Assignment 3: Runway Length and EMAS Design

Date Due: February 9, 2015 Instructor: Trani

Problem 1

A new airport will be constructed in a 4000 acre land located 2,500 feet above sea level. The new airport site has a design temperature of 25 degrees Celsius. The critical design aircraft for the airport is the Boeing 747-8 and shown in Figure 1.

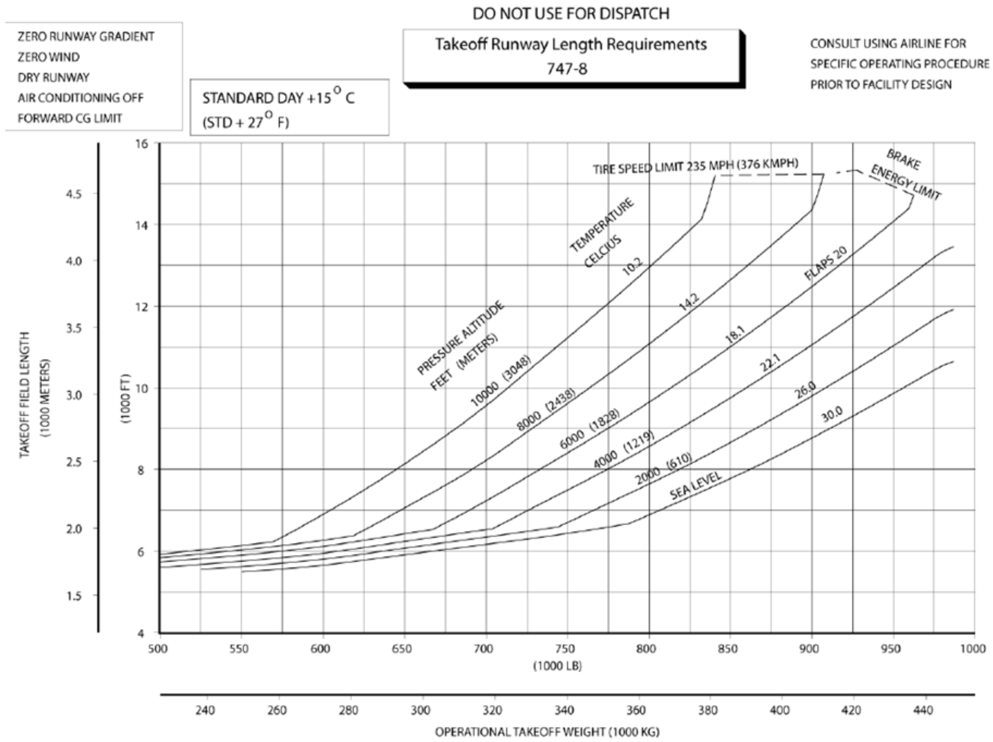
Table 1. Aircraft for Airport in Problem 1.

Aircraft	Engine	Remarks
Boeing 747-8 (passenger) 987,000 Maximum Takeoff Weight	GEnx 2B engines	Passenger configuration with a total of 513 seats

Figure 1. Boeing 747-8 Passenger Version (A.A. Trani).

a) Find the runway length required to satisfy FAA and EASA regulations to operate the critical aircraft without takeoff restrictions from the new airport. State the temperature profile used in your calculations.
Design temperature 25 degrees Celsius
Elevation: 2500 feet
The standard day Temp: 10 degrees Celsius
Use Standard Day +15 ° C
From the Takeoff Runway length requirements graph (STD+15° C)

At maximum takeoff weight, the takeoff runway length needed is 12,400 ft.



b) Find the dimensions of the runway safety area, runway protection zones, object free areas and obstacle free zone (including dimensions of the inner transitional surface) for the runway at the new airport. The new runway is expected to have a Category 2 Instrument Landing System (ILS) with visibility minima of 1200 feet RVR.

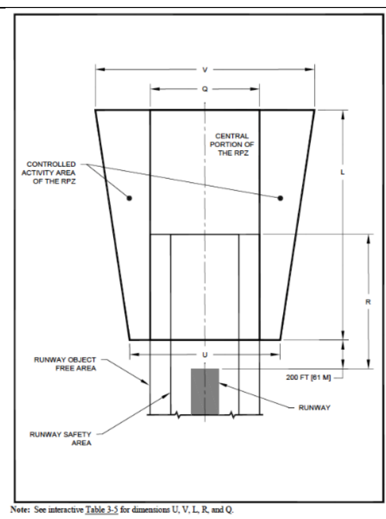
Runway protection zones:

Aircraft: Boeing 747 - 8

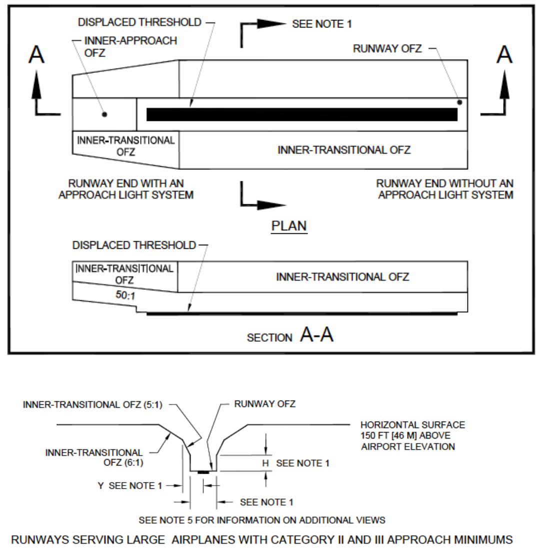
Approach speed = 152 knots

Wingspan = 68.4 m

ADG = VI   TDG = 5

	RSA - Length beyond departure end (R): 1000ft - Length prior to threshold (P): 600ft - Width (C): 500ft RPZ - Length (L): 2500ft - Inner Width (U): 1000ft - Outer Width (V): 1750ft - Acres: 78.914 ROFA - Length beyond runway end (R): 1000ft - Length prior to threshold (P): 600ft - Width (Q): 800ft

OFZ

	Inner-transitional OFZ (for Cat-II/III) Width of OFZ: 400 feet (122 m) for operations by large aircraft $H_{meters} = 16 - 0.13(S_{meters}) - 0.0022(E_{meters}) = 5.43m$ (18.328 feet) $Y_{meters} = 132 + 1.08(S_{meters}) - 0.024(E_{meters}) = 187.58m$ (622.352 feet) Where: S_{meter}=most demanding wingspan, 68.4m E_{meter}=runway threshold elevation above sea level, 762m (2500ft)

c) Draw all 4 basic runway protection areas to scale using Autocad or any drawing program of your choice (planview drawing is OK).

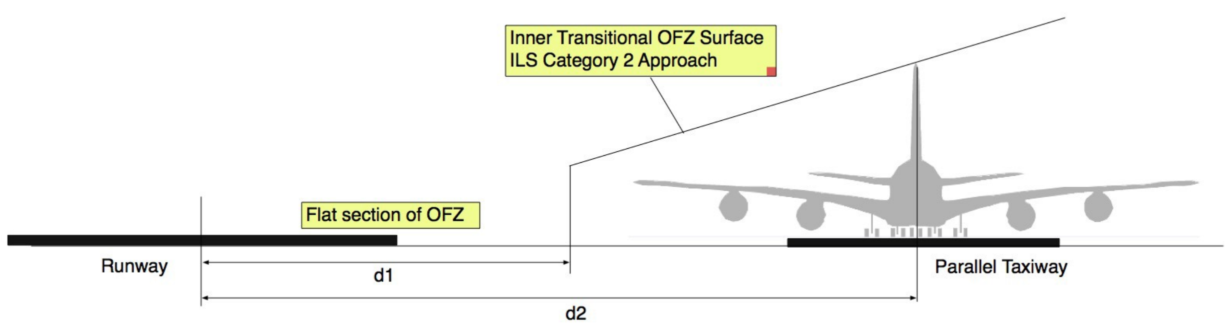
d) Find the dimensions of distances d1 and d2 (shown in the diagram below) to satisfy the new runway OFZ surface. Note that the distance d2 is the minimum distance between the runway centerline to a parallel taxiway allowing the critical aircraft tail to be outside the inner transitional OFZ volume.

- D1 : flat section of OFZ (ROFZ) is 200 feet (61m) for operations by large aircraft
- H_{meters}: 5.43m
- Slope: 5 (horizontal) : 1 (vertical) to the 187.58m (Y_{meters}) offset from the center line
- The height of first inner-transitional OFZ :

$$h_1 = 5.43 + \frac{187.58 - 61}{5} = 30.65 \text{ m}$$

The height of the aircraft (Boeing 747-8) on the next runway is 19.51m at maximum height.

- Therefore, d2=61m+(19.51m-5.43m)*5=131.4m (431 feet).



Problem 2

La Guardia Airport (LGA) has installed EMAS systems on all the runway ends. Assume the critical aircraft operating at LGA and used in the EMAS installation is the Boeing 757-200 (pictured below).

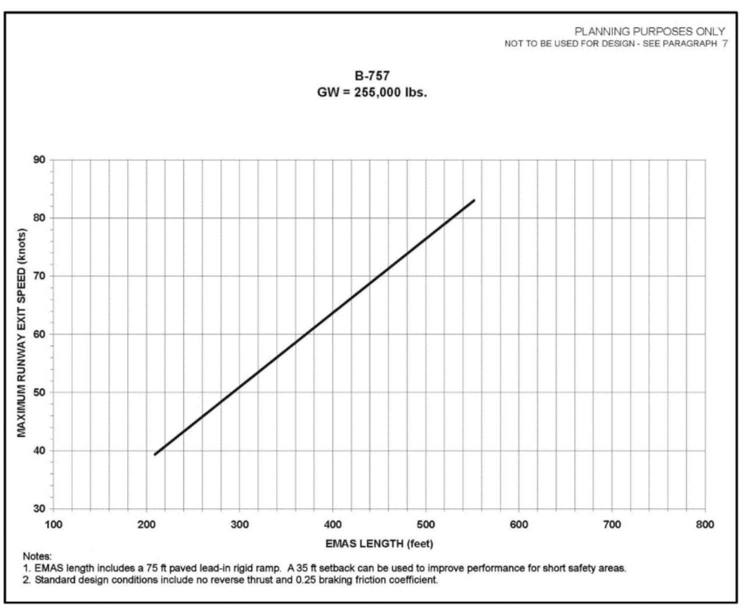
Figure 2. Boeing 757-200 Lining up and Waiting at CLT Airport (A.A. Trani).

a) Use Google Earth and estimate the length of the EMAS systems installed at runways ends 4 and 31.

- Runway 13/31=327 ft (100 m)
- Runway 4/22=276 ft (84.2m)

b) Using the guidance of the Advisory Circular 150/5220-22A estimate the length of an EMAS installation to stop the critical aircraft at the design speed of 70 knots.

The LGA airport requires 450ft of EMAS length at the design speed of 70 knots.



Problem 2

c) If the values estimated in parts (a) and (b) are not the same, estimate the maximum exit speed the EMAS systems at LGA would contain the critical aircraft. Explain.

- Runway 13/31: up to 55 knots of maximum runway exit speed
- Runway 4/22: up to 50 knots of maximum runway exit speed

Problem 3

Read the short article about airport Approach Lighting Systems (ALS) in Wikipedia (https://en.wikipedia.org/wiki/Approach_lighting_system) and answer briefly.

a) What is the purpose of the ALS system.

ALS usually serves a runway that has an instrument approach procedure (IAP) associated with it and allows the pilot to visually identify the runway environment and align the aircraft with the runway upon arriving at a prescribed point on an approach.

b) How many types of Medium-intensity Approach Lighting Systems are listed in article?

MALSR: Medium-intensity Approach Lighting System with Runway Alignment Indicator Lights

MALSF: Medium-intensity Approach Lighting System with Sequenced Flashing lights

c) Who controls the runway lights at an airport with a control tower?

The runway lighting is controlled by the air traffic control tower.

d) Can the approach lights of the ALS system be installed inside the RSA area?

Yes. From Chapter 6 of the AC 150/5300-13A

NAVAID	Fixed-By-Function		
	In RSA	In ROFA	Associated Equipment
Airport Beacon	No	No	N/A
ALS	Yes	Yes	No [1]
ASDE-X	No	No	N/A
ASOS, AWOS	No	No	N/A
ASR	No	No	N/A
ATCT	No	No	N/A
DME	No	No	No
GS	No [2]	No [2, 3]	No
IM	Yes	Yes	Yes
LDIN	Yes	Yes	No [1]
LOC	No	No	No
LLWAS	No	No	No
MM	No	No	No
NDB	No	No	N/A
OM	No	No	No
PRM	No	No	No

Problem 4

Use Google Earth and Airnav.com to learn about the runway features of the Virginia Tech/Montgomery County Executive Airport (BCB). The current airport is designed for Runway Design Code (RDC) group B-II and visibility minima no less than one mile. The airport has approach capability with a localizer and 1 mile visibility conditions. A new runway expansion to 5,500 feet is planned to allow RDC group C-II to operate at the airport with the same visibility minima as the existing airport. C-II include medium size corporate jets like the Cessna Citation X (see Figure 3) and the Gulfstream G350.

a) Compare the RSA and ROFA dimensions of the airport using the old and new design standards. Comment.

RDC group B-II	RDC group C-II
RSA • Length beyond departure end: 300ft • Length prior to threshold: 300ft • Width: 150ft ROFA • Length beyond runway end: 300ft • Length prior to threshold: 300ft • Width: 500ft	RSA • Length beyond departure end: 1000ft • Length prior to threshold: 600ft • Width: 550ft ROFA • Length beyond runway end: 1000ft • Length prior to threshold: 600ft • Width: 800ft

The new RDC category requires longer dimensions.

b) Estimate the length of the displaced threshold on runway end 30 to satisfy the new RSA requirement. Explain why a displaced threshold is needed on runway 30 today.

Currently, the length of RSA and ROFA is 300ft. If the BCB airport redesign to RDC C-II, the RSA and ROFA should be 600ft prior to threshold. However, the airport is right next to the road (south main street), so the displaced threshold is essential. The BCB airport has 150ft of displaced threshold. Therefore, an additional 450ft distance is needed for a 600 foot displaced threshold.

c) Compare the dimensions of the approach and departure RPZ surfaces of the old and new design standard. Comment.

RDC group B-II	RDC group C-II
RPZ • Length: 1000ft • Inner Width: 500ft • Outer Width: 700ft • Acres: 13.770	RPZ • Length: 1700ft • Inner Width: 500ft • Outer Width: 1010ft • Acres: 29.465

Figure 3. Cessna Citation X at BCB Airport (A.A. Trani). One of the Fastest Civilian Aircraft Flying Today (Mach 0.925 Maximum Speed).