Assignment 9: Airport Runway Capacity

Date Due: April 6, 2018
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Problem 1

A single runway airport has a single 9,100 feet runway oriented East-West. The airport has an airport surveillance radar (ASR) which tracks aircraft up to 50 nautical miles form the airport site. The radar has a scan rate of 4 seconds. Tables 1 through 3 show technical parameters and the typical ATC separations at the airport under IMC conditions. Assume the minimum separations under VMC conditions are reduced by 10% from those observed under IMC conditions. Four aircraft groups operate at the airport. The airport has the following technical parameters: a) in-trail delivery error of 14 seconds (because there is a radar at the site), b) departure-arrival separation for both VMC and IMC conditions is 2 nautical miles, c) probability of violation is 5%. Arriving aircraft are "vectored" by ATC to the final approach fix located 11 miles from the runway threshold (see Figure). Arrivals follow in-trail after crossing the final approach fix. The airport aircraft mix, runway occupancy times and approach speeds are shown in Table 1.

You are allowed to modify the spreadsheet provided in class to solve the problem. Show me sample calculations for both opening and closing cases so that I know that you can do such calculations by hand.

a) Calculate the arrival-departure saturation capacity diagram (Pareto diagram) under IMC conditions. In your diagram, include at least one point to estimate the departure capacity with 100% arrival priority under mixed runway operations. Show me sample calculations of Tij and Bij so that I can judge your analysis.

b) Repeat part (a) for VMC conditions. Comment on the differences observed. Specifically, comment on the number of departure values obtained with 100% arrivals. Show me sample calculations of Tij and Bij so that I can judge your analysis.

Table 1. Runway Occupancy Times and Fleet Mix for Problem 1.

Aircraft RECAT Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
Small	23	46	123
Large	69	49	134
Heavy	8	62	147
Totals	100		

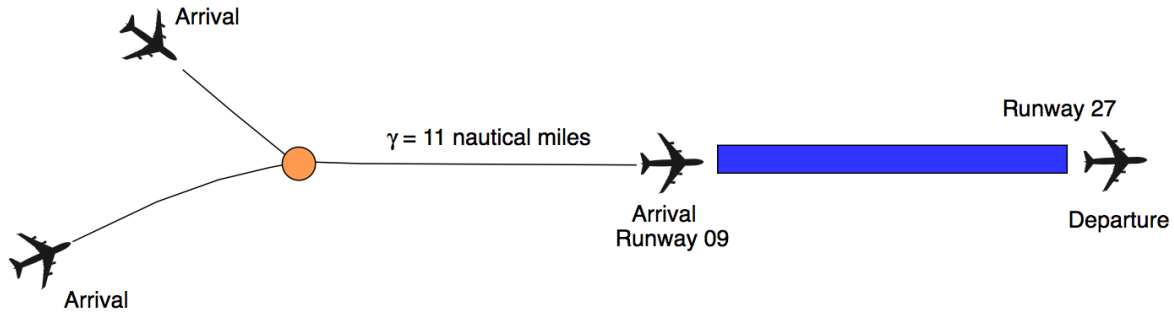

Table 2. Minimum arrival-arrival separations under IMC conditions. Values in are nautical miles. Values Shown Do Not Include Buffers.

Minimum Separation Matrix (nm)		Arrivals-Arrivals			
		Trailing Aircraft (Header Columns)			
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	3	3	3	3	3
Large	4	3	3	3	3
B757	5	4	3	3	3
Heavy	6	5	4	3	3
Superheavy	8	8	8	8	8

Table 3. Minimum departure-departure separations under IMC conditions. Values in are seconds. Buffers are not Included. Add 10 Seconds as Typical Buffers for each Cell Value in your Solution.

Departure-Departure Separation Matrix (seconds)					
		Trailing Aircraft (Header Columns)			
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	60	60	60	60	60
Large	90	60	60	60	60
B757	120	120	60	60	60
Heavy	120	120	120	120	90
Superheavy	150	120	120	120	120

Problem 2

This problem analyzes the runway capacity for LaGuardia Airport. Use Google Earth to make distance assessments of intersection distances for runways at LGA. Assume landing aircraft on runway 22 touchdown just before the intersection with runway 13 (i.e., no wake vortex effect for departures on runway 13).

Assume IMC conditions, with arrivals to runway 22 and departures from runway 13. The airport fleet mix is shown in Table 3. Note that LGA is using the new Re-Categorization developed by FAA with 6 groups (see page 43 of the Aircraft Classification handout). Assume the departing aircraft acceleration is 2.1 m/s^2. Consider the interactions between arrivals on runway 22 and departures on runway 13. For this analysis we use the following technical parameters: a) in-trail delivery error of 18 seconds under IMC conditions, b) probability of violation is 5%. Arriving aircraft are "vectored" by ATC to the final approach fix located 8 miles from the runway 22 threshold. Assume the fleet mix for all the runways is the same (to simplify the problem). The minimum separation matrix for LGA is shown on page 43 of the Aircraft Classification handout. LGA has several runway exits for runway 22 and hence minimum radar separation is 2.5 nm (blank cells on page 43 of the aircraft classification handout).

The ATC operations at LGA are such that, if an arrival is 2.5 nm from runway 22 threshold, the departure on runway 13 can be cleared for takeoff. The 2.5 nm distance provides a margin of safety for the departure to accelerate on runway 13 and cross the intersection.

Table 4. Runway Operational Parameters and Fleet Mix for LGA Airport. RECAT Phase 1 Groups.

Aircraft RECAT Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
A	0	N/A	N/A
B	0	N/A	N/A
C	2	60	146
D	71	50	142
E	24	49	138
F	3	51	127
Totals	100		

*Table 4. Departure-Departure Separations with **Buffers Included**. Columns 2-7 are the Following Aircraft. First Column Presents the Lead Aircraft. Values in are seconds.*

Aircraft	A	B	C	D	E	F
A	125	125	130	130	130	180
B	75	130	130	130	130	130
C	70	70	90	120	120	120
D	70	70	70	70	70	70
E	70	70	70	70	70	70
F	70	70	70	70	70	70

a) Explain in detail your analysis to account for the dependency between operations on runways 22 and 13. Estimate the arrival and departure capacities for LGA when runway 22 is used for arrivals and 13 for departures.

b) Plot the IMC capacity diagram for this airport.

c) Find the highest number of total operations (sum of arrivals and departures) possible at LGA. To solve this, consider that arrivals could be separated above the minimum separation values (i.e., opening larger gaps). Comment.

d) Do you think is safe to conduct Land and Hold Short Operations (LAHSO) if runway 31 is used for arrivals and 04 for departures? Explain.