Assignment 7: Airport Capacity and Geometric Design

Solution
Instructor: Trani

Problem 1

An airport is designing a new ramp area to accommodate three Boeing 747-8 cargo planes simultaneously. The airport authority needs to know the dimensions (A through R) of the apron area shown in Figure 1. In your solution consider the maneuvering envelopes of the Boeing 747-8 using the Boeing technical data. The design is such that aircraft are expected to power on their own out of the three positions (i.e., no need for a tow truck). Design and draw to scale your solution assuming no more than 55 degrees of steering angle available to the pilot. Provide at least 30 feet if clearance between a maneuvering aircraft and the wingtip of the adjacent vehicle. Assume the cargo building needs to be 45 feet in depth.

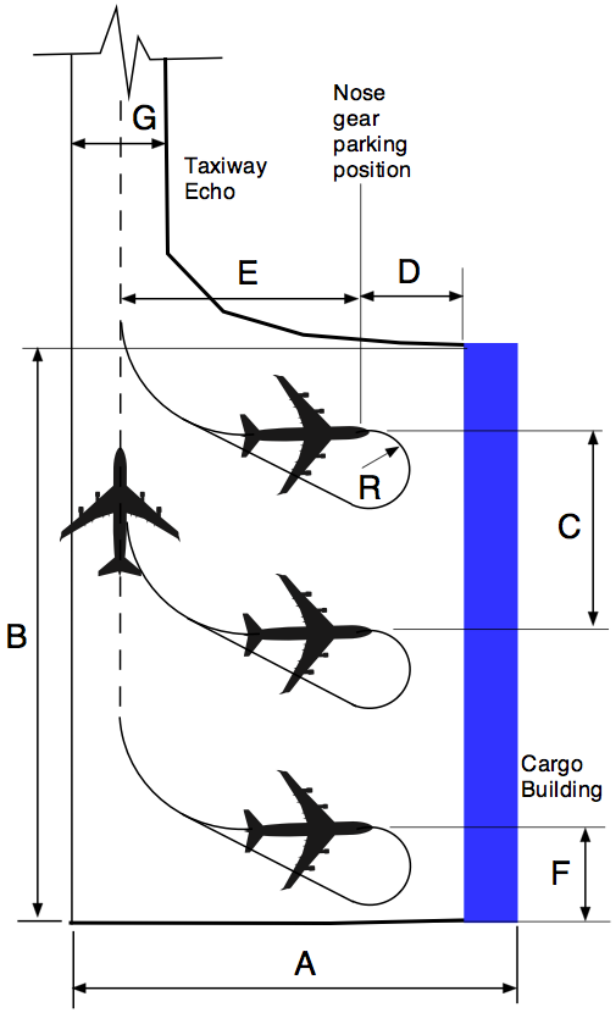
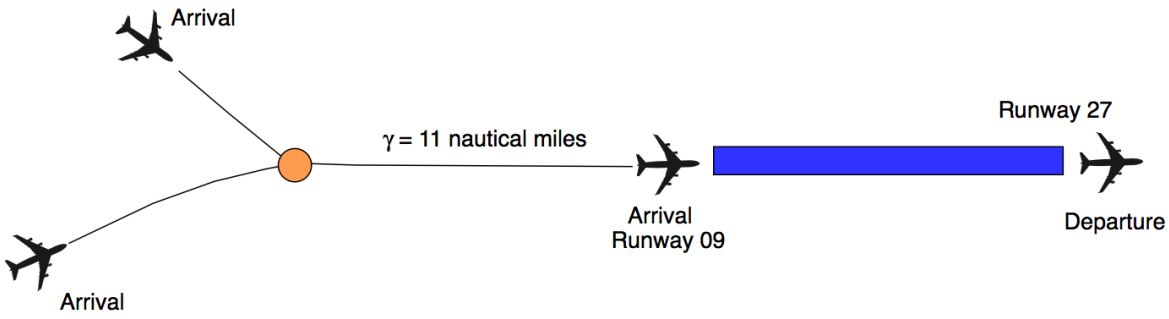


Figure 1. Proposed Cargo Ramp at the end of Taxiway "Echo".

Table 1a. Set of Dimensions to Execute a Feasible Solution for Problem of Figure 1.

Element	Dimension (meters)
A	205
B	380
D	30
E	80
G	25 (TDG 7)
R	43
F	80



Problem 2

Figure 2. Airport Diagram for Problem 2.

An airport shown in Figure 2 has a single 8,800 feet runway oriented East-West. The airport has a standard 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 and 2 show 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 (show all your work). 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. Airport Arrival Occupancy Times and Fleet Mix for Problem 1.

	Small	Large	B757	Heavy	Superheavy
ROT (s)	48	51	60	65	75
Percent Mix (%)	10	55	10	20	5
Vapproach (knots)	120	140	142	155	150

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.

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

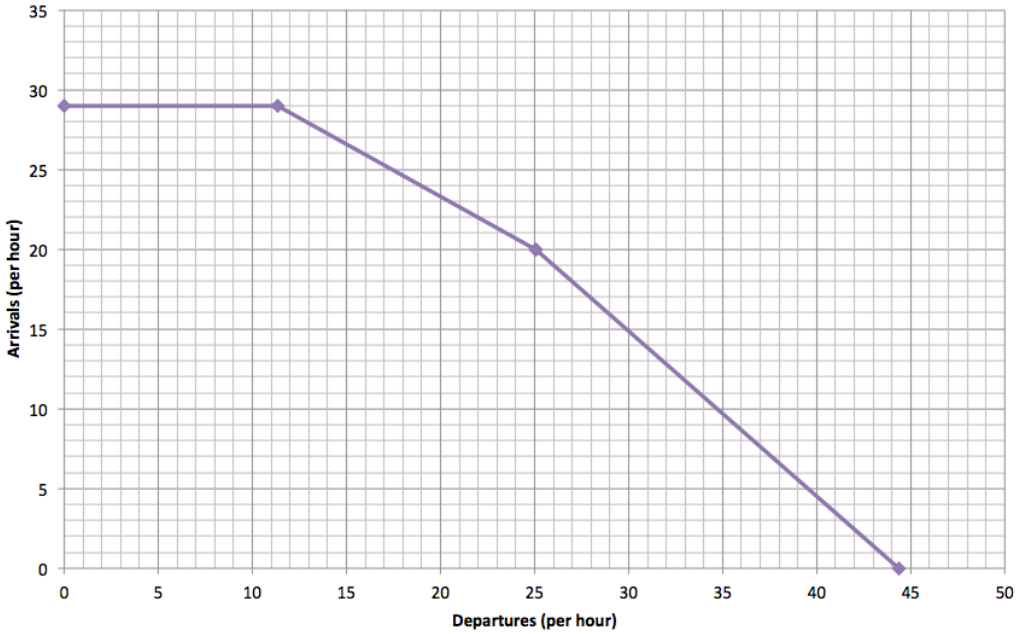


Figure 2a. IMC Pareto Capacity Diagram Obtained using Excel Program Provided in Class.

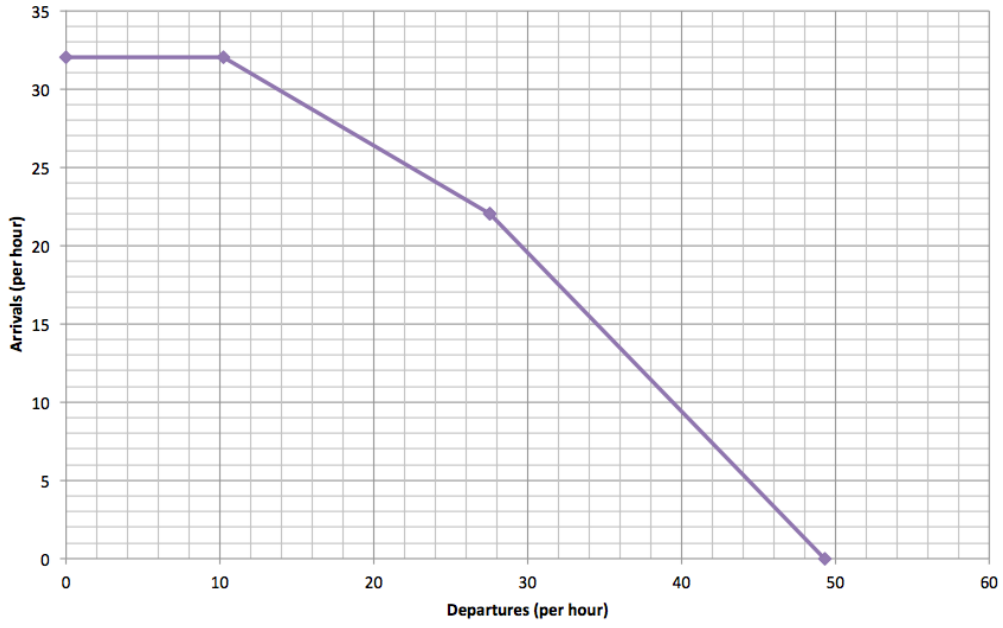


Figure 2b. VMC Pareto Capacity Diagram Obtained using Excel Program Provided in Class. Separations are Reduced by 10% Compared to IMC Conditions.

Problem 3

NextGen is the set of technologies that FAA is trying to develop to improve capacity of the NAS including the capacity of airports. One of the key technologies is the use of satellite-based surveillance called ADS-B Out.

Read the article on ADS-B out (http://en.wikipedia.org/wiki/Automatic_dependent_surveillance-broadcast) and answer the following questions:

a) How would ADS-B Out help air traffic controllers manage traffic in the future?

b) Can ADS-B Out help improve the capacity of the system to handle oceanic flights (i.e., those flying from North America to Europe or from Asia to Europe?). Briefly explain. You can read the article: http://www.aviationweek.com/Article.aspx?id=/article-xml/awx_03_14_2014_p0-672545.xml to understand the impact of ADS-B in the recent mystery of flight 370.

c) Will ADS-B Out improve runway capacity?

d) Assume that ADS-B Out allow a reduction in the following key parameters for Problem 2: i) reduction of common approach path from 11 to 6 miles and ii) reduction of inter-arrival time delivery accuracy parameter from 14 to 8 seconds. Estimate the Pareto diagram for the airport in Problem 2 using such parameters. Are the differences significant? Comment.

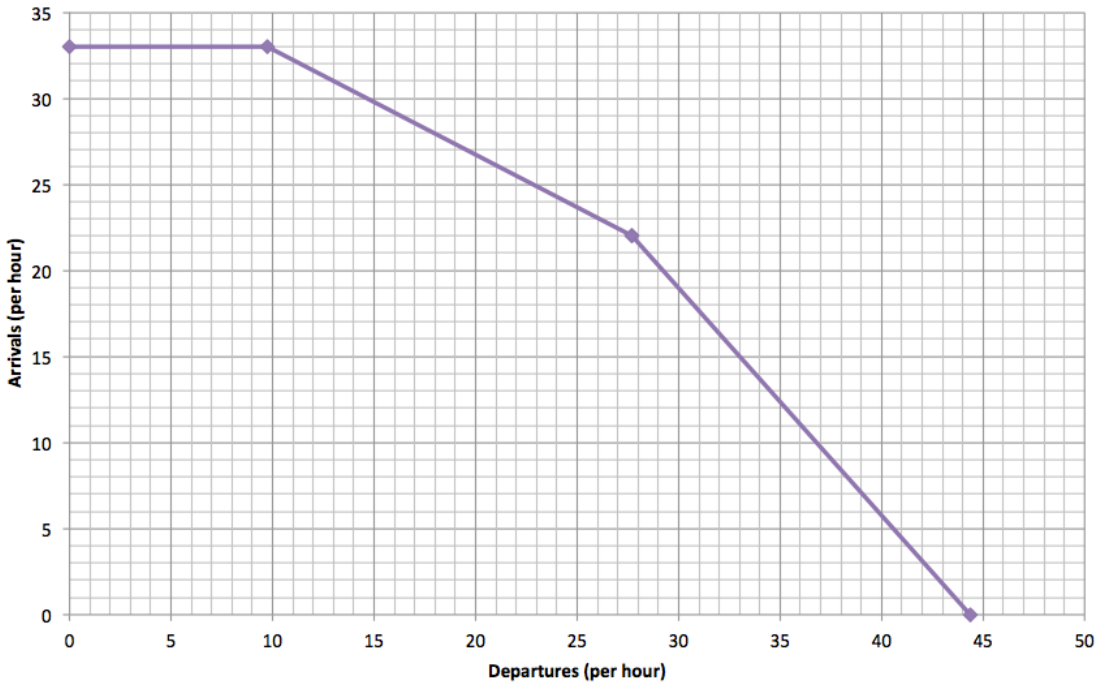


Figure 3a IMC Pareto Diagram for Problem 2 with NextGen Assumptions. The Arrival Capacity Gains are on the Order of 4 arrivals per hour (13% improvement). The Departure Saturation Capacity does See a Benefit According to the Statement of the Problem.