Assignment 4

Date Due: September 26, 2022 Instructor: Trani

Problem 1

An airline wants to build a new 90-foot tall hangar 600 feet from the runway centerline of a 10,000 foot precision runway. The runway serves commercial aircraft including the Boeing 747-8I. The runway has a Category 1 Instrument landing system with visibility minima requirements down to 1/2 mile. **The airport elevation is 4,000 feet above sea level.**

a) Create a table with dimensions (length and width) of the RSA, RPZ, ROFA and OFZ (all components) for the design aircraft.

Aircraft belongs to ADG VI and AAC D. The values in the table reflect visibility minima lower than 3/4 of mile.

RUNWAY PROTECTION	
Runway Safety Area (RSA)	
Length beyond departure end [9, 10]	1,000 ft
Length prior to threshold [11]	600 ft
Width	500 ft
Runway Object Free Area (ROFA)	
Length beyond runway end	1,000 ft
Length prior to threshold [11]	600 ft
Width	800 ft
Obstacle Free Zone (OFZ)	
Runway, Inner-approach, Inner-Transitional	
Precision Obstacle Free Zone (POFZ)	
Length	200 ft
Width	800 ft
Approach Runway Protection Zone (RPZ)	
Length	2,500 ft
Inner Width	1,000 ft
Outer Width	1,750 ft
Departure Runway Protection Zone (RPZ)	
Length	1,700 ft
Inner Width	500 ft
Outer Width	1,010 ft

b) Does the hangar violate any of the four basic surfaces around the runway? Your analysis should include checking RSA, ROFA, OFZ (all components) and RPZ.

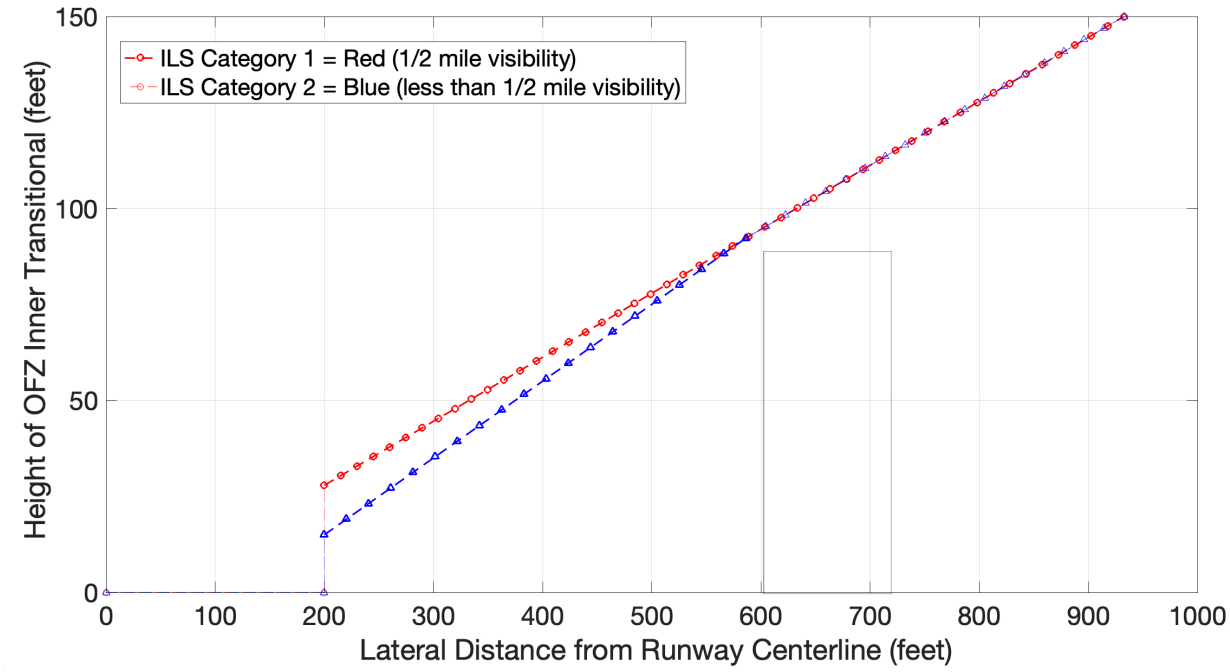
The location of the hangar is beyond the location of the ROFA, RSA and RPZ. The formulas to use in calculating the runway OFZ are:

1. For runways with IFPs lower than ¾ mile (1.2 km) but not lower than ½ mile (0.8 km), the IT-OFZ begins at the edges of the ROFZ and inner-approach OFZ, then rises vertically for height "H," and then slopes 6 (horizontal) to 1 (vertical) out to a height of 150 feet (46 m) above the established airport elevation.

   a. In U.S. customary units,

   $H_{feet} = 61 - 0.094(S_{feet}) - 0.003(E_{feet})$.

The hangar does not violate the runway inner transitional OFZ (see diagram below). The Critical height of the inner transitional OFZ 600 feet from the runway centerline is ~93 feet.



c) If the runway has a High Intensity Approach Lighting System with Sequenced Flashing Lights (ALSF-2) (read short article at https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/lsg/als), find the size of the inner-approach (OFZ) surface.

The inner-approach surface starts 200 feet from the end of the runway and ends 200 feet beyond the last light element of the ALS. The ALSF-2 system is 2,400 feet long. Hence the inner approach surface ends 2,600 feet from the runway threshold. Slope is 50:1.

Figure 1. Boeing 747-8I at Chicago O'Hare International Airport (A.A. Trani).

Problem 2

Familiarize yourself with the FAA AC 150/5220-22B before trying this problem.

Review the configuration of Charleston, West Virginia Airport (CRW) using Google Earth and the Arnav database. Specifically, look at the the runway threshold 5. Due to a geotechnical engineering problem, a landslide destroyed the EMAS installed at the site on threshold 5.

a) If an EMAS system is to be reconstructed on threshold 5, estimate the size of the arrestor bed if the critical aircraft operating at CRW is an Airbus A319 which is similar in size to the Boeing 737-400 contained in the EMAS document (see Figure below). Use the recommended EMAS design speed in your analysis.

For a 70 knot runway exit speed, the EMAS dimension would be 395 feet.

b) If the geotechnical engineering team decides that an EMAS bed cannot be no longer than 320 feet due to the steep slope characteristics at the site, estimate the maximum exit speed that such EMAS could protect against an overrun for the critical aircraft.

The maximum runway exit speed is limited to 58 knots.

c) Look at the declared distances for CRW runway 23 and tell me if the published LDA for that runway protects an aircraft against overrun at the end of landing runway. Be specific in your analysis. You can use Google Earth or Bing to measure the distances along the runway centerline.

LDA on runway 23 is 6215 feet. Using Google Earth I measure 6,210 feet (close of the published LDA) from the start of the runway (displaced threshold) on runway 23 to the end of the runway. The old EMAS provides the required safety area beyond the runway. If the EMAS is 395 feet (calculated in part (a)), then the LDA is legal.

d) Are landings on runway 23 protected against an undershoot? To answer this question, consider (and state) the required RSA dimensions for the critical aircraft.

Yes, the displaced threshold on runway 23 offers ~600 feet of protection prior to the landing runway. 600 feet is needed for ADG III and AAC C. See Table G-9 in the AC 150/5300-13B.

e) Read the article (https://www.flightglobal.com/pictures-crushable-concrete-cushions-crj-overrun-at-yeager/91521.article) and tell me what kind of aircraft was involved in this accident. What is the size of the arrestor bed needed to stop the aircraft involved in the accident - assume the recommended design exit speed?

For a CRJ-200 the required dimension of the arrestor bed is 330 feet. Runway exit speed is 70 knots.

Figure 2. Airbus A319 of Spirit Airlines. Critical Commercial Aircraft Operating at CRW (A.A. Trani).

Problem 3

Look at the EMAS installed on runway threshold 4 at LaGuardia Airport (LGA). The critical aircraft operating at LGA is a Boeing 757-200 (see picture below).

a) Measure the EMAS bed carefully. State the dimensions of the arrestor bed. Repeat the procedure for threshold 22.

Runway 4 EMAS is ~275 feet. Runway 22 EMAS is ~220 feet. None of the EMAS systems complies with the 70 knot runway exit speed.

b) Estimate the maximum runway exit speed supported by the EMAS system installed at LGA runway threshold 4 considering the critical aircraft.

~46 knots maximum runway exit speed. Still some protection compared to the no-EMAS alternative.

c) Estimate the maximum runway exit speed supported by the EMAS system installed at LGA runway threshold 22 considering the critical aircraft.

~ 42 knots maximum runway exit speed.

Figure 3. Boeing 757-200. Critical Commercial Aircraft Operating at LGA (A.A. Trani).

Problem 4

The Master Plan 2020 for Roanoke/Blacksburg Regional Airport (ROA) airport states that in Phase II runway 6-24 will be extended to 7,700 feet with both ends protected by 1,000 foot RSA areas.

Future airlines may use the Boeing 737-8 (also called Boeing 737-8 Max) with characteristics shown in Table 1. For this analysis, use the latest version of the Boeing 737-8 Max documents for airport design (Revision G published on May 2022).

Table 1. Aircraft Considered in the ROA Airport Re-Evaluation. Picture Source: A.A. Trani.

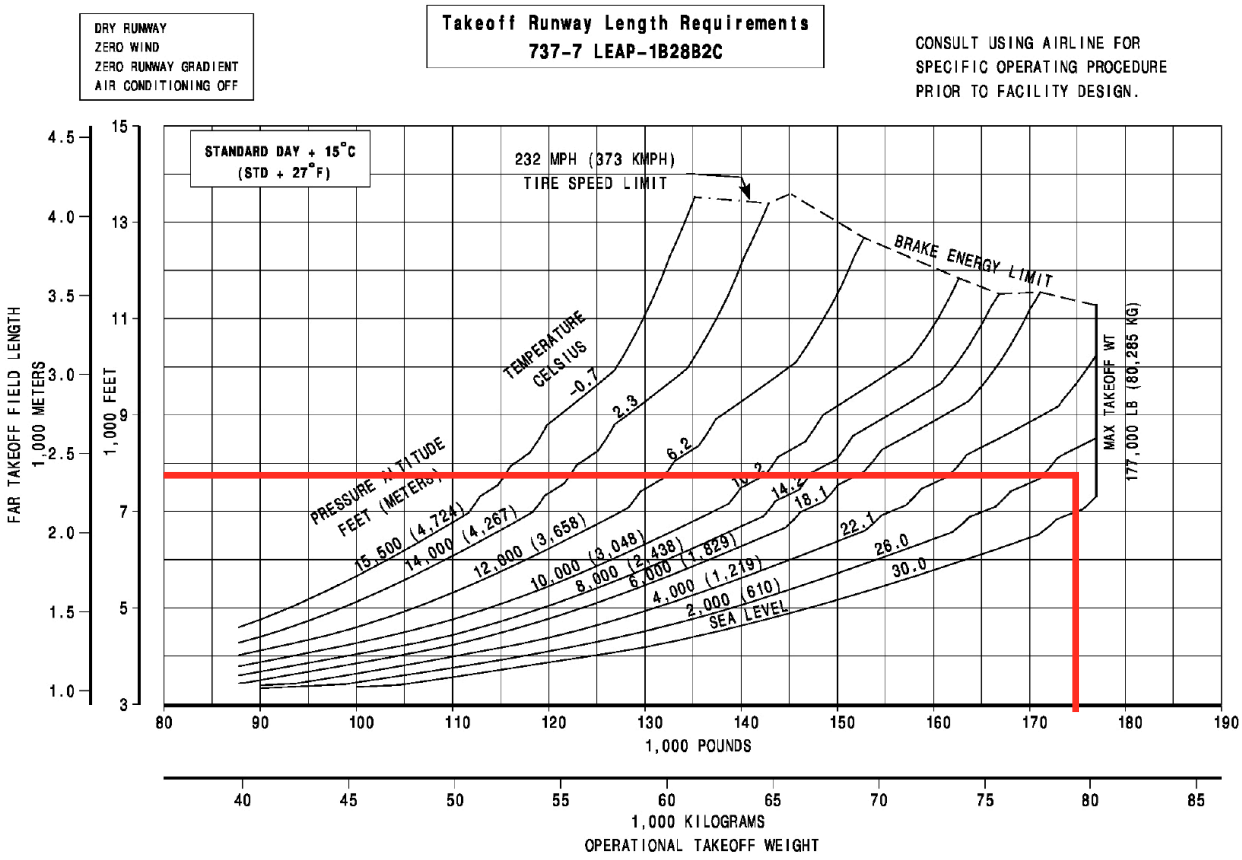
Aircraft	*Engine*	*Remarks*
Boeing 737-8 (Max) with CFM LEAP-1B28B1 engines. Aircraft maximum design takeoff weight is 179,800 lb. 178 seats in a two-class layout. **Note:** Boeing does not publish the operating empty weight (OEW) of the Boeing 737-8 Max series aircraft in the tables (all other Boeing aircraft publish OEW in the tables in Section 2 of the airport planning documents). However, The payload range diagram for this aircraft provides the value of OEW indirectly because the y-axis in the payload-range diagram is OEW + Payload. For the Boeing 737-8 Max the OEW is approximately 104,000 lbs.		
		

a) With the new runway in Phase II of the ROA Master Plan what is the maximum distance the airline could fly using the Boeing 737-8 Max?

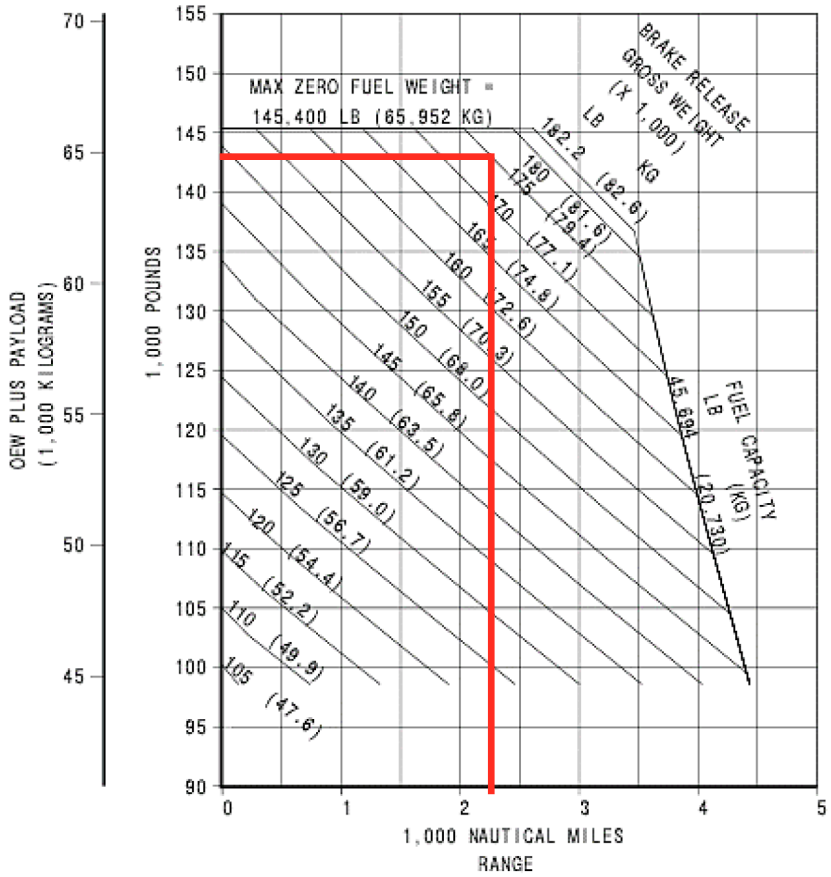
ROA is located 1175 feet above mean sea level conditions. ISA temperature at airport elevation in Roanoke is 55 degrees F. Design temperature is 84.7 deg. F. ROA design temperature is ISA + 29.7 deg. F. Use the ISA + 27 deg. F performance curves.

b) Will the airport support flights to the West Coast non-stop? For example flights to Los Angeles or San Francisco. Consider typical adjustments to the distance flown to account for weather and Air Traffic control deviations.

In your answers, clearly state the mean daily maximum temperature of the hottest month (design temperature), weights, and other considerations.



Takeoff Performance Chart for Boeing 737-8 Max.



The 7700 foot runway allows the Boeing 737-8 Max to operate at 175,000 lbs. of takeoff weight.

OEW = 104,000 lbs

PYL = 178 seats (220 lbs/seat) = 39,160 lbs

OEW + PYL = 143,160 lbs

Use the payload-range diagram for the aircraft and the estimated range is 2,200 nm. However, considering 6% of correction for weather and ATC deviations, the usable range is 2,075 nm. The aircraft can perform non-stop flights to Los Angeles, San Diego and San Francisco.

Problem 5

Use Google Earth (or Bing) and Airnav (www.airnav.com), to answer the following short questions.

Detroit International Airport (DTW)

a) Can the airport conduct simultaneous approaches in Instrument meteorological conditions? State the two runways that can offer enough separation to conduct simultaneous approaches at DTW.

DTW can execute simultaneous instrument approaches. A good combination of runways is 3R and 4L. The runways are separated by more than 3,400 feet. There are other permissible combinations such as 4L and 3L as well.

b) Briefly explain the FAA rule used and the distance between the runways in question.

3,400 feet is the minimum separation between parallel runways because the airport is located at an elevation of 645 feet above sea level.

Chicago O'Hare International Airport (ORD)

a. Can the airport conduct simultaneous approaches to runways 27R, 27L and 28C in instrument meteorological conditions? Briefly explain the rule used.

The airport is authorized for triple instrument approaches. The rule is 3,400 feet between each runway centerline (assuming straight-in approaches).

b. Can the airport conduct simultaneous approaches to runways 27R, 27L and 28C in visual meteorological conditions? Briefly explain the rule used.

Yes.