FLIGHT SAFETY FOUNDATION
Airport Operations
Vol. 16 No. 2 For Everyone Concerned with the Safety of Flight March/April 1990

Precision Runway Monitors

Recent increases in air traffic demand have exceeded the capacity of many major airports with a resultant major increase in delays to air traffic. Consequently, the U.S. Congress has directed the U.S. Federal Aviation Administration (FAA) to initiate programs to improve airport capacity.

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The most effective way of increasing the capacity of an airport is to establish an additional traffic lane (an additional instrument approach to an additional runway), which can be operated simultaneously with the existing runway layout. However, present criteria limit simultaneous instrument approaches to parallel runways which are spaced at least 4,300 feet apart. The 4,300-foot limit is due largely to the update rate and angular accuracy of existing airport surveillance radars.

It is a fundamental air traffic control principle that the separation between any pair of aircraft must always be greater than any possible reduction in separation that can occur before the separation can be re-checked and corrected. Existing airport surveillance radars have an antenna rotation rate of 12.5 rpm, which provides an update (interval between scans) every 4.8 seconds. This update rate is sufficient for monitoring simultaneous approaches to parallel runways spaced at least 4,300 feet apart. But for runways with less spacing, less time is available for the detection and correction of a hazardous situation; so a higher update rate is necessary.

In a 1981 report, the MITRE Corporation, a non-profit research group for U.S. military and civilian agencies, concluded that a more accurate surveillance sensor (or monitor system) would be necessary before simultaneous IFR approaches could be permitted to parallel runways spaced closer than 4,300 feet.

In 1982, the Industry Task Force on Airport Capacity Improvement and Delay Reduction recommended that the FAA initiate the necessary development, testing and demonstrations to permit the safe introduction of simultaneous parallel IFR approaches with runway spacing between 4,300 and 3,000 feet. Ten airports are in that category as shown in Table 1.

In 1987, the FAA's Air Traffic Plans and Requirements Service reaffirmed its requirements for improved surveillance coverage. As a result, the agency established two separate programs to develop specialized surveillance equipment to monitor parallel approaches. Later, it was decided to extend the application of such equipment to monitor approaches to converging runways, with potential benefit to the 30 airports listed in Table 2.

Two versions of a Parallel/Converging Runway Monitor (PCRM) have been developed. Both are secondary radar systems with monopulse processing, to obtain the very high target accuracy required to monitor targets less than 4,300 feet apart.

Memphis Installation Uses Twin Antennas

One version of the PCRM was developed by Massachu-

Ten Candidate Airports for Simultaneous Parallel IFR Approaches		
Airport	Runways	Centerline Spacing, ft.
Kennedy Int'l., New York, N.Y.	4R,4L	3,000
Phoenix Sky Harbor Int'l., Ariz.	8R,8L	3,400
Minneapolis-St. Paul Int'l., Minn.	11R,11L	3,380
Salt Lake City Int'l., Utah	16R,16L	3,500
Detroit Metro Wayne Co., Mich	3L,3C	3,800
Ft. Lauderdale-Hollywood Int'l., Fla.	27R,27L	4,000
Portland Int'l., Ore.	28R,28L	3,100
Raleigh-Durham Int'l., N.C.	5R,5L	3,500
Memphis Int'l., Tenn.	36R,36L	3,400
Dallas Love, Tex.	31R,31L	2,975

Table 1

setts Institute of Technology, Lincoln Laboratory, and is installed at Memphis, Tennessee, International Airport. As shown in Figure 1, it uses two 5-foot open-array antennas, mounted back-to-back on a 12.5-rpm rotating pedestal, to provide 25 scans per minute for an update every 2.4 seconds.

Raleigh-Durham Uses Electronic Scanning Antenna

The other version of the PCRM was developed by MSI Services, Inc. in association with the Allied Corporation, Bendix Communications Division as a sub-contractor, and is installed at Raleigh-Durham Airport, North Carolina. It uses an electronically scanned (stationary) antenna built in the form of a cylinder 17 feet in diameter and five feet high, as shown in Figure 2. The outside of this antenna is studded with 128 vertical columns of 10 dipoles each. The radar beam is controlled by a computer, and can jump instantly from any azimuth to any other azimuth. With a 30-nm range, the PCRM can differentiate between two targets 600 feet apart at 10 nm.

Every four seconds, the PCRM scans all targets within range. But it has a special area of interest — a keyhole-shaped area, covering a 5-nm radius around the airport, plus a 25-nm extension covering the dual approach courses and the turn-on areas. The area of interest can be moved to cover other runway alignments, as desired. All targets within the area of interest are scanned twice per second.

Displays are Similar

Both types of PCRM will use a 19-inch rectangular display. As shown in Figure 3, each aircraft target will be displayed with an alpha-numeric target label showing the aircraft call-sign and other pertinent data selectable by the controller. The current position and trail of each target will be displayed, with a vector line showing the predicted movement of the target during the next few seconds.

Altitude filtering will be used to avoid the display of targets on the ground and targets overflying the area at altitudes far above the guide path.

The controller will be able to select any target for display in an expanded area on the display. Tracking circuits will activate suitable audio and video alarms if any target gets too close to the protected area (formerly called the no transgression zone), a 2,000-foot-wide area equidistant from the extended centerlines of two runways.

Thirty Candidate Airports for Simultaneous Converging IFR Approaches	
Location	Airport
Airports ranked 1 through 5*	
Oakland, Calif.	Metro Oakland International
Denver, Colo.	Stapleton International
St. Louis, Mo.	Lambert-St. Louis International
Newark, N.J.	Newark International
Houston, Tex.	Houston Intercontinental
Airports ranked 6 through 10*	
Boston, Mass.	Gen Edw. L. Logan International
Raleigh, N.C.	Raleigh-Durham
Cleveland, Ohio	Cleveland-Hopkins International
Memphis, Tenn.	Memphis International
Houston, Tex.	William P. Hobby
Airports ranked 11 through 20*	
Anchorage, Alaska	Anchorage International
Burbank, Calif.	Burbank-Glendale-Pasadena
San Diego, Calif.	San Diego International-Lindbergh Field
New Orleans, La.	New Orleans International (Moissant)
Hyannis, Mass.	Barnstable Municipal
Kansas City, Mo.	Kansas City International
Omaha, Neb.	Eppley Airfield
Islip, N.Y.	Long Island-MacArthur
Rochester, N.Y.	Rochester Monroe County
San Antonio, Tex.	San Antonio International
Airports ranked 21 through 30*	
Little Rock, Ark.	Adams Field
Windsor Locks, Conn.	Bradley International
Jacksonville, Fla.	Jacksonville International
Indianapolis, Ind.	Indianapolis International
Greensboro, N.C.	Greensboro-High Point-Winston
Atlantic City, N.J.	Atlantic City Int'l.
Syracuse, N.Y.	Syracuse-Hancock International
Richmond, Va.	Richard Evelyn Bird International
Spokane, Wash.	Spokane International
Madison, Wisc.	Dane County Regional

*Ranked by hours of reduced delay in 1994 from simultaneous IFR converging approaches, alphabetically by state and city.

Table 2

Controller's PCRM Display

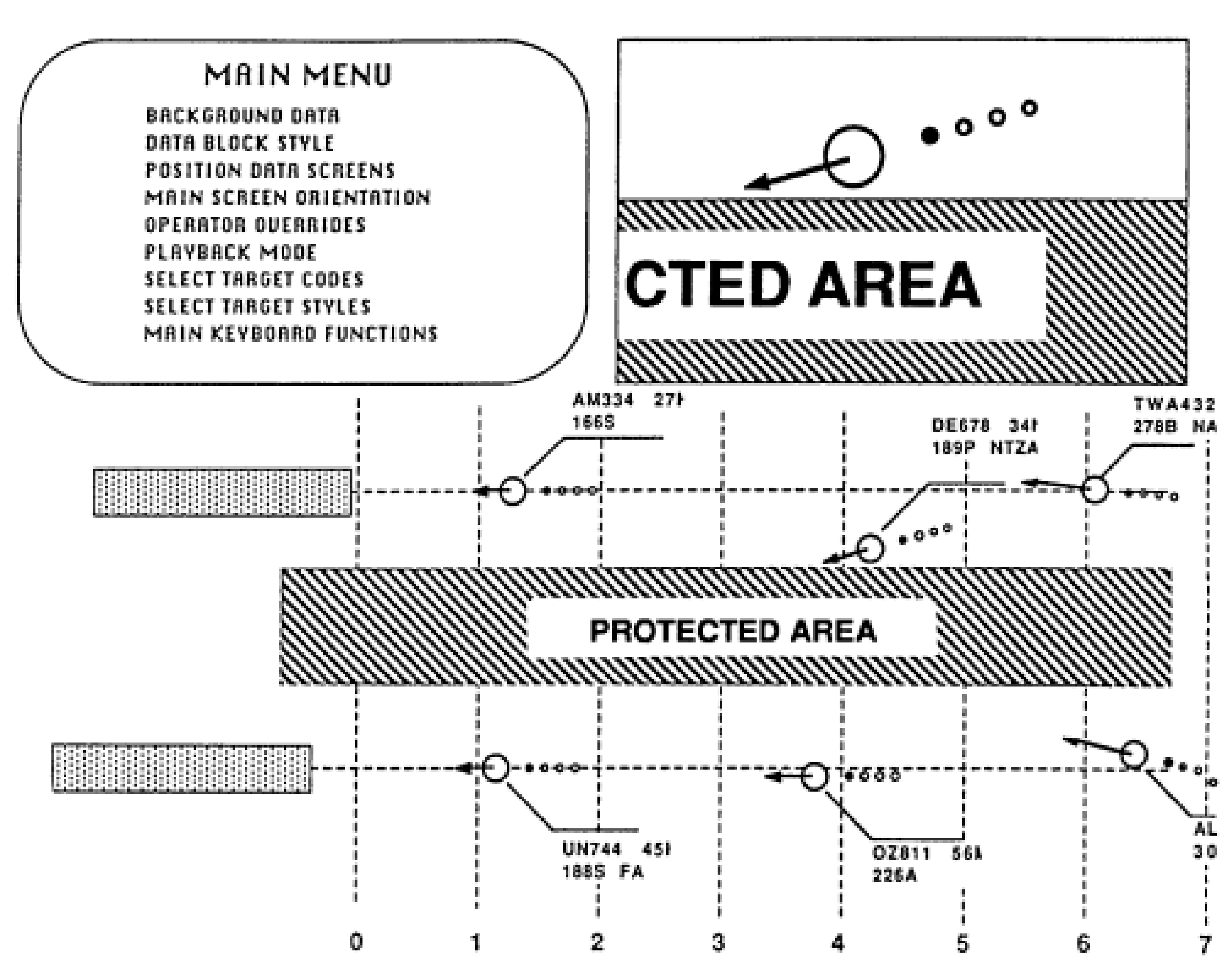

Figure 3. The main display of the parallel/converging runway monitor is set up to show aircraft targets with identification callouts selectable by the controller. Range from the runway thresholds is shown in nm. The trail of each target is shown by small circles and its predicted movement during the next few seconds is indicated by a small arrow. Also displayed are the computer menu, showing functions available to the controller (upper left), and an expansion option, which the controller can use to enlarge a portion of the main display to better view an errant aircraft, such as the one above that is headed into the protected area between the parallel approaches.

Test Program Is Underway

Both versions of the PCRM are being thoroughly tested. The test programs are being conducted in five phases, as follows: Phase I of the VFR test consists of the collection and analysis of approach data within the keyhole-shaped area, using targets of opportunity as well as simulated targets.

Phase II will determine the effect of system failures in 10 percent of the simulator approaches. One primary question is: can the controller provide adequate diversionary

Figure 1. One type of Parallel/Converging Runway Monitor (PCRM) antenna is composed of two rotating open-arrays mounted back-to-back. This doubles the effective scanning speed and provides fast radar screen updates.

Figure 2. A non-rotating, electronically scanned Parallel/Converging Runway Monitor (PCRM) antenna is computer controlled to provide updates as fast as twice per second in a selected area of interest, such as dual approach courses.

action if an aircraft in one lane suddenly turns 30 degrees toward an aircraft in the opposite lane? (So far, the answer is yes.)

Phase III will consist of parallel approach operations in VFR conditions using a government aircraft in parallel with a normal operation, with ATC control of both aircraft. This work is expected to result in the refinement of tentative ATC procedures and the standardization of approach procedures.

Phase IV will implement parallel approaches with one-mile visibility at the highest final approach fix altitude. Government and industry coordination will be necessary in drafting material for the appropriate handbooks and directives.

Phase V will implement the procedures of Category I minimums (ceiling 200 feet and visibility 1/2 mile or a runway visual range of 2,400 feet).

What Is The Future of PCRM ?

Following successful completion of the test and demonstration programs, quantities of one or both types of systems will be produced and installed over a period of approximately six years.

It is hoped that the PCRM concept will permit the use of simultaneous IFR approaches to parallel runways spaced as close together as 3,000 feet, and possibly even 2,500 feet, after sufficient operational experience is gained in the use of this equipment.♦

About the Author

Tirey K. Vickers began his career in air traffic control during the 1940s and was chief ATC specialist at the U.S. Federal Aviation Administration's (FAA) Technical Development Center when he left the government. His career includes a solid background in air navigation systems and airport development. He is a consultant to MSI, a Washington, D.C., consulting company, and he specializes in air traffic control.

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