway	Kansas City	Pittsburgh
Chicago O'Hare	Louisville	Portland
Cincinnati	Miami	Providence
Dallas-Ft. Worth	Milwaukee	Rochester
Dayton	Minneapolis	San Antonio
Denver (DIA)	Nashville	San Francisco
Detroit	New York (JFK)	St. Louis
Ft. Lauderdale	New York (LGA)	Washington Dulles
Honolulu	New Orleans	Windsor Locks
Houston Hobby	Newark	

Traffic Alert And Collision Avoidance System (TCAS)/Cockpit Display Of Traffic Information (CDTI) For Separation Assistance

Objective:

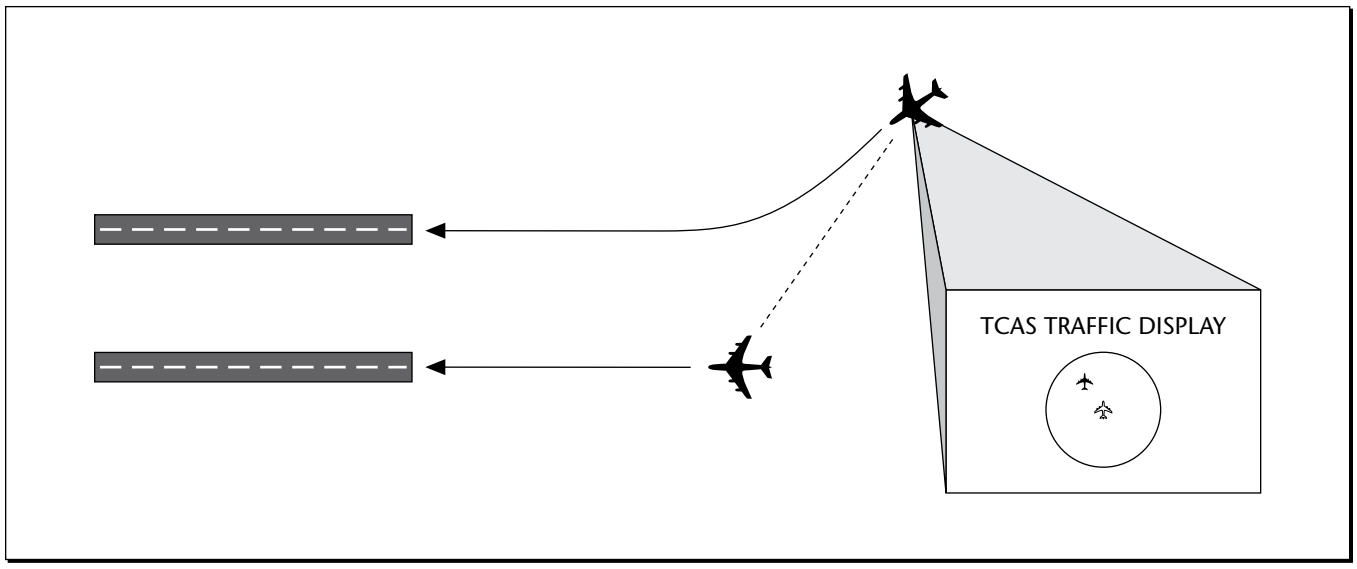
Develop the means for flight crews to provide separation assistance through the use of a cockpit display of traffic. The use of this information should result in capacity improvements beyond that which is available only using radar and voice communications.

Concept:

The cockpit display of traffic information associated with TCAS can provide the mechanism whereby the flight crew can assist the controller in reducing the spacing tolerances that are maintained between aircraft for many phases of flight.

Status:

A TCAS/CDTI feasibility study was published in April 1991. From that study, efforts are moving forward to conduct concept and interactive simulations that will eventually lead to refined ATC procedures. Data and information gathering is underway and preliminary concept simulations are being devised for testing in an integrated laboratory environment. Initial emphasis will be on the use of TCAS/CDTI to support oceanic climbs/descents, i.e., use the TCAS traffic display to ensure safe separation when one aircraft wants to climb/descend through the altitude of another aircraft.



SUMMARY

In FY91, more than half of all delays were attributed to adverse weather conditions. Many of these delays can be reduced if the approach procedures used during IFR operations are able to approximate the operational capacity of those used during visual meteorological conditions.

The focus of these initiatives is to meet the following objectives:

- The use of parallel runways spaced closely together for simultaneous arrival operations.
- Increased arrival rates to converging and intersecting runways.
- Use of airborne equipment to improve separation criteria.

For the aviation industry, implementation of these initiatives directly translates into increased operating efficiency. Substantial cost savings through a significant reduction in fuel usage will be complemented by the more efficient utilization of airframes and airport and airline personnel.

For the foreseeable future, these capacity initiatives will help to set the standard for enhancing aviation system capacity and will stimulate future developments in advanced surveillance, communication, and automation systems.

HISTORY

Volume 1 in this series of pamphlets detailing capacity initiatives discussed the procedures listed below. The list provides the current status of each initiative.

- Simultaneous (Independent) Parallel Approaches Using the Precision Runway Monitor (PRM) to runways separated by 3,400 to 4,299 feet.
  ⇒ National standard published November 1991. First PRM commissioned at Raleigh-Durham in June 1993.

- Improved Dependent Parallel Approaches to runways separated by 2,500 to 4,299 feet that reduce the required diagonal separation from 2.0 to 1.5 nautical miles.
  ⇒ National standard published June 1992.

- Reduced Longitudinal Separation on Wet Runways from 3 to 2.5 nautical miles inside the final approach fix (FAF).
  ⇒ National standard published June 1992.

- Dependent Converging Instrument Approaches (DCIA) using the Converging Runway Display Aid (CRDA).
  ⇒ National standard published November 1992

- Simultaneous ILS & LDA Approaches
  ⇒ SFO LDA commissioned.

- Flight Management System (FMS) Transition to Existing Approaches. Use of FMS computers to transition aircraft from the en route phase of flight to existing charted visual flight procedures (CVFP) and ILS approaches.
  ⇒ National standard published December 1992.

NOTES

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