



Example of Runway Length Analysis



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Runway Length Estimation Example

A new airport will be constructed at a site located 3,500 feet above sea level. Temperature data collected at the site shows the mean daily maximum temperature of the hottest month to be **26 degrees Celsius**. The table below shows the critical design aircraft information. Figure 1 shows a picture of the design aircraft.

<i>Aircraft</i>	<i>Engine</i>	<i>Remarks</i>
<i>Boeing 747-8 (passenger version) 987,000 Maximum Takeoff Weight</i>	<i>GEnx 2B engines</i>	<i>Passenger configuration with a total of 515 seats</i>



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



Typical Questions

1. Find the runway length required to satisfy FAA and EASA regulations to operate the critical aircraft **without takeoff restrictions from the new airport.** This implies the airline will be able to depart at the maximum takeoff gross weight from the airport.
2. Find the amount of belly cargo the aircraft can carry while using the runway design of part (1).
3. Estimate how far can the aircraft fly without refueling for the runway design in part (1)?



Answers

1. Find the runway length required to satisfy FAA and EASA regulations to operate the critical aircraft without takeoff restrictions from the new airport. This implies the airline will be able to depart at the maximum takeoff gross weight from the airport.

ISA Temperature at 3,500ft is 8.1C (remember temperature is linear with altitude).

Try ISA + 15 deg. C. - $8.1 + 15 = 23.1$ deg. C

23.1 deg. C is more than 1.7 deg. C from ISA + 15 deg. C

1.7 deg. C. if the margin FAA allows you to use to the closest chart.

Use the takeoff figures for ISA+25C. The temperature at the airport is well above ISA + 15 deg. C.



Answer to Question 1



747-8 Airplane Characteristics for Airport Planning

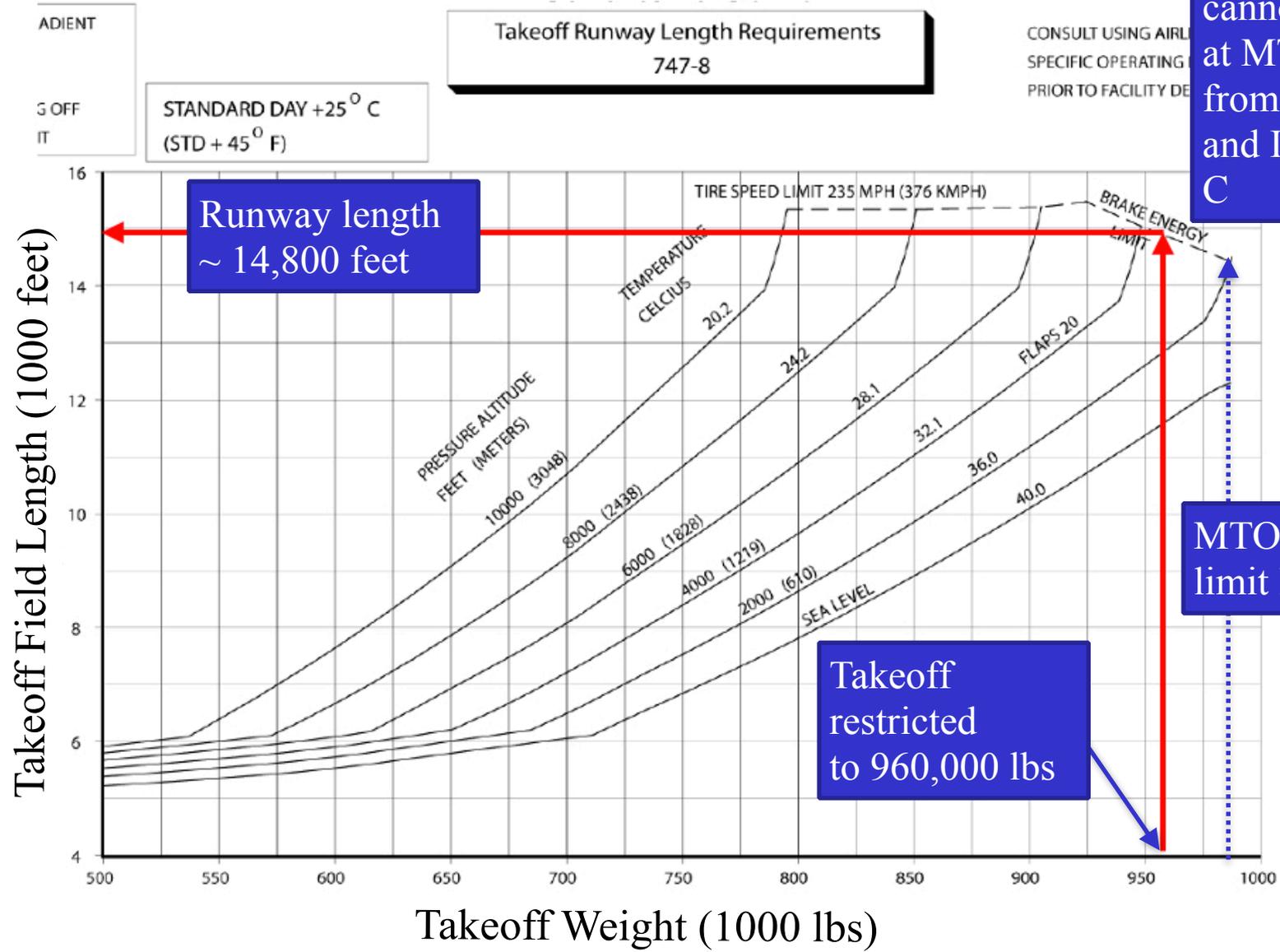
Consult the Boeing documentation
to solve the problem

CHARACTERISTICS	UNITS	747-8
MAX DESIGN TAXI WEIGHT	POUNDS	990,000
	KILOGRAMS	449,056
MAX DESIGN TAKEOFF WEIGHT	POUNDS	987,000
	KILOGRAMS	447,696
MAX DESIGN LANDING WEIGHT	POUNDS	688,000
	KILOGRAMS	312,072
MAX DESIGN ZERO FUEL WEIGHT	POUNDS	651,000
	KILOGRAMS	295,289
OPERATING EMPTY WEIGHT (1)	POUNDS	485,300
	KILOGRAMS	220,128
MAX STRUCTURAL PAYLOAD	POUNDS	167,700
	KILOGRAMS	76,067
TYPICAL SEATING CAPACITY (INCLUDES UPPER DECK)	UPPER DECK	48 BUSINESS CLASS
	MAIN DECK	19 FIRST, 96 BUSINESS, 352 ECONOMY
MAX CARGO - LOWER DECK CONTAINERS (LD-1)	CUBIC FEET	5,705
	CUBIC METERS	162
MAX CARGO - LOWER DECK BULK CARGO	CUBIC FEET	640
	CUBIC METERS	18.1
USABLE FUEL CAPACITY	U.S. GALLONS	63,034 (2)
	LITERS	238,610
	POUNDS	426,109
	KILOGRAMS	193,280

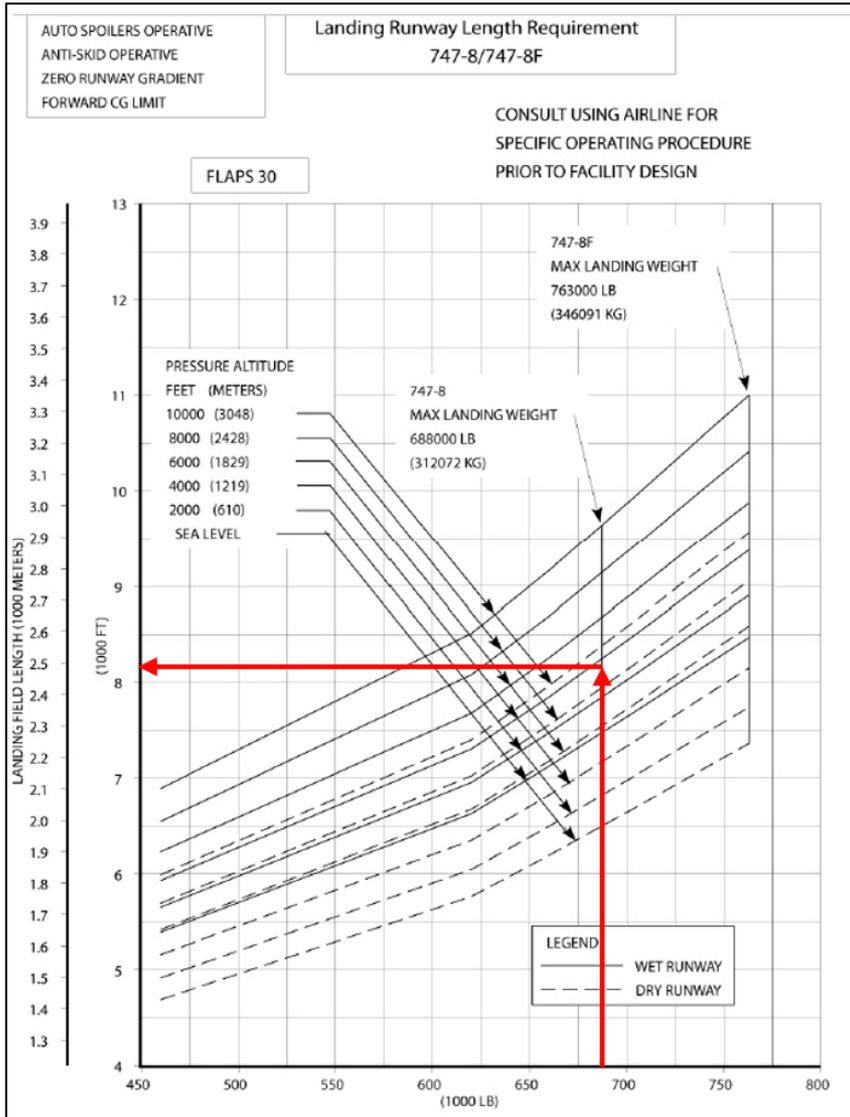


Answer to Question 1

Aircraft cannot operate at MTOW from 3,500 feet and ISA + 25 deg. C



Answer to Question 1



Note: Maximum allowable landing weights for freighter and passenger versions are not the same.

Use the MALW of the passenger version since the problem involves a passenger Boeing 747-8.

FAA Landing Field Length
~ 8,200 feet

Takeoff distance is greater than landing distance. The airport needs a runway 14,800 feet long.



Find Cargo Capacity of the Aircraft

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$$\text{OEW} = 485,300 \text{ lbs}$$

$$\text{Passenger load} = 515 * (220 \text{ lbs/passenger}) \text{ lbs} = 121,000 \text{ lbs}$$

$$\text{OEW} + \text{Passenger Payload} = 485,300 \text{ lbs} + 121,000 \text{ lbs} = \mathbf{606,300 \text{ lbs}}$$

Maximum Design Zero Fuel Weight is the maximum weight before fuel is added

$$\text{Maximum Design Zero Fuel (MDZF)} = 651,000 \text{ lbs}$$

$$\text{Maximum Belly Cargo} = 651,000 \text{ lbs} - 606,300 \text{ lbs} = 44,700 \text{ lbs}$$

Restricted takeoff weight limit is 960,000 lbs

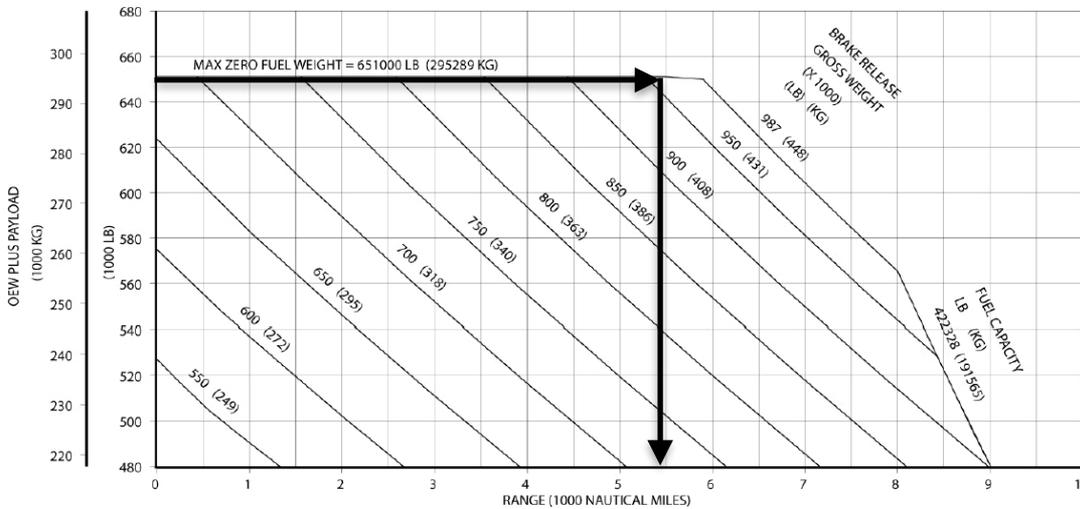


Estimation of Aircraft Range for Design Conditions

Payload / Range
747-8

STANDARD DAY, ZERO WIND
MACH 0.855 CRUISE
STEP CLIMB AT 2000 FT INCREMENTS
NORMAL POWER EXTRACTION AND AIR CONDITIONING BLEED
TYPICAL MISSION RULES

CONSULT USING AIRLINE FOR SPECIFIC OPERATING
PROCEDURE AND OEW PRIOR TO FACILITY DESIGN



OEW = 485,300 lbs

Passenger load = 515 * (220
lbs/passenger) lbs = 121,000 lbs

Maximum Belly Cargo =
651,000 lbs - 606,300 lbs =
44,700 lbs

Find OEW + Payload
485,300 lbs + 121,000 lbs +
44,700 lbs

Restricted takeoff weight limit is
960,000 lbs

Aircraft can fly 5,400 nautical miles

OEW + Payload = 651,000 lbs
(same as maximum zero fuel
weight)