# Assignment 2: Simple Runway Length Calculations

**Solution** Instructor: A. A. Trani

**Problem 1**

The Kit Carson County Airport (ITR) near Burlington in the State of Colorado is planning a new master plan. The airport serves general aviation (i.e., piston-powered) aircraft and would like to serve corporate jets such as the Falcon 900 (shown in Figure 1).

a) For the master plan, estimate a suitable runway length to operate all aircraft safely at the airport. If a runway extension is needed, make a recommendation.

Recognize the critical aircraft (Falcon 900) in Table 3-1 as part of the aircraft that make up 75% of fleet mix of aircraft. Use 60% useful load factor curves since the airport is located in a rural area. Use Figure 3-1 reproduced below. The design temperature is 90 deg. F. Airport elevation is 4,218 feet.

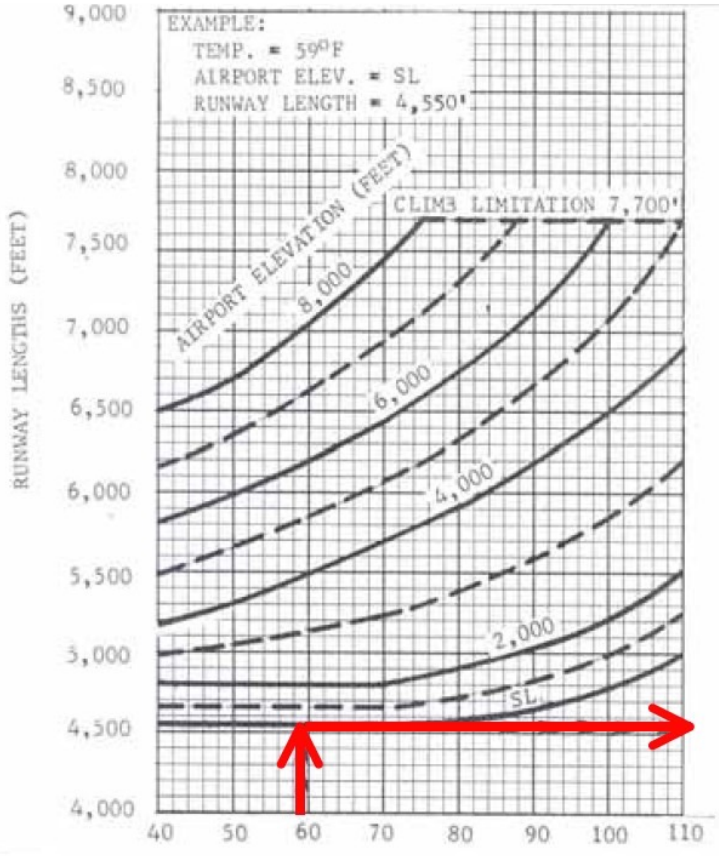
Runway length (unadjusted) is 6,300 feet.

Adjustments: Grade and Wet pavement conditions (mutually exclusive)

Delta elevation is 16.8 feet. Add 168 feet to the solution obtained above. Runway length = 6,468 feet (adjusted)

Wet pavement: adds 15% up to 5,500 feet whichever is less. No adjustment needed because the runway length is above 5,500 feet.

**Design Runway length is then: 6,500 feet (rounded to nearest 100 feet).**



Runway Length for 75% of the Fleet Mix.

b) Verify if the smaller GA aircraft require more runway than the the corporate jets.

Small aircraft can operate from this location based on the runway length estimated above.

c) If this airport had been located at sea level under (ISA + 30 deg. F) conditions, what would be the runway length needed?

ISA conditions at sea level conditions is 59 deg. ISA + 30 deg. F is then 89 deg. F. The uncorrected runway length would be 4,600 feet instead of 6,300 feet).


*Figure 1. Falcon 900 Aircraft Departing San Jose International Airport (A.A. Trani)*

## Problem 2

a) Use the fundamental equation of motion included in the class notes, to explain the effect of aircraft mass on runway length requirements.

b) An aircraft has a stalling speed of 96 knots at sea level conditions in the landing flap configuration. What is the typical approach speed of this aircraft according to US regulations.

Approach speed is 30% above stall. 124.8 knots.

c) For the aircraft in part (b) estimate the approach speed in la Paz Bolivia located 13,325 feet above sea level. Assume all other conditions are the same.

At 13,325 feet estimate the air density to be 0.813 kg/cu. meter. (use the table provided with value of the International Standard Atmosphere) and interpolate.

The basic lift equation is:

$$V_{stall} = \sqrt{\frac{2mg}{\rho S C_{l\max}}}$$

Them only term that is affected while operating from a higher elevation airport is the air density. The new stall speed will be:

$$V_{stall-seaLevel} = V_{stall-LaPaz}\sqrt{\frac{\rho_{seaLevel}}{\rho_{LaPaz}}}$$

$$V_{stall-seaLevel} = 96\sqrt{\frac{1.225}{0.813}} = 117.8 \text{ knots}$$

The approach speed in La Paz will be 153 knots (30% above the new stall speed).

## Problem 3

Using the World airport database linked in our web site (http://worldaerodata.com), collect data about the longest runway length and airfield elevation for the following international airports: Shanghai International Airport (PVG), Toluca International (TLC) and Montreal (YUL).

a) Plot the longest runway length vs airfield elevation. Is there a trend in terms of runway length vs. airfield elevation? Comment.

b) Why would an airport like New York Kennedy must have one very long runway (like runway 31L)? Answer the question by looking at the Boeing or Airbus documents for Boeing 747-400 or Airbus A380 including the takeoff performance charts.

It is clear that to provide adequate runway length for B747-400 and A380 at near MTOW conditions, the runway length needs to be above 12,000 feet at sea level conditions. JFK runways 13R/31L and 4L/22R provide 12,000 feet or more.

## Problem 4

A new airport is to be constructed in Washington State. The airport authority would like to request your services to estimate the runway length requirements to support regular operations using the aircraft shown in Table 1. The new airport is to be located at 3,150 feet above sea level conditions. Use the maximum temperature of the hottest month as 85 deg. oF.

Table 1. Aircraft for Airport in Problem 1.

| Aircraft | Engine | Remarks |
|---|---|---|
| Boeing 717-200<br>121,000 MTOW<br>Passenger aircraft | BMW/Rolls-Royce BR715 high-bypass-ratio engines. | To be used in routes of up to 1,750 nm to the US West Coast |

a) Find the runway length needed to operate the aircraft. Use standard two-class cabin configurations stated in the Boeing APM documents (when applicable).

Use 85 deg. F as design temperature. This is 15 deg. C above ISA conditions.

OEW = 31,071 kg

PYL =10,600 kg (106 seats)

Use the Payload-Range diagram to find the DTW to fly 1,750 nm.

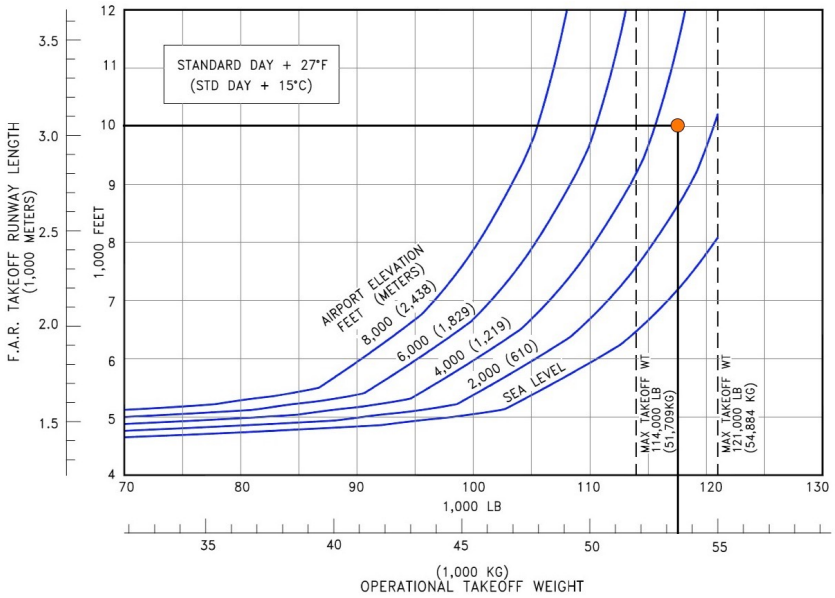
OEW + PYL = 41,671 kg

DTW ~ 53,500 kg

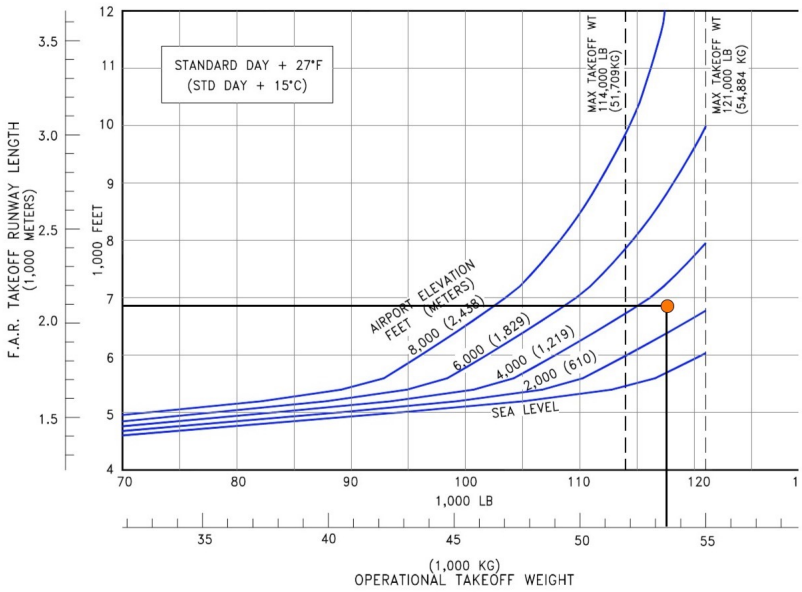
**Runway length (takeoff) - 10,000 feet (wet conditions from Boeing chart) if the aircraft has the BR715 18,500 lb thrust engines.**

**Runway length (takeoff) - 6,900 feet (wet conditions from Boeing chart) if aircraft has the BR715 21,000 lb thrust engines.**

**Bottom line: The engine selection affects the runway length drastically for this aircraft. The high thrust engine reduces the runway length by 3,100 feet (31% from the original 10,000 feet).**




Boeing 717-200 with 18,500 lb Engines. Source: Boeing.




Boeing 717-200 with 21,000 lb Engines. Source: Boeing.

b) Can the aircraft carry some cargo in the 1,750 nm flight above the passenger load? Explain.

If runway is not a constraint, the aircraft could carry another 1,384 kg. of cargo to reach the value of MTOW.