SECTION 1.11 ATPL PERFORMANCE AND LOADING (PL)

Unit 1.11.1 APLC: ATPL performance and loading – all aircraft categories – *Reserved*

Unit 1.11.2 APLA: ATPL performance and loading – aeroplane

1. Reserved

2. Take-off and landing performance

2.1 Terminology

2.1.1 Explain the following terms in the context of take-off and landing performance:

(a) speeds:

(i) V_1, V_R, V_2;

(ii) V_S and derivatives (for example, 1.3 V_S);

(iii) maximum rate and maximum angle climb speed;

(iv) $V_{MCA,}$ V_{MCG};

(v) flap retraction speed schedule;

(b) distances:

(i) TORR/TORA, TODR/TODA, ASDR/ASDA, LDR/LDA;

(ii) balanced field length;

(iii) clearway, stopway;

(c) weights:

(i) TOW/MTOW, LW/MLW, ZFW/MZFW;

(ii) basic operating weight;

(iii) useable fuel;

(iv) payload;

(d) take-off segments:

(i) first, second, third and fourth segments;

(e) pavement segments:

(i) LCN, CAN, PCN;

(ii) pavement concession;

(iii) wheel loading.

2.2 Theory – take-off performance

2.2.1 Runway:

(a) derivation/basis of take-off distance;

(b) derivation/basis of accelerate-stop distance:

(i) delay factors assumed;

(ii) use of reverse thrust;

(c) derivation/basis of V_1;

(d) concept of balanced field length;

(e) clearways and stopways:

(i) function;

(ii) effect on V_1;

(iii) effect on TOW when runway-limited;

(f) V_R and V_2:

(i) interrelationship with V_1;

(ii) range of acceptable values;

(g) allowance for headwind/tailwind;
(h) allowance for abnormal runway surfaces:
(i) wet;
(ii) standing water/snow;
(iii) gravel.

2.2.2 Take-off climb:
(a) concept/purpose of take-off segments;
(b) composition of segments:
(i) first;
(ii) second;
(iii) third;
(iv) fourth;
(c) take-off climb gradients:
(i) distinction between gross and net gradient;
(ii) purpose of net gradient;
(d) gradients required in each segment:
(i) gross and net;
(ii) two-, three- and four-engine aircraft;
(e) obstacle clearance requirements:
(i) take-off area (IMC case only);
(ii) vertical clearance;
(f) curved departures:
(i) point at which turn may commence;
(ii) bank angle;
(iii) vertical clearance.

2.2.3 Take-off weight restrictions:
(a) factors affecting the maximum permissible take-off weight, including;
(i) structural limit;
(ii) TODA limit;
(iii) ASDA limit;
(iv) second-segment climb limit;
(v) effect of different flap settings:
(A) lift-off speed;
(B) lift-off distance;
(C) second segment performance;
(vi) effect of increased V_2 (‘V_2 overspeed’):
(A) lift-off speed;
(B) lift-off distance;
(C) second segment climb performance;
(vii) typical penalties applied for non-standard take-off:
(A) line-up allowance;
(B) use of anti-ice;
(C) non-availability of reverse thrust;
(D) non-availability of anti-skid braking;
(E) non-availability of ground spoilers;
(F) abnormal runway surface.

2.2.4 Effects of operating technique:

(a) explain the effects of early or late rotation speed:
  (i) runway distance to lift-off;
  (ii) vertical clearance at runway end;
(b) explain the effects of too-rapid or too-slow rotation rate:
  (i) runway distance to lift-off;
  (ii) obstacle clearance;
(c) possibility of tail-strike or stall with early or rapid rotation.

2.2.5 Take-off thrust de-rating:
(a) concept of de-rated thrust;
(b) typical restrictions/limitations on use of de-rate;
(c) typical de-rate values.

2.3 Practical application – take-off
(a) use typical operations manual data to determine either:
  (i) MTOW on given runway; or
  (ii) minimum runway length at given take-off weight incorporating any or all of the following variables:
    (A) runway slope;
    (B) wet runway;
    (C) wind component;
    (D) temperature;
    (E) altitude;
    (F) flap setting;
    (G) engine type and/or power derate setting;
    (H) obstacles of various heights at various distances;
(b) use typical operations manual data to determine V_1, V_R and V_2.

2.4 Theory – landing performance

2.4.1 Runway:
(a) derivation/basis of landing distance:
  (i) certification landing technique;
  (ii) factoring;
(b) normal/abnormal runway surfaces;
(c) allowance for wind.

2.4.2 Approach and touchdown:
(a) determination/basis of VREF:
  (i) nominally 1.3 V_S;
  (ii) typical additives for gust;
(b) nominal approach path:
  (i) 3°-degree slope;
  (ii) runway aim point (1,000 ft from threshold);
  (iii) threshold crossing height;
  (iv) compare with certification landing technique;
(c) effect of different flap settings:
  (i) approach speed;
  (ii) visibility (cockpit cutoff angle);
  (iii) low-speed stability;
  (iv) go-around capability.

2.4.3 Flight path gradients – landing:

(a) net path at 1,500 ft above airfield;

(b) missed approach climb:

(i) configuration;

(ii) required gradients for two-, three- and four-engine aircraft;

(c) landing climb:

(i) configuration;

(ii) required gradients for two-, three- and four-engine aircraft.

2.4.4 Landing weight restrictions:

(a) explain the factors affecting the maximum permissible landing weight, including:

(i) structural limit;

(ii) LDA limit;

(iii) missed approach climb limit;

(iv) landing climb limit;

(v) typical penalties applied for non-standard landing:

(A) non-availability of reverse thrust;

(B) non-availability of anti-skid;

(C) non-availability of ground spoilers;

(vi) abnormal runway surface.

2.4.5 Effects of operating technique:

(a) effect of excessive touchdown speed;

(b) effect of late touchdown such as prolonged flare and holding off;

(c) effect of delayed reverse thrust.

2.5 Practical application – landing

(a) using typical operations manual data, calculate each of the following:

(i) MLW on given runway; or

(ii) minimum runway length at given landing weight incorporating any or all of the following variables:

(A) runway slope;

(B) wet runway;

(C) wind component;

(D) temperature;

(E) altitude;

(F) flap setting;

(iii) Reference velocity ($V_{REF)}$; and

(b) using typical operations manual data:

(i) calculate the MTOW and the MLW, taking into consideration the limiting factors that are applicable to the given circumstances, and then deciding which of those factors is the critically limiting one, being aware that the TOW might be limited by cruising level or landing factors; and

(ii) determine the limiting variable for a given take-off situation (for example, the limiting temperature at which a given take-off can be made).

3. Climb, cruise and descent performance

3.1 Terminology

3.1.1 Understand and be able to use terms in correct context:

(a) LRC;

(b) specific range;

(c) PNR;
(d) point of safe diversion (PSD);
(e) ETP;
(f) ISA and temperature derivatives (for example, ISA+10°).

3.2 Theory

3.2.1 Basis of speed and thrust management:
(a) basic theory:
(i) drag (thrust) versus speed;
(ii) thrust/speed required for minimum drag;
(iii) thrust/speed required for minimum fuel consumption;
(iv) specific range;
(v) thrust available versus thrust required;
(vi) excess thrust;
(vii) climb speeds;
(viii) best rate of climb;
(ix) best angle of climb;
(x) graphical representations of the above.
(b) effect of altitude and temperature variations:
(i) fuel consumption;
(ii) range;
(iii) specific range;
(iv) rate of climb.

3.2.2 Effect of operational decisions:
(a) factors affecting choice of cruise speed (general discussion only):
(i) direct costs;
(ii) indirect costs;
(iii) scheduled departure/arrival times;
(iv) effect on connecting flights;
(v) effects of competition;
(vi) making up for delayed departure;
(b) selection of cruise schedules:
(i) economic cruise;
(ii) LRC;
(iii) use of high-speed cruise;
(iv) selection of cruise altitude;
(v) performance index for FMS input;
(c) selection of descent point:
(i) fuel used on descent;
(ii) fuel used at low level;
(iii) effect of early/late descent;
(d) engine-out considerations.

3.2.3 En route flight path gradients:
(a) en route climb gradient:
(i) two-engine aircraft;
(ii) three- and four-engine aircraft;
(b) en route obstacle clearance (IMC case):

(i) horizontal distance from obstacles;

(ii) vertical clearance of obstacles;

(iii) net gradient required at minimum clearance;

(c) drift-down procedure:

(i) increased vertical clearance required.

3.3 Practical application

3.3.1 For the climb segment, given appropriate initial data, including variations from ISA, use typical operations manual information to determine each of the following:

(a) time/distance/fuel used to a given altitude;

(b) altitude reached after a given time or distance;

(c) fuel/distance/time requirements for intermediate level changes.

3.3.2 Cruise and descent:

(a) given appropriate initial data, including variations from ISA, use typical operations manual information to determine, under normal and engine-out conditions:

(i) maximum and optimum cruise levels;

(ii) TAS and fuel consumption at specified altitudes, adjusting for use of airconditioning packs, bleed air, etc. as required;

(iii) maximum weight or temperature at which specified performance and/or altitudes can be attained;

(iv) holding speeds and fuel consumption at specified and optimum altitudes;

(v) appropriate descent points and calculate time/fuel used on descent.

4. Weight and balance

4.1 Terminology

4.1.1 Explain, and be able to apply, the following terms and concepts in their correct context:

(a) CG;

(b) moment arm;

(c) CG index;

(d) CG envelope;

(e) loading zones;

(f) floor limits;

(g) basic weight;

(h) zero-fuel weight;

(i) average weights for passengers and baggage;

(j) approved load control system.

4.2 Theory

4.2.1 Basic weight and balance:

(a) explain the basic theory of CG and moments in respect to the following:

(i) CG index;

(ii) CG envelope;

(b) explain the following terminology for weights:

(i) basic weight;

(ii) operating weight;

(iii) zero-fuel weight;

(iv) fuel weight;

(v) payload;

(c) explain the consequences of overloading on:

(i) take-off performance;

(ii) climb/cruise performance;

(iii) aircraft structure;

(d) understand requirement for passenger seal allocation and need to control seating changes in large aircraft.

4.2.2 Load control system:

(a) describe purpose/function of a load control system:

(i) weight control authority;

(b) describe requirements and responsibilities of approved load controllers (ALC);

(c) describe responsibilities of pilot in command;

(d) describe the requirements for load sheet and explain the contents.

4.3 Practical application

4.3.1 Use typical operations manual information to extract weight and balance data:

(a) given appropriate initial data, determine any or all of:

(i) CG at empty weight;

(ii) movement of CG with addition of fuel and payload;

(iii) movement of CG due to fuel consumption in flight;

(iv) effect on CG of raising/lowering undercarriage and/or flaps;

(b) determine CG limits for take-off, cruise and landing;

(c) determine adjustments (if any) required to fuel or payload to permit operations within the CG envelope;

(d) passenger load may be presented as block loads (for example, 24 adults in Zone A, 36 adults and 4 children in Zone B, etc.).

4.3.2 Given appropriate initial data, assess a completed weight and balance proforma and determine whether it is acceptable for flight.

Unit 1.11.3 APLH: ATPL performance and loading – helicopter

1. Reserved

2. Take-off and landing performance

2.1 Terminology

2.1.1 Explain the following terms in the context of take-off and landing performance:

(a) speeds:

(i) V_{TOSS}, V_{YSE};

(ii) maximum rate and maximum angle climb speed;

(iii) CDP (speed/time), LDP;

(b) distance (a basic understanding is required at the ATPL level):

(i) TORR/TORA, TODR/TODA, ASDR/ASDA, LDR/LDA;

(ii) balanced field length;

(iii) clearway, stopway;

(c) weights:

(i) TOW/MTOW, LW/MLW, ZFW/MZFW;

(ii) basic operating weight;

(iii) useable fuel;

(iv) payload;

(d) pavement parameters:

(i) LCN, ACN, PCN;

(ii) pavement concession;

(iii) wheel loading.

2.2 Theory – take-off performance

2.2.1 For runways and helipads, explain the following:

(a) derivation of take-off distance;

(b) derivation of accelerate-stop distance with delay factors assumed;

(c) clearways and stopways and their function;

(d) allowance for headwind and tailwind.

2.2.2 For take-off performance, explain the following:

(a) concept and purpose of take-off segments;

(b) composition of the first, second, third and fourth segments:

(c) take-off climb gradients, including:

(i) distinction between gross and net gradient; and

(ii) purpose of net gradient;

(d) gradients required in each segment, including:

(i) gross and net obstacle clearance requirements take-off area (IMC case only); and

(ii) vertical clearance;

(e) for curved departures, the point at which turn may commence taking into account vertical clearance.

2.2.3 Take-off weight restrictions:

(a) describe the following factors that affect the maximum permissible take-off weight:

(i) structural limit;

(ii) en route accountability VFR;

(iii) en route accountability night/IFR;

(iv) second-segment climb limit;

(v) landing weight;

(vi) en route climb requirement.

2.2.4 Explain power assessment.

2.3 Practical application – take-off

2.3.1 Use typical flight manual data to determine each of the following:

(a) MTOW for a given runway or helipad;

(b) minimum runway length at given take-off weight incorporating each of the following variables:

(i) wind component;

(ii) temperature;

(iii) altitude;

(iv) engine type and/or power setting.

2.4 Theory – landing performance

2.4.1 For runway landing performance, explain the derivation and basis of landing distance for the following:

(a) certification landing technique;

(b) factoring;

(c) allowance for wind.

2.4.2 For approach and touchdown performance, explain the determination of the nominal landing decision point (LDP):

2.4.3 For landing weight restrictions, explain the factors affecting the maximum permissible landing weight.

2.4.4 Describe effects of different operating techniques on landing performance.

2.5 Practical application-landing

2.5.1 Using typical flight manual data

(a) calculate each of the following:

(i) MLW for a given runway or helipad;

(ii) MTOW and MLW taking into considering the limitations applicable to the given circumstances, including deciding which of those factors is the critical limiting one, being aware that the TOW may be limited by cruising level or landing factors; and

(b) determine the limiting variable for a given take-off situation (for example, the limiting temperature at which a given take-off can be made).

3. Climb, cruise and descent performance

3.1 Terminology

3.1.1 Understand and be able to use terms in correct context:

(a) LRC;

(b) specific range;

(c) PNR;

(d) point of safe diversion (PSD);

(e) CP or ETP;

(f) ISA and temperature derivatives (for example, ISA+10^{o}).

3.2 Theory

3.2.1 Basis of speed management:

(a) effect of altitude and temperature variations:

(i) fuel consumption;

(ii) range;

(iii) specific range;

(iv) rate of climb.

3.2.2 Effect of operational decisions:

(a) factors affecting choice of cruise speed;

(b) selection of descent point;

(c) engine-out considerations.

3.2.3 En route flight path gradients:

(a) en route climb gradient;

(b) en route obstacle clearance (IMC case):

(i) horizontal distance from obstacles;

(ii) vertical clearance of obstacles;

(iii) net gradient required at minimum clearance;

(c) drift down procedure:

(i) increased vertical clearance required.

3.3 Practical application

3.3.1 Climb:

(a) given appropriate initial data, including variations from ISA, use typical flight manual information to determine:

(i) time/distance/fuel used to a given altitude, or altitude reached after a given time or distance.

3.3.2 Cruise and descent:

(a) given appropriate initial data, including variations from ISA, use typical flight manual information to determine, under normal and engine-out conditions:

(i) maximum and optimum cruise levels;

(ii) TAS and fuel consumption at specified altitudes, adjusting for use of bleed air, etc., as required;

(iii) maximum weight or temperature at which specified performance and/or altitudes can be attained;

(iv) holding speeds and fuel consumption at specified and optimum altitudes;

(v) appropriate descent points and calculate time on descent.

4. <u>Weight and balance</u>

4.1 Terminology

4.1.1 Understand, and be able to apply, in correct context the following terms and concepts:

(a) CG;

(b) moment arm;

(c) CG index;

(d) CG envelope;

(e) loading zones;

(f) floor limits;

(g) basic weight;

(h) zero-fuel weight;

(i) average weights for passengers and baggage;

(j) approved load control system.

4.2 Theory

4.2.1 Basic weight and balance:

(a) review basic theory of CG and moments:

(i) CG index and CG envelope;

(b) review standard terminology for weights:

(i) basic weight, operating weight, zero-fuel weight;

(ii) fuel weight, payload;

(c) understand the consequences of overloading on:

(i) take-off performance;

(ii) climb/cruise performance, aircraft structure;

(d) understand requirement for passenger seat allocation and need to control seating changes in large aircraft;

(e) effect of weight on autorotation and landing.

4.2.2 Load control system:

(a) purpose/function of a load control system:

(i) weight control authority;

(b) approved load controlled (ALC):

(i) responsibility of ALC;

(c) responsibilities of pilot in command:

(i) pilots may assume responsibilities of ALC;

(d) load sheet;

(i) requirements;

(ii) contents.

4.3 Practical application

4.3.1 Use typical flight manual information to extract weight and balance data:

(a) given appropriate initial data, determine any or all of:

(i) CG at empty weight;

(ii) movement of CG with addition of fuel and payload;

(iii) movement of CG due to fuel consumption in flight;

(iv) effect on CG of raising/lowering undercarriage;

(b) determine CG limits for take-off, cruise and landing;

(c) determine adjustments (if any) required to the payload to permit operations within the CG envelope.

4.3.2 Given appropriate initial data, assess a completed weight and balance proforma and determine whether it is acceptable for flight.

4.3.3 Sling load/hoist:

(a) effects on CG.

Unit 1.11.4 APLP: ATPL performance and loading – powered-lift – *Reserved*