

Payload-Range Diagrams

- 1) Brueget's Range Equation.
 - a. Derive Brueget's Range Equation
 - b. Include units and show how units yield Range (nm)
 - c. List the assumptions for Brueget's range Equation

$$a) \quad R = (a/c) M (L/D) \ln (W_{initial} / W_{final})$$

$$b) \quad (ft/sec) / (lbs \text{ fuel}/sec/lbs \text{ thrust}) = ft \text{ (convert to nm - } 1ft = 0.00016457nm)$$

c) zero wind conditions, standard cruise speed, standard day conditions (e.g., standard atmosphere) and standard domestic fuel reserves

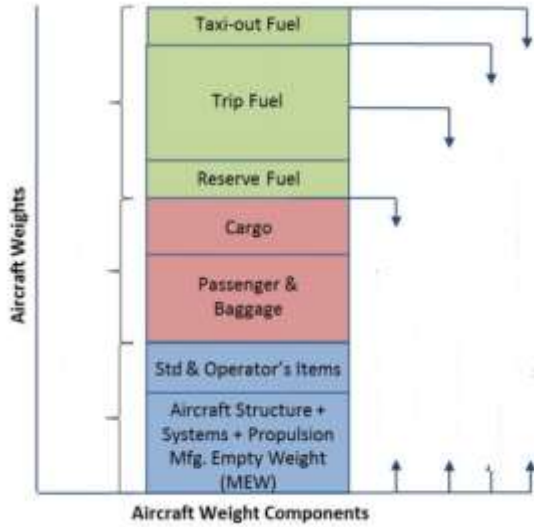
- 2) Calculate the Range for the following aircraft.
 - Maximum Zero Fuel Weight = 600,000 lb aircraft
 - W fuel = 180,000 lbs
 - W final = 600,000 – 180,000 lbs
 - Constant speed V = 642.9 ft/sec
 - Constant altitude = 30,000 ft
 - L/D = 18.712
 - c = 0.0002361 lbs fuel/sec/lbs thrust

$$R = (a/c) M (L/D) \ln (W_{initial} / W_{final}) = (V/c) (L/D) \ln (W_{initial} / W_{final})$$

$$V = Ma$$

$$(642.9 \text{ ft}/sec / 0.0002361 \text{ lbs fuel}/sec/lbs \text{ thrust}) (18.712) (\ln (600,000 / (600,000 - 180,000))) = 18173570 \text{ ft} = 3442 \text{ nm}$$

3) Insert the “Aircraft Weight Definitions” (on the right) in to the diagram on the left (3 on the left of the diagram, 4 on the right of the diagram).



Aircraft Weight Definitions

Maximum Taxi Weight (MTW) : The maximum weight for ground maneuver as limited by airplane strength and airworthiness requirements.

Maximum Design Takeoff Weight (MDTOW) : The maximum certified weight at which the aircraft can take-off as limited by airplane strength and airworthiness requirements. Often lower MDTOWs are deliberately certified for a particular aircraft, and these lower values are referred to as simply MTOW.

Maximum Landing Weight (MLW) : The maximum weight for landing as limited by airplane strength and airworthiness requirements.

Maximum Payload: The maximum zero fuel weight minus the operational empty weight.

Maximum Zero-Fuel Weight (MZFW) : The maximum weight permitted before usable fuel and other specified are loaded. MZFW is limited by strength and airworthiness requirements The MZFW minus the OEW equals structural payload.

Operator's Empty Weight (OEW) : The weight of the aircraft prepared for service and is composed of the MEW plus operator items.

Manufacturer's Empty Weight (MEW) : The weight of the aircraft as it has been built by the manufacturer, excluding any operator items.

- 4) Define the points A, B, C, D, in the payload range diagram

A = maximum payload with no fuel on-board

B = maximum range the aircraft can fly with maximum payload

C = maximum range with full fuel tanks where a reasonable payload can be carried (maximum fuel volume capacity has been reached and this is where the aircraft is most structurally efficient in terms of fuel carriage)

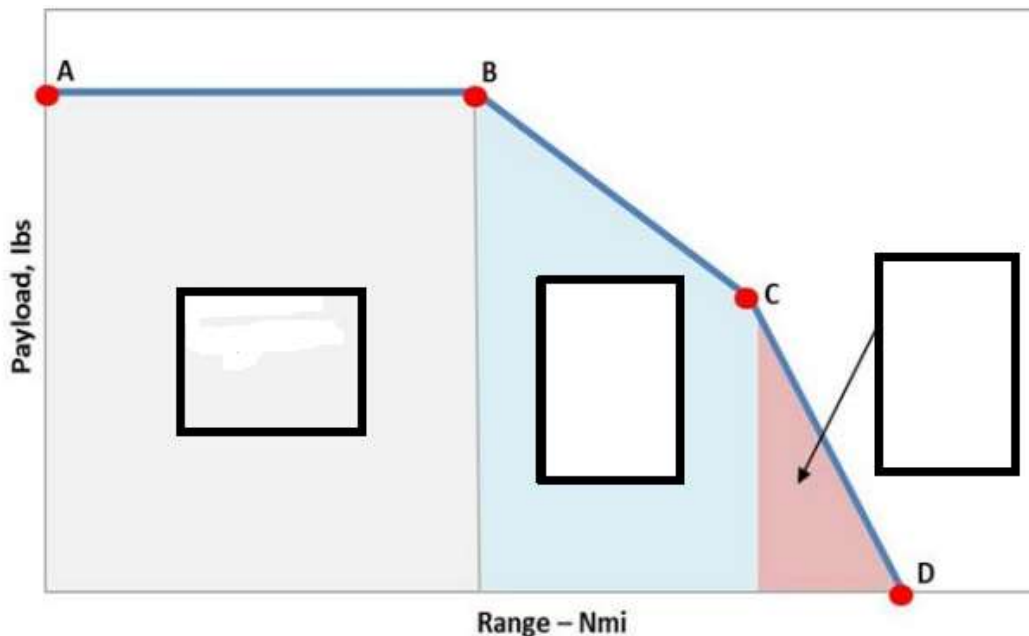
D = maximum ferry-range (Operator's Empty Weight (OEW))

- 5) Define the regions A-B, B-C, C-D in the payload range diagram

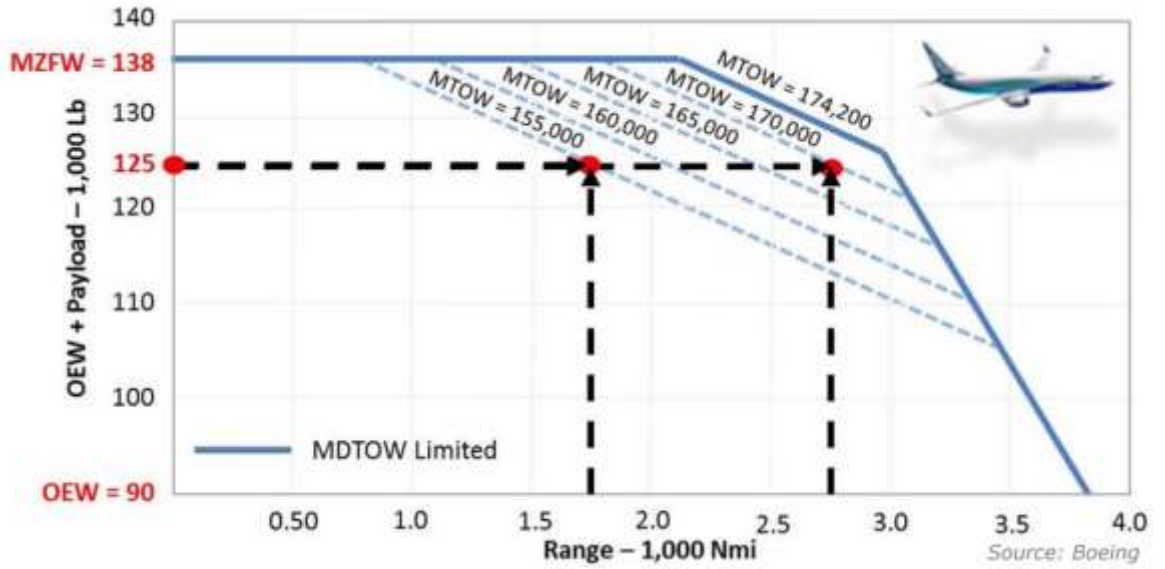
A-B = Maximum Payload

B-C = Tradeoff Fuel and Payload

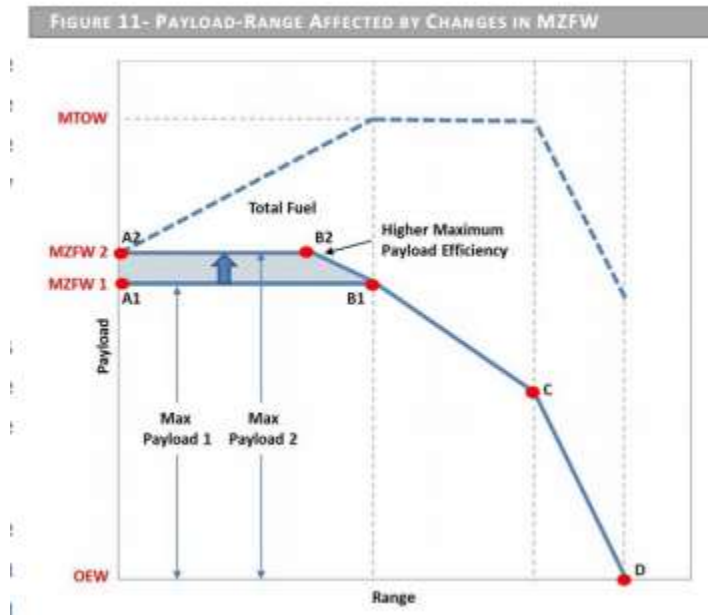
C-D = Tradeoff Payload and Range



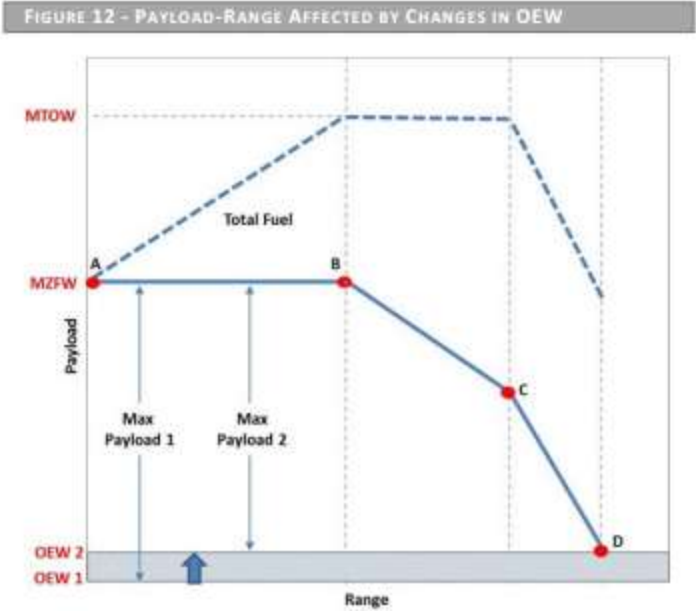
- 6) For the Payload-Range diagram for the B737-800 shown below



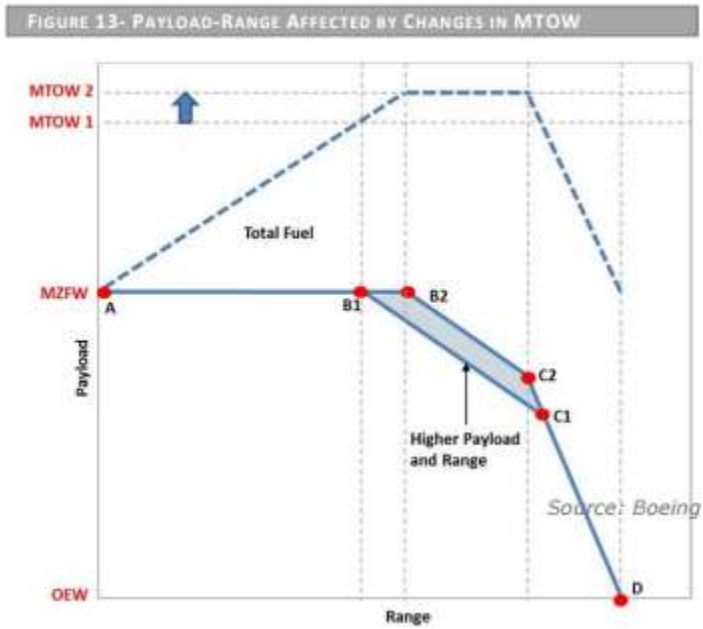
- a. What is the maximum range a payload + fuel of 48K lbs can be transported?



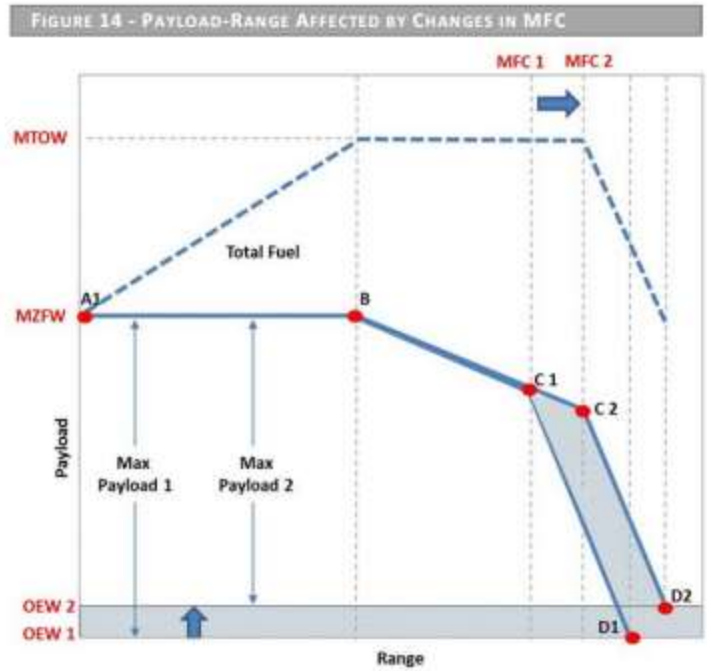
- b. What is the impact on range if the MZFW is increased and the payload+fuel is increased the same amount?



c. What is the impact on payload + fuel if the OEW is increased for a range of 2.5Knm?



d. What is the impact on range if the MTOW is increased for a payload+fuel of 48K lbs?



- e. What is the impact on range of adding winglets to the aircraft for a payload+fuel of 48K lbs.?

