Part 66 L

UK Glider Inspector
Revision Primer

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PART 66 Revision Primer

Introduction

This document contains useful revision material which covers a number of subjects related to the various Part 66 exams. Reading, understanding, remembering this information will help to prepare a candidate for taking the required Part 66 Exams in the UK. Additional reference material has been noted in Appendix 1 and will help to further broaden the experience needed as a Part 66 engineer.

Chapters :-

Chapter 1.

Basic Knowledge

This section attempts to understand a candidate's basic knowledge in a number of key areas which are instrumental for aircraft maintenance. These include mathematics, conversions, chemistry, physics, temperature, expansion, electrical pressure, air dynamics, and fire prevention amongst others.

Mathematics

In the context of physical problems like acceleration and deceleration the idea of looking at an object, which is, for example, rolling down a hill and accelerating at a rate of 3 ft./s. If it starts rolling at 10 ft./s after a number of seconds say five it will have increased in speed by five seconds times 3 fs/sec or 15 ft/sec in total. Adding its initial speed of 10ft/sec means that after 5 seconds its speed will be 25 ft/second. A similar approach could be taken to determine the speed of an object rolling uphill and decelerating.

Conversions

Often numbers are expressed in different ways. For example in the case of time one and a half minutes can be expressed as one minute and 30 seconds or in as decimal 1.5 minutes. A similar approach is taken for angles where one degree also comprises of 60 minutes. Fractions of a degree can be expressed in minutes or in the equivalent decimal number.

Chemistry / Physics

We all live in an atmosphere that comprises mainly Nitrogen and Oxygen. In both cases an atom of Oxygen or Nitrogen is made up of a number of protons, neutrons and electrons.

Aircraft structural designs have to take into account physical forces that are likely to be encountered during operation. Compression and extension of components are typical forces that have to be taken into account. Similarly, twisting forces are accommodated and resisted by torsion of the components.

Thermal expansion and contraction have to be taken into account and in some cases their properties are chosen for their specific expansion characteristics. An example of this might be a liquid in glass thermometer where the fluids used expand linearly with temperature.

Electrical

Understanding electrical components which are the building blocks of modern electrical circuits are important. Items such as Transistors, Capacitors and resistors are all commonly used and are usually marked to show their values and characteristics. For example a resistor with three colour bands uses the first digit to describe the first significant digit. The second band represents the second significant digit. The third band represents the multiplier.

Sometimes there is a fourth band which represents the component tolerance, but if this is absent, the default tolerance is 20%.

Ohms law is one example of many electrical formula and states that the Voltage is calculated by multiplying the Current by the Resistance.

Pressure

In scientific calculations, standard models like the [International Standard Atmosphere] assign constant standard values at mean sea level for atmospheric properties like pressure, temperature, and density. The ICAO standard atmosphere is the aeronautical reference that is used for this.

Aerodynamics

Aerodynamics is the study of how forces and motion act on objects moving through the air. Wings are a crucial component in the design of aircraft and the generation of lift which comes from the relative speeds of the air passing both over and under a wing and the resultant pressures generated. In recent times the shape of the wing or the aerofoil used has been optimised to generate a very smooth or "laminar" flow. There sections produce much lower skin friction and are more efficient and usually have the thickest part of the wing section further back to extend the positive pressure gradient for as far back as possible. The very thin layer of air that comes in direct contact with the wing is known as the boundary layer . It's the source of skin friction drag, and can actually decrease pressure drag. The point where the smooth laminar flow detaches from the wing and re-attaches in turbulent flow is known as the transition bubble.

Thermal / Heat

Our atmosphere is a complex combination of parcels of air in relative motion to each other. Heat from the sun heats the land and this in turn warms the air by the process known as convection. When this air gets significant warmer than the surrounding air, it will detach and begin to rise. It will continue to rise whilst it is warmer than the surrounding air. Hot air balloons use this principle to allow then to take off and rise. If a hot air balloon encounters an area of warmer air, however, if will generally begin to fall. Only by applying more heat from the burners will its balance be restored causing it to stop falling and eventually begin to rise again.

Fire and its prevention is an important area for engineers to be familiar with. Good design of electrical systems using appropriately rated cables and protection with fuses and how to calculate the correct ratings for these is considered necessary knowledge. Similarly in a workshop environment, or in powered aircraft, understanding types of fire extinguisher devices is important as only certain types of extinguishers should be used as determined by the type of the fire. Electrical fires and fires originating from fuels or oils require specific fire extinguisher types. Simple fires, such as those originating from organics materials including cloths, plastics, wood and paper can be extinguished using a simple water fire extinguisher.

Chapter 2.

Human Factors – Revision Primer

It is intended to show how human capabilities and limitations can influence task performance and safety within the maintenance and inspection environments.

Human factor related issues, often fall into a number of different categories. These include environmental physical and procedural amongst others. Examples and considerations in these categories are shown below.

Fundamentally, as is known by Murphy's Law, "anything that can go wrong, will go wrong"

Physical considerations do become more apparent as people get older. However, some can be issues at any age. For example, people of any age can suffer from colour defective vision. This is often an issue in the aircraft maintenance environment as colour is sometimes used and people are frequently found to suffer with red green colour blindness, which can affect their ability to perform certain tasks

Vision can also become degraded due to normal aging and something known as presbyopia, which usually begins somewhere between 40 & 45 years of age.

Physical weight can also become an issue and is often measured using body mass index a healthy body mass index for an adult is typically in the 20 to 24 range more than this will be considered obese and below this could be considered underweight and can affect engineers' performance

Important for a person's health are things like stress and sleep. With respect to sleep, both quality and quantity are equally important. Inadequate sleep levels can contribute to mistakes being made during work.

Environmental factors can pay a large part in the quality of maintenance actions. Poor heat, light and humidity and all factors which can have negative impacts on the outcome.

Whilst inadequate lighting can be an issue, working under very bright artificial light can also cause issues due to excessive glare. It is important to always assess the environment and stop should it be considered inappropriate.

Cold stress results in a loss in body heat and working outside with high winds accelerate convective heat loss, creating a wind-chill effect that lowers skin temperature rapidly and can impact performance

Performance / Judgement

As an engineer you will be required to exercise sound judgement and this comes from a good background of knowledge, experience and also the ability to not be affected by adverse pressure. Being pushed to go faster at work or to do work which is outside of your sphere of knowledge must be resisted. If in doubt, stop and if you are unsure, seek input from a more experienced engineer.

Procedures can often be used to prevent making performance related mistakes. Checklists can be a good method of recording that a job has been done, and was not, for example, done on a different aircraft earlier in the week.

Chapter 3.

Aviation Legislation

This section covers a large number of items related to aircraft maintenance and operation from an aviation legislation perspective. A whole host of items are covered relating to the categories of Part 66 itself, and its applicability to different categories of aircraft. The types of maintenance that can be done and by who. The keeping of records, manuals and incorporation of changes, including airworthiness directives. The release of an aircraft to service, and also the reporting of issues encountered during the operation of the aircraft. How to prepare an aircraft for flight and its normal operation.

The basic license

Part 66 aircraft categories exist and are applicable to different types of aircraft. Groups 1 & 2 cover more complex aircraft. Group 3 cover more conventional piston aircraft whilst Group 4 covers sailplanes and balloons.

The Part 66 license can only be used and its privileges exercised when it is valid. A license becomes invalid when the five-year validity has been exceeded or is invalid should the license not be signed by the holder.

An aircraft maintenance license has associated privileges and these become invalid as soon as a license is invalid.

For aircraft used in commercial operations air transport operators must either hold their own approved CAMO linked directly to their Air Operator Certificate (AOC) or formally contract an approved external CAMO.

Whilst all major maintenance will be performed by a Licensed engineer, smaller maintenance can be performed by the pilot owner of an aircraft. Part ML Annex VB Appendix II describes the additional requirements and precautions before attempting any relevant pilot owner maintenance.

Increasingly common is the operation of aircraft with a higher Maximum Take of weight and the European classification of ELA-1 aircraft describes this class. ELA-1 aircraft continuous airworthiness regulation uses Part ML when they are not operated under a commercial air transport Air Operator Certificate.

Changes or repairs

A standard change or repair (usually done using the CS-STAN principles) should include clear technical definitions, step-by-step instructions, and compliance records to prove continued airworthiness**.** CS-STAN is normally used for changes that are considered minor.

Following a standard change, information regarding the Certificate of Release to Service can be found in UK CAA Regulatory library AMC1 ML.A.801.

Where modifications or repair are being performed on an aircraft, they must be approved by an approved design organisation or directly via a CAA assigned airworthiness surveyor.

Manuals, Maintenance Programs & records

Information relating to continued airworthiness will include a section relating to airworthiness limitations. This will typically include mandatory replacement times for applicable components, inspection intervals, and specific system restrictions required to keep the aircraft safe and legally compliant**.**

The aircraft flight manual will include any specific task that are required as part of the process of preparing an aircraft for flight . The UK Civil Aviation Authority officially approves the core technical contents, operating limitations, and emergency procedures detailed in the Aircraft Flight Manual, however, when preparing an aircraft for a specific flight on a day-to-day operational basis, the execution and compliance with those pre-flight tasks are governed by specific responsibilities including Pilot in Charge or Aircraft operator. Pre-flight preparations detailed in a Flight Manual (AFM) or Pilot's Operating Handbook (POH)—such as normal pre-flight inspections, assembling components intended for daily setup (like glider wings), or setting switches and controls, do not require a Certificate of Release to Service.

During the maintenance of an aircraft and when referring to maintenance data relevant to that aircraft and the task in hand, it is important to make sure that the data is correct and that all revisions have been incorporated and as such is up-to-date.

The aircraft owner or operator is ultimately responsible for ensuring that continuing airworthiness and maintenance reference data are kept current and managed properly, while the Approved Maintenance Organization (AMO) / Part-145 maintenance organization or Continuing Airworthiness Management Organisation (CAMO) is responsible for holding, controlling, and applying that current data during actual maintenance operations.

Frequently it is necessary for an owner (often with the help/advice of a maintenance engineer) to create a tailored maintenance program for their aircraft where deviations exist to the information for continued airworthiness generated by the design approval holder. Should no deviations exist then a tailored maintenance program is not required.

Where an urgent issue is identified with a specific aircraft type and following an investigation by the type holder it sometimes become necessary to issue an airworthiness directive. In this case it is mandatory to implement the action(s) listed in the timetable dictated for the aircraft to remain airworthy.

Other

During operation of an aircraft, any reportable occurrence that endangers flight safety should be reported to the CAA using the established Mandatory Occurrence Reporting (MOR) system at the earliest opportunity.

Chapter 4.

(UNDER DEVELOPMENT)

Chapter 5.

Composite Airframe Primer

Composite airframes are becoming increasingly popular and bring many advantages compared with Wood or metal aircraft. This section covers a number of topics related to composite aircraft including Inspection, structures, construction techniques and materials .

Inspection

Inspecting an aircraft component is ideally conducted in an aircraft workshop but this is not always possible. You should resist pressure to inspect a component outside as eye limitation in ambient light / sunshine can mean that things can easily get missed.

When trying to identify damage, sometimes a tap-test is conducted on wings and fuselage. To be able to interpret the results correctly it is important to know the location of the internal components (ie ribs, frames etc).

Sometimes a Tap test can prove difficult and results inconclusive. In this case and for some areas of the structure, such as a wing spar boom in the root rib area, for example, a strong light to look through the structure can be an effective non-destructive way to inspect the aircraft structure.

Sometimes it will be necessary to inspect an aircraft following some form of event. The nature of the event will usually dictate the inspection required. For example, excessive positive "G" will put large compression stress to the upper surface of the wings.
Although less common today, some manufacturers will publish data relating to the wing resonant frequency as determined by a frequency test. Sometimes an acceptable range is defined and as this will vary from type to type, the type certificate holder should be the place to determine this frequency for a particular aircraft type.

With composite aircraft the metal pin components are typically bonded to the grp structure. Major components like the main location pin at the end of a spar stub and then wrapped making inspection difficult. Any movement of a pin in this area can be due to internal corrosion of the metal pin / mounting plate and will require further invasive investigation.

External finishes

Gel coat is now being replaced by Polyurethane paint. When selecting a paint it is important to make sure that the paint has good UV protection to preserve the underlying structure.

Whilst Gelcoat is not often used as a final finish anymore, it is still often sprayed into the mould to provide a high-quality finish to the visible external surface of the moulded component, prior to adding the structural components from the outside in.

Repairs

The ratio of cloth to resin for a repair will vary by cloth type, but typically a ratio of 1:1 should be used. When sanding an outer skin as part of a sandwich repair, the sanding disk can be angled to help achieved the required splice angle.

Typically the top and bottom wing skins are fabricated in moulds. The wing spar is typically bonded into one half and then the two moulds are pressed together to join the component. To ensure that a proper bond is achieved, excess thickened resign is normally applied on the main spar to ensure a good bond between it and the outer wing skins.

When conducting a sandwich repair where new foam core material is added, it is essential to make sure that the new foam is completely bonded to the inner skin. This is critical to ensure structural integrity of the repair.

When completing repairs with epoxy resin hollow spheres or micro balloons are sometimes added to reduce the volume and density whilst preserving the strength. This can help to avoid adding excess weight in repaired structures. This combination is also sometimes used to supplement a core filler and restore profile before adding an outer cloth layer.

After completing a repair and curing at room temperature full strength of the repaired structure can only be achieved using a post-cure at elevated temperature. Different temperatures and cure times vary between aircraft types so the type certificate holder should be contacted if the specifics are not available in the aircraft manuals.

Sometimes a donor aircraft is used to make a mould to subsequently repair a damaged aircraft. It is important to make sure that the mould is substantial enough to retain its shape after removal from the donor aircraft otherwise the shape of the repair part made from that mould will be compromised.

The donor mould should be thorough cleaned and release agent applied prior to use.

With a large puncture damage through both outer and inner skins, it is necessary to repair the inner skin first and you will have to provide something to bridge the repair to the existing structure. This can be done by fabricating and installing a joining ring or removing some of the outer skin and foam to expose the inner skin and use that as the joiner. The new inner skin can then be made to the exact size and shape of the hole and bonded in place, attaching to the joiner and restoring inner skin integrity.

Sometimes any damage is confined to the outer skin only. In this case, the outer finish and skin can be carefully removed by sanding then several layers of cloth applied using the original repair scheme, prior to external filling, priming and painting.

Control systems

When repairing control cables, the correct cable sleeves should be used. For a 1/8-inch galvanised cable, ideally a plain copper sleeve should be used.

Turnbuckles were intensively used on older wood / fabric aircraft and whilst used less so today, can still be found in some control circuits. It is important to make sure that both terminals are equally screwed into the barrel.

Joining cables using a Nicropress it is important to use the right swage pattern and number of swage actions. For example, a 3.2mm cable will require 3 swage actions using the M groove on a multi-groove nicropress tool.

Most modern aircraft have defined ranges for the control weight and mass balance. This will vary between aircraft types and this critical data can usually be found in the aircraft maintenance manual

Chapter 6.

Under development

Chapter 7.

Airframe General

This section covers a number of Airframe General categories including Control surfaces, Controls, Control connections, Instruments, Engine related, Weighing, Brakes & undercarriage, Hooks, wing performance and canopies.

Controls

Cs22 contains many details about the glider specifics. For example, in the cockpit CS22 specifies the colours of the controls. Flaps are black, Cable release if yellow, Airbrakes are Blue and canopy normal operating handle is white (assuming it is not combined with a canopy jettison system)

Sailplane flying controls usually have specified maximum free play which should be frequently checked. The main risk of excessive free play in a control is flutter at higher speeds so it is important to make sure free play is within limits to avoid this.

On some gliders, the airbrakes are combined with the wing flap system. As the airbrakes are opened, creating drag, the flaps lower simultaneously, helping the compensate for the lost lift cause by the airbrakes

Following repair to a trim tab or control surface containing a trim tab, the tab should be locked in the neutral position then the static balance measured.

On a modern sailplane, a pre-curved mylar seal is often used to seal the control surface gaps and improve efficiency. When utilising such a seal, a sealing tape is usually applied to the leading edge of the mylar seal to achieve a smooth airflow blend .

Gliders normally have a simple fore-aft trim system and this is often achieved using a simple spring bias in the elevator control circuit.

When checking the aileron controls on a modern flapped glider it is required to do this in various flap settings as defined in the maintenance manual.

A glider drum-type wheel-brake can be adjusted by adjusting the length of the operating cable.

Control cables, adjustments and bearings

An aileron control system balance cable is used to ensure that the tension in the cable system is maintained in the circuit.

Having adjusted a turnbuckle is should be locked to prevent it from changing the tension on the cable, by using plain nuts and then locking wire. Locking clips can also be used in place of locking wire. To make sure that the turnbuckle is safely setup, make sure that a wire cannot pass though the safety hole and that only a limited number of threads are visible and not leaving too few engaged to carry the load.

Having swaged a control cable using a nicropress tool, it is possible to verify the swage using a tension tool, however this is often not possible for cables installed in an aircraft structure, in which case a “Go-No-Go” gauge should be used for each portion of the swage .
Sailplane flying controls normally have mechanical stops to limit their travel of operation. These stops can be incorrectly adjusted or can become loose or worn. For example, should the rudder contact the elevator when fully deflected, the rudder control stops should be checked for wear or poor adjustment.

Bearings are a frequent cause of problems on older high-hour sailplanes and should be checked for roughness or noise during operation and should be frequently lubricated. In the case of smooth indentations on the outer bearing face this could be due to brinelling, where micro-movements between the rolling elements and the outer race that rub away material and create shallow, spaced indentations

A tensiometer is used to check for the correct tension and with risers of different sizes it is necessary to reference the chart which shows how to correctly interpret the reading with different riser sizes.

Locking plates are sometimes used on aircraft and these can be used more than once provided that good serrations are still present and can be used to engage with the bolt.

When tightening a nut with a significant running torque (not the case with a plain nut / washer combination) then the running torque (if known) should be added to the required torque to ensure the nut torque is set to the correct value.

Castellated nuts can be difficult to torque as sometimes it is not possible to get the split pin through the hole within the specified torque. It is generally not acceptable to use a higher or lower torque value, so the nut should be replaced and a different one used which may work due to varying manufacturing tolerances.

Torque wrenches have a specified calibration date. No tolerance is allowed on this and once the calibration date has expired it should not be used.

Control linkages

During annual maintenance, it is normal to measure the ovality of the spherical ball on the L’hotellier couplings to check for wear. It is important in normal operation to make sure that the Ball and socket are correctly engaged and that a locking pin is used to prevent the wedge from moving and the connection coming undone inadvertently.

L'Hotelier control couplings are often locked with a locking pin or R-Clip, however the Wedekind type sleeve achieves the same objective of preventing the locking wedge from moving towards disengagement without any removable parts and is generally easier to use.

Tow hooks

Tost release hooks have a published number of operating cycles (10,000 spring operations). In a glider with both a nose and CofG hook, both hooks must be overhauled when this limit is reached regardless of whether the glider has only been using one of the hooks for launching, as both operate together and will have accumulated the same number of spring cycles.

In a glider with both nose and center of gravity hook (CofG), normally only the CofG hook is fitted with a back-release mechanism.

After changing both CofG and Nose hook assemblies on a glider, it is important to make sure that both hooks and open and close together.

Aerodynamics

Modern sailplane wings use very efficient 'Laminar Flow' wing sections. These sections typically have the widest part of the wing as far back as possible to maintain a positive pressure gradient and consequently smooth or 'Laminar' flow as far back as possible. At some point, however the airflow detaches from the wing and reattached in turbulent flow. This point is known as the transition bubble and can create some drag. Sailplane designers work out this point and place turbulator tape or blow holes to reduce the transition bubble and minimise the impact of it, improving the efficiency of the wing.

Power plants

On some GA aircraft and Touring Motor Gliders, an exhaust jacket is fitted to provide warm air to the cockpit. A leak in the exhaust can route dangerous Carbon Monoxide in to the cockpit via this warm air system, so it is normal to pressure test the exhaust system in a water bath to check for leaks as part of an annual inspection.

One or more fuel pumps are normally fitted into the fuel system of a self launching sailplane to ensure than sufficient fuel is provided during high power phases like take-off. With such a pumped system then the fuel flow should be at least 125% of that required at maximum power.

The throttle control on a touring motor glider is normally configured such that it is moved forward to increase power.

Cockpit

The control column normally has a fabric gaiter around it and this is essential to prevent any loose articles from fouling the controls and / or stick mechanism.

Damage found to a glider harness should result in the harness being removed and repaired, regardless of whether the harness is still within its typical 12 years life.

When changing cockpit seat cushions, it is really important to take on board latest thinking which has shown that using energy absorbing foam can provide significant pilot protection in the case of an accident or heavy landing.

Damage

If a sailplane has had a heavy landing, it typically must be inspected in an area where the best lighting is available for the inspection as poor or excessive lighting can cause damage to be missed.

Instruments

When connecting up a glider variometer, there are typically two connections. Once is the capacity which is where the flask is connected the other is for the total energy connection and is often labelled TE.

In a variometer, there is a calibrated hole which allows air entering or leaving the instrument from the flask to return to a state of equilibrium . if this hole were to become partially blocked then the vario would overread in a climb or dive.

An airspeed indicator (ASI) has a direct input from the glider pitot, often in the nose, and also a free and open static port often connected to ports on the glider fuselage. Should a glider static port become partially blocked, the ASI will tend to over-read.

When performing a leak check on a sailplane pitot system, the pitot system is usually pressurised and held at pressure looking for a leak.

Flarm systems are now commonplace in gliders and have been a major contributor to safety. The firmware in these units should be updated every 12 months and this requirement should be included in the glider maintenance program and recorded.

Whilst solid state turn and slip systems are now being adopted, there are still a good number of mechanical turn and slip units in service and there operate using an internal rate gyroscope using the principle of precession.

A compass correction card (also called a [compass deviation card]) is a small label or table used to list the small errors of a magnetic compass caused by onboard metal and electronics.

When mounting instruments into a CS22 sailplane the mounting must be able to accept *at least* 15G in the forward direction.

Electrical

If an operator wishes to add a voltmeter to a circuit in a sailplane, then the meter should be installed in parallel with the circuit so that the voltage can be correctly measured.

A main fuse in a sailplane circuit should be fitted as close to the battery as possible to minimise the amount of unprotected wiring in the system. Ideally this should be within 100mm of the power source.

When upgrading a sailplane battery system from lead-acid to Lithium Ion, you should check if the new battery has a built-in battery management system (BMS). This turns the battery output off at a specific voltage. If the battery does not have one built-in, then an external BMS should be added.

Although quite rare, a sailplane ammeter which has a scale of 60-0-60 is used to indicate battery charge and discharge.

Glider fuse systems are usually ones which contain a single-use component which will melt above a certain level and must be replaced. Alternatively a circuit breaker can be used which will disconnect at a calibrated level and can normally be manually reset. With either type of fuse system it should only be replaced / reset once after which further investigation should be performed of the circuit to identify the fault. In *no* circumstances should an automatic resetting circuit breaker be used as this could reset and cause cable burn or fire.

A Touring Motor Glider is usually equipped with an Alternator. An alternator usually outputs a voltage in the 13.5-14.5 range. If the voltage exceeds this then damage can occur to the battery system, such as electrolyte boiling due to overcharging and this can be verified by measuring the output voltage from the alternator with the engine running.

Weight and balance

Sailplanes need to be weighed periodically and required the weight of the glider to be measured, usually at both the main and tailwheel with the glider in a specified flying attitude. The wings are also weighed and the weight of the non-lifting parts are determined. With this information the cockpit min and max loadings can be determined and is always the *least generous*, having taken into account the maximum weight, pilot seat load and centre of gravity range. All measurements made during the weighing process reference the specified datum and all measurements aft of this datum are considered positive whilst ones forward of the datum are negative.

Cleaning

Extreme care must be taken when cleaning an aircraft canopy or acrylic window and normally water and detergent is best. Solvents can damage the canopy in a way that cannot easily be repaired.

Fluids

"Fluid 4" in a brake context typically refers to DOT 4 brake fluid, a standard glycol-based hydraulic fluid widely used in modern disc brake systems.

Propellors & pylon systems

Wire locking of bolts such as on a propellor, should always be routed such that if either bolt being locked tries to come loose then the wire will prevent that. Considerations need to be taken for both right hand and left hand threads, although most bolts use right hand threads.

A wood propellor with minor damage can be repaired provided the damage is within the limits stated by the manufacturer. It is important to make sure that the finish on the rear surface is well maintained otherwise dampness or moisture ingress can occur and can cause the propellor to warp over time.

A damaged propellor seal on a variable pitch propellor cannot be "patched" or repaired; it must be completely replaced. This requires a specialized teardown process that must be performed by a certified repair station.

A four blade propellor has more surface area and tighter spacing between blades, maintaining uniform symmetry across all four blades is critical to avoid imbalance and vibration. For this reason all four blades should be refinished and repainted using the same identical process.
Some wood propellors use a metal leading edge strip. Over time and due to cyclic forces, the metal strip can start to de-bond from the main body of the blade. Be sure to check for this during an inspection.

In a two-seat self-launching motor glider, the engine controls are always fitted in the front (pilots) position. These can (but not always) be duplicated in the rear seat. The propellor must typically be vertical to allow the engine pylon to retract correctly and with an automatic brake system, a contactless proximity switch on the pylon is used to detect propellor position and to apply the propellor braking system.

When the engine pylon is extended on a self-launching sailplane, the drive system will typically stop automatically when fully extended. If it does not stop in the correct position, it is likely that the ‘Up’ limit switch is not operating correctly or is incorrectly adjusted.

Chapter 8.

Powerplants – Primer

Regulation

Most powered aircraft and sailplanes are required to have a Noise certificate. The exception being self-sustainer powered sailplanes

For a serviced engine on an ELA-1 Touring Motor Glider (TMG) where standard parts (like standard gaskets) are fitted, a separate component release certificate (EASA Form 1 **or** CAA Form 1**)** is not required.

ELA1 aircraft that are not used for commercial operations can have their life extended on deviation provided that it is written into the Self-Declared maintenance program and accepted by the owner. Life limited components whose life is not limited by AD can also be extended but eventually when a life limiting component that has a life limited by AD or if considered critical is reached then that item must be overhauled.

Engine wear & maintenance

Most powered sailplanes use two-stroke piston engines, however some are fitted with rotary (Wankel) type engines. These engines use a rotor rather than a piston and can achieve high rotational rates. The architecture of the rotary engines however means that the tips of the rotor can wear and impact engine performance

On a touring motor glider, the rubber hoses will typically have a life specified by the Type Certificate (TC) holder and this should be adhered to.

Electric powerplants

Emerging battery technology has resulted in electric powered sailplanes not becoming quite common. The initial design used an electric motor on the nose and is known as a front-electric-sustainer or FES system. If a FES motor is removed and replaced it is important to make sure it is replaced in the same position as when it was removed otherwise vibrations can result.

Electric sailplanes with removable batteries such as the Front Electric Sustainer (FES) system prevent batteries from being connected incorrectly by using different size positive and negative connectors. The FES system powers the electric motor in the nose by converting the DC current into 3-phase AC current.

Propellors

Some Touring motor gliders (TMG's) can have 3 position propellors to allow optimised takeoff, cruise and gliding performance. The pitch change is achieved via a pitch change ring. Despite the pitch change mechanism being set correctly, sometimes the change can be difficult due to the fine / course stop sticking.

Some sailplane have a electrically adjustable pitch setting for the propellor. If the maximum static RPM not being achieved, this is usually due to the pitch ring being set too coarse.

Some aircraft have electrically adjustable propellors and when testing these make sure to test that the propellor pitch change mechanism reaches its limits.

Fuel system

Fuel gauges are notoriously inaccurate, so knowing the tank contents prior to flight gives you a good starting point. To do this , operators often fabricate a fuel tank dip stick which can be used to confirm the tank contents. To fabricate a dip stick, the aircraft should be initially set into the ground attitude. The tank is then emptied and known fuel added in stages and the dip stick marked accordingly at each stage.

Fuel tank contents can be measured using resistive or capacitive sensing systems. Alternatively, a fuel consumed quantity indication system measures the fuel consumed by the engine and by knowing the quantity of fuel in the tank prior to flight can be used to also display the calculated tank contents.

Inside the tank is often a fuel level transmitter which measures the fuel level in the tank. The tank may contain fuel and fuel vapour so it is important to avoid generating a spark should it be necessary to change this transmitter and so to help with this make sure that the aircraft is bonded to earth before commencing the change.

Some aircraft use a pulse-type of fuel pump. These pumps make a very different noise when pumping fuel or when the fuel line to the pump is empty. Typically with fuel being pumped the pump is relatively quiet, but when no fuel is being pumped due to no fuel being supplied, the pump will make a loud metallic noise.

A touring motor glider powered by a Rotax engine is best operated on an unleaded fuel such as UL-91. Lack of suitable supply of unleaded fuel however, may require the aircraft to operate on AVGAS instead which is perfectly acceptable, but the maintenance intervals must be adjusted accordingly due to the presence of lead in the AVGAS fuel.

When draining fuel from an aircraft, the fuel type can normally be determined by the colour. UL91 is normally Red in colour whilst Avgas is Blue.

In a sliding piston type carburettor, a rubber diaphragm is used to regulate the smooth fuel / air flow as determined by different throttle and engine conditions.

Ignition systems

Touring motor gliders can have different magneto systems. More recent motorgliders have dual electronic ignition boxes, whilst older motorgliders may have dual or single mechanical magneto system. In the case of the mechanical systems, the magneto should be inspected typically every 500 hours.

A spark plug is often tested under pressure because the increased pressure of the sparkplug tester simulates the engine cylinder when under compression. Under compression, the air density is increased which increases the resistance across the electrodes. The increased resistance requires the spark to have a higher voltage. if there is a fault with the spark plug, such as a crack in a ceramic insulator, the spark will go to ground through the crack instead of across the electrodes as it's supposed to.

More modern thyristor based electronic ignition system often store massive amounts of energy so it is essential to always allow the internal capacitors to discharge before working on such a system to prevent severe shock.

Some aircraft engines have an impulse couple fitted to one of the magnetos and this retards the ignition timing slight to prevent kickback and assist the starting process.

When checking the static timing on a magneto equipped engine it is important to make sure that the impulse coupling has fired first otherwise this will give an incorrect impression of the magneto timing. Once this has fired the timing can be determined by advancing the propellor to the timing mark and observing the timing light and the Before top dead centre mark to determine if a physical adjustment is required.

A Live / dead or “dead cut” check on an engine should typically be done at Idle. This confirms that the P-Lead is properly grounding each magneto. And is typically done after start-up or before shutdown.

Oil systems

When changing the oil on a Touring Motor Glider which normally operates on a semi-synthetic multigrade oil, an ashless dispersant (AD) oil can generally be used in place of a semi-synthetic multigrade oil provided the viscosity and specifications match the engine manufacturer's guidelines.

Jet engines

Some sailplanes are now equipped with a small Jet engine which can allow the sailplane to avoid landing in a field and return to base. These engines are robust but occasionally damage can be found on the compressor blades cause by injection of foreign material, corrosion or fatigue. If damage is found in this area, it cannot be repaired in the field and the engine should be removed and sent to the manufacturer for repair.

On a small sustainer Jet engine, lubrication is provided by mixing turbine oil with the Jet fuel which is fed through the ceramic bearings during normal operation. There is no separate oil tank.

Small sustainer Jet engines typically employ a Full Authority Digital Engine Control (FADEC) system. The Fadec controller managed all engine functions at all times.

Internal combustion engine types, troubleshooting & operation

In some powered sailplanes, a manually operated decompressor is fitted to allow the engine to spin freely and assist with the starting process. This is commonplace in 'self-sustaining' gliders where it is desirable to spin the engine easily with minimum height loss during the starting process.

Unlike a four stoke engine which has valves to control inlet and exhaust, a two-stroke engine uses piston-controlled inlet and exhaust ports to control gas flow.

Detonation in an engine can be caused by a number of things. Incorrect fuel grade can be one cause. Excessive carbon build-up can provide localised ignition sites. Over advanced ignition timing caused the ignition to fire too early is another common cause as is a fuel air mixture that is too lean.

A four-stroke engine is named as such due to the four cycles that the engine goes through during a normal cycle. Those are namely Induction, Compression, Spark and Exhaust. The inlet and exhaust valves open before induction and before exhaust respectively.

Sometimes an engine can backfire due to a lean fuel / air mixture caused by the fuel burning too slowly in the cylinder. This can be caused by slow combustion, ignition of fresh fuel charge or exhaust afterfire.

When conducting performance runs on an aircraft engine, the plane should be facing directly into wind, allowing air to flow freely into the cowling and cooling fins and preventing high cylinder head temperatures and overheating.

Troubleshooting a modern sailplane engine equipped with an electronic control unit usually requires connection of a PC equipped with suitable software.

Pylon based engine systems

Within the engine bay of a self-launching motor glider, it is common for the bay to be painted with special intumescent paint. This pain swells under heat and can prevent heat from a fire being passed into the structure for a period of time and this combined with fire warning system can provide good protection to the pilot in the event of a fire giving time to land.

The exhaust system on a self-launching sailplane often disconnects from the engine as part of the extension / retraction process. During regular inspections the integrity of the slip joints and exhaust supporting springs should be verified visually.

As the engine is retracted, most self-launching gliders have an interlock to make sure the propellor is correctly positions to prevent it impacting the engine bay doors. This is usually achieved by a propellor position proximity sensor. If the alignment is wrong, this sensor should be checked for position or malfunction.

Chapter 12.

Avionics & Instruments – Primer

Emergency location Transmitters (ELT's)

Sailplanes and aircraft operating in challenging environments are Increasingly fitting an Emergency Location Transmitter to alert emergency services should the worst happen. An ELT unit contains a battery which typically has a life of 5 years with the date stamped on the side of the unit. If an ELT operates for more than one hour the battery should be changed.

An Emergency Location Transmitter (ELT) is typically capable of transmitting on 121.5MHz which is less monitored in recent times except by rescue teams and also on 406MHz which is used by satellite-based search and rescue and can include precise GPS coordinates.

VHF Radios

A dedicated radio frequency is allocated and can be used in an emergency. This frequency is 121.5MHz.

Although not generally used on a sailplane, a Whip antenna can sometimes be used on a GA Aircraft. It is possible to reduce the length of the antenna whilst maintaining its performance by fitting a loading coil in series with the antenna.

Sometimes a VHF radio can experience poor reception and whilst location relative to the calling station can be the cause, hardware issues can also be responsible. A common problem is when the Aerial connector suffers water contamination so this is worth checking this should poor reception be experienced.

A number of years ago, the frequency spacing on the UK was changed from 25 KHz to 8.33kHz. This allowed many more frequencies to be accommodated. 25 KHz radios have largely been replaced although 8.33 radios can still be selected to operate on 25KHz spacing. Should a transmission be made on a 25KHz band a number of 8.33 radio channels in the frequency range may be affected.

Transponders

An aircraft transponder works by receiving an interrogation radio signal from a ground-based radar station and automatically transmitting a coded reply back with the aircraft's identity and altitude. This coded signal identifies the aircraft on a radar display. There are a few different types of transponders in use in the UK however a Mode S type transponder in aviation can directly exchange two-way data with a ground station. An aircraft transponder transmits of 1,090 MHz and receives on 1,030 MHz. Sometimes portable transponders can be used and if doing so it is essential to make sure that the aircraft specific 24bit registration code is entered to ensure correct identification by ground stations.

Battery systems

There has been much evolution in aircraft batteries in recent years. Wet Lead acid batteries were replaced with Dryfit batteries which are valve-regulated lead-acid (VRLA) gel batteries where the liquid electrolyte is trapped and immobilized in a silica gel structure. More recently, Lead acid batteries have beeen replaced by more modern lithium-based solutions. Lithium-Ion Phosphate batteries are popular as they are much less likely to catch fire and can accept a large number of charge cycles during their useful use period.

Instruments

An aircraft measures both Static and dynamic pressure sources and different instruments are used to measure each of these. An Altimeter measures the static pressure of the surrounding air mass, whilst and airspeed indicator measures the dynamic pressure caused by the forward motion of the aircraft

Gliders still use simple altimeters to measure the elevation above a datum altitude that is set on the subscale. These are generally very accurate, however over time wear can occur and internal corrosion can cause the mechanism to bind.

Appendix 1. Reference links

FAA Acceptable methods, techniques & Practices – Aircraft Inspection & repair

https://www.faa.gov/documentlibrary/media/advisory_circular/ac_43.13-1b_w-chg1.pdf

BGA Standard Repairs to Gliders

https://members.gliding.co.uk/library/standard-repairs-to-gliders/

Additional Part 66 Exam study material

https://members.gliding.co.uk/library/inspector-information/part66l-tk-exams-potential- study-resources/