Assignment 4

Date Due: September 27, 2025 Instructor: Trani

Problem 1

Before solving this problem, familiarize yourself with the FAA AC 150/5220-22B and review the course notes.

A regional airport in Oregon is evaluating the need for a runway arrestor system (EMAS). The airport has a 670-foot grassy area at one runway end (see Figure 1). The critical aircraft is the Boeing 717-200 (MTOW = 110,000 lbs.) also shown in Figure 1. The Boeing 717-200 is a derivative of the Douglas DC-9 and has similar size and weight. The airport has approach procedures with runway visibility minima of **3/4 of a nautical mile** (RVR). The airport is located at 587 feet above mean sea level conditions.

a) Find the RDC code for the runway design to accommodate the Boeing 717-200. State all three parameters of RDC.

ADG = III, AAC = C, then,

RDC: AAC-ADG-RVR

The RDC for the Airport is C-III-4000

Note: Use Table 1-3 in the FAA AC 150/5300-13B to select the correct Runway Visual Range (RVR).

Table 1-3. Visibility Minimums

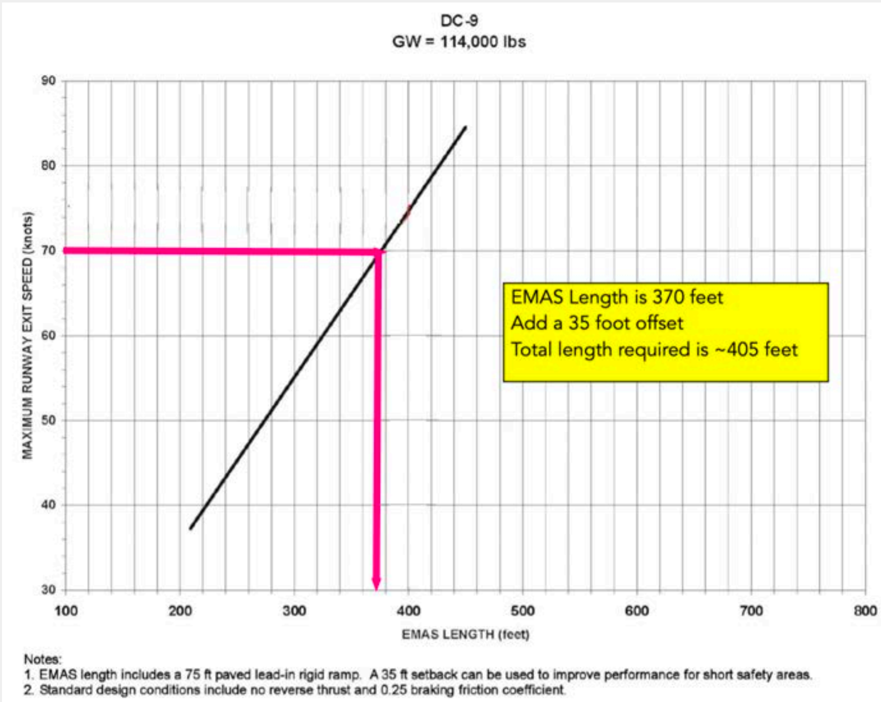
RVR *	Instrument Flight Visibility Category (statute mile)
5,000 ft (1,524 m)	Not lower than 1 mile (1.6 km)
4,000 ft (1,219 m)	Lower than 1 mile (1.6 km) but not lower than ¾ mile (1.2 km)
2,400 ft (732 m)	Lower than ¾ mile (1.2 km) but not lower than ½ mile (0.8 km)
1,600 ft (488 m)	Lower than ½ mile (0.8 km) but not lower than ¼ mile (0.4 km)
1,200 ft (366 m)	Lower than ¼ mile (0.4 km)

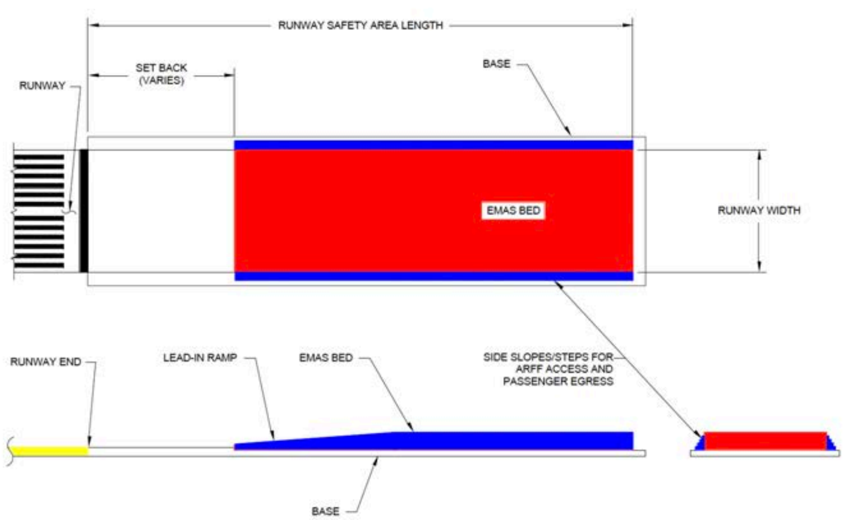
Note: * RVR values are not exact equivalents.

b) Find the size of the EMAS required to bring the runway end into compliance (i.e., legal RSA). State the recommended design exit speed used in your design.

Use the planning EMAS chart for the Douglas DC-9 (Douglas is now Boeing) as a surrogate for the Boeing 717-200. The Total EMAS length is ~405 feet including 370 feet ofcellular concrete bed and 35-foot offset (see figure below).

EMAS Dimensions for Boeing 717-200 (Using DC-9 as Surrogate Aircraft).





c) State the dimensions of the RSA, ROFA, and RPZ for the Boeing 717-200.

Use Table G-9 in Appendix G of the FAA AC 150/5300-13B. Use the column labeled “Not Lower than 3/4 mile” since the airport has visibility minima of 3/4 of a mile.

Runway Safety and Protection Surface Dimensions for RDC C-III-4000	
RSA	1000 feet beyond departure end 600 feet prior to landing threshold 500 feet wide

ROFA	1000 feet beyond departure end 600 feet prior to landing threshold 800 feet wide
Approach RPZ	1700 feet long 1000 feet inner width 1510 feet outer width
Departure RPZ	1700 feet long 500 feet inner width 1010 feet outer width

d) Draw to scale in the CAD software of your choice the three surfaces above.

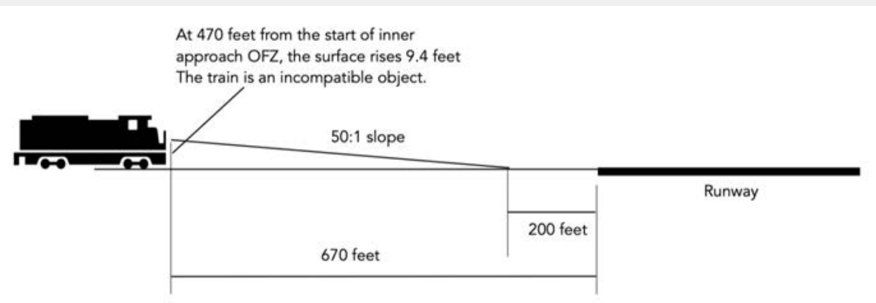
e) If the maximum height of a railroad car is 23 feet, find if the OFZ surface is violated by the passing train car. Show your calculations.

The FAA defines the Inner Approach (IA) OFZ surface as follows (see paragraph 3.11.3 in the FAA AC 150/5300-13B).

"The IA-OFZ is a defined volume of airspace centered on the approach area. It only applies to runways with an Approach Landing System (ALS). The IA-OFZ begins 200 feet (61 m) from the runway threshold at the same elevation as the runway threshold and extends 200 feet (61 m) beyond the last light unit in the ALS. Its width is the same as the ROFZ and rises at a slope of 50 (horizontal) to 1 (vertical) from its beginning."

At the location of the railroad track, 470 feet from the start of inner approach OFZ, the surface rises 9.4 feet. The train height of 23 feet is an incompatible object (see figure below).

Side View of Inner Approach OFZ Surface for Problem.

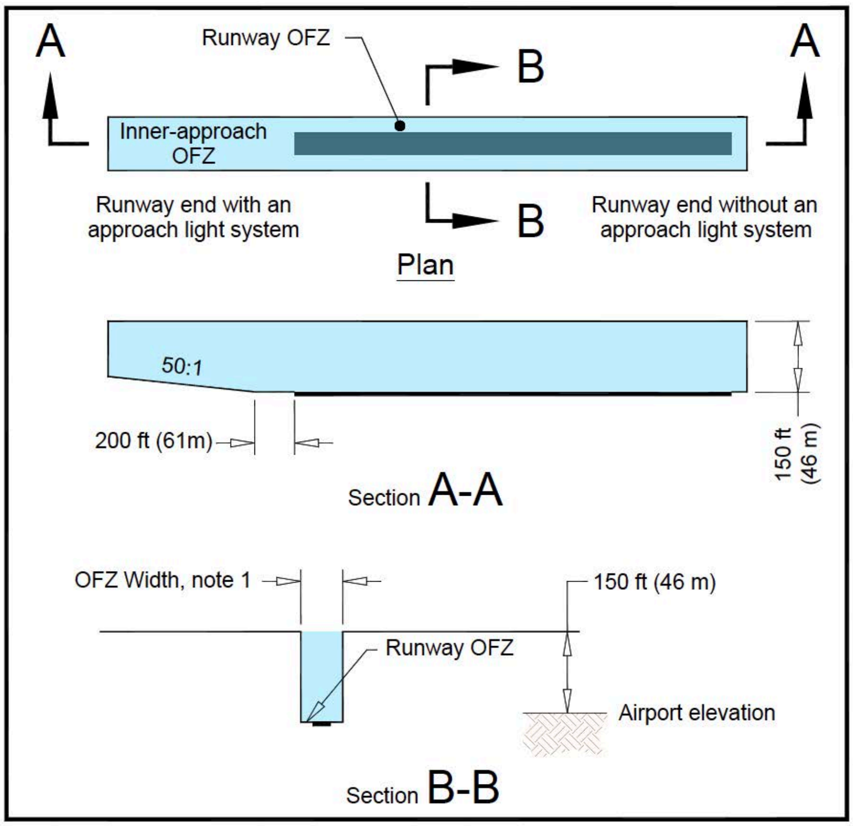


f) Find if the old administrative building penetrates the inner transitional OFZ surface. Show your calculations.

Since the airport is designed for visibility of 3/4 nautical mile, the OFZ surface is a "vertical wall" as shown below. The building is not an obstruction because the OFZ at the location of the building is 150-feet tall.

Side View of Inner Transitional OFZ Surface for Problem.

Figure 3-20. Obstacle Free Zone (OFZ) for Visual Runways and Runways with Not Lower Than ¾ Statute Mile (1.2 km) Approach Visibility Minimums



Note 1: Refer to paragraphs 3.11.2, 3.11.3, and 3.11.4 for dimensional values.

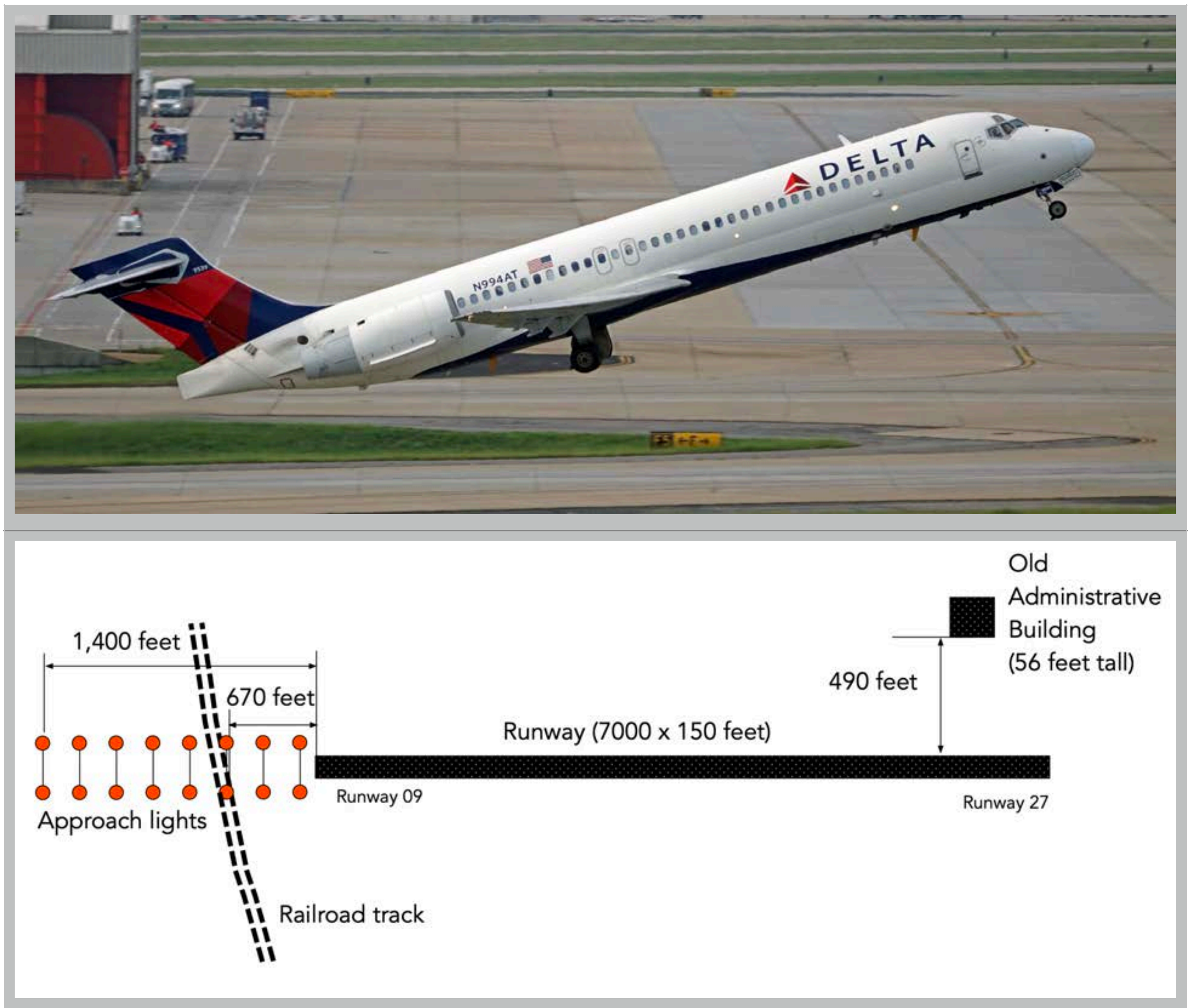


Figure 1. Boeing 717-200 Departs ATL Airport and Runway Layout for Problem 1.

Problem 2

Use Google Earth and review the EMAS systems installed at various airports and provide brief answers.

a) Estimate the size of the EMAS installed on runway 4 threshold at LGA airport. If the critical aircraft is the Boeing 757 (see Figure 2), estimate the EMAS maximum overrun speed protection at LGA for an aircraft landing on runway 22.

EMAS length ~ 280 feet with 35-foot offset (between runway end and the EMAS bed)

EMAS width ~ 160 feet

Using the Boeing 757 data, the maximum speed is ~47 knots.

The standard design speed for an EMAS should be 70 knots. That would require a 450-ft EMAS bed to stop the Boeing 757-200.

b) Estimate the size of the EMAS installed prior to runway 16 threshold at ROA airport. If the critical aircraft is the Boeing 757 (see Figure 2), estimate the EMAS maximum overrun speed protection at ROA for an aircraft landing on runway 34.

EMAS length ~ 300 feet with 300-foot offset (between runway end and the EMAS bed)

EMAS width ~ 160 feet

Using the Boeing 757 data, the maximum speed is ~52 knots.

The standard design speed for an EMAS should be 70 knots. That would require a 450-ft EMAS bed to stop the Boeing 757-200.

c) If the two EMAS systems are designed to stop the same aircraft, comment on the differences observed.

The EMAS length is limited by the space available after each runway end. ROA has a 300-foot offset. LGA has a short 35-foot offset. The ROA offset is a paved are (not full strength pavement) that helps reduce the runway exit speed in case of an overrun. Recall, 300 feet is 30% of the standard RSA length (1,000 feet) and hence we can estimate the exit speed if the pilots brakes along the fist 300 feet before the aircraft enters the EMAS bed.

From physics:

$$V_{final}^2 = V_o^2 - 2ad$$

$$V_{final} = \sqrt{V_o^2 - 2ad}$$

Assume an aircraft decelerates at a constant rate of $2m/s^2$ (typical). If the aircraft exits the runway at ROA at 70 knots (36 m/s), the final speed (V_{final}) at the entry point of the EMAS bed would be:

$V_{final} = \sqrt{36^2 - 2(2)(95)} = 30.3$ m/s (58.7 knots).

This shows that a Boeing 757-200 exiting the runway at 70 knots would expect to enter the EMAS at 58.7 knots if the pilot brakes at $2m/s^2$ in the 300-ft offset area.

The design at ROA seems slightly better than that at LGA.

Figure 2. Boeing 757-200 Landing on Runway 26R at Atlanta Hartsfield International Airport (A.A. Trani).

Problem 3

Use Google Earth and familiarize yourself with Los Angeles International Airport (see Figure 3). Use Google Earth to measure distances.

a) An Airbus A380 lands on runway 25L in low visibility conditions (1/2 mile visibility or less) and the aircraft is instructed to taxi on taxiway H (Hotel) - the taxiway between runways 25L and 25R. Does the aircraft tail violates the inner transitional surface of runway 25R? Explain and show your calculations. The critical aircraft at the airport is the Airbus A380 (see Airbus documentation or the FAA Aircraft Characteristic Database). Consider the elevation of the airport in your calculations. In your analysis, assume the A380 taxies on the centerline of taxiway H.

Figure 2. Los Angeles International Airport Southside Runways. Source: Google Earth.

Refer to Figure 3-22 in the FAA AC 150/5300-13B to solve this problem. The figure is reproduced below for convenience. The equations to find the values of H (vertical height) and Y (distance from runway centerline to corner point for change in slope) are:

$H_{feet} = 53 - 0.13(S_{feet}) - 0.0022(E_{feet})$

$Y_{feet} = 440 + 1.08(S_{feet}) - 0.024(E_{feet})$

$S_{feet} = 262$ feet (Airbus A380)
$E_{feet} = 127.8$ feet (LAX airfield elevation)

$H_{feet} = 18.7$ feet

$Y_{feet} = 719.9$ feet

The parallel taxiway (H - Hotel) is located 400 feet from the runway centerline of Runway 25R.

The figures below illustrate the situation. The vertical tail of the Airbus A380 penetrates the Inner Transitional OFZ and hence Runway 25R cannot be used for departures while the A380 taxies on taxiway H (Hotel).

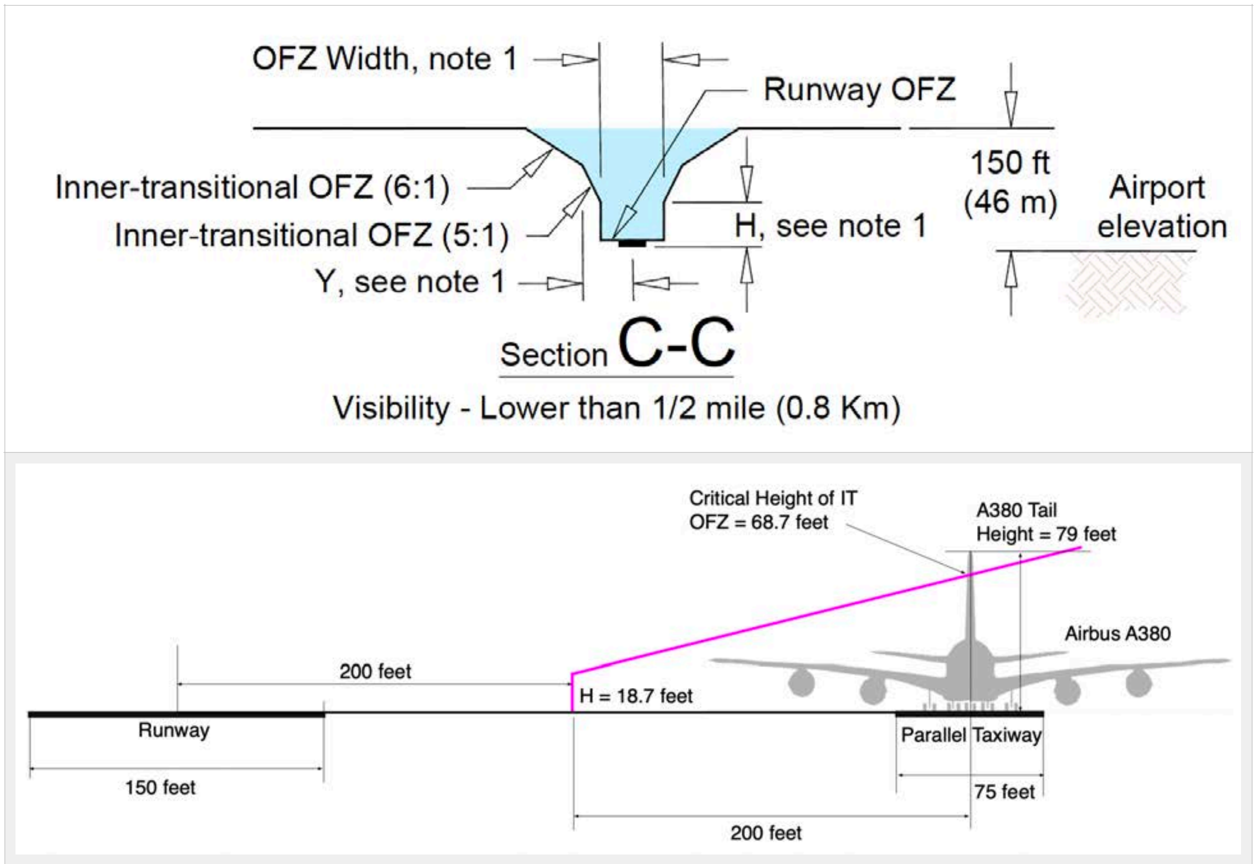


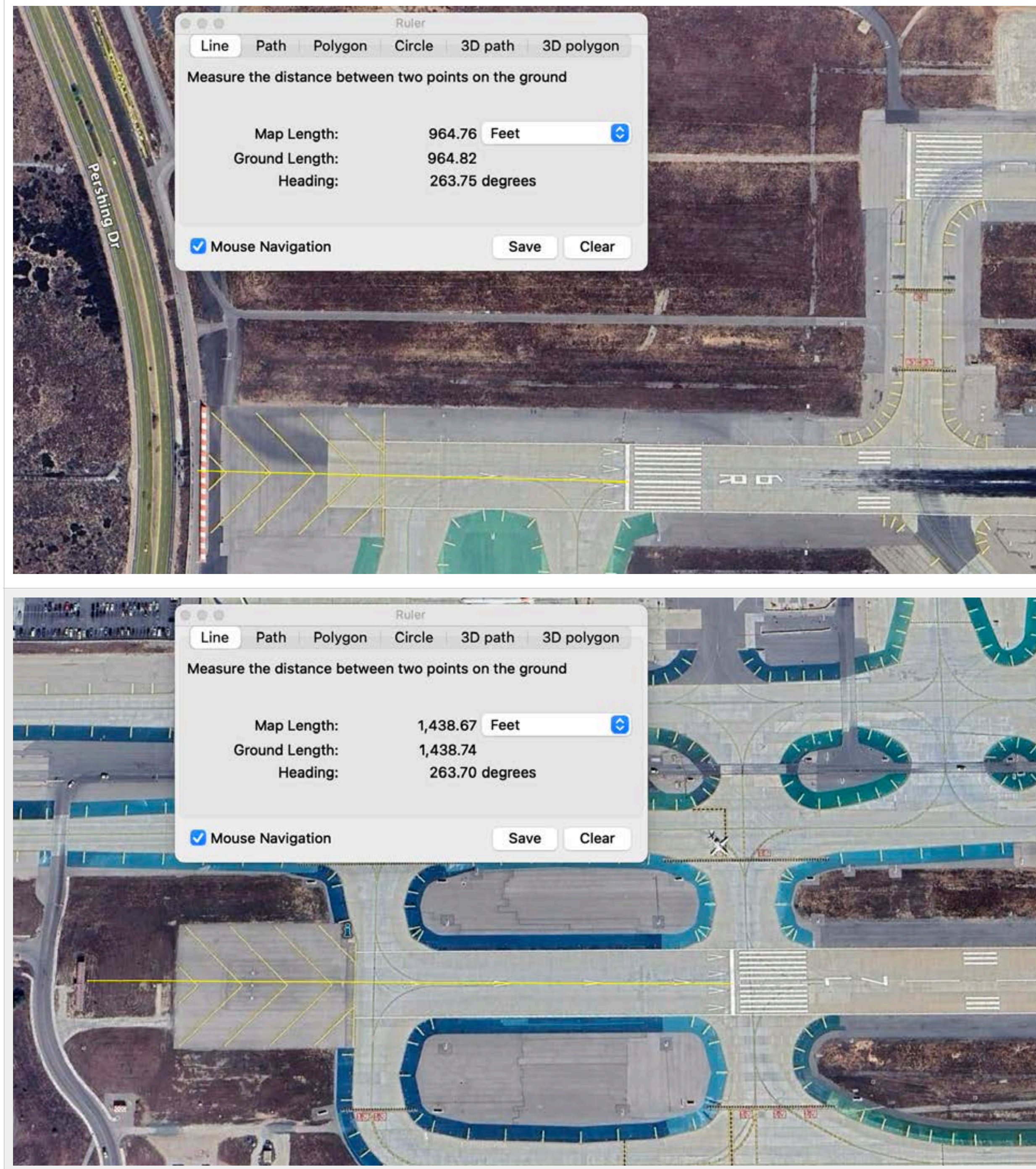
Figure 2. Cross Section of Runway 25R and Parallel Taxiway H at LAX Airport.

b) 95% of the time, aircraft depart LAX to the ocean using runways 24L and 25R. Are the runway safety areas protected for departures from runways 24L and 25R? The critical aircraft if the Airbus A380. LAX can operate with visibility minima below 1/2 mile. Explain and provide details of the distance measured to make your assessment.

For the visibility minima stated (below 1/2 mile) we need runway safety areas of 1,000 feet to protect against an aircraft overrun.

Runway 24L has a n equivalent RSA of 965 feet (see figure below). The distance is close enough to 1,000 feet to be considered a standard RSA area. Recall, satellite images can introduce parallax errors in measuring distance.

Runway 25R has an equivalent RSA of 1,438 feet (see figure below). The RSA is protected.



Los Angeles International Airport RSA Distances to Protect Departures for Runways 24L and 25R Against Overruns. Source: Google Earth.

Problem 4

Use Google Earth to examine runway 6-24 at Cuyahoga County Airport (CGF).

The critical aircraft is a corporate jet similar in size to the Gulfstream III. The airport has approach procedures with runway visibility minima of 1 nautical mile (RVR).

a) List all four declared distances for each runway end.

Use Airnav to find the four declared distances for runway 6-24 at the airport.

Runway 6

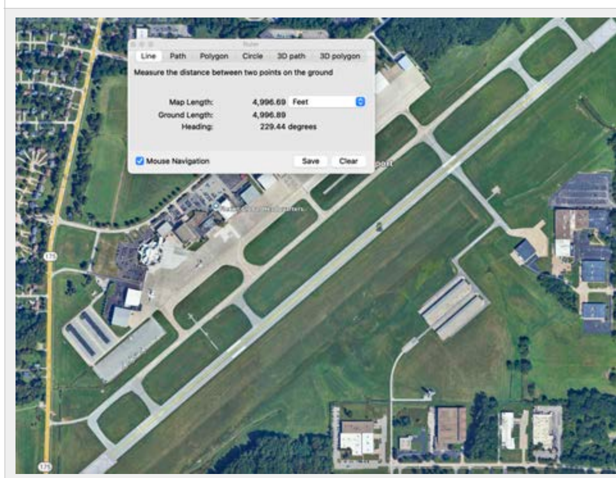
TORA:5502 TODA:5502 ASDA:5502 LDA:5184 all in feet

Runway 24

TORA:5502 TODA:5502 ASDA:5502 LDA:5000 all in feet.

b) Verify if the Landing distance available for both ends is correct.

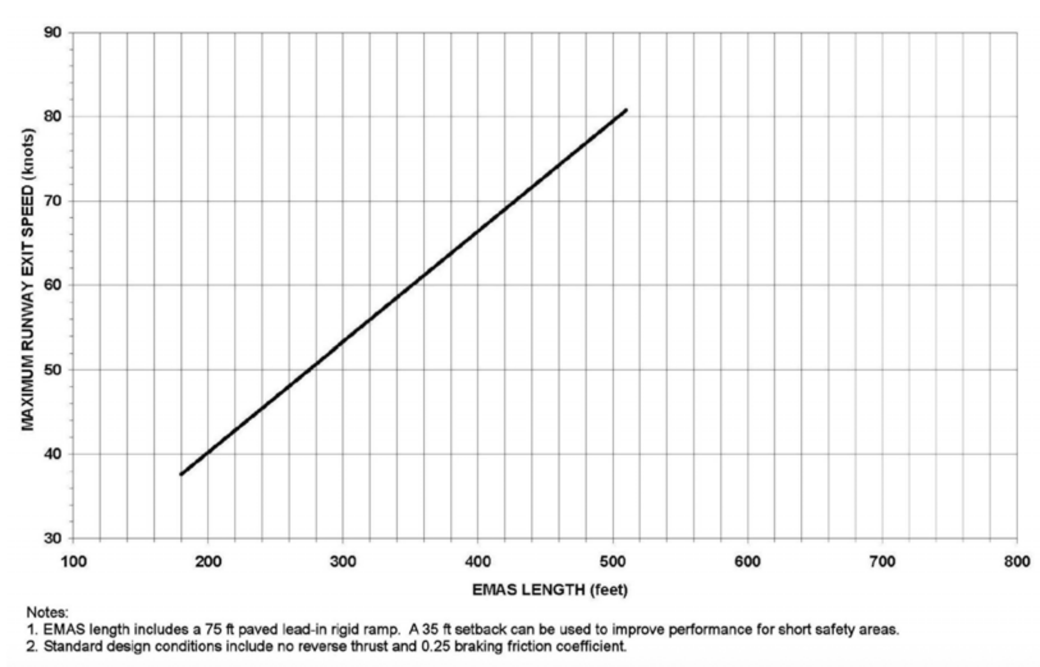
LDA distances measured in Google Earth are 5,187 feet for runway 6 and 4,997 feet for runway 24. The published LDA distances are correct (see figure below).



Cuyahoga County Airport LDA Distances for Runways 6 and 24 , Respectively. Source: Google Earth.

c) Estimate the standard EMAS required to stop the critical aircraft in case of an overrun.

The FAA EMAS design chart shows that a standard EMAS designed to stop an aircraft departing the runway at 70 knots requires a bed 430 feet long (see the planning chart below).



EMAS Design Chart for Gulfstream G-III. Source: FAA AC 150/5220-22.

d) Why do both ends require an EMAS. Explain.

The runway ens are close to Bishop Road and Highway 175. The proximity of both roads does not allow a 1000-foot RSA. Providing 1000-foot RSA on both ends (without an RSA) would reduce the declared runway distances very short and unusable for large corporate jets flying international routes. EMAS provides protection and preserves longer LDA and TORA.

e) Is the level of overrun protection the same on both runway ends? Explain.

EMAS before runway 6 threshold is 400 feet. This EMAS protects against overruns for landings on runway 24. Runway 24 LDA is 5000 feet.

EMAS before runway 24 threshold is 290 feet. This EMAS protects against overruns for landings on runway 06. Runway 06 LDA is 5184 feet.

Note that the level of protection for landings is about the same because landings on runway 24 have shorter LDA and hence benefits from a longer EMAS bed (400 feet).

f) Knowing the takeoff distance available at the airport, find the maximum distance that can be flown by a Gulfstream 350 (similar to the Gulfstream III) departing CFG. For this analysis use SARLAT. Use the design temperature at the airport.

Use 5502 feet as the runway distance available for takeoff.

Elevation = 876 feet above mean se a level

Delta elevation between thresholds is 2.1 feet. Average grade is 0.03% (use zero in SARLAT)

Design temperature = 82.3 (historical average of daily mean max. Temperature of the hottest month of the year).

The figure below shows that on a dry runway, the Gulfstream 350 can fly 3,507 nautical miles with the average passenger load (six passengers) and two pilots. Departing from a wet runway, the aircraft can fly 2,739 nautical miles.

Aircraft Name	Aircraft Mix	NBAA IFR Maximum Range		Useful Load (Takeoff Weight)	
		Dry	Wet	Dry	Wet
Jet					
GLF4 - Gulfstream G350	100%	100 % FLIGHTS IN NAS 3507 nm / 6 pax	100 % FLIGHTS IN NAS 2739 nm / 6 pax	99 % 70523 lbs	81 % 65712 lbs

Runway Evaluation Analysis for Gulfstream 350 in SARLAT.