Exam 2 - Take Home

Open Notes and Internet

Instructor: A.A. Trani

Solution Key

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 used, FAA tables used, and others. You will be penalized if you do not include the graphics of the information used to answer the question.

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)

Answer the following questions briefly.

a) For Boston Logan International Airport (BOS), find the azimuth range (i.e., ten degrees of azimuth) with the most predominant wind direction. Please justify your answer by showing me the Iowa State Mesonet model wind rose. Use 30 years of wind data.

The predominant azimuth direction of wind is 284-295 degrees (5.4% of the time). The second peak range is 225-234 degrees. The Mesonet Windrose is shown in Figure 1.2.

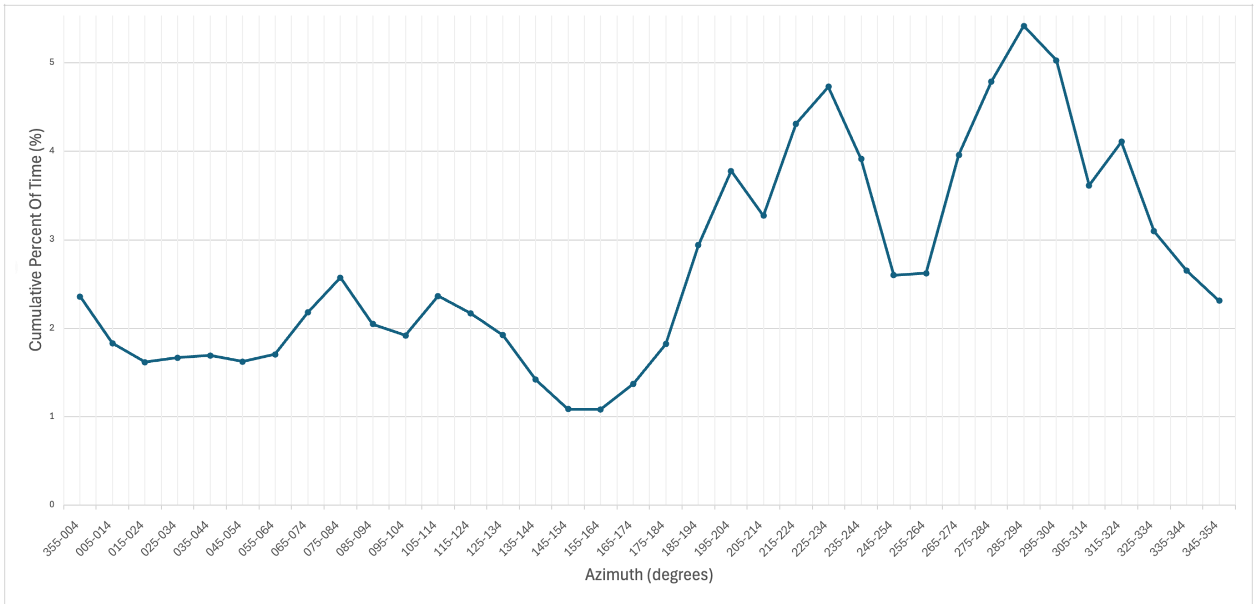


Figure 1.1 Mesonet Cumulative Wind Data (Azimuth versus Cumulative Percent). Boston Logan Airport (30 years of data).

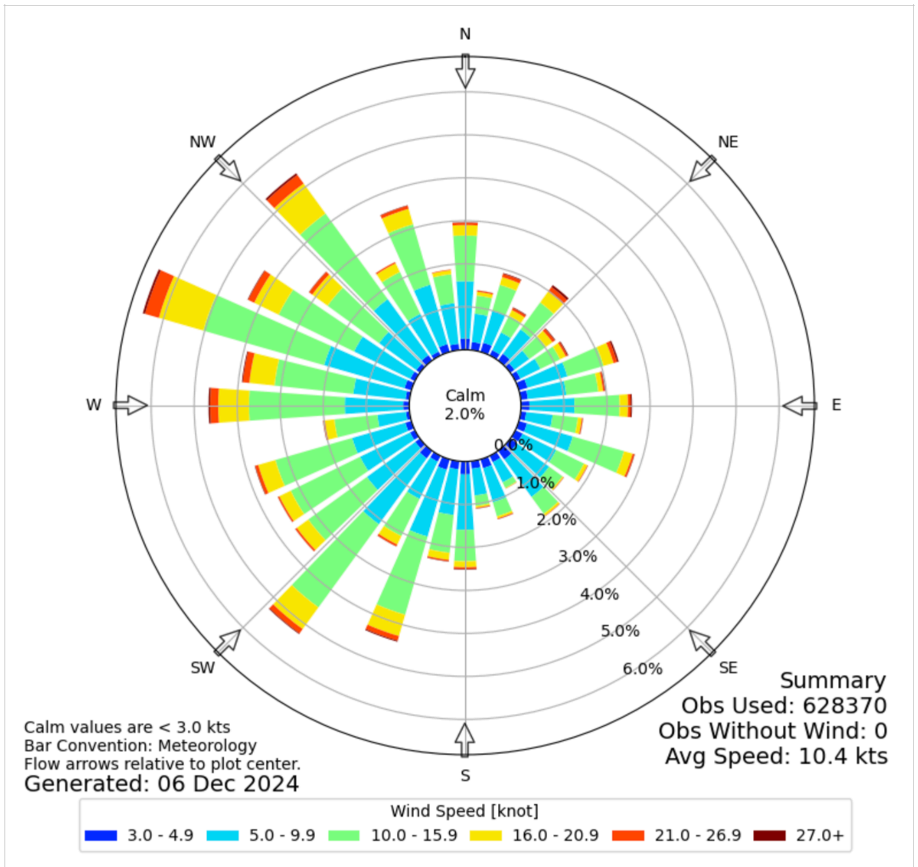
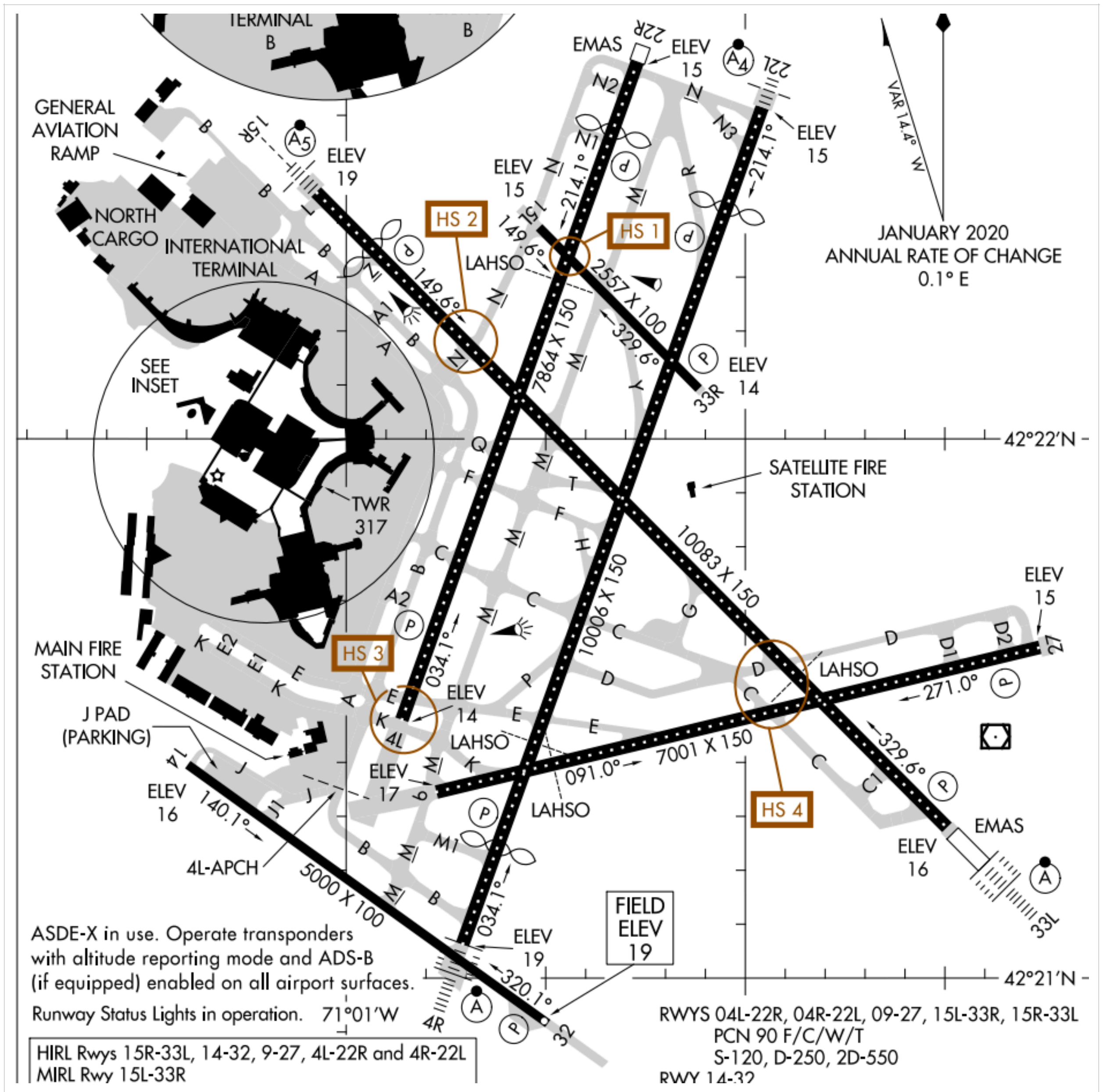


Figure 1.2 Mesonet Wind Rose Data (1950-2024).

b) Are the runways at BOS oriented correctly? Comment.

The Boston Logan Airport runway configuration shown in Figure 1.2 demonstrates that runways 22L and 22R are well placed to reduce the crosswind component of the second peak. No runways are oriented exactly with the first peak. Overall, they are oriented a slightly off to the 30-year data collected from the BOS Logan ASOS source.



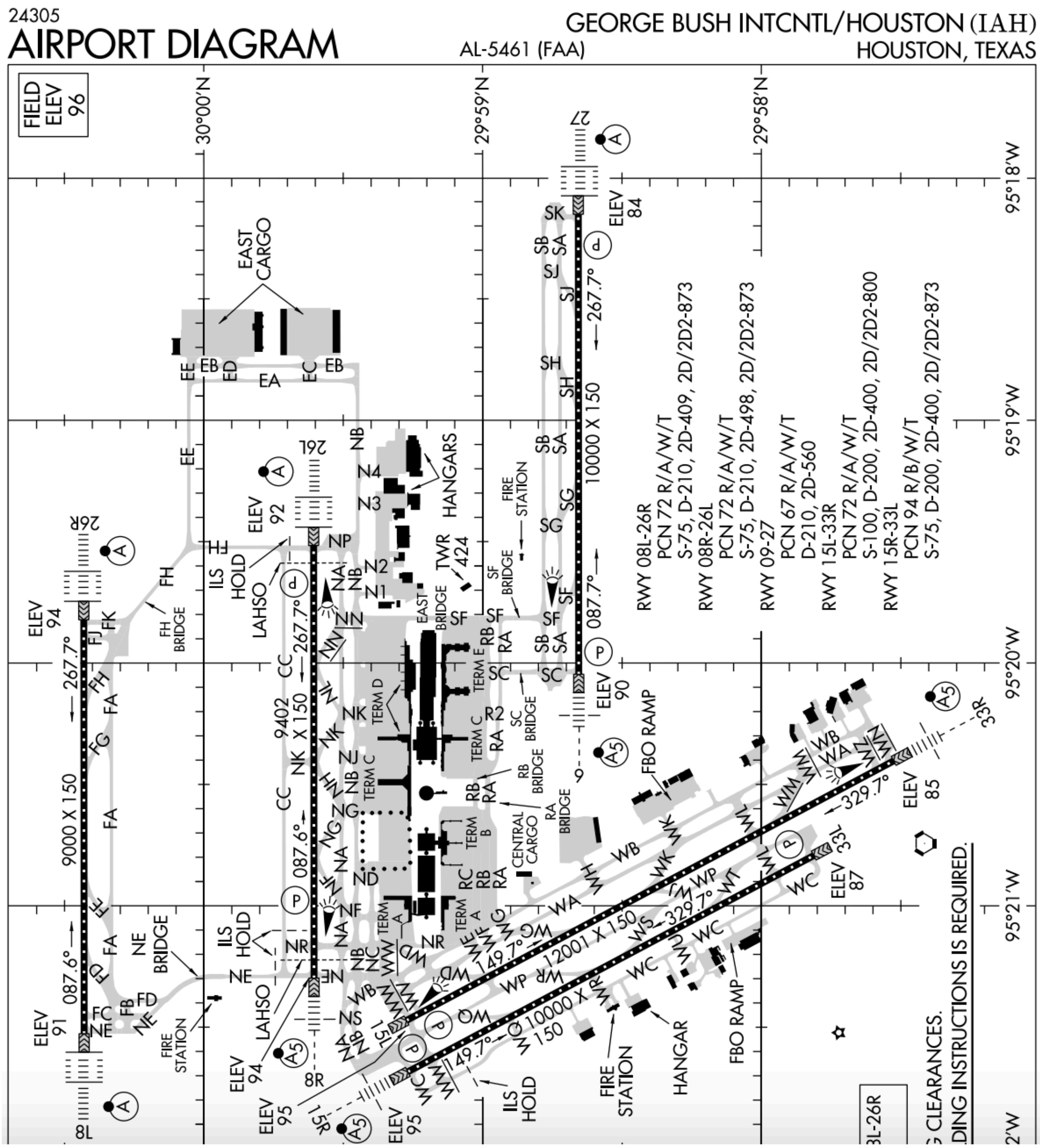
Boston Logan International Airport.

c) Can Fort Lauderdale International Airport do simultaneous independent approaches in bad weather conditions? Comment on the FAA rule used.

Yes, the separation between the parallel runways is 4,000 feet. Using PRM or ADS-B, satisfies the FAA criteria for simultaneous arrivals.

d) During heavy wind from the West, George Bush Intercontinental Airport (IAH) operates arrivals on runway 26R and departures on runway 33R. Is the configuration subject to Converging Runway Operations (CRO)? Explain the reason for your answer.

The runway thresholds are separated by more than 1 nm (separation is ~7,000 feet). **CRO operations do not apply** If landings are conducted on runway 26L instead of 26R, the seperation would be 2,300 feet and CRO operations apply.



George Bush International Airport.

e) Find the maximum takeoff weight possible for an Airbus A350-1000 (see Figure 1) using the longest runway at IAH. Assume ISA + 15 deg—Centigrade operating conditions.

The longest runway is 12,001 feet (3,630 meters). Figure 1.3 shows that the maximum takeoff weight is 315 metric tons.

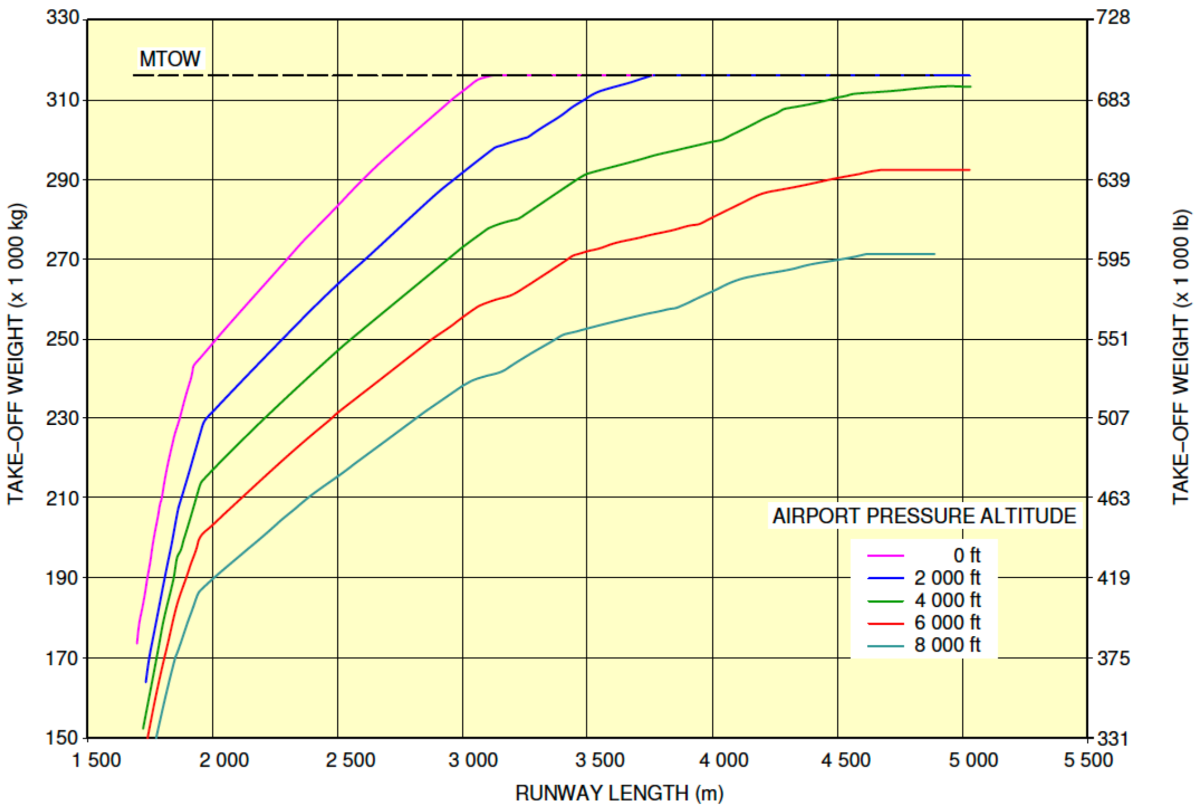


Figure 1.3 Airbus A350-1000 Takeoff Data. ISA + 15 deg. C.

f) How far can the Airbus A350 fly with 366 passengers (no extra cargo) based on the findings of part (e)?

Figure 1.3 illustrates the payload-range diagram for the A350-1000. Looking at the payload-range diagram, the aircraft can fly 8,300 nm, departing at the maximum takeoff weight (315 metric tons) per Airbus's assumed 95 kilograms per passenger. If you use the 100 kilogram per passenger guidance stated in class, the range is reduced to 8,200 nm.

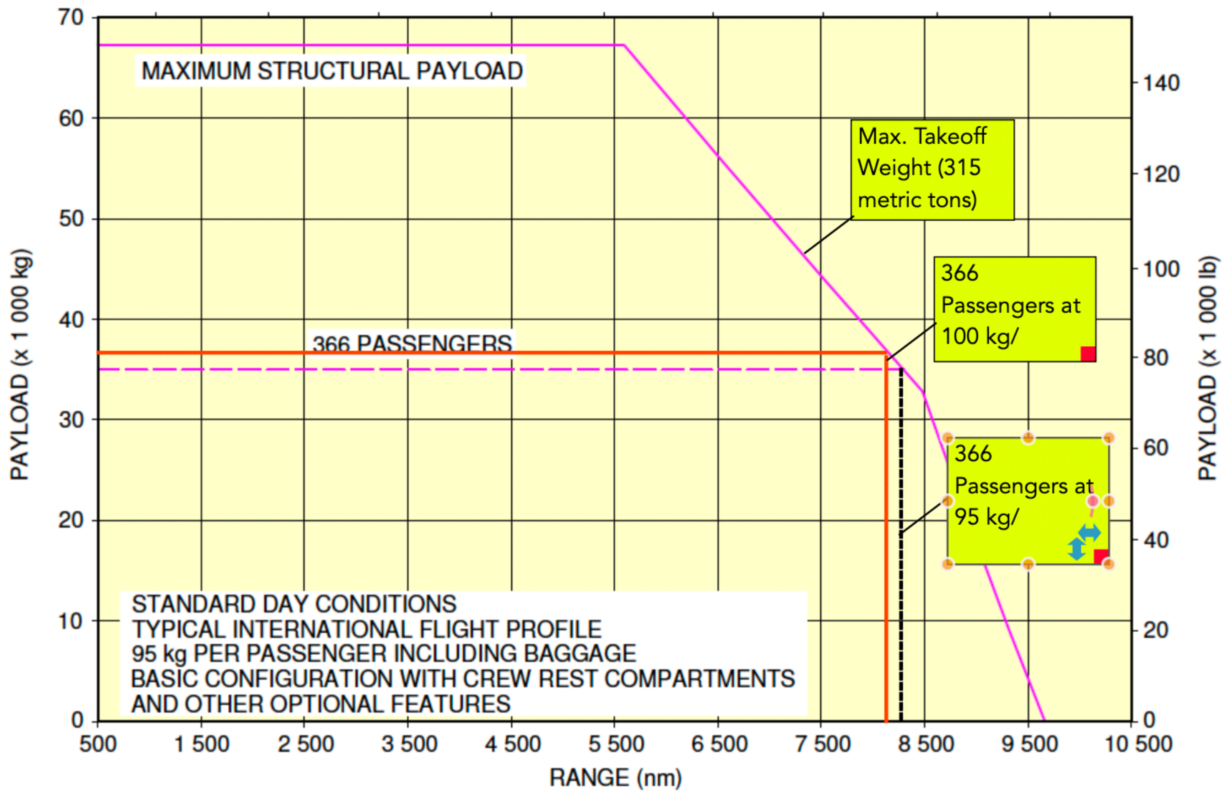


Figure 1.3 Airbus A350-1000 Takeoff Data. ISA + 15 deg. C.

Figure 1. Airbus A350-1000 landing at San Diego International Airport (A. Trani).

Problem 2 (40 Points)

This problem analyzes the runway capacity for an airport with the runway configuration shown in Figure 2. The airport fleet mix is shown in Table 1. Runway 4L is used for departures, while runway 4R is exclusively for arrivals.

For this analysis, we use the following technical parameters: a) in-trail delivery error of 20 seconds under IMC conditions, b) probability of violation is 5%. Arriving aircraft are "vectored" by ATC to intercept the extended centerline of runway 4R at a fix (point in space) located 13 miles from the runway threshold. Use the In-Trail Arrival-Arrival Separation Rules consistent with the Consolidated Wake Turbulence groups provided in class (i.e., FAA Order JO 7110.126B) to solve the problem. The departure-departure separation is consistent with the values on page 38 of the runway capacity handout (taken from FAA JO 7110.126B). Use 10 seconds for departure-departure buffers to model pilot reaction time and jet engine mechanical lags.

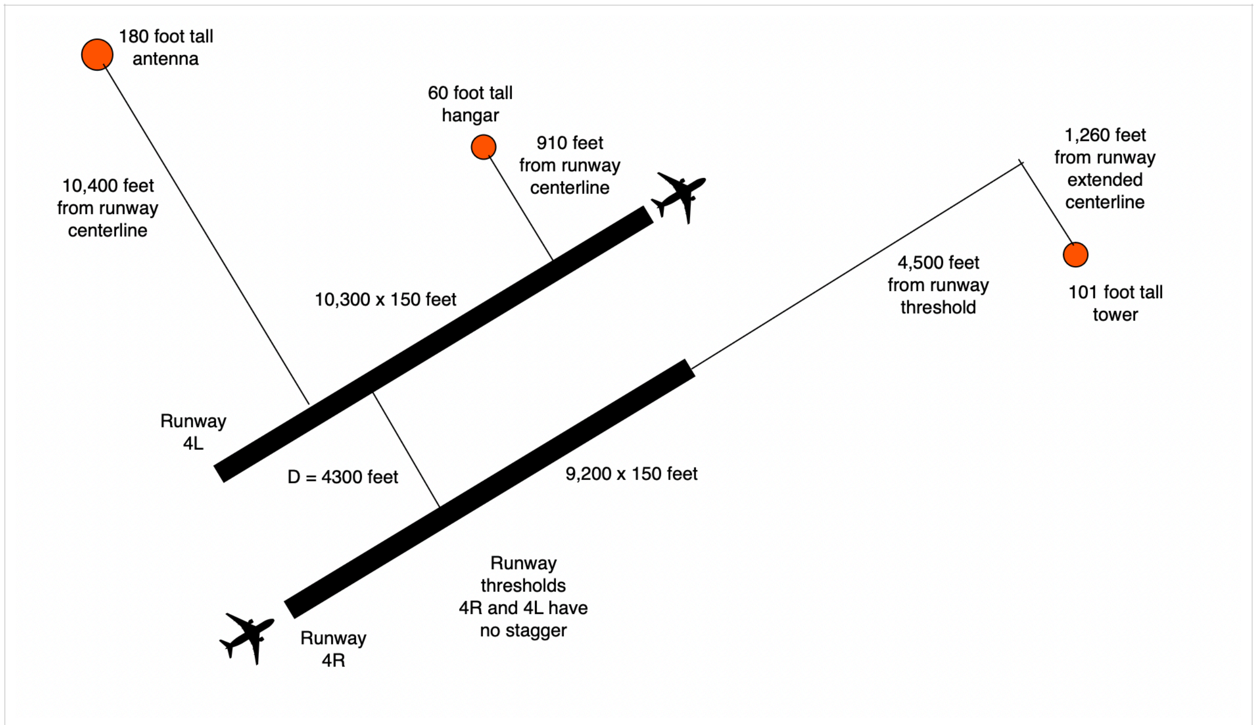


Figure 2. Runway Configuration for Problem 2. Both Runways are Precision Runways. Object Heights are Above Ground Level.

Table 1. Runway Operational Parameters and Fleet Mix for Problem 2. Consolidated Wake Turbulence Groups.

Aircraft Consolidated Wake Turbulence Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from Final Approach Fix
E	5	59	145
F	54	52	139
G	28	51	133
H	13	49	125

a) Estimate runway 4R's arrival capacity in IMC conditions. Please show me a couple of sample calculations for Tij and Bij (one for the opening case and one for the closing case). Also, please show me the manual calculation of the gap (G) allowing one departure between successive arrivals.

The Runway Capacity for Runway 4R is 30.6 arrivals/hr.

b) Estimate the departure capacity of runway 4L in IMC conditions.

The Runway Capacity for Runway 4L is 51.4 arrivals/hr.

c) Draw the Pareto diagram (i.e., arrival-departure diagram) for the runway configuration shown in Figure 2.

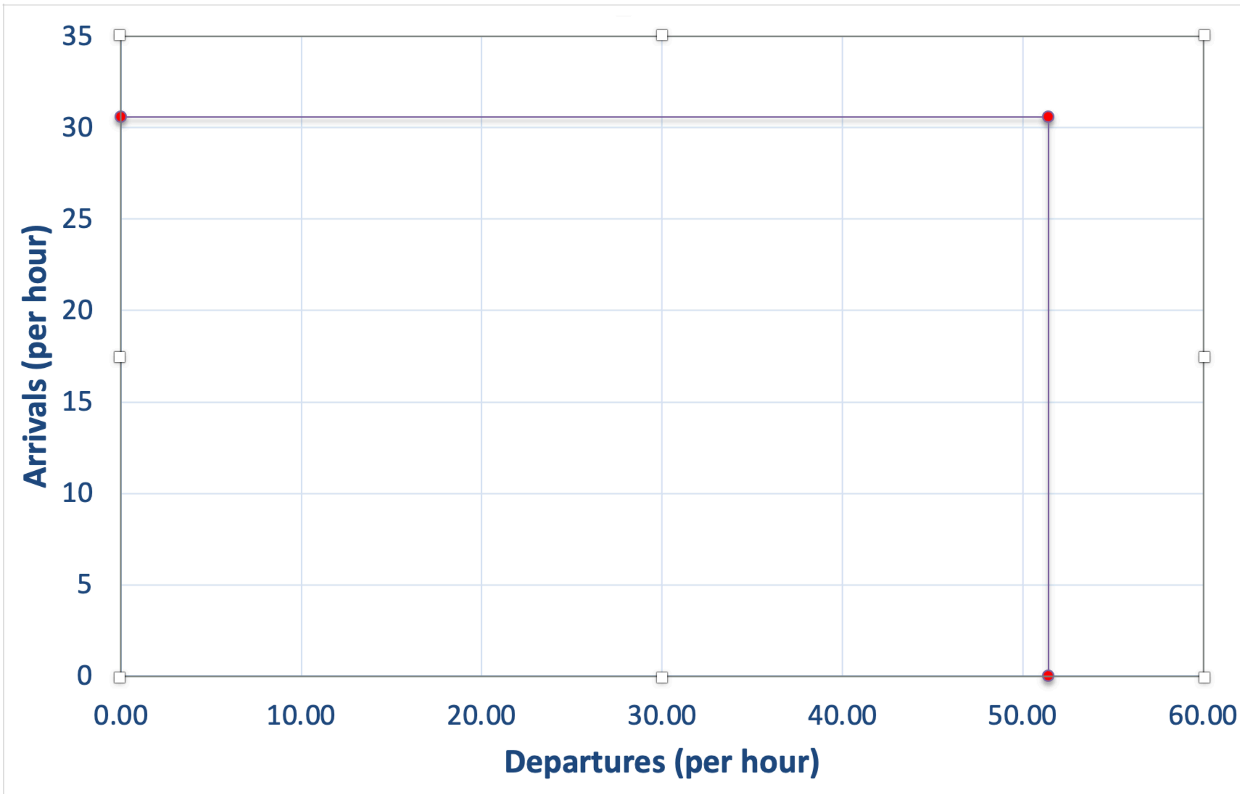


Figure 2.1 Pareto Diagram with Two Runways Operated in Segragated Mode (Arrivals-Departures).

d) If both runways are used in mixed operations (i.e., arrivals and departures on the same runway), draw the new Pareto diagram to represent the maximum number of arrivals and departures per hour. In your solution, assume 2.3 nm as the minimum distance between an arrival and a departure.

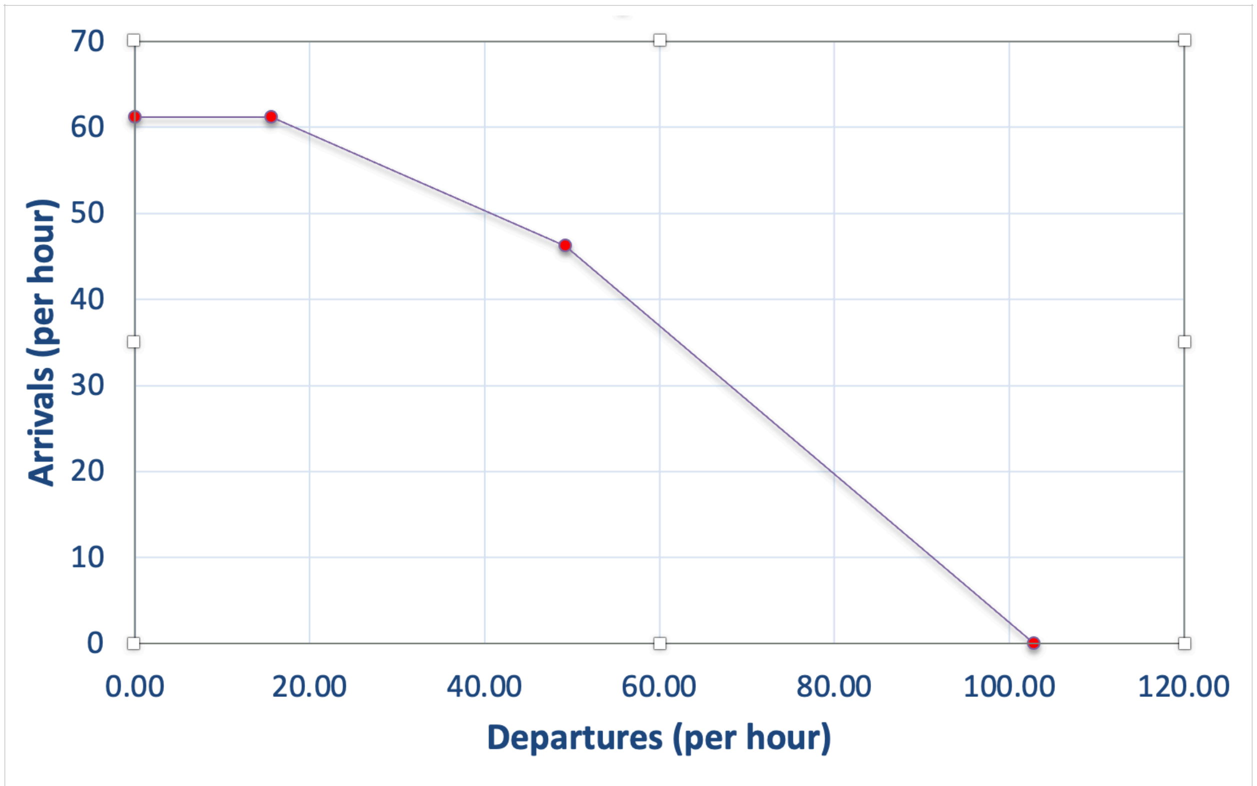


Figure 2.2 Pareto Diagram with Two Runways Operated in Mixed Mode (Arrivals-Departures).

Problem 3 (30 Points)

To solve this problem, refer to the airport configuration shown in Figure 2. The airport is located at 345 feet above mean sea level.

a) Find out if each one of the objects in the figure is an obstruction to navigation. State the critical Part 77 surface for each object. Also, state any remedial action.

i) The hangar is inside the transitional surface. The maximum height of the transitional surface 910 feet from the runway centerline is 58.57 feet (see calculation below). **The hangar penetrates the transitional surface.**

$h_t = (910 - 500)/7 = 58.57$ feet

500 feet is the semi-width of the primary surface.

ii) The 180-foot antenna lies on the Conical Surface, which extends beyond the Horizontal Surface for 4,000 feet at a slope of 20:1. The height of the Conical Surface at the antenna's location (i.e., 400 feet from the intersection of the horizontal and conical surfaces) is 170 feet (see calculation below). **The antenna penetrates the conical surface.**

$h_c = 150 + (10400 - 10000)/20 = 170$ feet

iii) The tower lies on the transition surface next to the approach surface. The approach surface's height at the tower's location is 86 feet. The transition surface has a 7:1 slope. 115 feet from the approach surface edge, the transition surface has a height of 102.43 feet. **The tower is not an obstruction to navigation.**

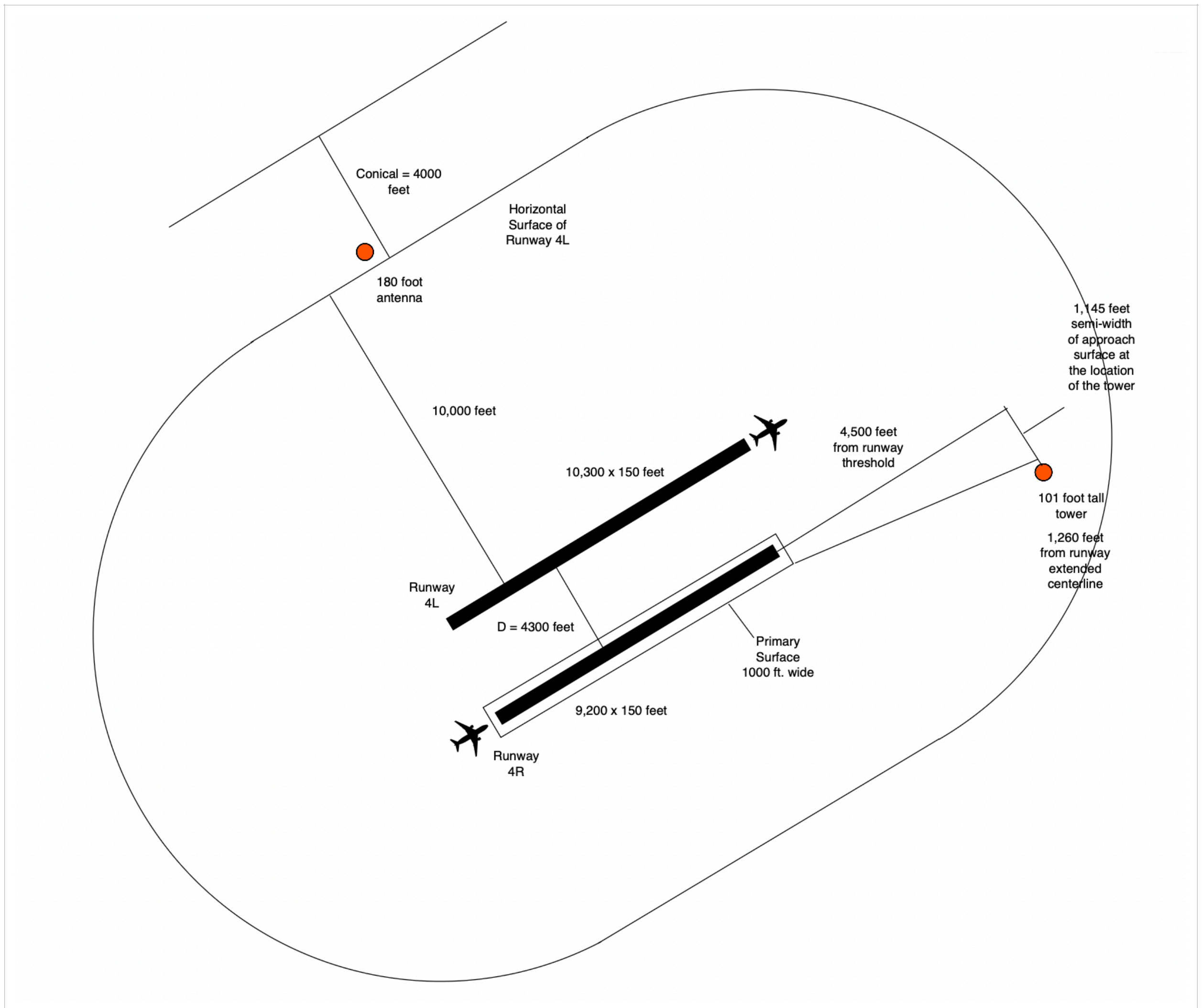


Figure 3.1 Tower and Antenna Location for Problem 3.

b) Will the 60-foot hangar violate the inner transitional OFZ surface of runway 4L? Assume ILS Category I operations. The critical aircraft is the Airbus A350-1000, shown in Figure 1.

The Airbus A350-1000 has a wingspan of 212.43 feet. The airport is 345 feet above sea level, and the hangar is 910 feet from the runway centerline. Figure 3.1 shows that a 60-foot hangar will not violate the inner transitional OFZ.

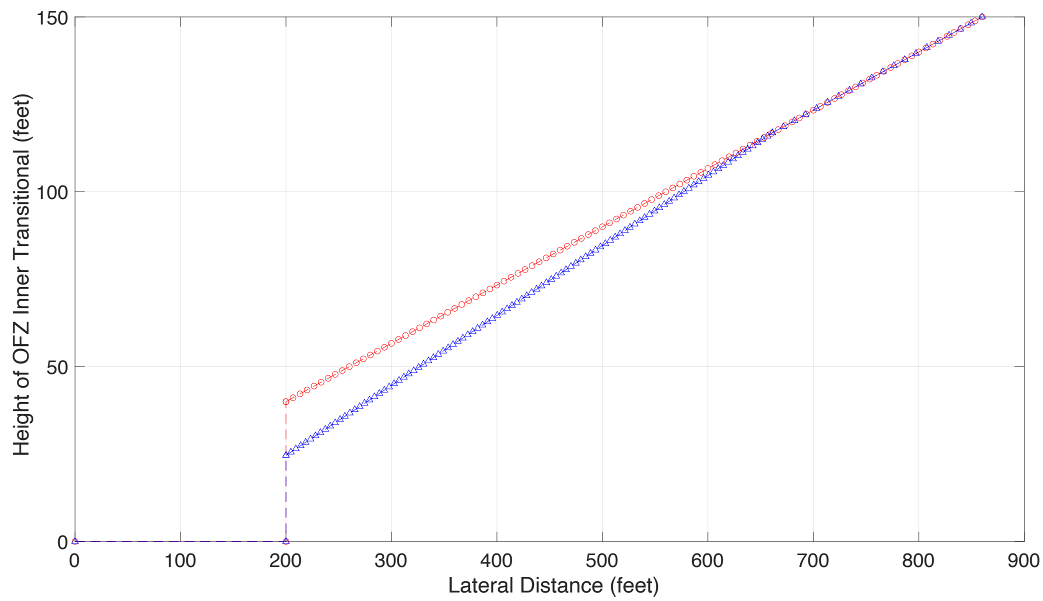


Figure 3.1 Inner Transitional OFZ for Airbus A350-1000. Blue Line is the Category II OFZ. The Red Line is the Category I OFZ.

c) Find the **minimum** distance between runway 4R and a parallel taxiway if two high-speed, acute-angle exits are to be constructed.

The Airbus A350-1000 has dimensions CMG ~110 feet and MGW = 42.13 feet. TDG is 6, and ADG is V. The minimum distance (according to Table 4-3) is 485 feet. The recommended distance is 600 feet to improve the use of the HS runway exit at higher entry speeds.

Table 4-3. Runway to Taxiway Separation for Reverse Turns from a High-Speed Exit Based on TDG

Runway Centerline to Taxiway/ Taxilane Centerline	TDG			
	3	4	5	6
Recommended separation	350 ft (106.7 m)	450 ft (137.2 m)	450 ft (137.2 m)	600 ft (182.9 m)
Radius for 150-degree turn after 30-degree exit	79 ft (24.1 m)	121 ft (36.0 m)	121 ft (36.9 m)	152 ft (46.3 m)
Minimum separation [1]	348 ft (106.1 m)	427 ft (130.1 m)	427 ft (130.1 m)	485 ft (147.8 m)

Note 1: Minimum separation distance based on the standard 30-degree high speed exit and maximum 50-degree steering angle for the reverse turn.

Figure 3.2 FAA Recommended and Minimum Distances with High-Speed Runway Exits. Source: FAA AC 150/5300-13B Change 1.

d) Generate a CAD drawing solution for a right-angle exit to be constructed 4,600 feet from runway threshold 4R. Use the minimum centerline radius required by the FAA. State all the necessary dimensions to build the fillet, including the fillet lengths, widths, centerline radius, and fillet radius.

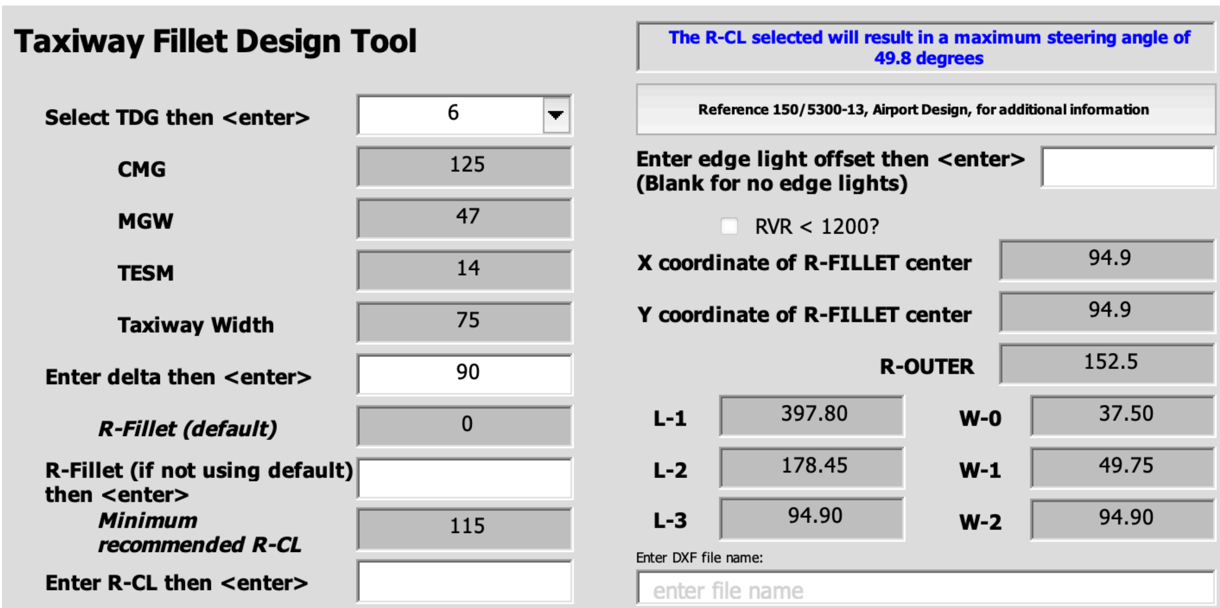


Figure 3.3 Design Dimensions for a Right Angle Runway Exit with Minimum Radii (115 feet) for TDG 6.

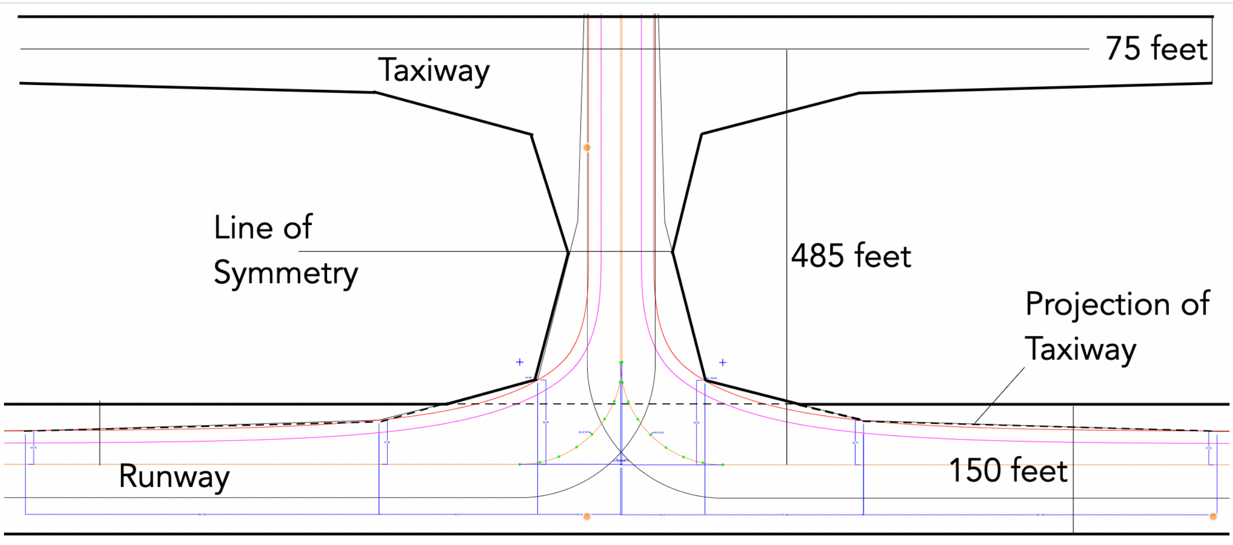


Figure 3.4 Right Angle Runway Exit with Minimum Radii (115 feet) for TDG 6.