



# Federal Aviation Administration

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## Memorandum

Date: NOV 19 2007  
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Subject: Engineering Brief No. 75: Incorporation of Runway Incursion Prevention  
into Taxiway and Apron Design

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This Engineering Brief provides guidance on design strategies of taxiways and aprons to help prevent runway incursions. Data and incident analysis provided by Mitre Corporation and advice from regional Runway Safety Action Teams generated the recommendation in this guidance.

These design strategies are only recommendations. They are not a set of standards that must be followed whenever possible. Airfield design is often a process that must balance safety, efficiency, capacity and other factors. There will be cases where the strict application of these recommendations is unjustified and unwise. Instead, use the recommendations as a checklist to insure the runway incursion aspects of any design proposal are properly considered.

Key elements of this Engineering Brief will be incorporated into the new comprehensive revisions to Advisory Circular 150/5300-13, which we hope to complete in the next 18 months.

**ENGINEERING BRIEF NO. 75****INCORPORATION OF RUNWAY INCURSION PREVENTION  
INTO TAXIWAY AND APRON DESIGN**

NOVEMBER 8, 2007

**PURPOSE:** This engineering brief provides interim guidance for the planning and design of taxiway and apron improvements to minimize the likelihood of runway incursions<sup>1</sup>. This guidance provides recommended taxiway and apron layouts to enhance runway safety by encouraging certain configurations and identifying layouts to avoid when possible. The comprehensive re-write of FAA AC 150/5300-13, "Airport Design" will incorporate these recommendations.

**BACKGROUND:** Studies performed by the Federal Aviation Administration (FAA) over the last several years analyzed the role of taxiway and apron design coupled with operational procedures to reduce the probability of runway incursions. Airport Design and Operations Teams subjected the cumulative study results to a series of assessments at selected airports across the National Airspace System (NAS). These teams have addressed a variety of airport-specific issues at different types of airports, including issues involving taxiway layout inherited from an older airfield runway configuration, issues associated with runway crossings, and discontinuing the practice of using a runway as a taxiway. This engineering brief describes the lessons learned by these teams from both analysis and practical application. This information is intended to serve as guidance for airport planners, engineers, airport operators and FAA personnel in the process of preparing, reviewing and approving airport layout plans, project design documents, and safety plans.

**RECOMMENDATIONS:****A) TAXIWAY DESIGN:****1.0 Introduction**

A key role of the FAA's Runway Safety Program is to find ways to reduce runway incursions with the corollary benefit of mitigating the potential for an aircraft accident. The FAA studied all relevant factors contributing to the quantity and severity of past runway incursions. Besides human factors, the studies focused on the layout of the airport, including runway and taxiway geometry in these accidents. This guidance provides recommendations in the design and operational use of taxiways to enhance runway safety.

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<sup>1</sup> A Runway Incursion is defined as "Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take off of aircraft."

## **2.0 Taxiway Concepts To Decrease the Potential for Runway Incursions**

### **Overview**

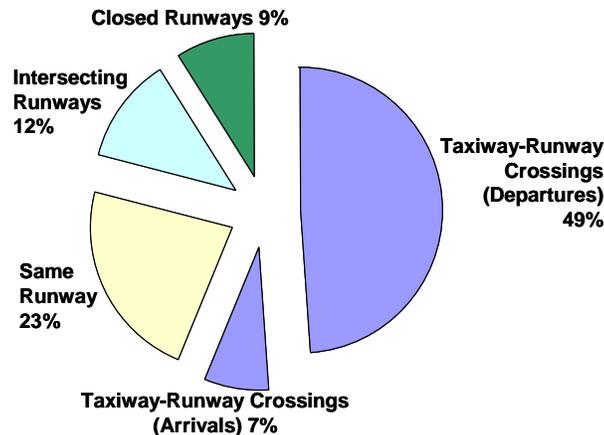
A taxiway's location, alignment, width, and operational use plays a crucial role in enhancing runway safety at airports. As new taxiways are planned, consider runway safety in addition to the utility and efficiency requirements associated with the taxiway function. Significant changes to taxiways warrant detailed studies to evaluate the potential impact on runway safety. When considering changes in taxiway (and airfield) design, consider the following general principles:

- Limit the number of aircraft crossing an active runway
- Optimize pilots' recognition of entry to the runway (increase situational awareness) through design of taxiway layout, for example,
  - Use a right angle for taxiway-runway intersections (except for high speed exits)
  - Limit the number of taxiways intersecting in one spot
  - Avoid wide expanses of pavement at runway entry
- Insure the taxiway layouts take operational requirements and realities into account to:
  - Safely and efficiently manage departure queues
  - Avoid using runways as taxiways
  - Use taxi strategies to reduce the number of active runway crossings
  - Correct runway incursion "hot spots"

This engineering brief elaborates on the "why" and "how" of these principles in detail.

### **Limit the Number of Aircraft Crossing an Active Runway**

Limiting the number of aircraft crossing a runway is a priority in the design of the airport to enhance runway safety. A review of the Category A and B runway incursions<sup>2</sup> at the Operational Evolution Plan (OEP) 35 airports from 1997 through 2003 found more than half are associated with taxiing aircraft crossing an active runway, as shown in Figure A.



**Figure A:** Operational Characteristics of Category A and B Runway Incursions at the OEP 35 Airports

<sup>2</sup> FAA classifies runway incursions by severity with a letter code that ranges from A to D, where A and B are the most serious (having the greatest potential for collision).

Of these, almost 90% are arriving aircraft crossing departure-only runways en route to their gate. (At major airports with parallel runways located on the same side of the terminal complex, the runway nearest to the terminal complex is typically used for departures while the runway farthest from the complex is used for arrivals.) Thus, implementing design changes to airports reducing the number of required taxiway-runway crossings by aircraft (which can include surface traffic movement strategies avoiding runway crossings) can significantly reduce the number of Category A and B runway incursions at large airports. Airport planners should discuss the use of these with the FAA Air Traffic personnel during the update of an Airport Layout Plan (ALP) and during the project planning stage.

Analysis shows that Category A and B incursions occur at a rate of about 1.5 to 2.1 per million aircraft taxiing across a runway, depending on which third of the runway is crossed. While this may seem infrequent, the sheer number of taxiway-runway crossings in the NAS means that they add up quickly over time. For example, at Dallas/Fort Worth International Airport (DFW), there are an estimated 1700 crossings of active runways by taxiing aircraft *each day*. Thus, if runway incursions continue to occur at the same rate as they have in recent years, and if DFW were to follow the historical pattern of the other OEP 35 airports (it's actual rate is lower), then it could be expected that on average one Category A or B incursion could occur each year at DFW strictly due to expected runway crossings.

The risk of a Category A or B incursion is higher for crossings occurring in the first third of the runway and lower in the last two thirds. Since it is not possible to entirely eliminate runway crossing situations, establishing designs and associated surface traffic flow strategies keeping taxiway-runway crossings by aircraft in the last two thirds of the runway (as measured from the arrival threshold) significantly reduces the risk. The preference is for aircraft to cross in the last third of the runway whenever possible, since within the middle third of the runway the arriving/departing aircraft is usually on the ground and traveling at a high rate of speed. The studies also indicated a larger propensity for category A and B incursions when the angle of intersection of the taxiway and runway is not at a 90° angle or the taxiway is very wide, than those occurring at 90-degree intersections with normal widths.

### **Optimize Pilots' Recognition of Runway Entry (situational awareness)**

As the levels of traffic and complexity of airports increases, every effective means of making the entry to a runway obvious to pilots should be considered. Many aspects of taxiway and airfield design have direct impact on a pilot's situational awareness when approaching an active runway. These include visual aids supporting low visibility operations, threshold displacement locations, geometry of taxiway-runway intersections, use of parallel taxiways, configuration of and path to entrance taxiways, and the configuration of exit taxiways.

### **General Taxiway Layout Design Considerations**

Along with the geometric configuration of taxiways, planners should consider where the design will put the runway holding position(s). The configuration or angle of a taxiway connecting to a runway may complicate the installation of runway holding position markings, lighting and signage. This situation may create a "human factors" problem, that is, the ability to see and understand the holding points. The consideration of these combined factors may require reconfiguration of the taxiways to enhance runway safety. A key element of reducing runway incursions is to provide the best possible visual cues to the pilot of the runway holding position, occasionally requiring reconfiguring the taxiway.

In general, designers should avoid designating taxiway names by function (See Figures 1A and 1B). Avoid taxiway nomenclature assigning the same name to a taxiway making several turns along its route. By designating different taxiway names along a prescribed route a pilot is forced to look for the next taxiway segment where a turn is required promoting situational awareness. If the instructions are to “taxi Alpha to Runway 22” (even though the route may be lengthy and change directions) the pilot may be less engaged and may not pay sufficient attention to the airport diagram. The general convention should be to assign the same designation to the parallel taxiway for its respective runway.

FIGURE 1A, "INADVISABLE TAXIWAY DESIGNATION"

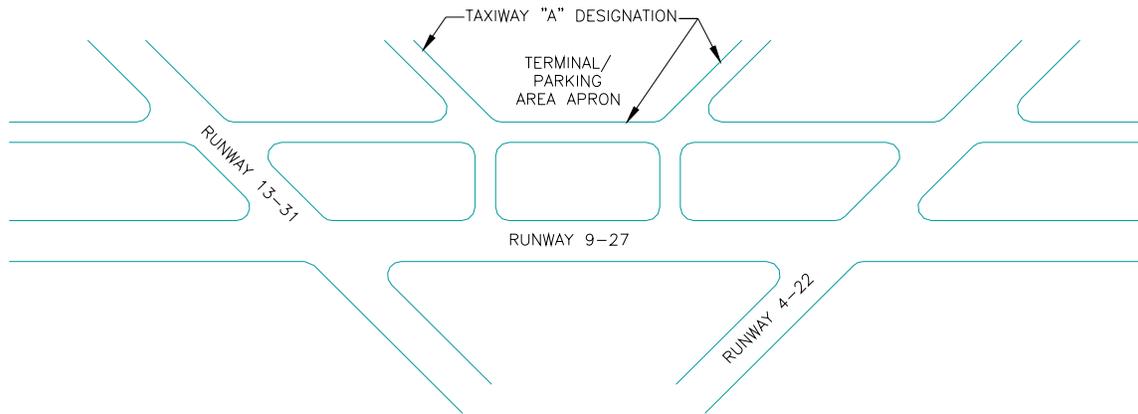
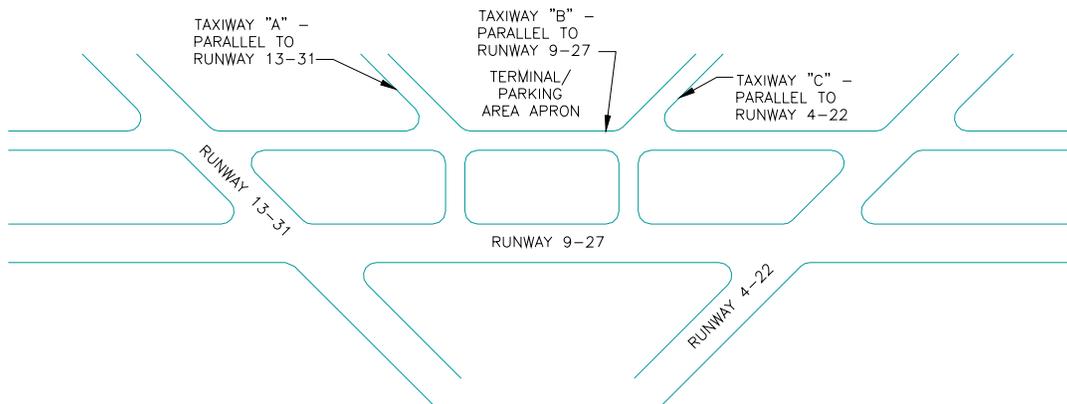


FIGURE 1B, "RECOMMENDED TAXIWAY DESIGNATION"



### **3.0 Taxiway Layout Design Considerations:**

#### **Threshold Displacement Considerations**

##### **Precision Obstacle Free Zone (POFZ) and Restrictions**

In some situations it is advantageous to provide greater separation between the runway and parallel taxiway to keep aircraft clear of the POFZ or to avoid displacing landing thresholds (whenever possible) with existing or planned approach visibility minima below  $\frac{3}{4}$  mile and 250ft. Height Above Touchdown (HAT). The POFZ is defined in paragraph 306(d) of FAA Advisory Circular 150/5300-13, "Airport Design".

Under these conditions, the holding position may differ from the pilot's expected location due to the POFZ clearance requirements. The POFZ is located adjacent to the threshold where it is 800 feet wide and extends 200 feet into the approach area. If the POFZ overlies a parallel taxiway, the clearance requirement would necessitate placement of the hold line on the parallel taxiway and not the typical location expected by a pilot. These unusual holding position locations are frequently missed by pilots and lead to runway incursions.

##### **Terminal Instrument Procedures (TERPS) "W" and "X" surfaces and Threshold Siting Surface**

When a threshold is displaced, additional consideration of the TERPS and airport threshold siting surfaces could adversely affect the location of the runway holding position. Typically this conflict occurs when departure aircraft taxi on a parallel taxiway past the displaced threshold to the end of the runway for takeoff. If the runway holding position is not appropriately located to protect these surfaces the aircraft could penetrate the surface. The TERPS "W" Surface is a sloped surface extending out from the POFZ into the approach and must remain clear to protect the airborne aircraft flying an instrument approach procedure. The TERPS "X" Surface is a transitional surface sloping from the sides of the "W" surface and also must remain clear. These TERPS surfaces are defined in Chapter 3 of FAA Order 8260.3B, "United States Standard for Terminal Instrument Procedures". Similarly, when landing thresholds contain excessive displacements taxiing aircraft could penetrate the visual threshold siting surfaces shown in Table A2-1, Appendix 2, AC 150/5300-13, "Airport Design". Protecting these surfaces may require locating the runway holding position in a less traditional location than what is expected by pilots.

#### **Taxiway Intersections**

##### **Right-angle vs. Angled Taxiways**

Right-angle taxiways are the recommended standard for all runway/taxiway intersections, except where there is a need for high-speed exit taxiways. Right-angle taxiways provide the best visual perspective to a pilot approaching an intersection with the runway to observe aircraft in both the left and right directions. They also provide the optimum orientation of the runway holding position signs so they are visible to the taxiing aircraft. FAA studies indicate the risk of a runway incursion increases exponentially on angled (less than or greater than 90°) taxiways used for crossing the runway.

**Limit the number of taxiways that intersect at one spot**

Good airport design practices keep taxiway intersections simple by reducing the number of taxiways intersecting at a single location. Complex intersections increase the possibility of pilot error. Avoid designs where more than two taxiways intersect in a single location whenever possible to utilize the “3-point node decision” concept and reduce confusion for a pilot. A greater number of taxiways also creates more pavement area, limiting the effectiveness of the taxiway signage and lighting and increases the likelihood of pilots becoming disoriented.

Taxiways should never go across the intersection of two runways. Taxiway configurations with multiple taxiway and runway intersections in a single area create large expanses of pavement making it difficult to provide proper signage, marking and lighting. These expansive pavement areas and numerous markings for taxiway (yellow) and runway (white) centerline and edge markings lend themselves to pilot disorientation. Additionally, planners and designers should locate taxiways outside the Runway Safety Areas of intersecting runways.

**Fillet Design**

Design pavement fillets at taxiway intersections to accommodate the most critical aircraft for the turning maneuver based on their wheelbase and main gear width dimensions. Avoid excessive pavement fillets since they force airfield signage farther from the taxiway centerline potentially contributing to pilot disorientation. When frequently used as departure or arrival routes, plan taxiway intersections to require a turn of no more than 90° whenever possible. Acute angled turns require a much larger pavement fillet to accommodate the main gear.

**Parallel Taxiways****Full Parallel Taxiway**

Full parallel taxiways are recommended as a standard airport design element when justified through planning and they are listed in Table 3-1 of the FAA Order 5090.3C, “Field Formulation of the National Plan of Integrated Airport Systems (NPIAS)” as being considered fundamental airport development. Full parallel taxiways provide a standard routing of aircraft to and from the runway recognizable to the pilots. Parallel taxiways additionally limit direct inadvertent access onto runways for departing aircraft and reduce runway crossings by providing access to the runway ends on each side of the runway (where necessary). Therefore, runway safety will be enhanced since facilities on both sides of the runway will have access to the end of the runway without requiring a runway crossing.

**Dual Parallel Taxiway**

Use dual parallel taxiways to increase efficiency. Consider dual taxiways parallel to the runway for queuing departing aircraft instead of providing a large holding area at the runway end that requires large expanses of pavement.

**Entrance Taxiways, Holding Bays, and Turnarounds for Runway Ends****Entrance taxiways**

When possible, connect entrance taxiways to the runway end at a right angle. Right-angle taxiways provide the best visual perspective to a pilot approaching an intersection with the

runway to observe aircraft in both the left and right directions. The right-angle also provides for the optimum orientation of the runway holding position signs so they are visible to the taxiing aircraft.

#### **Avoid over-wide entrance to runway**

Where possible, avoid wide pavement areas such as expansive intersections or departure holding areas at runway ends extending through the Runway Holding Position location (See Figures 2A and 2B). Wide pavement areas at any intersection force locating signage and edge lighting further from the taxiway centerline, increasing the probability the pilot will miss these guidance cues. Wide pavement areas at the runway holding positions for departure queuing could be problematic, especially if other visual guidance such as surface painted holding position signs are not provided (See Figures 3A, 3B and 3C). Where substantial departure queuing is needed, the preferred alternatives would include providing separate standard-width by-pass taxiway stub connectors (perpendicular to runway) separated by “islands” and using the standard taxiway-taxiway separation or providing an additional dual parallel taxiway instead, improving the visibility of runway holding position signs for the pilot.

FIGURE 2A, "INADVISABLE LAYOUT OF TAXIWAY INTERSECTION - WIDE PAVEMENT AREA"

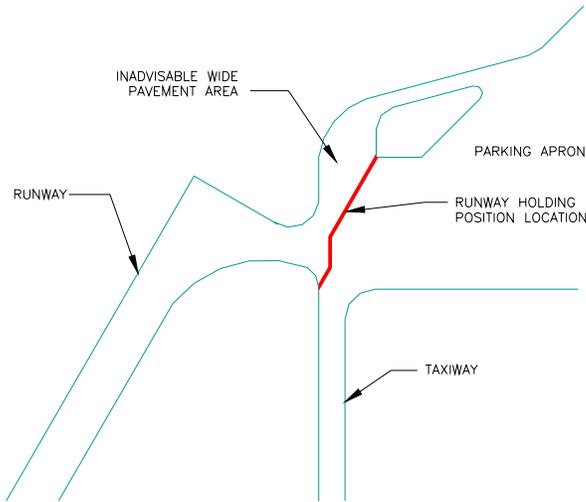


FIGURE 2B, "RECOMMENDED LAYOUT OF TAXIWAY INTERSECTION - CHANNELIZE PAVEMENT AREA"

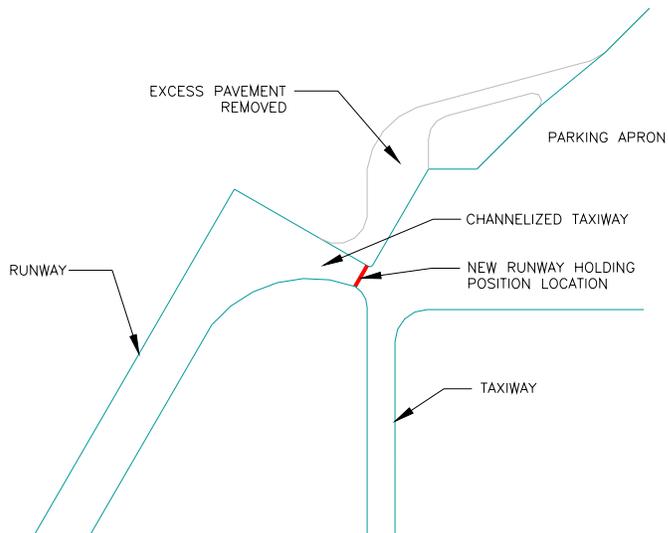


FIGURE 3A, "INADVISABLE LAYOUT OF DEPARTURE HOLDING AREA"

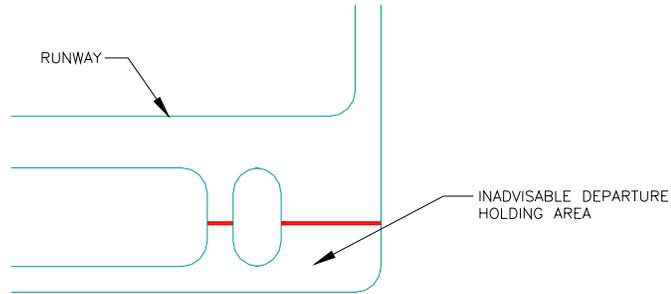


FIGURE 3B, "RECOMMENDED LAYOUT OPTION OF DEPARTURE HOLDING AREA - PERPENDICULAR TO RUNWAY"

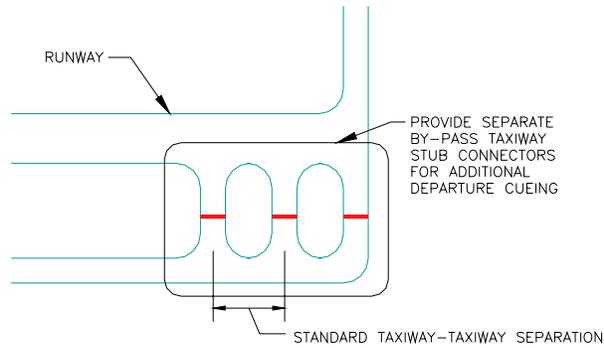
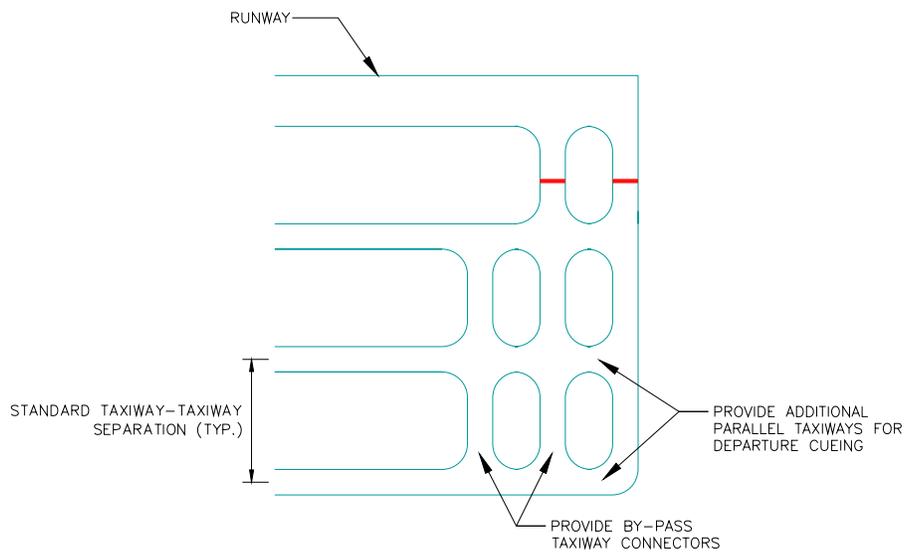


FIGURE 3C, "RECOMMENDED LAYOUT OPTION OF DEPARTURE HOLDING AREA - PARALLEL TO RUNWAY"



**By-Pass Taxiway**

The use of by-pass taxiways increase the efficiency of the departure queuing and flow and are encouraged over wide departure holding areas. Locate this separate taxiway connector at a standard taxiway-taxiway separation distance from a primary entrance taxiway and using standard width taxiway providing standard lighting, signage and markings increasing their visibility at the runway holding position.

**Limit short connecting taxiway segments**

Avoid the use of short, non-standard, taxiway segments connecting to the runway. These configurations can place aircraft where they encounter the runway holding position almost immediately upon entry onto the segment or the straight portion of the segment. This pattern can catch a flight crew by surprise resulting in their failure to hold short. Minimizing or eliminating these situations through the use of the required runway to parallel taxiway separation requirements should decrease the risk of runway incursions. If the airport geometry requires the development of short non-standard taxiway segments, designers and planners should consider relocating the runway holding position marking to make it more conspicuous.

**Possible impact to POFZ and TERPS Surfaces**

Holding bays or turnarounds at the runway end could conflict with existing or planned POFZ or TERPS Surfaces for the same reasons outlined in the “Threshold Displacement Considerations” section above. It is therefore encouraged to site the holding bays or turnaround areas outside of these surfaces.

**Exit Taxiways****High Speed**

Terminate high-speed exit taxiways at a parallel taxiway if possible, requiring pilot awareness of their location. High-speed exit taxiways providing a direct route across a parallel runway is especially problematic. This configuration exists at a major international airport resulting in a relatively high runway incursion rate and was key in the decision to relocate one of the runways. Avoid high-speed exit taxiways providing direct crossing of a parallel runway due to the frequency and severity of the resulting runway incursions.

Avoid runway high-speed exit taxiways from both directions meeting at the same point (See Figures 4A and 4B). High-speed exit taxiways from a runway from each operational direction should not be co-located. Separate these exit taxiways to limit the pavement area at the intersection. Also, some pilots may attempt to double-back on the “first” taxiway they reach and be occupying the runway for a longer duration, increasing the possibility of a runway incursion.

FIGURE 4A, "INADVISABLE CO-LOCATION OF HIGH-SPEED EXIT TAXIWAYS"

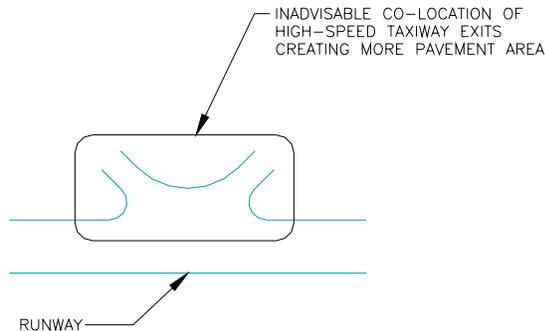
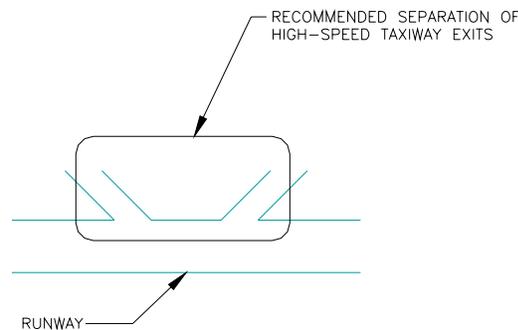


FIGURE 4B, "RECOMMENDED LOCATION OF HIGH-SPEED EXIT TAXIWAYS"



Do not plan or design high-speed exit taxiways for runway crossings. If runway crossings are needed in the vicinity of a high-speed exit taxiway, incorporate a separate right-angled taxiway for the runway crossing. The operational use of particular taxiways should be discussed with the local Air Traffic Control Tower (ATCT) where appropriate to establish general conventions to promote runway safety.

### **Acute-Angled Taxiways**

Avoid acute-angled taxiways to exit the runway requiring turns in excess of 90° whenever possible. This abrupt angle requires the pilot to slow down considerably on the runway to negotiate the turn, resulting in additional runway occupancy time, decreasing efficiency, increasing the possibility of a runway incursion and creates difficulty with pilots' recognition of the runway entrance.

### **Apron Taxiways and Taxilanes**

Avoid taxiway layouts providing straight direct access onto a runway from a terminal or parking apron area (See Figures 5A and 5B). Taxiway geometry should force the pilot to consciously

make turns to promote situational awareness. Especially troublesome are taxiways from the terminal area that form a straight line to the midsection of a runway. Departing aircraft may be preparing for the flight and inadvertently proceed straight onto a runway. Furthermore, the location of the crossing taxiway along the runway length affects the runway incursion risk (the risk of a Category A or B incursion is higher for crossings in the first third of the runway and lower in the last two thirds). The preferred location for crossings is within the last third of the runway, since within the middle third of the runway the arriving/ departing aircraft is usually on the ground and traveling at a high rate of speed. Consider realigning taxiway connectors and/or providing an offset between the runway exit connectors and the departure taxiway route before providing a direct path to the runway from the apron.

FIGURE 5A, "INADVISABLE LAYOUT OF DEPARTURE TAXIWAY ROUTE"

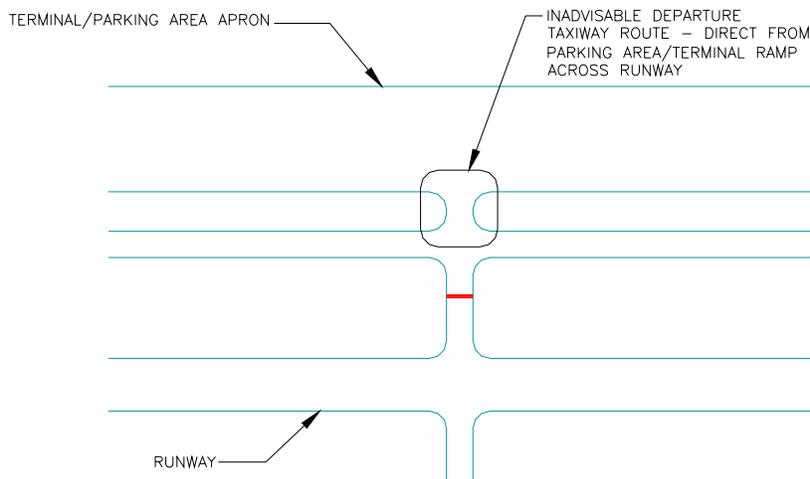
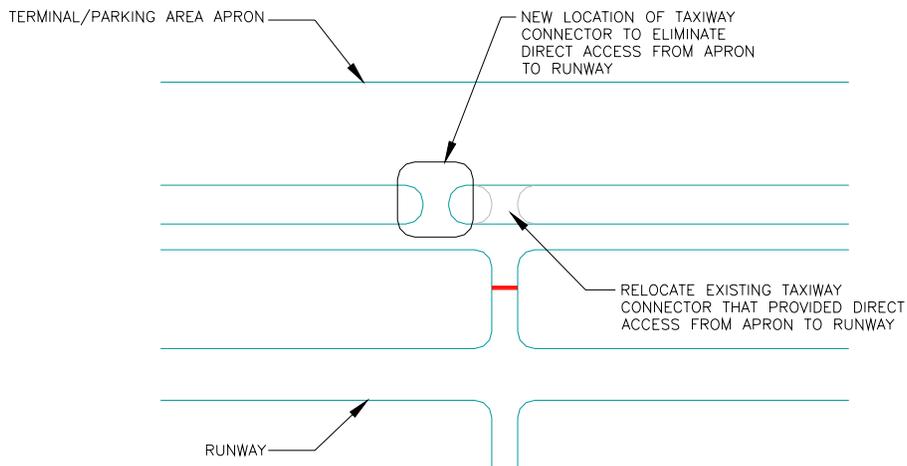


FIGURE 5B, "RECOMMENDED LAYOUT OF TAXIWAY DEPARTURE ROUTE"



### **One-Way Taxiways**

If using one-way taxiways on an airport, as in the case of taxiways used exclusively for exiting a runway, planners should provide for the addition of standard “Do Not Enter” signs to alert pilots of this situation and promote situational awareness and enhance runway safety.

### **In-Line Taxiways**

An in-line, or aligned, taxiway is one whose centerline coincides with a runway centerline. Aligned taxiways should not be approved for new construction since they increase the risk of runway incursions and pose operational problems, making them a poor airport design element. They are especially problematic if the runway is used for mixed arrivals and departures. The holding position locations will be in an unfamiliar location to the pilot in order to protect for the approach surface. This condition could cause the pilot to miss the holding position and lead to a runway incursion.

### **End-Around Taxiways (EATs)**

Since the single greatest risk of runway incursions is associated with taxiing aircraft crossing an active runway, airfield design that decreases the number of crossings will reduce the risk of runway incursions. Where land is available, consider adding “perimeter” or “end-around” taxiways around the ends of those runways with significant number of aircraft crossing operations, enabling aircraft to bypass the runway altogether.

Currently, a national standard for end-around taxiways (EATs) exists only for the departure end of runways (that are used for either departures or arrivals). In accordance with the Safety Risk Management Document (SRMD) for departure-end EATs, application of these standards is limited to airports with “greater than 150,000 departure operations and greater than 10,000 minutes of delay annually” (or approximately the 30 largest airports). A national standard for EATs for the arrival end of the runway (under approaching aircraft) is under development but not yet available.

Advisory Circular (AC) 150/5300-13, “Airport Design” Paragraph 415 contains detailed planning and design guidance on End-Around Taxiways.

### **Markings/Lighting/ Signage**

Standardized location and visibility of the markings, lighting and signage on taxiways provide excellent mitigations of runway incursion risks. The design of the taxiway systems should always consider providing the pilot with a better view of these visual aids. The alignment and width of taxiways play an important factor in the siting of these visual aids.

## **4.0 Operational Considerations**

### **General**

Taxiway and airfield design planning goes hand-in-hand with operational considerations. Discuss the operational use of particular taxiways with the local Air Traffic Control Tower (ATCT), where appropriate, to establish general conventions to promote runway safety. During taxiway planning, consider providing separate departure and arrival taxiway routes in the vicinity of the runway, where possible.

Generally, where taxiways intersect a runway the following operational uses will enhance runway safety:

- a. Angled taxiways should be reserved for high-speed exits from the runway only.
- b. Taxiways used for aircraft crossing runways should form a right angle with the runway and be located within the last “third” of the runway.
- c. Taxiways leading from the terminal area primarily used for departure routing should not lead directly onto a runway; they should terminate at a parallel taxiway.

### **Use of Taxi Strategies That Reduce the Number of “Active” Runway Crossings**

Where construction of End-Around Taxiways (EATs) is not feasible, then another option to reduce the conflicts associated with aircraft taxiing across runways is to move the crossing point to a location not in conflict with the runway operations (departures or arrivals), as follows:

- **Departures:** Route the taxiing aircraft to the end of the runway where departures normally start their takeoff roll and displace the start of takeoff roll to the next intersection for all aircraft for which it is feasible (considering takeoff runway length requirements). Takeoffs at these intersections may be feasible for a large percentage of aircraft; those aircraft needing additional length could continue to use the full length of the runway (and would not likely result in an incursion, as they would be entering the runway at the same point as the crossing aircraft). This intersection takeoff strategy would need to be analyzed to ensure that there would be no jet blast impacts. The Chicago O’Hare Modernization Program (OMP) plans to make extensive use of this strategy to reduce the number of “active” crossings by taxiing aircraft.
- **Arrivals:** Route the taxiing aircraft to the far end of the runway, beyond any approved “Land and Hold Short Operations (LAHSO)” point. National rules on LAHSO do not allow for participation by all arrivals; a small percentage would need to be separated from crossing aircraft. Again, the Chicago OMP plans to make extensive use of this strategy as well.

These strategies can have an effect on taxi times and require a suitable supporting taxiway infrastructure. Prior to implementation, discuss these strategies with the local Air Traffic Control Tower (ATCT) and perform an analysis to understand the impacts (especially changes in taxi-in and taxi-out times). At the same time, however, they allow departure and arrival operations on the runways to proceed unimpeded. This can result in a potentially significant increase in runway throughput, which could offset any increases in taxi time.

**Use of Runways as Taxiways**

The use of runways as taxiways is not recommended. Use the runway environment only for the landing and takeoff of aircraft. Using runways as taxiways can lead to runway incursions either by a pilot inadvertently attempting to takeoff or land on the runway while someone is taxiing or by a lapse in communication between air traffic controllers. Also, taxiing on a wide runway does not afford the same visual cues to a pilot since the signage is located far from the centerline, especially if they are to hold short of an intersecting runway.

**B) APRON AND SERVICE ROAD DESIGN:****Introduction**

Proper layout of aircraft aprons and service roads on the airfield contributes to the enhancement of runway safety and the reduction of runway incursions.

At General Aviation (GA) airports, give proper consideration to siting an aircraft apron to limit runway crossings whenever possible enhancing runway safety.

**Fueling**

The use of hydrant fueling is encouraged to limit the associated risk involved with fuel truck activity on the Air Operations Area (AOA). If fuel truck deliveries are necessary, ensure these movements are separated from the movement environment to the extent practicable to enhance runway safety. This may require the construction of service roads as described below.

**Navigational and Visual Aid (NAVAID/ VISAID) Placement**

When making decisions about placement of these facilities, be sure to plan for access by maintenance vehicles. The placement of many NAVAIDs/VISAIDs and other airport facilities is often dictated by function, however, there is flexibility in the placement of some facilities. Where possible, select a location allowing the required service to be performed without requiring a maintenance vehicle to enter/cross a runway.

**Service Roads**

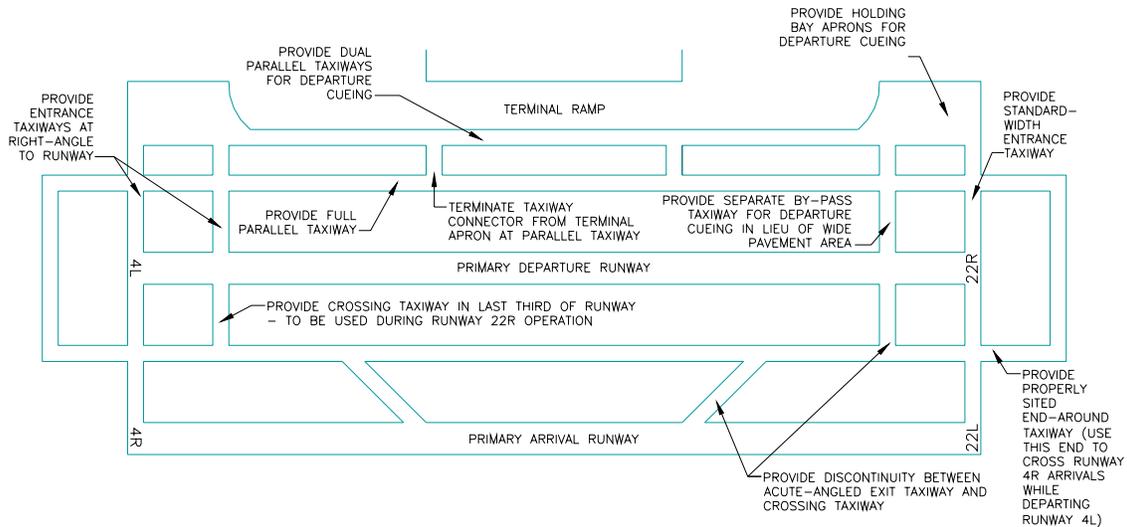
The construction of service roads should adequately separate vehicles from the movement area. Design service roads on the AOA so they are outside the airport design and air navigation clearance surfaces wherever practical.

**C) EVALUATION OF THE OVERALL AIRFIELD LAYOUT**

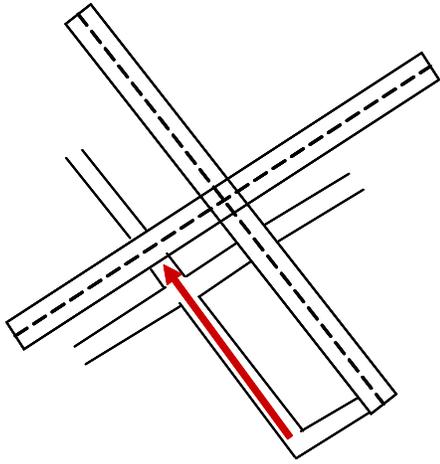
In planning an airport layout to minimize runway incursions, there is not one generic solution. Airports vary immensely from one another due to differing needs and physical constraints. The important point is to consider the recommendations in this engineering brief when planning an element of the taxiway system to keep runway safety as the highest priority in airport design.

Figure 6 is an overall concept diagram of a generic airfield containing some of the important taxiway layout features discussed in this engineering brief. Consider the overall surface traffic patterns of the airfield and the historical pattern of incursions at the airport. Individual solutions to these conditions will vary.

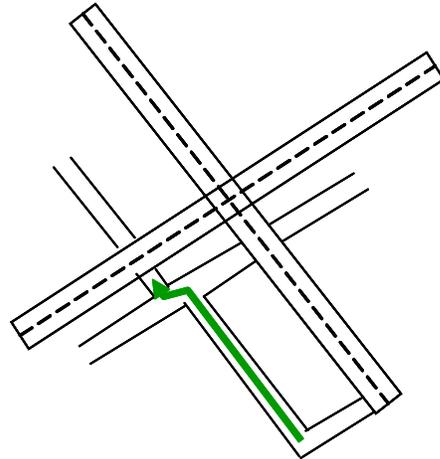
FIGURE 6, "OVERALL AIRFIELD LAYOUT CONCEPT"



Airports with a history of runway incursions at a specific “hot-spot” location should consider altering the taxiway alignment if other improvements to markings, lighting and signage do not remedy the situation. One example of this is a taxiway layout that includes a long taxi path leading directly to a runway (Figure B.); if there is a history of incursions by aircraft at this intersection, it could potentially be resolved by modifying the taxiway structure to require some (limited) maneuvering prior to reaching the runway (Figure C.). This would interrupt the taxi process, forcing the aircraft to turn prior to the runway, as a means of recognizing that the runway environment is being entered.



**Figure B.**



**Figure C.**