Quiz 2 - Take Home

Open Notes and Internet

Instructor: A.A. Trani

Solution

Instructions

Create a solution file using the word processor of your choice. Convert to PDF and submit to Canvas. Include all screen captures of all your work including aircraft manufacturer's tables and figures, FAA nomographs and others.

Honor Code Pledge

The information provided in this exam is my own work. I have not received information from another person while doing this exam.

_____ (your signature/name)

Problem 1 (30 Points)

This problem analyzes the obstructions to navigation for the airport configuration shown in Figure 1. The airport is located at an elevation of 1,560 feet above mean sea level conditions. Runway 6/24 is a precision runway. Runway 14/32 is a non-precision runway with visibility minima down to 3/4 mile. The critical aircraft operating at the airport is the Boeing 787-8 Dreamliner (see Figure 2).

a) Analyze the three objects shown in Figure 1 and determine if any of the objects is an an obstruction to navigation. In your analysis, include checks for the following criteria:

   a. FAR Part 77,

   b. Runway OFZ,

   c. New runway siting criteria (FAA AC 150/5300-13B).

156-foot antenna

I) The antenna is inside the intersection of horizontal surfaces for runways 6/14 and 14/32 (see Figure 2).

II) **The antenna violates the horizontal surface for runways 6/24 (precision runway) and runway 14/32 (non-precision runway).**

79-foot hangar

III) **Violates the transitional surface for runway 6/24 (precision runway).** The transitional surface starts 500 feet from the runway centerline. At a location 1040 feet from the runway centerline, the transitional surface height is 77.14 feet ((1040-500)/7) The hangar violates the transitional surfaces by 1.86 feet.

IV) The hangar does not violate the inner transitional OFZ surface (see Figure 1). At 1,040 feet from the runway centerline, the inner transitional OFZ has reached 150 feet (the height of the horizontal surface).

V) Technically, the hangar should have never been permitted at the location.

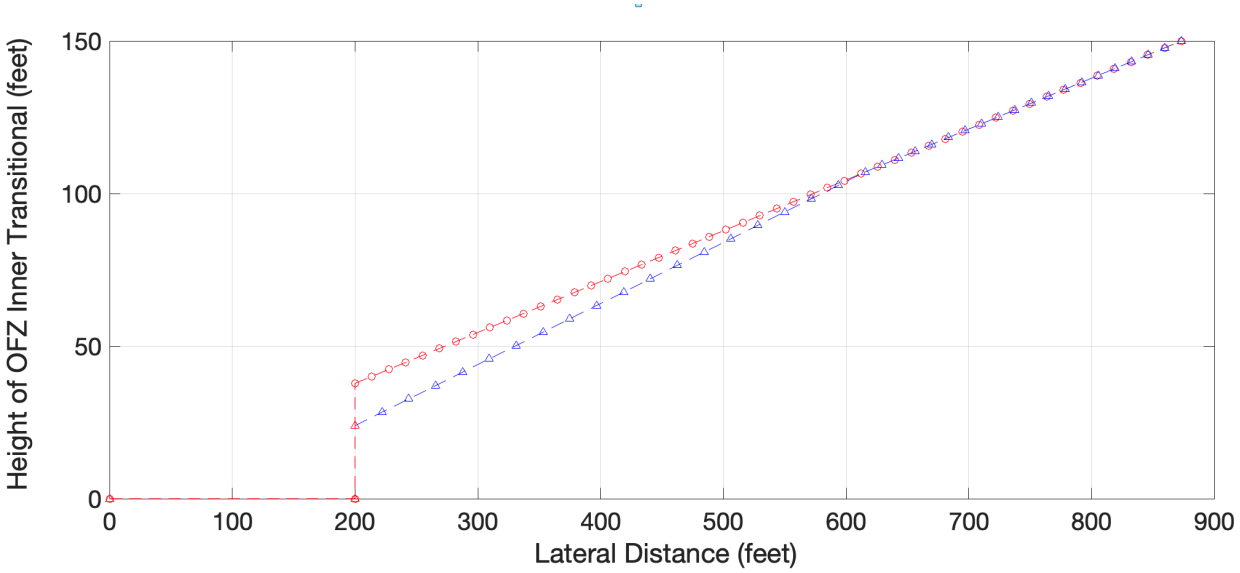


Figure 1. Inner Transitional OFZ Surface for Boeing 787-8 at 1,560 feet Elevation.

81-foot water tank

VI) The water tank is in the transitional surface of runway 6/24 (see Figure 2).

VII) At 2230 feet from the start of the approach surface for runway 24, the height of the approach surface is 44.6 feet (2230/50). The width of the approach surface at a point 2,230 feet from the start of the approach surface is 834.5 feet

(500+0.15*2230). The water tank is 190.5 feet inside of the transitional surface (190.5 feet from the edge of the approach surface of runway 6/24). The transitional surface slopes at 7:1. The height of the transitional surface 190.5 feet from the edge of the approach surface is (44.6+27.21 = 71.8 feet).

VIII) **The water tank violates the transitional surface for runway 6/24 (precision runway).** The height of the transitional surface at the location of the tank is 71.8 feet.

Note: ou were expected to perform some basic analysis of new runway siting criteria explained in Section 3.6 in the FAA AC 150/5300-13B. The analysis includes approach and departure surfaces for a precision and non-precision runway.

For a precision runway, FAA stipulates:

"Maintain the 40:1 instrument departure surface associated with the ends of runways with published instrument departure procedures to be clear of obstacles, or with applicable mitigation, as identified in paragraph 3.6.2.2."

b) If any of the objects is an obstruction to navigation, what remedial actions can the airport authority take the mitigate the problem? Explain.

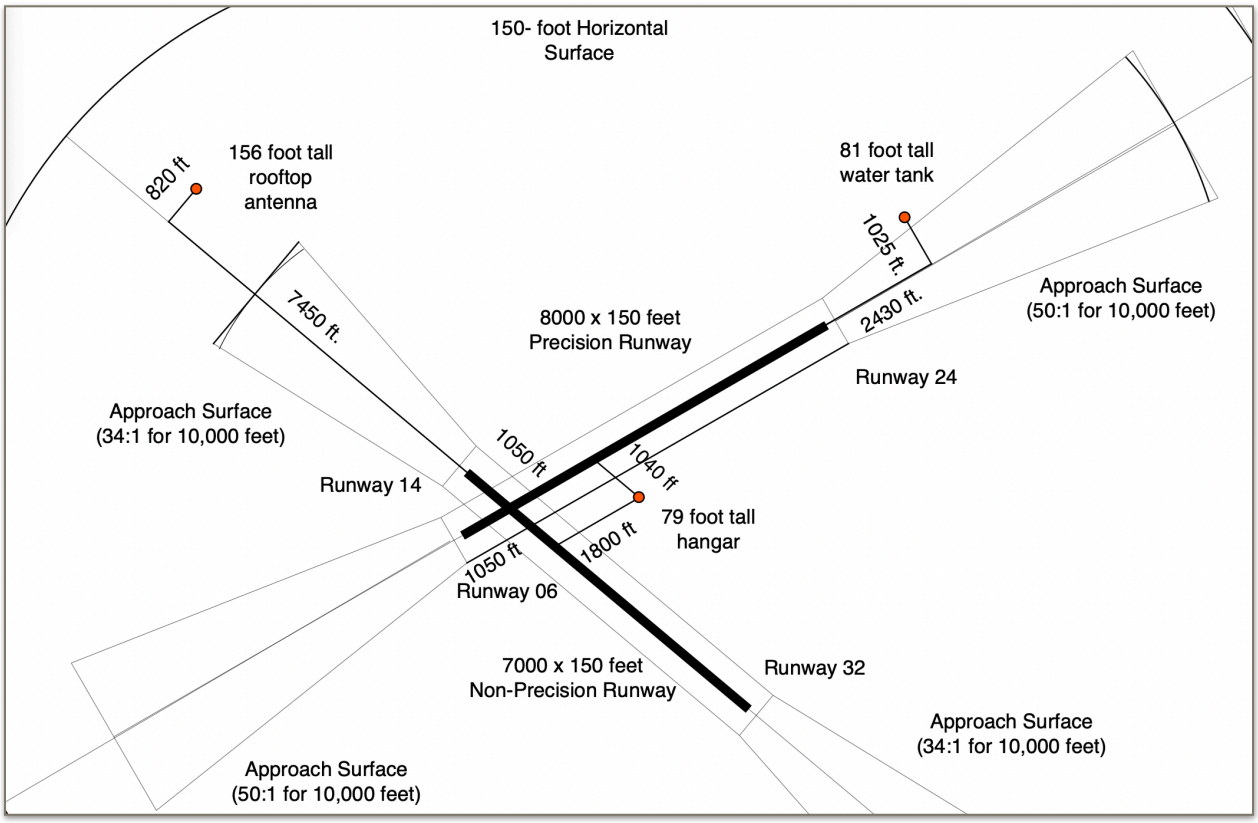


Figure 2. Potential Obstructions to Navigation for Problem 1 with Approach, Primary and Horizontal Surfaces.

Instrument (Precision) Runway Approach Surface Standards. Source: FAA AC 150/5300-13B (Chapter 3).

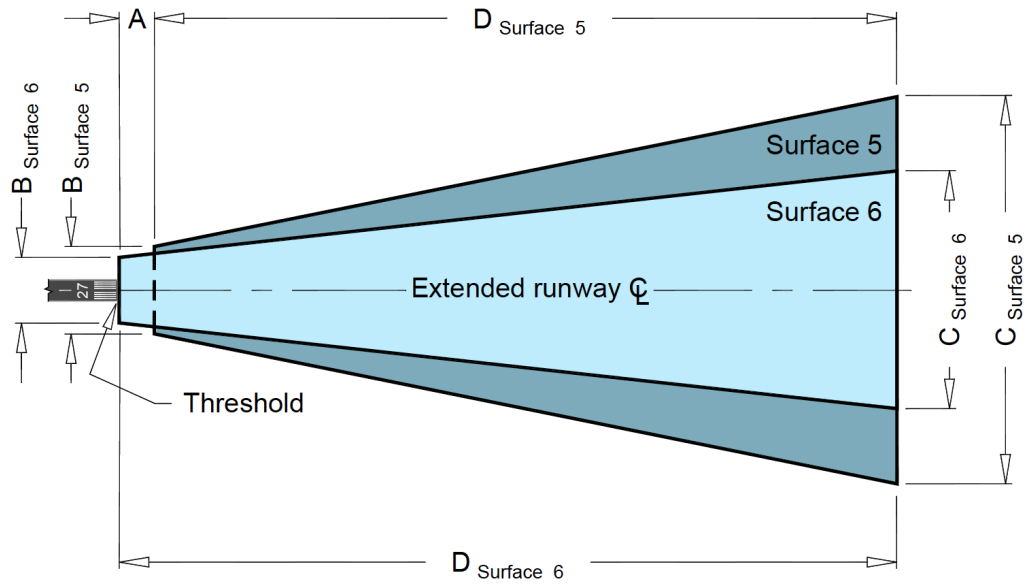


Table 3-4. APV and PA Instrument Runway Approach Surfaces

Surface	Runway Type	Visibility minimums	A ft (m)	B ft (m)	C ft (m)	D [4] ft (m)	Slope
Surface 5	Approach end of runways providing ILS, MMLS, PAR, and localizer type directional aid with glidepath, LPV, LNAV/VNAV, RNP, or GLS.	≥ ¾ statute mile (1.2 km)	200 (61)	400 (122)	3,400 (1,036)	10,000 (3,048)	20:1
		< ¾ statute mile (1.2 km)	200 (61)	400 (122)	3,400 (1,036)	10,000 (3,048)	34:1
Surface 6	Approach end of runways providing ILS, MMLS, PAR, and localizer type directional aid with glidepath, LPV, LNAV/VNAV, RNP, or GLS.	All	0	Runway Width + 200 (61)	1,520 (463)	10,200 (3,109)	30:1

Precision Runway Departure Surface Standards. Source: FAA AC 150/5300-13B (Chapter 3).

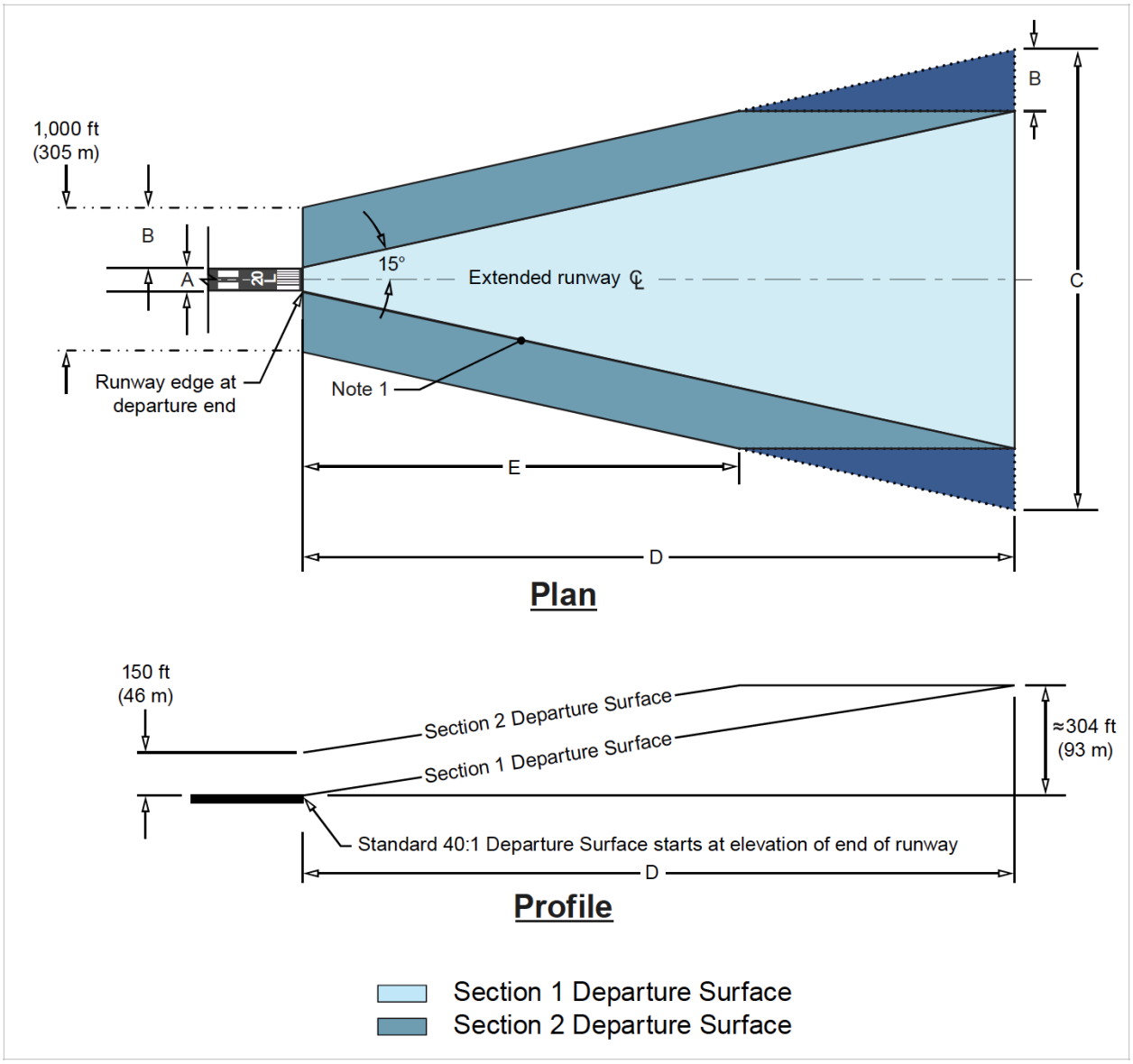


Table 3-5. Instrument Departure Surface

Surface	Runway Type	A ft (m)	B ft (m)	C ft (m)	D [4] ft (m)	E ft (m)	Section 2 Angle θ [2]	Section 2 Transverse Slope m²
Surface 7	Runways providing instrument departure operations	60 (18.3)	470 (143)	7,512 (2,290)	12,152 (3,704)	6,152 (1,875)	17:7	3.13:1
		75 (22.9)	462.5 (141)				18.0	3.08:1
		100 (30.5)	450 (137)				18.4	3.00:1
		150 (46)	425 (130)				19.4	2.83:1
		200 (61)	400 (122)				20.6	2.67:1

Note 1: Section 1 of the departure surface starts at the DER elevation for the width of the runway and rises along the extended runway centerline at 40:1. Section 2 starts at an equal elevation to the adjoining Section 1. Section 2 continues until reaching 304 ft (93 m) and then levels off until reaching the line where Section 1 and Section 2 reach 304 ft (93 m) above DER elevation, then that part of Section 2 that leveled off continues at a 40:1 slope.

Figure 2. Critical Aircraft for Problem 1. Boeing 787-8 Dreamliner Landing at IAD Airport (A. Trani).

Problem 2 (30 Points)

For the airport configuration described in Problem 1, perform the following geometric design assessments. The critical aircraft is the Boeing 787-8 Dreamliners shown in Figure 2.

a) Determine the centerline distance between runway 6/24 and taxiway "Alpha".

The separation between runway centerline and taxiway "Alpha" is 450 feet for ADG V and AAC D. According to the notes in FAA AC 150/5300-13B (Appendix G).

"The standard runway centerline to parallel taxiway centerline separation distance is 400 feet (122 m) for airports at or below an elevation of 1,345 feet (410 m); ***450 feet (137 m) for airports between elevations of 1,345 feet (410 m) and 6,560 feet (2,000 m)****; and 500 feet (152 m) for airports above an elevation of 6,560 feet (2,000 m)."*

b) Determine the centerline distance between runway 14/32 and taxiway "Bravo".

The separation between runway centerline and taxiway "Bravo" is 450 feet for ADG V and AAC D. This assumes no high-speed runway exits will be provided.

c) Will the 79-foot tall hangar be a problem to locate taxiway "Alpha". Explain. Check violations for TSA and TOFA.

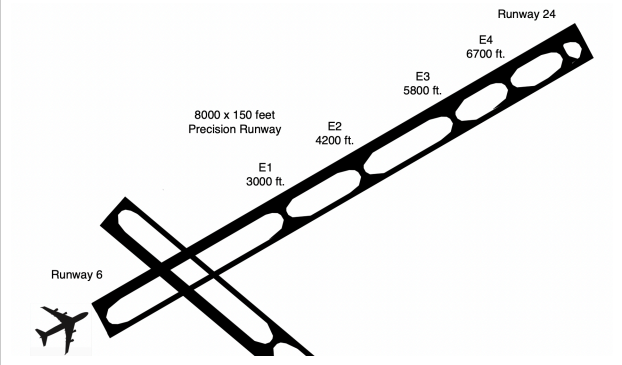
No violations of the TSA or TOFA for taxiway Alpha.

d) Locate five right-angle runway exits (as shown in Figure 3) to efficiently move landing aircraft on runway 6 to the airport terminal. The aircraft fleet mix is given on Table 2. Explain your rationale for selecting the runway exit locations.

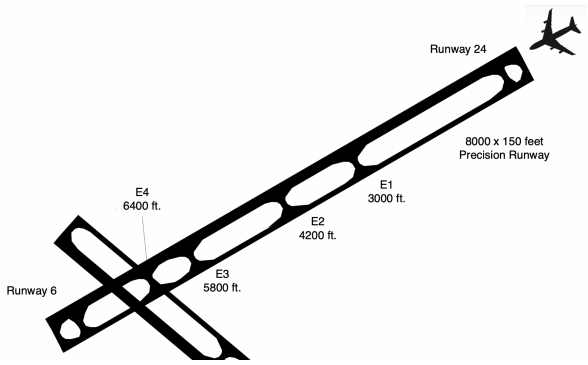
I start with a rough assessment of how many aircraft in each AAC group can use a runway exit placed insect a way that 75% of the landings exit at a given location. Table 1 shows the unadjusted and adjusted locations corrected by file elevation (150 feet for every 1000 ft elevation). Since the airport elevation is less than 2,000 feet, FAA Figure 4-17 suggests no correction. Both solutions are acceptable.

Table 1. Aircraft Fleet Mix for Problem 1.

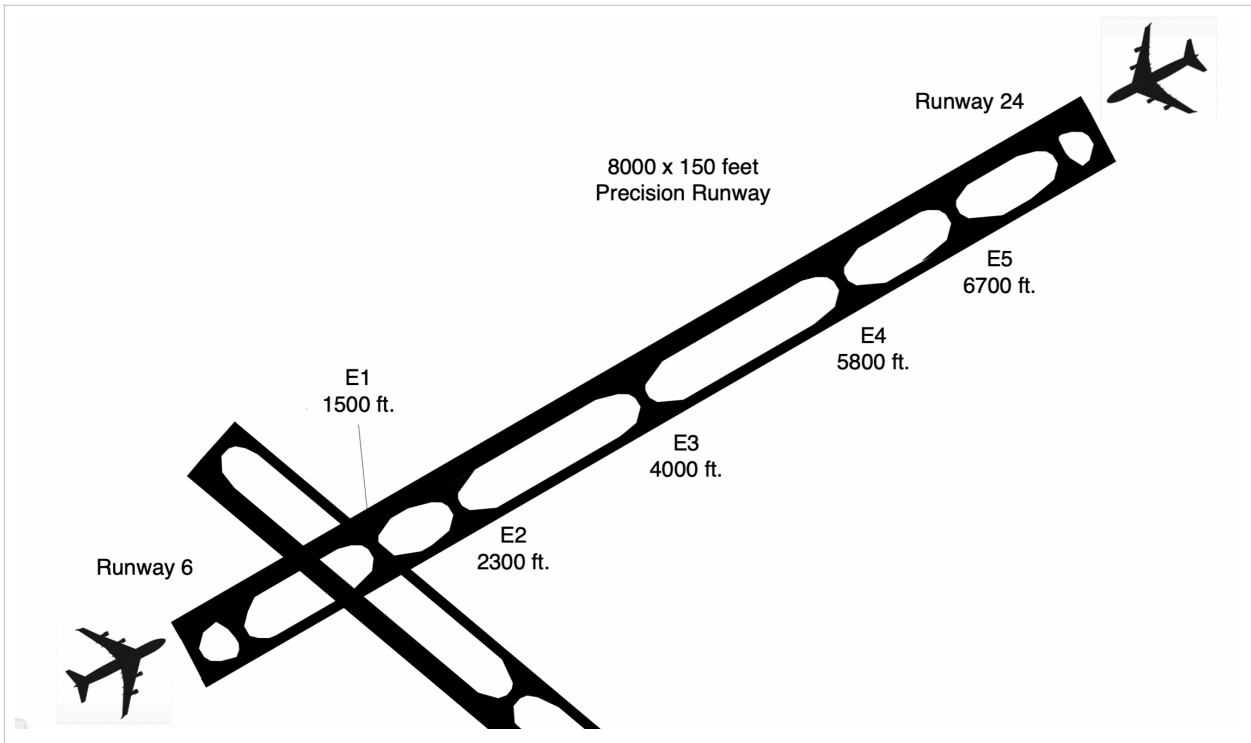
Aircraft ID	AAC Group	Fleet Mix (%)	Location of Right Angle Exit to Serve 75 Population (Sea level) - feet	Adjusted Location of Right Angle Exit to Serve 75 Population (Sea level)
SR22	A	15	2750	2984
C680	B	10	4000	4234
A320	C	30	5600	5834
B738	D	35	6500	6734
B788	D	10	6500	6734



Runway Exit Locations for Landings on Runway 6.



Runway Exit Locations for Landings on Runway 24.



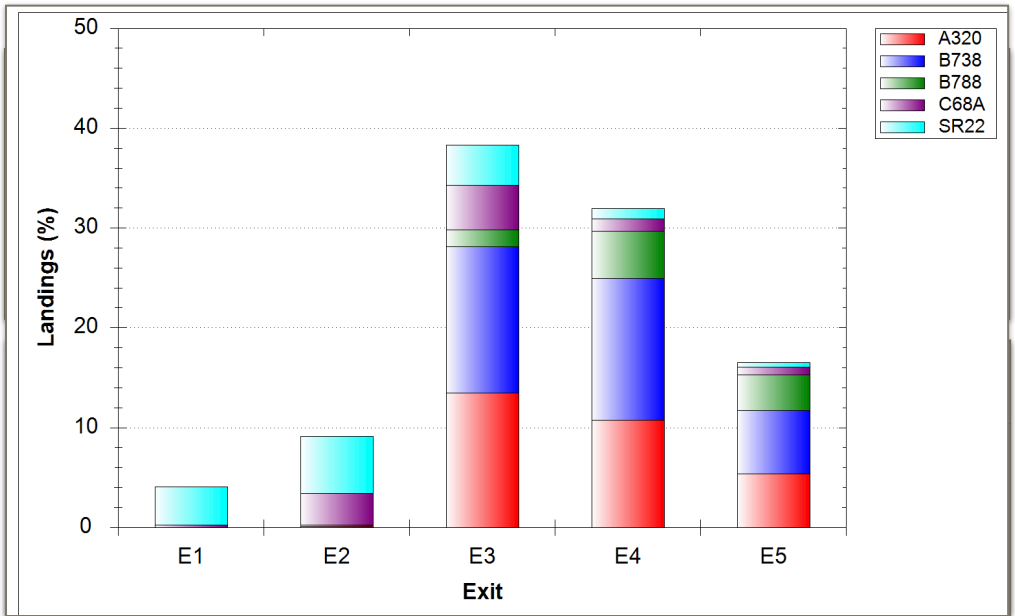
Possible Arrangement of Runway Exit Locations for Landings on both Runways (a compromise). One Two Runway Entrance Exits are Recommended by FAA.

e) For part (d) estimate the runway occupancy time expected from your runway exit placement.

This part requires that run the REDIM model.

Example 1: A configuration with adjusted locations for Runway 6 based on 75% of the landings able to make the runway exit.

Exit	Exit Status	Exit Geometry	Point Of Curvature Location (ft)
E1	Open	90 degree	2,999
E2	Open	90 degree	4,199
E3	Open	90 degree	5,801
E4	Open	90 degree	6,699
E5	Open	90 degree	7,799



Observations:

I) Exit E1 Is used little. That exit could be eliminated and perhaps an exit E2 located midfield (4,000 feet from either end is perhaps better to serve GA aircraft (including corporate jets).

II) Exits E3 and E4 are used consistently by AAC C and D aircraft. Those exits are critical for the airport fleet mix.

Now we estimate the ROT using the compromise configuration with runway exit located for both runway ends. For landings on runway 6 we find the following results:

Runway Exit Locations

(Runwa_6_24_compromise)

Exit	Exit Status	Exit Geometry	Point Of Curvature Location (ft)
E1	Open	90 degree	1,499
E2	Open	90 degree	2,300
E3	Open	90 degree	3,999
E4	Open	90 degree	5,801
E5	Open	90 degree	6,699
E6	Open	90 degree	7,799

Runway Occupancy Times (58.5 s - Std Dev: 11.4 s) - All

(Runwa_6_24_compromise)

Aircraft Name	E1	E2	E3	E4	E5	E6
A320			34.8s	51.3s	57.3s	67.4s
B738			30.9s	49.6s	55.3s	64.8s
B788				56.0s	63.6s	74.7s
C68A			43.4s	61.9s	69.8s	81.8s
SR22	25.9s	35.0s	56.7s	79.3s	89.6s	103.7s

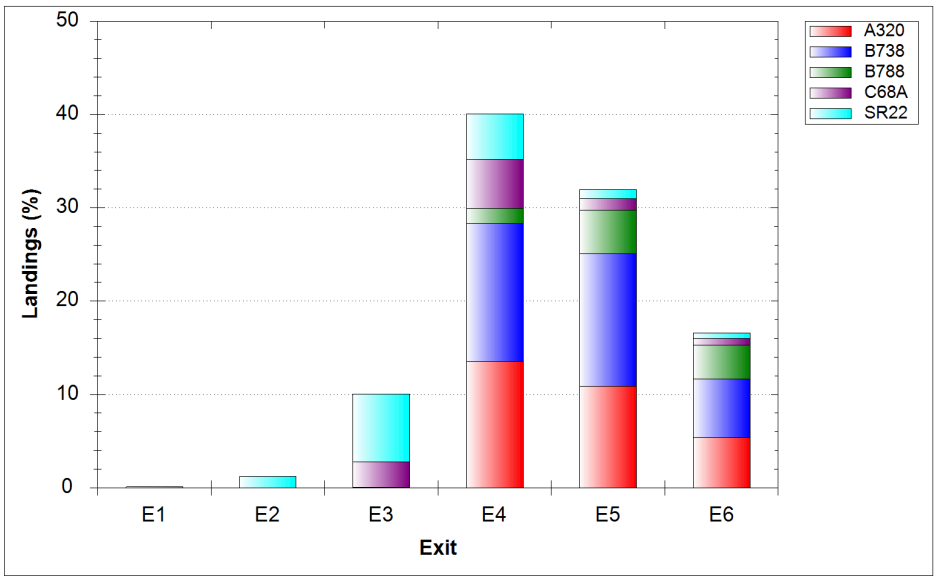
Runway Exit Aircraft Assignment - All

(Runwa_6_24_compromise)

Aircraft Name	E1	E2	E3	E4	E5	E6	Aircraft Mix
A320			0.1%	45.5%	36.5%	18.0%	29.8%
B738			0.0%	41.9%	40.2%	17.9%	35.3%
B788				16.8%	47.1%	36.1%	10.0%

Runway Exit Aircraft Assignment - All

(Runwa_6_24_compromise)



As expected, Exits E1 and E2 are not used much because they are located for landings on runway 24.

The airport client would like to know if a high-speed exit is necessary to process landings on runway 6. The peak hour landing rate is 15 aircraft per hour. Explain if you would consider a high-speed runway.

High-speed runway exits are not justified because the peak hour demand is less than 30 arrivals per hour.

f) If a high-speed runway exit was to be constructed on runway 6/24, would would be the recommended separation between the runway and the taxiway centerline “Alpha”?

600 feet would be recommended.

Problem 3 (40 Points)

Refer to the airport configuration shown in Figure 3 to answer the following questions.

a) Determine the length of the airport terminal finger pier designed to accommodate eight gates (four per side of the finger pier) with two Boeing 787-8 and six Boeing 737-800 parked simultaneously. Assume the width of the finger pier terminal element is 100 feet to accommodate eight departure gate lounges with plenty of seats for departing passengers. The client wants one wide-body aircraft gate on each side of the finger pier.

The pier configuration would be 750 feet long allowing four aircraft parked on each side plus room to maneuver.

b) Determine the distance needed between taxiway "Bravo" and taxilane 'Charlie".

A 250 feet distance is recommended. This allows ADG V aircraft to turn 180 degrees either way. However, my design configuration allows one additional apparel taxiway between Charlie and Bravo in the future. For that reason, I would plan 500 feet between taxiways Charlie and Bravo.

c) Determine the distance from the runway 14/32 centerline to the finger pier terminal considering the provision of parallel taxiway "Bravo" and parallel taxilane "Charlie".

My solution considers a future parallel taxiway development between Charlie and Bravo. The distance is 1,300 feet from the runway centerline to the face of the Pier-Finger terminal. If no future parallel taxiway is expected, the distance would be 1,050 feet. Both solutions prove ample room for a high-ceiling terminal with a two-level configuration.

d) Draw to scale your solution for the airport terminal finger pier including the apron area with taxi lanes "Charlie", "Echo" and "Delta" with eight boxes representative of the dimensions of the aircraft.

Bonus Points (4): Obtain the DXF files from the Boeing web site (https://www.boeing.com/commercial/airports/3_view.page) and draw your solution in part (d) using the actual aircraft shapes.

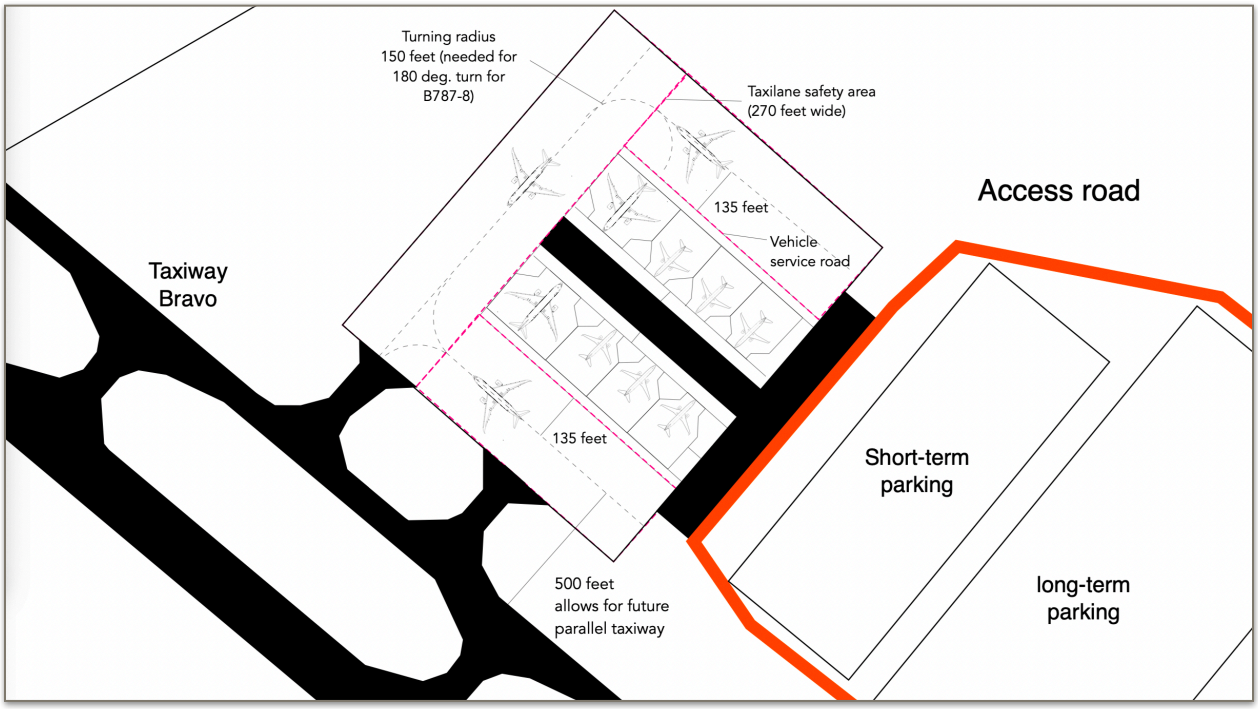


Figure 3. Terminal Configuration with Eight Gates. Pier-Finger Terminal is 750 feet long.

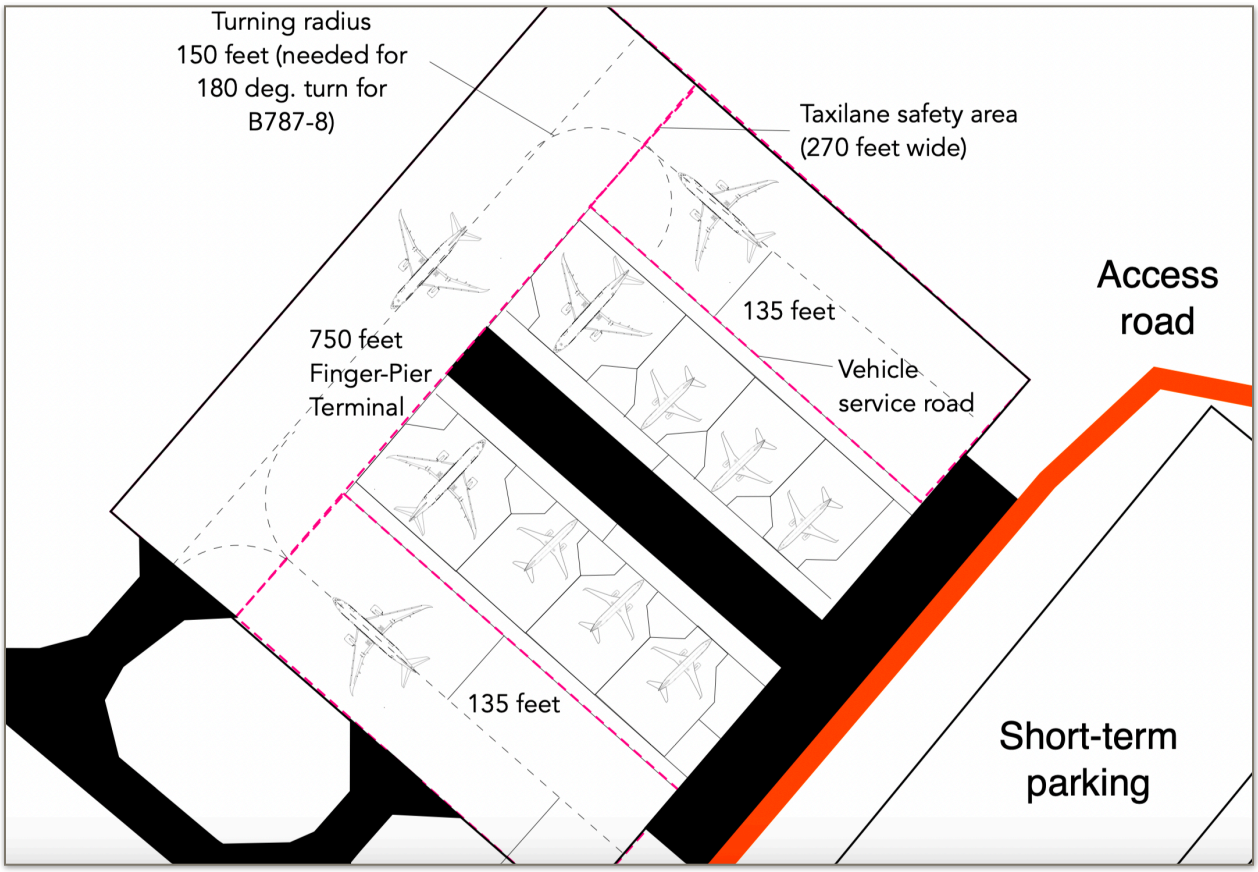


Figure 4. Detail of the AirportTerminal Configuration with Eight Gates.