Assignment 8: Runway Exit Placement and Runway Exit Geometric Design

Date Due: November 8, 2026

Problem 1

A regional commercial airport is planning to construct an 8,500-foot runway (see Figure 1). The airport serves 5% AAC A aircraft, 10% AAC B aircraft, and 85% AAC C class aircraft. The largest aircraft expected to operate at the airport is the Airbus A321neo (see Figure 2).

Using the cumulative runway exit distribution charts (see Figure 4-17 in the FAA AC 150/5300-13B) provided in class on pages 73-78 of the Runway Exit Design handout to perform a first-order analysis of runway exit locations. During the peak periods, the airport expects 35 operations per hour on the new runway. The design team suggests two high-speed exits per runway direction (see Figure 1). The airport is located 1,300 feet above mean sea level. Use the correction factors suggested in the handout.

a) Locate two high-speed locations F and G for landings on runway 9 and two HS exits for landings on runway 27. Use the class guidance of 50% of percent operations able to make the first high-speed runway exit and 95% by the second high-speed exit. In your analysis, consider AAC groups C and D to locate the high speed runway exits. **The airfield elevation should be consider in the analysis**. Clearly state your assumptions and correction factors for airfield elevation used. Remember that the locations suggested by the cumulative curves are the locations the point of curvature (PC) of each runway exit.

The Airbus A321neo belongs to ADG III. The TDG is 3.

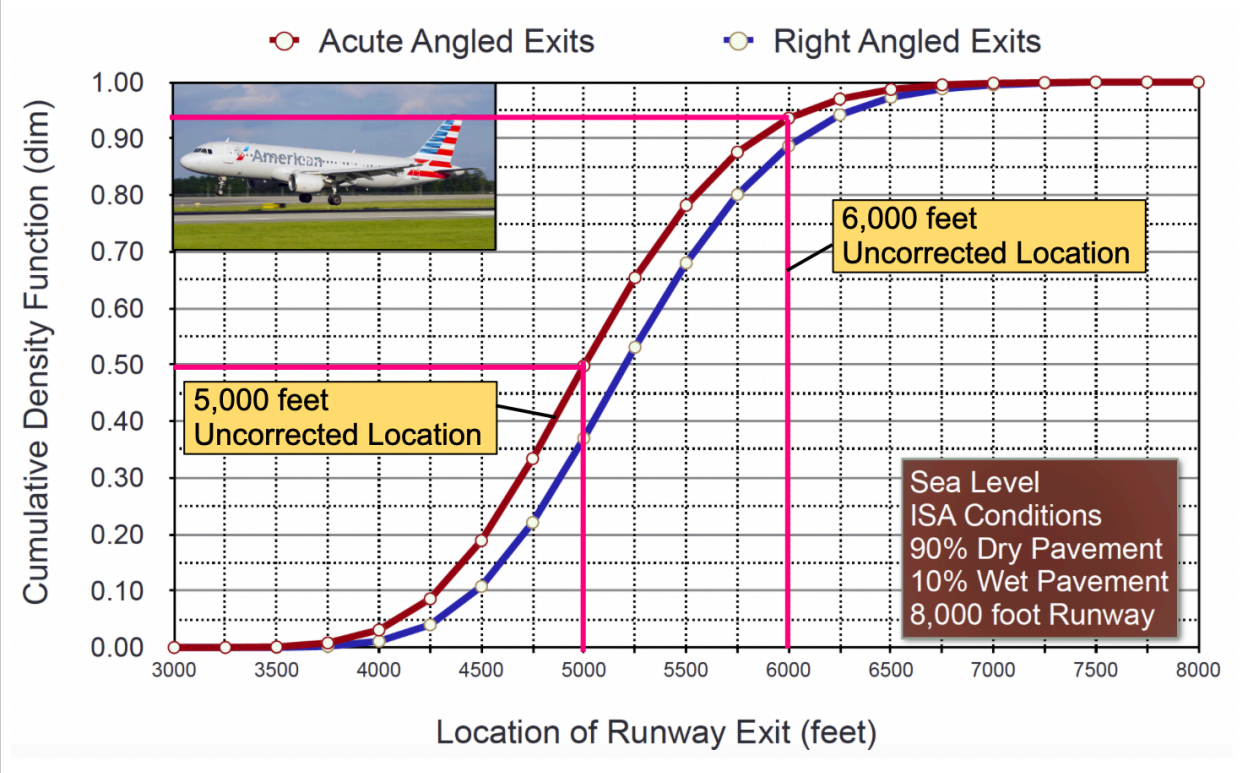


Figure 1.1 Cumulative Density Function of Runway Exit Probability for AAC C.

Applying a correction of 150 feet additional distance for every 1,000 foot elevation.

*Location to serve 50% of the population = 5000 + 1300/1000*150 = 5,195 feet*

*Location to serve 95% of the population = 6000 + 1300/1000*150 = 6,195 feet*

The location of the HS runway exits for AAC D would be: 5,800 and 7,000 feet uncorrected. Applying the correction factor (increase 167 feet for every 1000 foot elevation, yields 6,017 and 7,217 feet.

Since the largest aircraft is the A321neo, I would recommend designing for class AAC for now.

b) Recommend the runway centerline to taxiway centerline distance for the new runway considering recommended practices for high-speed runway exits.

FAA recommended distance between runway and taxiway centerline is 350 feet.

The recommendation stated in class is 600 feet because 350 feet does not provide adequate deceleration distance on the tangent section of the HS exit.

c) Use the FAA high-speed templates (https://www.faa.gov/airports/engineering/airport_design) to draw (in CAD) the high-speed runway exit "Golf" (G) in Figure 1. Show the dimensions in your drawing. State the aircraft and taxiway design group used in your analysis.

The TDG for the critical aircraft is TDG 3 (Airbus A321neo). The HS exit solution should be consistent with your recommendation in part (b). A CAD drawing is expected here.

d) Estimate the minimum centerline distance between runway exit centerlines H and I. Tell me the rationale of the separation between the two runway exits.

The taxiway-taxiway centerline distance according to Table 4-1 in the FAA AC 150/5300-13B is 144.5 feet. The distance allows two Airbus A321neo to be side by side on the bypass runway exits (entrances).

e) Draw in CAD the dimensions of runway exit **B**. Your drawing should show the complete runway entrance from runway to parallel taxiway (no half solution is acceptable). Show the dimensions of your design in your drawing including the radius of the right-angle centerline and associated dimensions W0-W3, L1-L3, and three radii.

I used a centerline radius of 150 feet in my solution which yields a steering angle of 25 degrees. The minimum radius in the fillet tool is 60 feet (with 50 degrees of steering angle) but that is too low to maneuver an aircraft outside the runway. When designing runway exits also consider future needs such as operations with ADG IV and V which can use the 8,500 foot runway.

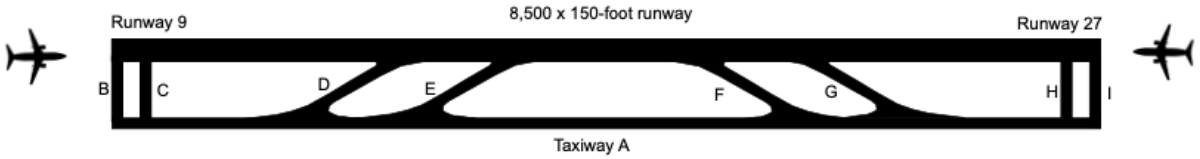
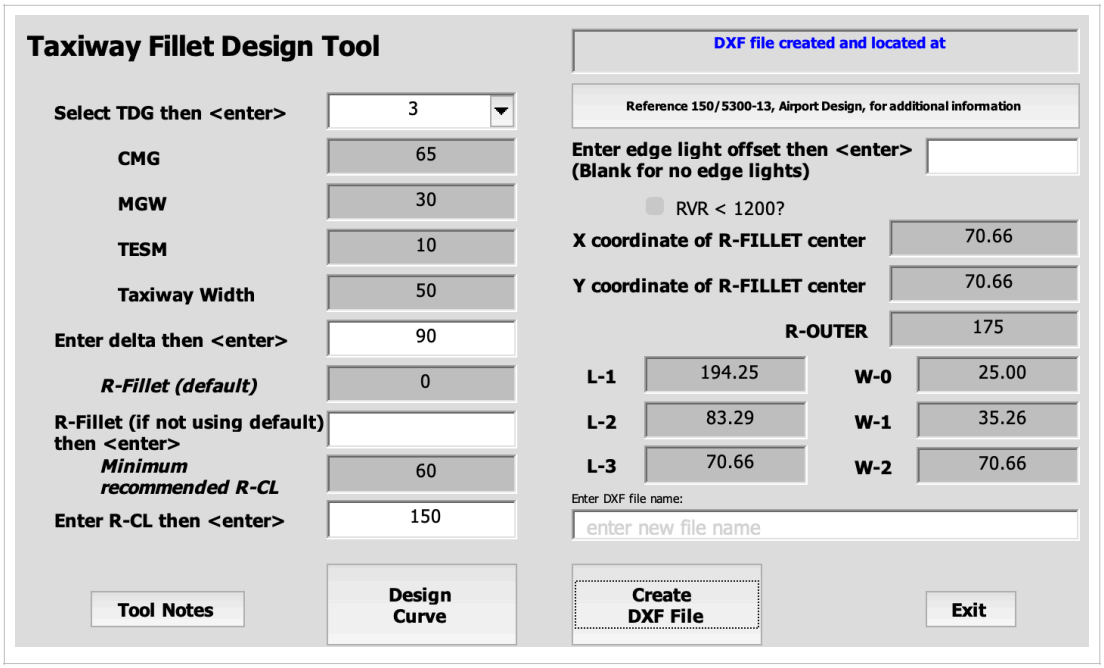


Figure 1. New Runway Configuration for Problem 1.


Taxiway Fillet Design Tool
DXF file created and located at
Reference 150/5300-13, Airport Design, for additional information
Select TDG then <enter>
3
CMG
65
MGW
30
TESM
10
Taxiway Width
50
Enter delta then <enter>
90
R-Fillet (default)
0
R-Fillet (if not using default) then <enter>
Minimum recommended R-CL
60
Enter R-CL then <enter>
150
Enter edge light offset then <enter> (Blank for no edge lights)
RVR < 1200?
X coordinate of R-FILLET center
70.66
Y coordinate of R-FILLET center
70.66
R-OUTER
175
L-1
194.25
W-0
25.00
L-2
83.29
W-1
35.26
L-3
70.66
W-2
70.66
Enter DXF file name:
enter new file name
Tool Notes
Design Curve
Create DXF File
Exit

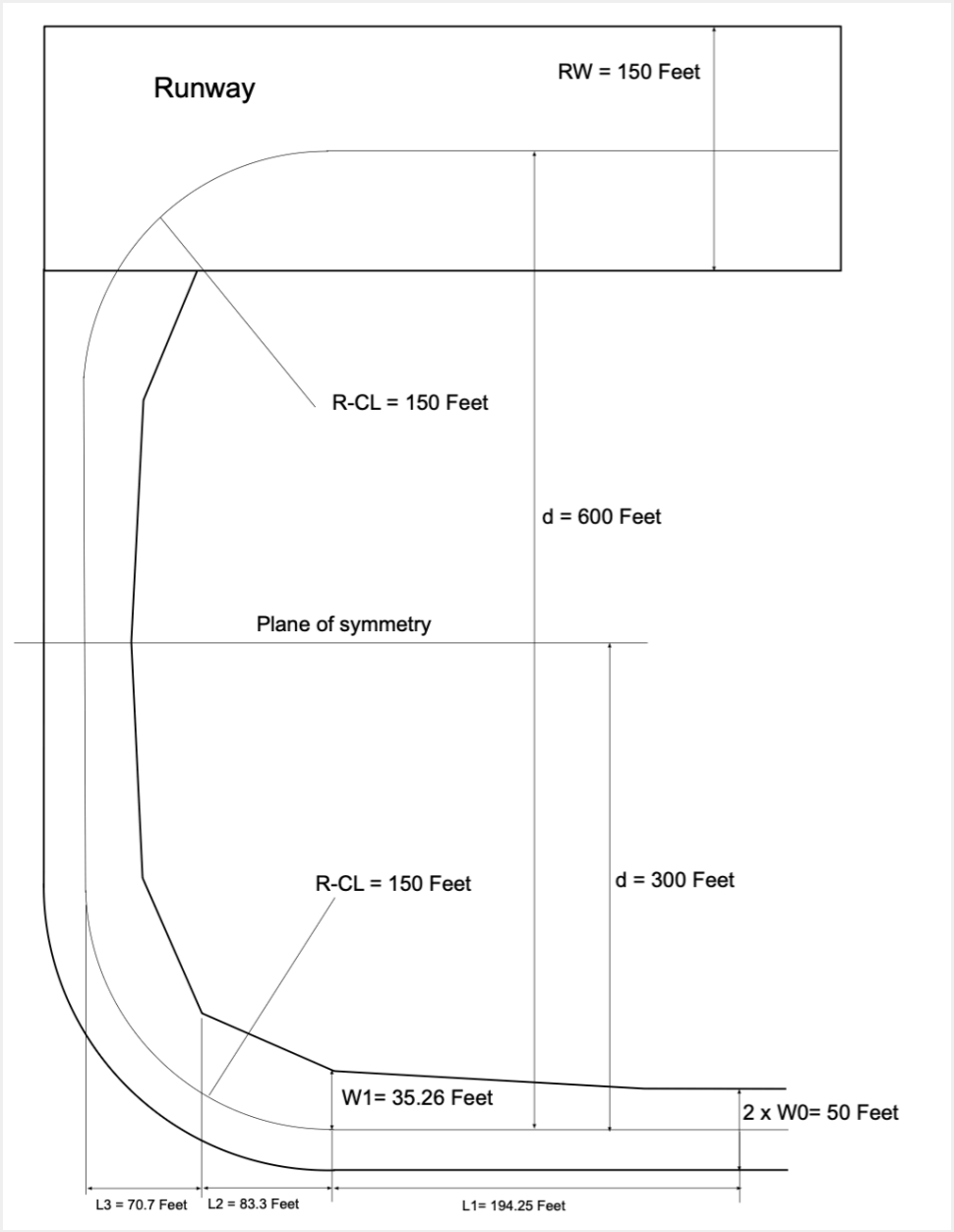


Figure 1.1. CAD Solution for Runway Exit Bravo (B).



Figure 2. Airbus A321neo Landing at Atlanta Hartsfield-Jackson International Airport (A. Trani).

Problem 2

Use the latest version (4.02) of the Runway Exit Design Model (REDIM) developed by Virginia Tech for FAA to evaluate the performance of your first-order analysis in Problem 1. Table 1 shows the fleet mix to be used in Problem 2. In the analysis, use the exit locations proposed in Problem 1.

The current version (REDIM 4) can be downloaded at the link below:

https://atsl.cee.vt.edu/products/runway-exit-design-interactive-model--redim-1.html

The MATLAB Runtime should install automatically with the REDIM install. However, if the model fails to install the MATLAB runtime, you can install it separately by downloading it here:

https://atsl-software-downloads.s3.amazonaws.com/redim/MATLAB_Runtimes/MATLAB_Runtime_R2021b_Update_3_win64.exe

Use the example described in the notes to do this exercise.

Assume an operating temperature of 85 deg.F. and use 90% dry pavement conditions. Run your analysis with Pilot Motivation Factors of 1.0 (default) for all aircraft.

Table 1. Aircraft Fleet Mix to Model Runway Occupancy Times for Problem 2. Use the Exit Locations Obtained in Problem 1.

Aircraft ID	Aircraft	Fleet Mix (%)
C182	Cessna 182	5
C56X	Cessna Citation 560 XL	7
C700	Cessna Longitude	3
B737	Boeing 737-700	20
B712	Boeing 717-200	20
E170	Embraer 170	35

Aircraft ID	Aircraft	Fleet Mix (%)
A21N	Airbus A321neo	10
Totals		100

a) Estimate the weighted average runway occupancy time (ROT) and the standard deviation of ROT on the runway considering the fleet mix in Table 1.

The REDIM outputs are shown below. The weighted average ROT is reported to be 54.5 seconds. The Standard Deviation of ROT is 13.3 seconds.

Exit	Exit Status	Exit Geometry	Point Of Curvature Location (ft)
F	Open	30 degree High Speed	5,194
G	Open	30 degree High Speed	6,194
H	Open	90 degree	8,169
I	Open	90 degree	8,314

Aircraft Name	F	G	H	I
A21N	44.6s	51.7s	76.7s	74.0s
B712	40.4s	47.8s	71.3s	67.9s
B737	44.6s	51.6s	74.0s	69.9s
C182	81.9s	86.9s	133.1s	109.7s
C56X	51.5s	57.6s	80.5s	77.7s
C700	43.1s	50.0s	70.5s	66.3s
E170	44.3s	50.8s	73.4s	70.4s

Aircraft Name	F	G	H	I	Aircraft Mix
A21N	38.8%	40.0%	20.7%	0.5%	10.0%
B712	18.0%	48.4%	32.7%	0.8%	20.0%
B737	44.0%	40.5%	15.2%	0.3%	19.7%
C182	97.2%	2.5%	0.2%	0.1%	4.9%
C56X	65.6%	22.2%	11.9%	0.3%	7.2%
C700	11.8%	34.9%	51.2%	2.2%	3.0%
E170	48.7%	35.0%	15.8%	0.5%	35.2%
Exit Mix	43.1%	36.8%	19.6%	0.6%	

Figure 2.1 Initially Modeled Exits for 8500-foot Runway. Landings from the West. Note: Only Two High-Speed Exits F and G and Two Right-Angle Exits (H and I).

b) Show me the runway exit configuration diagram provided by REDIM 4. The runway configuration diagram is a plot of the location of the runway exits done by REDIM.

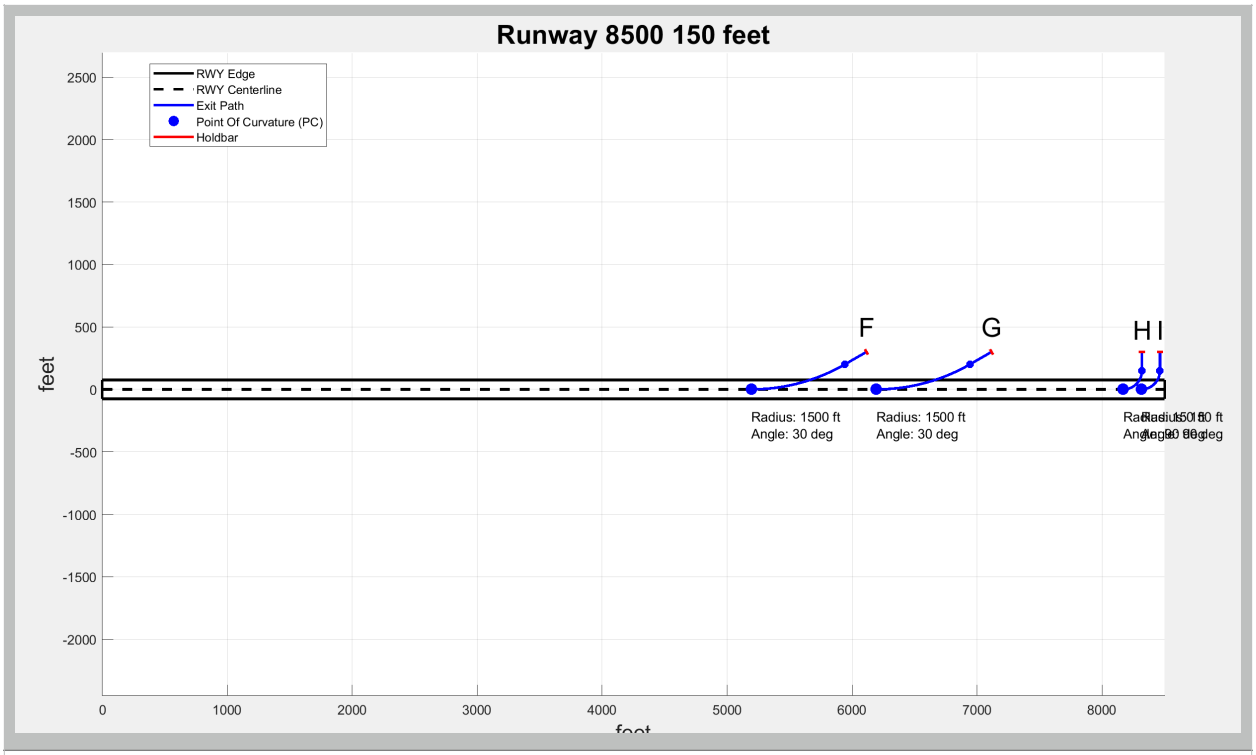


Figure 2.2 Runway Configuration Modeled in REDIM.

c) Estimate the percent of Airbus A321neo landings likely to use each of your two proposed high-speed runway exits (for example F and G in Figure 1). Show the full table of runway exit assignments provided by the model.

Runway exit F is used 38% of the time by the A321neo.

Runway exit G is used 40% of the time by the A321neo.

d) Estimate the percent of Embraer 170 landings likely to use each of the two proposed high-speed runway exits (F and G in Figure 1).

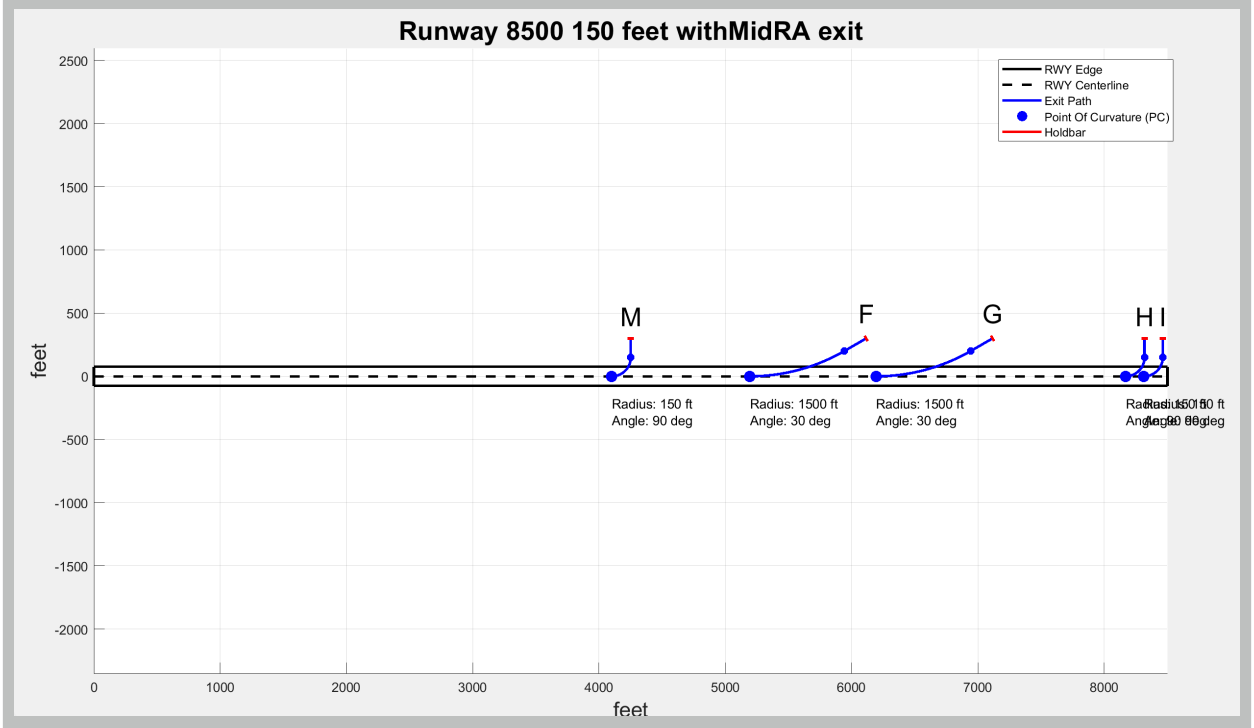
Runway exit F is used 48.7% of the time by the Embraer 170.

Runway exit G is used 35% of the time by the Embraer 170.

e) Would a right-angle runway exit at the runway mid-point improve the ROT time? Run that scenario and comment on any differences compared to the results obtained in part (a).

The REDIM outputs are shown below. The weighted average ROT is reported to be 53.7 seconds. The Standard Deviation of ROT is 12.8 seconds. The mid-point runway exit (called M) serves well small aircraft such as the Cessna 182 and the Cessna 560XI. 70.1% of the landings with Cessna 182 will exit at the mid-point (M). The reduction in ROT time is modest (slightly less than one second).

Exit	Exit Status	Exit Geometry	Point Of Curvature Location (ft)
M	Open	90 degree	4,101
F	Open	30 degree High Speed	5,194
G	Open	30 degree High Speed	6,194
H	Open	90 degree	8,169
I	Open	90 degree	8,314



Aircraft Name	M	F	G	H	I
A21N	39.4s	44.5s	51.7s	77.0s	75.1s
B712		40.4s	47.7s	71.4s	68.8s
B737	37.9s	44.5s	51.6s	74.1s	70.2s
C182	71.7s	75.6s	88.5s	134.8s	139.1s
C56X	41.9s	50.1s	58.1s	80.4s	74.6s
C700		42.8s	49.8s	70.4s	65.8s
E170	37.4s	43.9s	50.8s	73.6s	69.8s

Aircraft Name	M	F	G	H	I	Aircraft Mix
A21N	0.7%	37.4%	40.4%	20.8%	0.6%	10.0%
B712		18.0%	48.5%	32.7%	0.7%	20.0%
B737	1.1%	43.3%	39.8%	15.6%	0.2%	19.7%
C182	70.1%	25.9%	3.5%	0.2%	0.2%	4.9%
C56X	16.1%	49.2%	22.4%	12.1%	0.2%	7.2%
C700		11.8%	34.3%	51.2%	2.8%	3.0%
E170	2.6%	46.7%	34.7%	15.6%	0.5%	35.2%
Exit Mix	5.8%	37.5%	36.6%	19.6%	0.5%	

Figure 2.3 Modeled Exits for 8500-foot Runway with Mid-Runway Runway Exit.

Problem 3

Perform an evaluation of the runway exits at Charlotte International Airport runway 18R. **Use the Landing Event Database** developed by Virginia Tech for the FAA in the analysis. In your analysis consider **all the operations** in calendar year 2019. Consult the FAA airport diagram to identify the runway exits (FAA diagrams available at: https://www.faa.gov/airports/runway_safety/diagrams/).

a) Estimate the percent of Boeing 737-800 (B738) using high-speed runway exits W4 and W3.

Use the Landing Events Database (LED) to obtain the statistics.

Aircraft	W2	W3	W4	W7	Average
B738	73.8s 0.3%	53.7s 27.6%	45.0s 72.1%		47.5s

Figure 3.1Aircraft Utilization of Runway Exits for Runway 18R at CLT. The numbers reported are Fuselage Out ROT values.

72.1% of the Boeing 737-800 use runway exit W4. 27.6% of the Boeing 737-800 use runway exit W3.

b) For part(a), find the runway occupancy times (fuselage out) associated with Boeing 737-800 operations for W4 and W3.

Boeing 737-800 ROT is 53.7 seconds using runway exit W3. The ROT decreases to 45 seconds for runway exit W4.

c) Estimate the percent of Airbus A319 (A319) using high-speed runway exits W4 and W3.

Aircraft	W2	W3	W4	W7	Average
A319	69.7s 0.0%	55.0s 4.9%	48.1s 95.1%		48.5s

Figure 3.2 Airbus A319 ROT times.

The ROT times for the Airbus A319 are shown in Figure 3.2.

95.1% of the Airbus A319 use runway exit W4. 4.9% of the Airbus A319 use runway exit W3.

d) Compare the landing performance of the A319 and the B737-800 on runway 18R.

The Airbus A319 requires shorter distances to land compared to the Boeing 737-800.

e) Using the LED, determine the runway exit utilization of W3 and W4 for the Boeing 777-200. Compare the ROT times and the runway exit utilization of the B772 with the Airbus A319.

Boeing 777-200 aircraft land on runway 18R.During Covid, it looks lime the Boeing 777-200 was not used in those routes. We use the Boeing 767-300 (B763) instead. The ROT values for the wide-body aircraft are 4.6 to 8 seconds higher.

Aircraft	W2	W3	W4	W7	Average
A319	69.7s 0.0%	55.0s 4.9%	48.1s 95.1%		48.5s
B763		63.0s 12.5%	52.7s 87.5%		54.0s

Figure 3.3 Airbus A319 and B763 ROT times and Runway Exit Utilization.

f) Compare the 50th percentile ground speeds at the threshold observed at CLT runway 18R for the Boeing 777-200 and the Airbus A319. Comment on the observed values.

Using the Boeing 767-300 instead of the Boeing 777-200.

A319 threshold crossing speed = 132 knots

B763 threshold crossing speed = 133 knots

The approach speeds are very similar. The ROT times are very different because the Bowing 767-300 takes longer time to exit the runway after the PC point.