Chapter 10

Miscellaneous topics - 2

Lecture 39

Topics

10.3 Presentation of results

10.3.1 Presentation of results of a student project

10.3.2 A typical brochure

10.3 Presentation of results

At the end of the preliminary design phase of the airplane design, a large amount of information about the airplane is available. It is helpful to record this information in the form of a report which is called aircraft type specification. Though the configuration of the airplane will be updated during the subsequent phases of design, this report gives clear idea about the potential of the proposed design. The report will consist of textural descriptions, drawings, numerical data, graphs and charts. The type of information presented in the report will vary with the type of the airplane but would generally have the following sections (Ref.1.14, chapter 14).

1) Introduction

2) General design requirements i.e. the airworthiness regulations followed during the design process. For example FAR (Federal Airworthiness Regulations of Federal Aviation Administration) are followed in USA, EASA-CS(European Aviation Safety Agency – Certification Specifications) are followed in Europe. EASA requirements were earlier called JAR (Joint Airworthiness Requirements).

3) Geometric characteristics including overall dimensions, wing geometry, tail plane and elevator, fin and rudder, aileron and flap, fuselage dimensions and internal layout, landing gear, power plant, fuel tank locations. This section would include three view drawing of the airplane along with appropriate component geometry drawings.

4) Aerodynamic and structural criteria like flight envelope, gust envelope, operating speeds, design weights, pressurization profile, provision for towing, jacking and ground equipment.

5) Weight and balance including weights of payload, operational items and fixed equipment, centre of gravity limits.

6) Performance manual containing drag polars under different conditions, engine data, take-off, landing, climb, descent and maneuvering performance under different airfield conditions, temperatures, payload and configurations.

7) Airframe

Statements regarding structural design philosophy, materials used, fatigue philosophy, damage tolerance, fabrication techniques and maintainability philosophy. Structural details of major components will be illustrated by detailed drawings.

8) Landing gear

This part of the report contains details of main landing gear, nose/tail landing gear, retraction and deployment, landing gear bay doors, brakes and nose wheel steering.

9) Power plant and systems

This part of the report contains details like general description of the engine, mountings, controls, systems for starting, fuel supply, fire protection and lubrication.

10) Fuel system

Contains information about tankage, metering of fuel flow, controls, provisions for re-fuelling, dumping and ventilation.

11) Systems

Details of hydraulic, electrical, communication, flight control, environmental control systems along with details of avionics, instrumentation, safety systems in emergency. Appropriate diagrams should illustrate various systems.

Remark:

The type specification document acts as a common description of the airplane and serves as a goal throughout the subsequent stages of design. Changes in

this document are controlled by an amendment committee or management review board.

10.3.1 The presentation of the results of a student project

The airplane type specification as described earlier is a detailed document. As regards the presentation of the results of preliminary design (aerodynamic), the following items should be included.

a) Three-view drawing.

b) Dimensions

(i) Overall: length, span and height of airplane.

(ii) Wing: S, b, AR, c_r, c_t, λ , Λ , i_w , ε , Γ, $S_{aileron}$ /S , S_{flap} / S .

(iii) Fuselage: l_f , AR_f , lengths of nose section, cockpit, payload compartment, tail section. Figures showing the seating arrangement for passenger airplane/ payload arrangement in other cases.

(iv) Horizontal tail: S_t , b_t , AR_t , c_{rt} , c_{tt} , Λ_t , λ_t , i_t , $S_{elevator}$ / S_t, S_{tab} / S_t.

(v) Vertical tail: S_v , height , AR_v , c_{rv} , c_{tv}, Λ_v , λ_v , S_{rudder} / S_v , S_{tab}/S_v.

(vi) Landing gear: base, tread, type.

c) Engine:

Type, rating, make, location, nacelle size.

d) Performance:

Reference weight, $s_{t.o}$, s_{land} , $(R/C)_{max}$ at sea level, V_{max} and h_{vmax}, V_{cr} and h_{cr}, range, endurance, ceiling.

e) The following additional items need to be included

i) Payload versus range curve for passenger airplane.

ii) Climb performance with one engine inoperative.

iii) Take-off run, take-off distance with effect of ambient temperature and weight.

iv) Landing distance, landing run with effect of reverse thrust if available.

10.3.2 A typical brochure

This subsection gives brief information about Lockheed C-130H Hercules airplane and the C-130H-30 variant of it. Figure 10.3 shows the cover page of the

brochure. Figure 10.4 shows the overall dimensions of the two versions. It is seen that C-130H-30 has a fuselage longer by 4.6 m, than C-130H. Other dimensions are the same.

Figure 10.5 gives the specifications. It is seen that the empty weight of C-130H-30 has increased. However, the maximum take off weight, fuel weight and engine power are same as that of C-130H. Consequently, payload has been decreased appropriately. Fig.10.6 shows (a) payload vs range and (b) take off and landing distances for different gross weights.

Fig.10.3 Typical brochure

(Adapted from company brochure - Reproduced with permission from Lockheed-Martin)

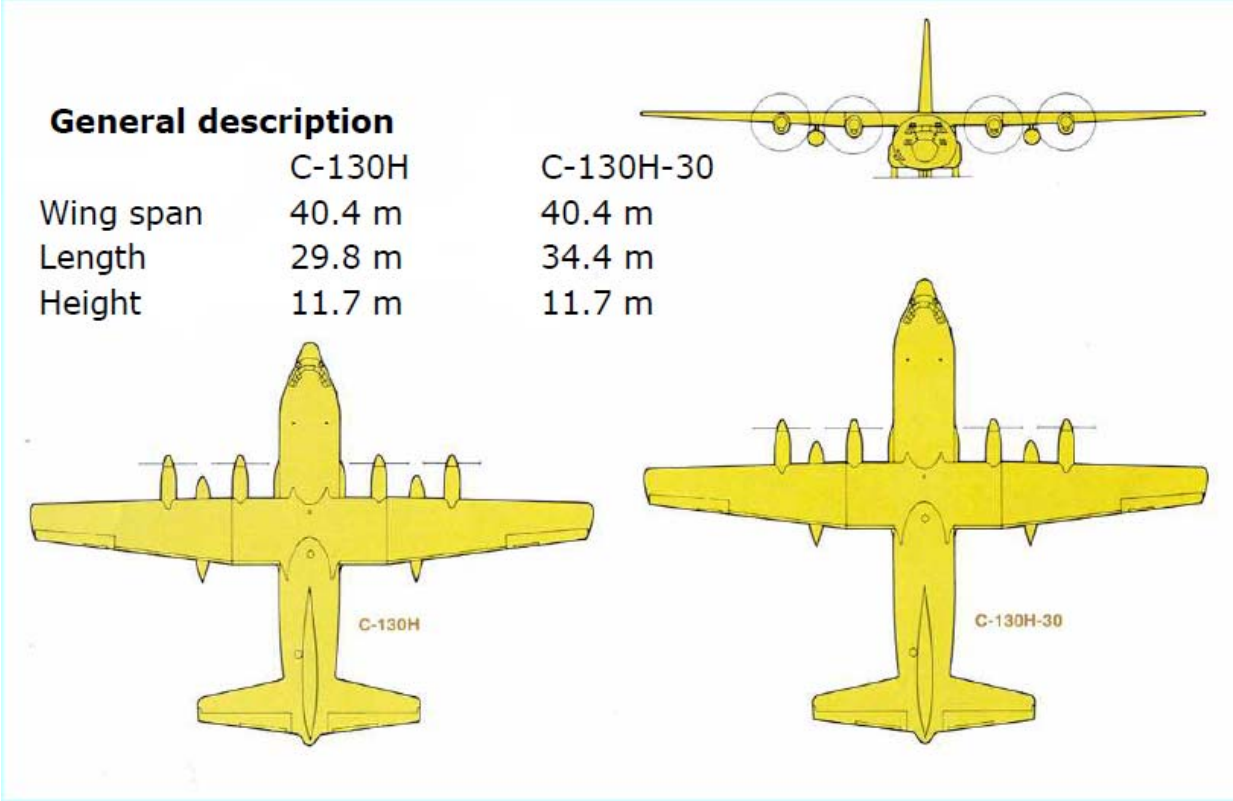


Fig.10.4 General description

(Adapted from company brochure- Reproduced with permission from Lockheed-Martin)

Weights

Item	C-130H	C-130H-30
Empty weight	32,426 kgf	34,137 kgf
Maximum payload	19,764 kgf	18,053 kg
Maximum take-off weight	70,306 kgf	70,306 kg
Maximum landing weight (5 fps)	70,306 kgf	70,306 kg
Normal landing weight (9 fps)	58,967 kgf	58,967 kg

Fuel

Item	Volume (liters)
Internal tank	26, 346
External tank (optional)	10,296
Total fuel	36,642 min
Single point refuel rate	2,270 litres/ min
Jettison rate	1,893 liters / min

Powerplants

Engines – four Allison T56-A-15, flat- rated at 4,508 eshp (3,663kw) @35^0 C at sea level.
Propellers – four blade Hamilton Standard hydromatic 4.11 m diameter.
Auxiliary power unit – Supplies air for engine starting , ground air conditioning , and drives 40 kVA generator.

Fig.10.5 Specifications of C-130H and C-130H-30

(Adapted from company brochure- Reproduced with permission from Lockheed-Martin)

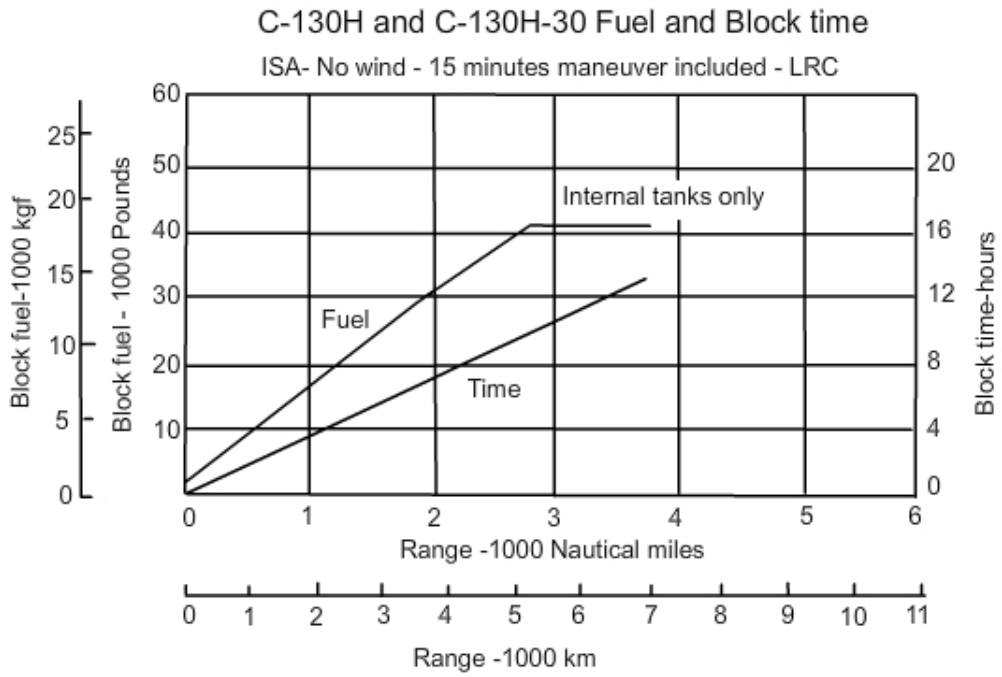


Fig.10.6a Outline of performance - Block fuel and block time

(Adapted from company brochure- Reproduced with permission from Lockheed-Martin)

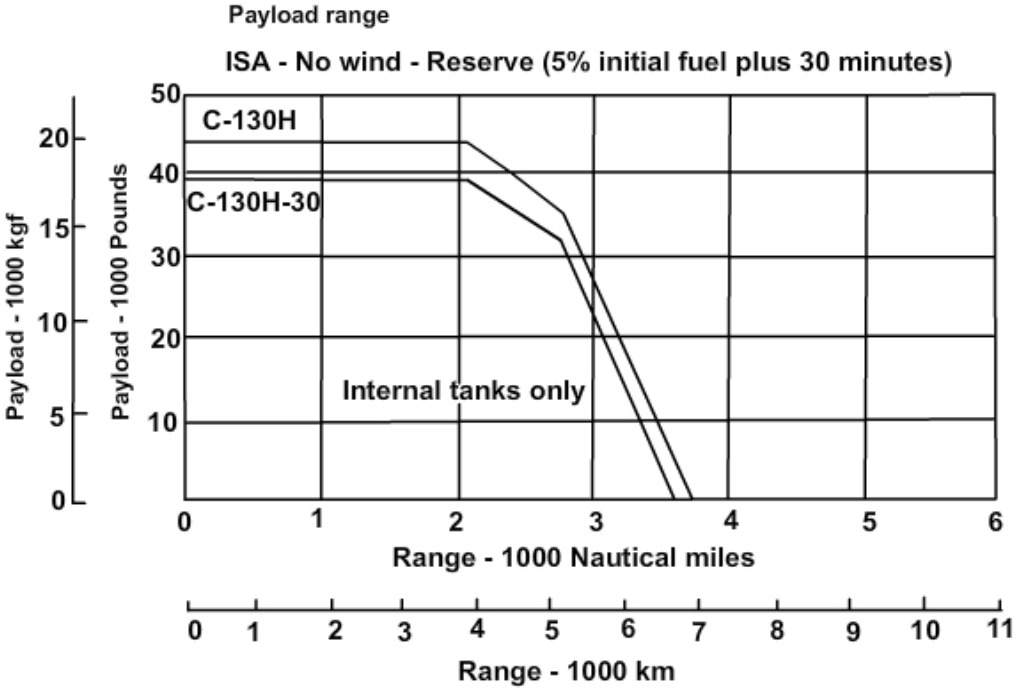


Fig.10.6b Outline of performance - Payload vs range

(Adapted from company brochure- Reproduced with permission from Lockheed-Martin)

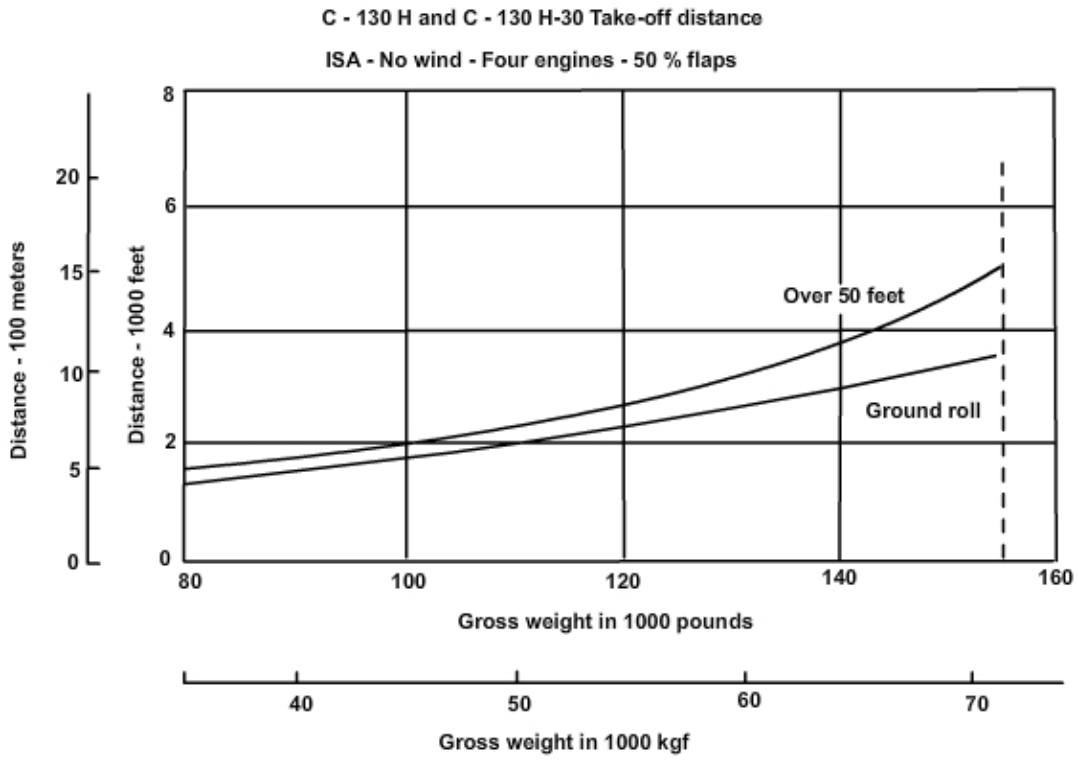


Fig.10.6c Outline of performance - Take -off distance

(Adapted from company brochure- Reproduced with permission from Lockheed-Martin)

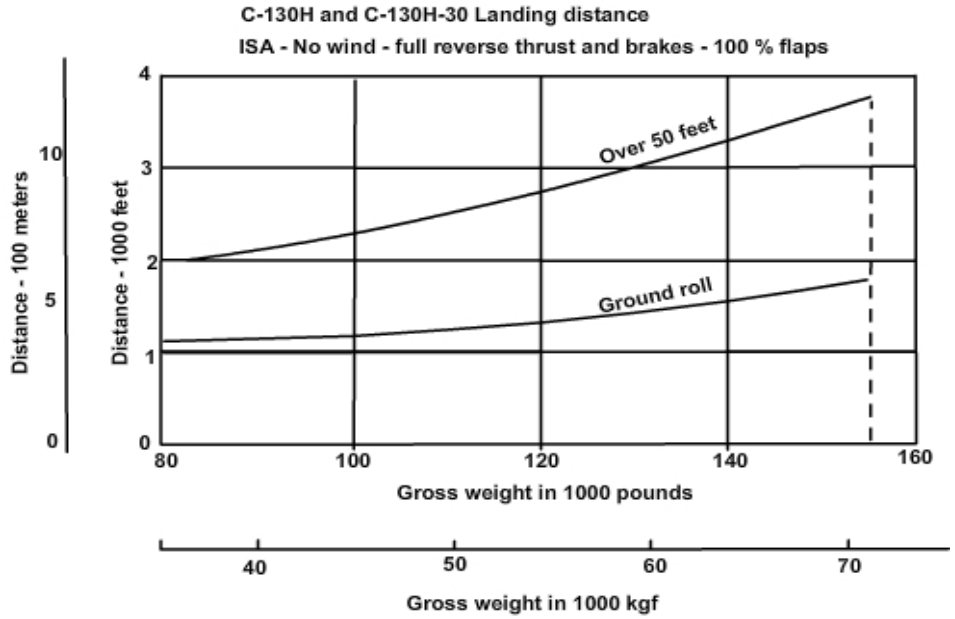
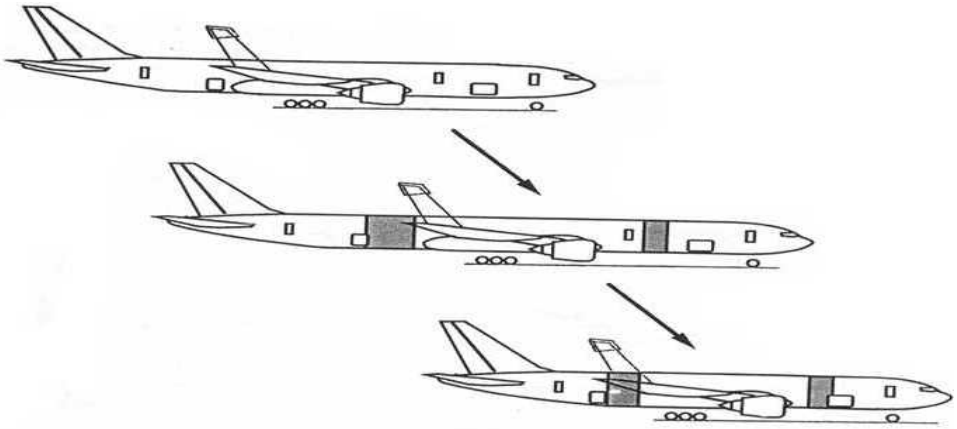


Fig.10.6d Outline of performance- Landing distance

(Adapted from company brochure- Reproduced with permission from Lockheed-Martin)

Remark:

In the case of passenger airplanes stretched versions or shortened versions are offered along with the basic design. In such cases, take off weight may be different for different versions and the engines may have different ratings for individual versions. Figure10.7 (from Ref.1.14, chapter 3) shows the different versions of Boeing 777 airplane.



Boeing 777 (model)	Maximum Take-off weight (kgf)	Engine Thrust (kgf)	Seats	Range (km)
-200A	247502	34968	300	9075
-200B	287011	40872	300	13705
-300	299728	40872	350	10556
-100	299728	40872	250	16112

Table 10.7 Versions of Boeing 777 airplane

(Adapted from Ref.1.14, chapter 3 with permission from author)