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The Rapid Runway Entry

The case is made to utilize high-speed runway entries, similar to high-speed exits, as a means of reducing runway occupancy time and avoiding conflict between landing and departing traffic.

by
Tirey K. Vickers
Airports/Airways Consultant

High-speed runway exits have been in use at a number of airports for the past 40 years. Their purpose is to reduce the runway occupancy time of arriving aircraft. Moving a landing aircraft off the runway quickly allows the next departure to start its takeoff sooner than it would be able to do if it had to wait until the arrival decelerated to a much slower speed before it could turn off the runway using a conventional, 90-degree runway exit.

Because airport capacity is inversely proportional to the average time intervals that take place between all the operations that occur on the runway, any reduction in the average interval tends to increase the airport's capacity.

The safe runway exit speed depends on the radius of the turn that is used to enter the exit taxiway. The U.S. Federal Aviation Administration (FAA) has published the following data (for dry pavement):

Safe Taxi Speed (mph)	Turn Radius (feet)
10	50
20	200
30	450
40	800

High-Speed Runway Entry — The Opposite Is also True

The rapid runway entry is similar to a high-speed runway exit — except that it is used in the opposite direction. Its purpose is to reduce the runway occupancy time of a departing aircraft by reducing the time required to pro-

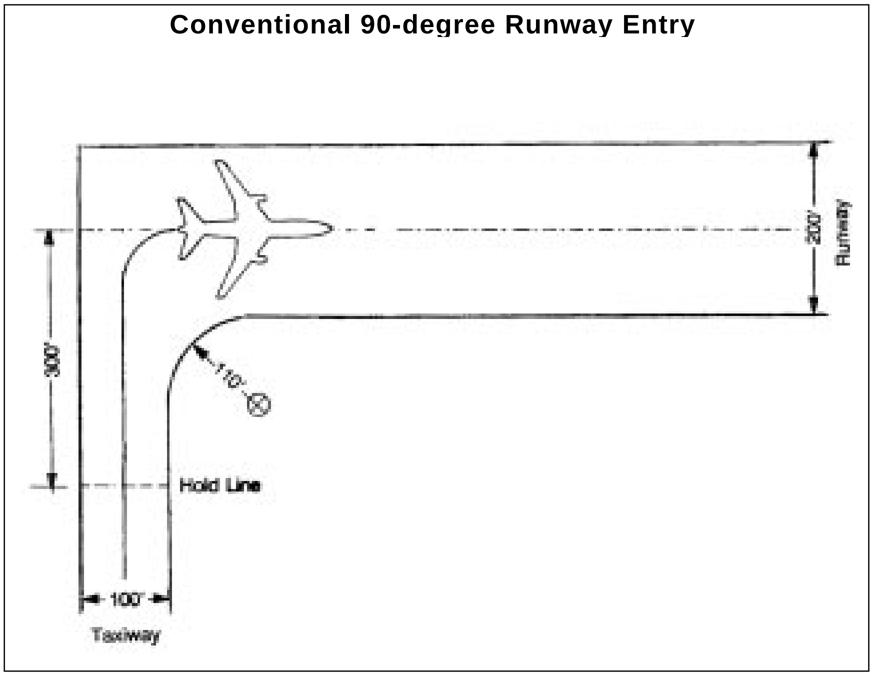

Figure 1

have allowed more than adequate separation before clearing the departure on to the runway in the first place. The use of this extra separation is prudent from the standpoint of safety, but it tends to increase the average runway interval, and thus reduces the airport capacity.

ceed from the hold line on the entry taxiway to the actual liftoff from the runway.

Conventional Runway Entry Has Good and Bad Points

Figure 1 shows a conventional 90-degree runway entry. With this configuration, when the pilot is cleared to taxi into takeoff position, the aircraft enters the runway at a slow speed, because it must make a 90-degree turn through a curve with a short radius to line up on the runway centerline. (A heavily loaded widebody jet can take up to 30 seconds just to make the 90-degree turn). The aircraft will stop on the runway if takeoff clearance has not been received.

Even then, the departing aircraft may hesitate on the runway if the crew is not completely ready to start the takeoff. In this case, the uncertainty about just when the takeoff will be started presents a problem for the air traffic controller, especially if there is an arriving aircraft travelling inbound to the same runway on the final approach path.

Because of this potential uncertainty, the controller usually will

Rapid Runway Entry Can Save Time, Trouble

Figure 2 shows a typical rapid runway entry. The operating procedure is based on the use of rolling takeoffs to minimize the runway occupancy time. The hold line marked on the taxiway is offset the same distance from the runway centerline as the hold line for a conventional 90-degree entry. A gently curved transition path from the hold line to the runway centerline allows the aircraft to accelerate to a reasonably safe taxi speed by the time it is aligned on the runway centerline. The curved transition path is marked on the pavement.

With this procedure, the aircraft is held at the hold line on the taxiway until the pilot advises the tower that he is ready to takeoff. If the runway is clear, and there is no possibility of a conflict with an aircraft on the approach path, the tower clears the departure for a rolling takeoff. This implies that the aircraft will not stop on the runway, but will continue accelerating when it is aligned with the runway centerline.

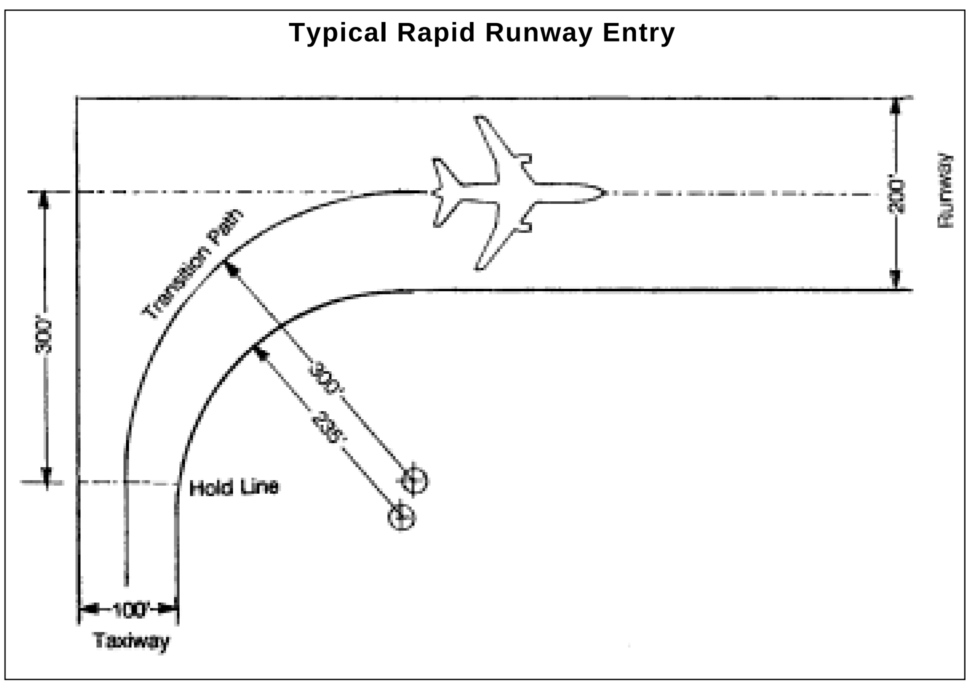

Figure 2

As in the case of the high-speed exit, the safe speed on the curved transition path depends upon the turn radius and the surface conditions. The pilot uses taxi power until turned enough that his aircraft's jet blast will not affect any aircraft behind him on the taxiway, then he increases power to attain the takeoff power setting by the time the aircraft is aligned on the runway centerline.

This procedure makes the actual takeoff time much more predictable by eliminating most of the uncertainty associated with an aircraft sitting on the end of the runway while an arrival is coming down the approach path. For example, the FAA requires that, in instrument meteorological conditions, a departure must have started its takeoff roll before a following arrival has reached a point two miles from the runway threshold.

Conventional Entry Using Rapid Entry Taxiway

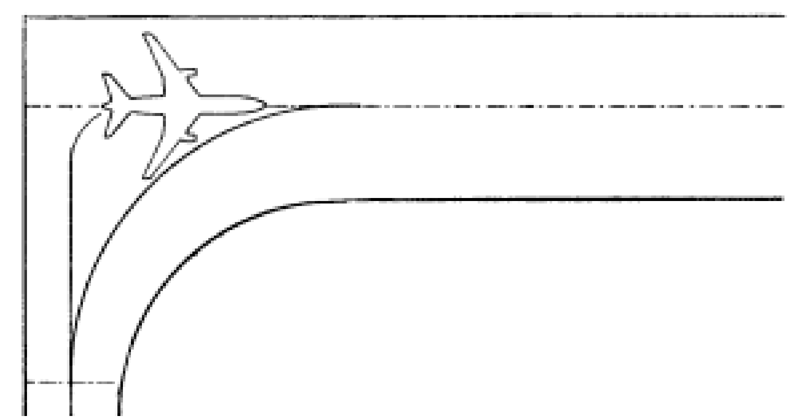

Figure 3

The rapid runway entry procedure allows the controller to minimize the actual separation between a departure and a following arrival to the allowable safe minimum. This predictability allows clearing a departure for takeoff ahead of an arrival, instead of making it wait until the arrival lands, completes its rollout, and vacates the runway. The use of the rapid entry procedure can increase capacity up to four operations per hour (two takeoffs and two landings) for a runway that is used for both takeoffs and landings.

Except for heavy jets, which are not presently permitted to make rolling takeoffs, most aircraft will be able to use the rapid runway entry described above. However, any pilot who does not prefer to use the rolling takeoff procedure or wants to utilize the full available length of the runway can still use a conventional takeoff procedure, as shown in Figure 3, provided he notifies the tower before reaching the hold line.

When the runway is used in the opposite direction, the rapid runway entry can serve as a high-speed exit for an aircraft which needs most of the runway for landing. Vancover International Airport, which has installed a rapid runway entry on runway 26, has found that Boeing 747 aircraft landing on runway 08 can, with minimum use of brakes, leave the runway via the rapid runway entry, at speeds of up to 30 mph. (The radius of the curved transition path at Vancouver is 140 meters (about 460 feet). By not having to slow below this speed while on the runway, the rapid runway exit saves about 15 seconds of runway occupancy time, allowing the next departure to take off that much sooner.

Extra Pavement Required for Rapid Runway Entry

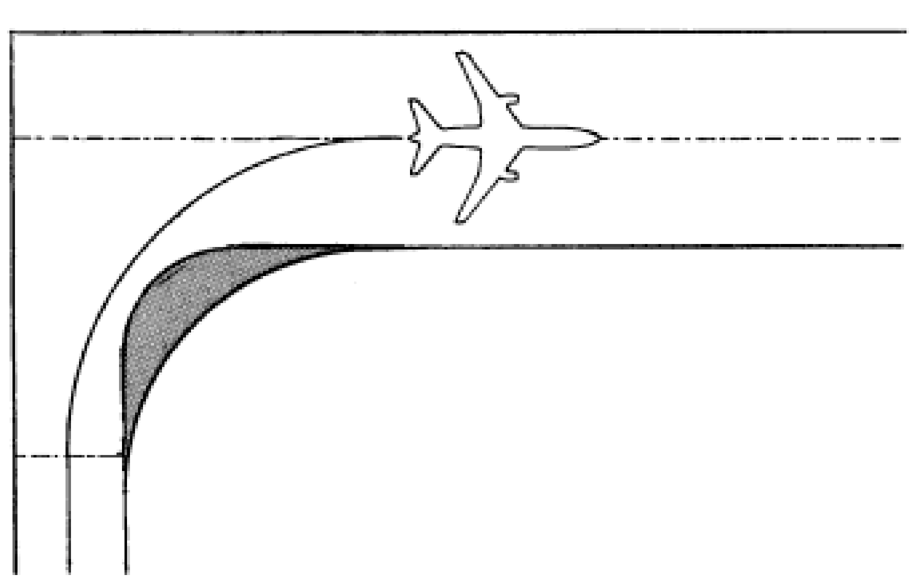

Figure 4

How Safety Is Affected By Use of Rapid Runway Entry

In view of the recent accident at Los Angeles International Airport, when an arriving aircraft collided with another holding on the runway for takeoff, the rapid entry procedure provides a safety advantage because no departure is cleared onto the active runway unless it is ready for immediate takeoff, reducing the possibility of conflict with another aircraft.

What Extra Airport Cost Is Involved?

A rapid runway entry is an extra-wide fillet between the entry taxiway and the runway. Figure 4 provides an indication of the extra amount of pavement required for a rapid runway entry. The cost should be weighed against the capacity and safety advantages it provides.

Depending on the actual design, there may be a slight loss in the effective runway length available to a departing aircraft, as compared to a conventional 90-degree runway entry. However, the maximum loss would be no more than the radius of the transition curve.

Weighing the Advantages

The reduced average runway occupancy times provided by the rapid runway entry concept offer a capacity increase of approximately four operations per hour, for any runway which must accommodate both takeoffs and landings. Additionally, the entry itself can also be used as a high-speed exit from the opposite direction.

The rapid runway entry procedure provides a safety advantage by not allowing departures on the active runway until they are ready for an immediate rolling takeoff. The resulting removal of uncertainty in the actual takeoff time reduces air traffic control (ATC) stress and allows the controller to safely use the minimum allowable separation between a departure and a following arrival on the same runway. ♦

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.

Vickers is editor of Journal of Air Traffic Control, *published by the Air Traffic Control Association, headquartered in Arlington, Va., U.S. He has been the publication's editor for 20 years, but still finds time to be a frequent contributor to technical publications and books on the science of air traffic control.*

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