Appendix II Subject No 64 Basic Turbine Knowledge

Each subject has been given a subject number and each topic within that subject a topic number. These reference numbers will be used on ‘knowledge deficiency reports’ and will provide valuable feed back to the examination candidate.

Sub Topic Syllabus Item

64.2 Basic Turbine Engine Theory

64.2.2 Describe Newton’s third law of motion and its practical application as it relates to the operation of a turbine engine.

64.2.4 Describe how gas undergoes changes in pressure, volume and temperature in accordance with Boyle’s and Charles’ Laws.

64.2.6 Describe each of the following and their application to turbine engine operation:

(a) Bernoulli’s Theorem;

(b) Brayton constant pressure cycle; and

(c) the pressure-temperature cycle.

64.2.8 Describe the changes to pressure, temperature and velocity of the gas flow as it passes through each section of a turbine engine.

64.2.10 Describe the changes in the airflow characteristics of velocity, temperature and pressure through a divergent and convergent duct at subsonic and supersonic speeds.

64.4 Turbine Engine Types

64.4.2 Compare the working cycle of a turbine engine and a piston engine.

64.4.4 Describe the comparative advantages of turbine engines versus piston engines for aircraft propulsion.

64.4.6 Describe the basic constructional arrangements of the following engine types:

(a) turboprop;

(b) turbo-shaft;

(c) turbojet; and

(d) turbofan.

64.4.8 Describe the operating parameters and uses of each of the above engines.

64.4.10 Identify engines that fall into either the thrust producing or torque producing category.

64.4.12 Describe the following mechanical arrangements of a turbine engine:

(a) single-spool;

(b) twin-spool; and

(c) triple-spool.

64.6 Turbine Engine Inlet Systems

64.6.2 Describe the purpose, construction and principles of operation of the engine inlet duct.

64.6.4 Describe and explain the purpose of a subsonic divergent inlet duct.

64.8 Turbine Engine Compressors

64.8.2 Describe the purpose of a compressor in a turbine engine.

64.8.4 Describe the basic principles of operation of centrifugal and axial flow compressors.

64.8.6 Describe the compressor arrangements found on the various types of turbine engine.

64.8.8 Describe the comparative advantages of centrifugal and axial flow compressors.

64.8.10 Describe the merits of combined centrifugal and axial flow compressor combinations in turbine engines.

64.8.12 Describe typical compressor pressure ratios for the various types and configuration of turbine engine and the factors that affect compression ratio.

64.8.14 Define bypass ratio.

64.8.16 Describe the operation of, and bypass ratios associated with, various bypass fans, from low bypass to ultra-high bypass.

64.8.18 Describe the purpose and function of:

- (a) impellers;
- (b) inlet guide vanes (fixed and variable);
- (c) rotor blades;
- (d) stator blades;
- (e) variable stator blades;
- (f) diffusers; and
- (g) bleed valves / bands.

64.8.20 Describe the pressure, temperature and velocity changes through a centrifugal compressor.

64.8.22 Describe the pressure, temperature and velocity changes through an axial flow compressor.

64.8.24 State the reasons why axial flow compressors have a higher number of stages than centrifugal compressors.

64.8.26 State the reason for the small pressure change per stage in an axial flow compressor.

64.8.28 State the reason for the decrease in size and increase in the number of compressor blades towards the rear of an axial flow compressor.

64.8.30 State the reasons for and advantages of multiple spool compressors.

64.8.32 For various types of compressor arrangements identify; N1, N2, and N3 and state whether each is HP, IP or LP.

64.8.34 Describe speed relationships between compressor sections and how these speeds may vary with changing atmospheric conditions.

64.8.36 Describe the common source of bleed air.

64.8.38 Explain what is meant by compressor stall/compressor surge.

64.8.40 State the conditions that are commonly known to produce compressor stall/surge with particular regard to:

(a) compressor maintenance;

(b) blade damage;

(c) intake damage/restriction;

(d) engine handling/operation; and

(e) fuel scheduling.

64.8.42 Describe the symptoms of a compressor stall/surge.

64.8.44 Describe the operation of the following stall/surge control devices:

(a) variable angle inlet guide and compressor vane systems;

(b) bleed valves; and

(c) bleed bands.

64.8.46 Describe the effects of a dirty, worn or damaged compressor on SFC and power output.

64.10 Turbine Engine Combustion Section

64.10.2 Describe the purpose and operation of the combustion chamber(s).

64.10.4 Describe the constructional features and principles of operation of the following types of combustion chamber:

(a) multiple can;

(b) annular;

(c) can annular; and

(d) reverse flow annular.

64.10.6 State the comparative advantages of each type of combustion chamber.

64.10.8 Describe the purpose of:

(a) swirl chambers;

(b) air shrouds;

(c) liners; and

(d) interconnectors.

64.10.10 Describe the uses of primary, secondary and tertiary air flow through and/or around a combustion chamber.

64.10.12 State the percentages of airflow typically used for cooling and for combustion.

64.10.14 Describe how flameout is caused and prevented.

64.12 Turbine Engine Turbine Section

64.12.2 State the purpose and operation of the turbine section.

64.12.4 Describe how a turbine blade extracts energy from the gas stream and drives the wheel/disc.

64.12.6 Describe the function of the following turbine assembly components:

(a) casing and associated structures;

(b) wheel/disc;

(c) shafts;

(d) nozzle guide vanes; and

(e) blades.

64.12.8 Describe the principles of operation and characteristics of the following turbine blade design types:

(a) impulse;

(b) impulse-reaction; and

(c) reaction.

64.12.10 State which type of turbine blade design is most common and explain why this type of blade is preferred.

64.12.12 Describe the gas flow pattern through nozzle and blade assembly with particular emphasis on static pressure, temperature and velocity.

64.12.14 Identify factors which limit the power available from the turbine section.

64.12.16 Describe multi-stage turbines.

64.12.18 State the reasons for compressor-turbine matching and how this is achieved.

64.12.20 State why turbine assemblies increase in diameter towards the rear of the engine.

64.12.22 Define turbine blade creep and state the causal factors for this condition.

64.14 Turbine Engine Exhaust Section

64.14.2 State the function of the exhaust section.

64.14.4 Describe the exhaust gas flow through convergent and divergent passages.

64.14.6 State the purpose, and principles of operation of the following exhaust nozzle types:

(a) convergent; and

(b) convergent-divergent.

64.14.8 Describe the noise levels of different types of exhaust system and the various means of noise suppression.

64.16 Thrust Reversers

64.16.2 Describe thrust reversal.

64.16.4 Explain the purpose and operation of thrust reversal.

64.16.6 Describe the various types of thrust reverser.

64.18 Turbine Engine Fuel Systems

64.18.2 Compare and differentiate between AVGAS and turbine engine fuel and describe methods of reducing the likelihood of fuelling with the wrong type.

64.18.4 State the differences between the various types of turbine engine fuel and identify their common usage names.

64.18.6 Describe the function of the following turbine engine fuel system components:

(a) fuel control unit (hydro pneumatic, hydro mechanical and electro-hydro mechanical);

(b) fuel filters;

(c) fuel heater;

(d) governors and limiting devices; and

(e) main fuel pumps.

64.18.8 State the ideal fuel/air ratio for a turbine engine.

64.18.10 Describe the following properties in relation to turbine engine fuels:

(a) specific gravity;

(b) fire hazard; and

(c) fuel icing.

64.18.12 State the effect of a change in specific gravity with respect to weight of fuel.

64.18.14 Describe the purposes of anti-icing and anti-microbiocidal additives in turbine engine fuels.

64.18.16 State the ground handling requirements and the safety precautions to be observed with the use of turbine engine fuels.

64.18.18 Describe the susceptibility of turbine fuels to water contamination over other types of aviation fuels.

64.18.20 Describe methods of fuel system contamination detection and control.

64.20 Turbine Engine Lubrication Systems

64.20.2 Describe the basic principles of operation of typical turbine engine lubrication systems.

64.20.4 Describe the function and principles of operation of the following turbine engine lubrication system components:

(a) oil cooler;

(b) oil-fuel heat exchangers;

(c) oil filters/screens (pressure and scavenge);

(d) oil system chip detectors and magnetic plugs;

(e) valves (bypass/check/relief); and

64.20.6 State the reason most turbine engines use fuel to cool the oil in preference to air.

64.22 Turbine Engine Starting; Ignition; Relight; and Shutdown

64.22.2 Describe the general precautions and safety checks prior to starting and ground running a turbine engine.

64.22.4 Describe general procedures for starting and shutting down a turbine engine.

64.22.6 Describe the positive cockpit indications of light-up during start.

64.22.8 Describe what is meant by self-sustaining rpm and how this is achieved.

64.22.10 Describe why it is important to accelerate an engine up to sustaining rpm as quickly and uniformly as possible.

64.22.12 Describe the causes, indications, effects and remedial actions for the following start defects:

(a) hung start;

(b) hot start;

(c) wet start;

(d) compressor stall/surge during start;

(e) tail pipe fire; and

(f) bleed band or bleed valve stuck in the open or closed position.

64.22.14 Describe why turbine engines are often fitted with separate low and high energy ignition systems.

64.22.16 Describe the conditions under which the ignition system(s) would be turned on.

64.22.18 Describe the requirement and general procedures for an engine relight in the air.

64.24 Turbine Engine Air Cooling and Sealing

64.24.2 Describe the requirement for cooling and sealing of turbine engine components.

64.24.4 Describe the uses of compressor bleed air for cooling and sealing.

64.24.6 Describe how turbine blades, discs and nozzles are cooled using compressor bleed air.

64.26 Turbine Engine Indicating and Instrumentation

64.26.2 Describe the following types of turbine engine indicators and instrumentation including their function and basic principles of operation:

(a) engine rpm;

(b) engine pressure ratio;

(c) engine torque;

(d) fuel flow;

(e) pressure indicators;

(f) temperature indicators; and

(g) vibration indicators.

64.26.4 State the meaning of the following terms:

(a) EPR;

(b) fan speed (N_1);

(c) TIT;

(d) ITT;

(e) TOT;

(f) TGT;

(g) EGT; and

(h) JPT.

64.28 Turbine Engine Performance

64.28.2 Define the following terms and describe the relationship between them, and their application to engine operation:

(a) power;

(b) thrust;

(c) torque;

(d) gross thrust;

(e) net thrust;

(f) thrust horsepower (THP);

(g) shaft horsepower (SHP);

(h) equivalent shaft horsepower (ESHP); and

(i) specific fuel consumption (SFC).

64.28.4 Describe the effect of the following factors on turbine engine performance:

(a) airspeed;

(b) ram effect;

(c) altitude;

(d) pressure;

(e) temperature;

(f) humidity; and

(g) bleed air.

64.28.6 Describe the requirements for and methods of thrust augmentation.

64.28.8 Describe the main factors that limit the power output of a turbine engine.

64.28.10 Describe the propulsive efficiency of the following types of turbine engine:

(a) turboprop/turboshaft;

(b) high bypass ratio turbofan;

(c) low bypass ratio turbofan; and

(d) turbojet.

64.28.12 State the causes of the reduction in SFC with increasing airspeed in turboprop engines.