Cobra AERO A33N
Operations, Maintenance and Service Manual

Author: Newton

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Change History	
Date	**Notes**
10/11/2019	Added spark plug section – hsh
12/4/2019	Added notes on Denso plugs
06/07/2021	Updated spark plug notes - Newton
02/21/2022	Propeller section added – hsh
08/02/2022	Updated maintenance overview table
02/21/2023	Major update with multiple inspections added

A33 Operations, Maintenance and Service

Discussion

Engine maintenance is highly influenced by the end user's op-tempo, duty cycle and environment. The following recommendations are provided as a starting point for operations personnel to adopt that ensures optimum performance of the propulsion system. It should be expected that some checks and inspections may need to be more frequent than suggested here. Conversely, some checks and inspections may be delayed relative to these recommendations. When available, criteria will be mentioned in the text of the specific item that allows the end user to safely explore these limits. Ultimately, the end user must take ownership of the propulsion maintenance and inspection as it will be specific to their system integration and use case. Cobra AERO will gladly assist in that process and look forward to helping you develop a maintenance program that best suits your needs. Your success is our success.

Document Intent

This document is formatted to allow the user to adapt the contents to the end user's aircraft operations manual. Every line item will receive a Discussion of the purpose, intent and layman's description of the operation where applicable. This will be followed by a much simplified bulleted list of the type of Inspection, Service or both that may be copied into a checklist format or into separate manual types. These sections may be followed by detailed instructions and/or images that may also be copied into other manuals as deemed appropriate by the end user. Some images may illustrate hardware that varies from your configuration, but these should not detract from the topic being covered.

Special note:

The A33 propulsion system is fitted with a Power4Flight IntelliJect ECU. This ECU has powerful features that can be enabled to assist operators in their maintenance plan. Configurable maintenance plans can trigger alerts via your Autopilot and automatically log details to a maintenance file maintained within the ECU. Please see your IntelliJect ECU manual for details.

“WARNING”

THE COBRA AERO A33N PROPULSION SYSTEM IS INTENDED ONLY FOR USE POWERING AN UNCREWED AERIAL VEHICLE. USE FOR OTHER PURPOSES IS NEITHER ENCOURAGED NOR LEGAL IN MANY JURISDICTIONS.

THIS ENGINE IS FUELED WITH GASOLINE. GASOLINE IS TOXIC, IS EXTREMELY FLAMMABLE, AND IT IS A KNOWN CARCINOGEN. PROCEED WITH CAUTION.

AFTER THE ENGINE HAS RUN, THERE ARE MANY HOT SURFACES. KEEP ALL BODY PARTS AWAY FROM HOT SURFACES SUCH AS THE CYLIDNER, THE EXHAUST, AND THE CRANKCASE.

THIS ENGINE IS DESIGNED TO SPIN A PROPELLER. A SPINNING PROPELLER CAN CAUSE INJURY OR EVEN DEATH. PROCEED WITH CAUTION WHEN NEAR THE RUNNING ENGINE.

IT IS YOUR RESPONSIBILITY AS THE OPERATOR OF THIS ENGINE TO ENSURE THAT IT IS IN PROPER RUNNING CONDITION. THIS INCLUDES CHECKING REGULAR MAINTENANCE ITEMS ON SCHEDULE (SEE MANUAL), MAINTAINING PROPER FASTENER TORQUE, AND DETERMINING WHEN THE ENGINE REQUIRES AN OVERHAUL.

ALWAYS WEAR ADEQUATE SAFETY GEAR WHEN NEAR A RUNNING ENGINE. AT THE VERY LEAST, THIS SHOULD INCLUDE SAFETY GLASSES AND HEARING PROTECTION.

IMPORTANT SAFETY NOTICE

⚠ WARNING

Failure to follow WARNING instructions could result in severe injury or death to the machine operator, a bystander, or a person inspecting or repairing the engine.

CAUTION:

A CAUTION indicates special precautions that must be taken to avoid damage to the engine.

NOTE: A NOTE provides key information to make procedures easier or clearer.

A33 Field Maintenance Overview

Discussion

This manual will detail simple maintenance that can be conducted in the field. Field maintenance items can be grouped into three major categories: Safety, Performance and Special.

1. Safety – Safety maintenance items are generally performed prior to running an engine. They serve to identify problems that arise from normal use. In addition, known single point failure items which "can't fail" and deserve special attention are included.
2. Performance – During the course of pre-flight inspection, runups are almost always conducted. How well the engine starts, idles, transitions and the peak engine speed are all checks to establish the flight readiness of the propulsion system.
3. Special - As the name implies, special maintenance and inspection items are for circumstances where extra attention may be needed. Usually, these items are triggered by operating conditions or circumstances that make "special" items relevant.
4. Depot – Work and maintenance that requires special tools and knowledge are not considered simple maintenance and often these cannot be performed as field work. The best way to expediently mitigate Depot level work that surfaces when in the field is to have a spare propulsion unit on hand. It is the intention of the manufacturer that the entire A33 propulsion system should be treated as a Line Replaceable Unit (LRU) in these instances.

The table below illustrates baseline maintenance and inspection intervals.

Component	Time Required	Pre/Post Flight	Every 50 hours	At 100 hours	At 200 hours	At 300 hours	At 400 hours
Safety							
Servos	15 min	Inspect					Depot
Servo Linkages	5 min	Inspect					Depot
Wiring	20 min	Inspect					Depot
CHT sensor	20min	Inspect					Depot
Isolators	15 min	Inspect					Depot
Performance							
Air Filter	15 min	Inspect		Service	Service	Service	Depot
Fuel Filter	15 min	Inspect		Replace	Replace	Replace	Depot
Spark Plug	15 min	Inspect	Replace				Depot
CDI Spark Plug Cap	15 min	Inspect					Depot
Muffler	Varies***	Inspect		Inspect			Depot
Special							
Prop Strike or Hard Landing		**Inspect**					

*****refer to the Mufflers section for guidance as different mufflers have varying requirements**

Details on each of these maintenance items follows this table.

Servos

Discussion

Servos are critical components to unmanned systems. On the propulsion system, servos control the engine throttle and the cooling flap. The failure of either of these servos or their subparts can cause the engine to stop. It is good practice to inspect the mounting and linkages of both servos to ensure proper operation and a successful flight. The A33 propulsion unit ECU is configured such that, when the engine is not running, the cooling flap command will be the same as the throttle command. This is done specifically to aid pre and post flight inspection procedures. Inspect the full range of both servos operation and ensure nothing is binding, rubbing or that the linkage operates "over center". Pinch each linkage with your thumb and index finger and rotate the linkage. Note if the linkage is excessively loose or tight. Make sure to witness both the throttle servo and cooling flaps operate properly **independently**. Do not assume that witnessing one servo operate successfully that the other is also ready for flight by proxy.

Pre-Flight Inspection

1. While the engine is not running, command zero and 100% throttle.
    a. Ensure that both the throttle servo and cooling servo operate smoothly throughout their travel and that the servo is fixed securely in its mounting.
    b. Ensure neither servo linkage travels over center* at the extreme ends of their travel.
    c. Ensure there is nothing interfering (rubbing, chafing, sticking, etc.) with either servo or its linkage throughout its travel path.
2. The throttle servo failing any of the above inspections is reason to remove from service. Unfortunately, the throttle servo is NOT a field serviceable item.
3. The cooling flap servo failing any of the above inspections is reason to remove from service. If a replacement servo is available this may be a field serviceable item. Please contact Cobra-AERO customer support for assistance.

Service

1. If the throttle servo fails any of the above inspections, it is reason to remove from service.
    a. The throttle servo is NOT a field serviceable item.
2. If the cooling flap servo fails any of the above inspections, it is reason to remove from service. If a replacement servo is available this may be a field serviceable item.
    a. Please contact Cobra-AERO customer support for assistance.

* Over Center is a condition where the servo linkage is physically moved beyond 100%. Occasionally, this results in servo position becoming stuck beyond 1009% and causes excessive servo strain which can fail the servo.

Servo Linkages

Discussion

The servo linkages are as important as the servos themselves and as such, should be treated with the same care and scrutiny as the servos. Linkages need to pass the "Goldilocks" inspection criteria: they cannot be too loose, and they cannot be too tight. Too loose is indicated by a lash felt in the linkage when moving it manually. Grab the center of the linkage and move it along its axis, noting if any slop can be felt in the linkage assembly. Lash in a linkage leads to position hysteresis. Hysteresis in a throttle servo can result in unrepeatable engine speeds for a given throttle input. To determine if a linkage is too tight, pinch each linkage with your thumb and index finger and rotate the linkage, noting the effort it takes to move it. Another method that would indicate a linkage is too tight would be to cycle the servo and note how much the servo rocks in its soft mounts. As these are largely qualitative inspections, it is good to note how a new engine and linkage feels to establish a baseline for what is considered "OK" for both methods.

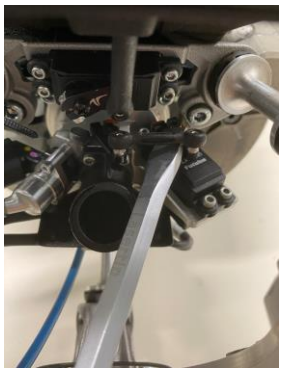
Pre-Flight Inspection

1. Pinch and rotate each linkage and note if there is lash or excessive tightness in the linkage.
2. Tug the linkage away from the pivot balls to see if it will become detached easily.

Service

1. A too loose or easily removed linkage must be replaced with a new linkage.
2. If the linkage is too tight then remove the linkage and note any problems that may be causing the condition (dirt, FOD, etc.)
    a. To remove a linkage, use a wide flat tool under the printed arm and gently twist the tool to pry the arm from the ball.

Pinch and rotate linkage to check



pry linkage to remove

Wiring

Discussion

EFI is a key component to increase the reliability and durability of small UAS engines. Wiring enables the application of EFI on the propulsion units. Diligence in inspecting the harnesses and sensor lines is critical to preventing in flight failures. A failure of any of the wires on the propulsion unit can mean the failure the entire propulsion system. Small, lightweight engines exhibit very high vibration loads and it should be expected that the life of harnessing is not infinite in this environment. Protections for wiring generally fall under two methods:

1) over wraps that provide a first level defense against damaging the wire's insulation. In many instances these protections are consumable in nature and need periodic refreshing.

2) tie downs that fix the harnessing in a location to mitigate conductor fatigue when possible.

Both methods can prove either good or bad for the harnessing in any given situation and only time and experience in conjunction with careful monitoring can reveal if a protection is beneficial.

NOTE: a tie down should never be applied directly to the insulation of the wiring or harnessing. There needs to be some form of overwrap protection between the insulation and the tie down point to serve as the sacrificial or witness layer for possible chafing.

Cobra-AERO has gone to great lengths to route and protect the wiring as best as possible based on the combined knowledge of many different customers. Nonetheless, every integration is unique in its challenges to overcome to ensure overall system reliability. The end user needs to ensure operator care is taken to identify and mitigate rubbing, chafing and fatiguing of the harnessing specific to its integration is critical to the continued reliability and durability of the propulsion system.

Pre-Flight Inspection

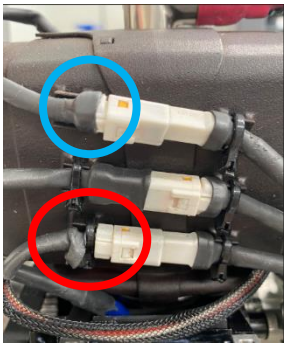
3. Inspect all wires and harnessing specifically looking for chafing/rubbing that is affecting the protections and insulation on the wires.

4. The A33 is fitted with multiple harnessing tie-down points to protect the wires as well as the small plastic electric connectors. The A33 propulsion system will have 14 zip-tie, tie-down points that should checked. Images are provided below for identification.
    a. On the side of the cowl are 6 points that protect the small plastic connectors
    b. An additional CHT tie-down will be near where the sensor line exists the cowl
    c. The ignition/CDI high tension line should be tied down in 2 locations
    d. On the intake are 4 tie-down locations that protect the small plastic connections for the throttle servo and MAT sensor
    e. In many installations there should also be an intermediate tie down point for the sensor lines coming from the cooling cowl. Typically, this is located on the vibration mount leg nearest the cowl sensor lines

Service

1. Chafing that has begun to affect the actual insulation of the wire should be considered as reason to remove the component from service until a replacement or repair is made.
2. Replace any broken or missing zip ties securing the wiring.

Chafing through wire protection



Missing and Misapplied zip tie

The 14 tie down locations identified specifically

CHT (Cylinder Head Temperature) Sensor

Discussion

The cylinder head temperature sensor on the A33 can be considered part of the wiring harness but is subjected to exceptional vibration and thermal conditions and thus needs extra attention. The CHT sensor is located far from the rotational axis of the vibration mount. As such, it is subjected to some of the worst vibration on the propulsion unit. The sensor has been designed to be as light as possible and has zip-tie fixing points to secure the leads but should still be inspected specifically to ensure the sensor has not become loose within the cylinder head. This can occur due to thermal cycling as well as vibration of the engine. A loose sensor will not fully register the true temperature of the cylinder and overheating can occur that would be invisible to the operator. In addition to the previously mentioned chafing and zip tie checks, trying to move/wiggle the blue anodized base of the CHT sensor is recommended. If the sensor is not tight in the threads of the cylinder head, it will likely rock in the threads indicating it has vibrated loose during operation. Re-tighten the sensor to 15 to 20 in-lbs. This is most easily with a ¼”

drive, deep well, 6-point, 8mm socket that has been split to allow room for the sensor lead to move to the side.

Spare parts recommendation: The CHT sensor should be considered a consumable component. Spare parts are recommended for field operations to minimize down time due to failed or failing CHT sensors.

Pre-Flight Inspection

1. Inspect the CHT sensor is tight in the engine by attempting to move the blue anodized base.
    a. Torque 15 to 20 in-lbs if loose

Service

1. Remove and replace a damaged or broken sensor.
    a. Wiring damage may be repaired however the sensor head is a non-serviceable part.

Tools & Materials Required:

8mm, deep well, split socket (1/4” drive, 6-point with split side)
7mm, deep well, normal and/or split socket (1/4” drive, 6-point with or w/o split side per preference)

1. Cut the two zip-ties that hold the CHT sensor harness to the cooling cowl.
2. Disconnect the small plastic connector.

The following images are of an engine without a cooling cowl fitted to better illustrate the service.

3. Use an 8mm 6-point deep socket that has been split to remove the CHT sensor.

4. The 8mm split socket will fit over the blue anodized base of the sensor for removal.

5. Occasionally, the blue anodized nut will break free from the sensor (note the exposed threads on the sensor head indicated in this picture). If this happens, the sensor will not be able to be removed without damaging the wires inside.

6. In this case, simply cut the sensor above the blue anodized nut and remove the blue nut.

7. At this stage a 7mm deep well socket can be used to remove the sensor

8. When installing a sensor, do not overtighten.

   15 to 20 in-lbs is sufficient to hold the sensor.

Isolators

Discussion

The A33 vibration mount uses 3 legs with rubber isolators on each end of the legs. The mount allows relatively free rotational movement while maintaining the thrust line of the propeller. The rubber isolators on the legs have a long service life but should be inspected regularly as though they are consumable. Rubber isolators that are missing, appear compressed or show any signs of cracking or deterioration should be replaced before flight. Also look at the washers for signs of bending or failure. A bent washer can be expected to appear over time and does not require replacement immediately. It should be noted however and replaced at earliest convenience as the washers assist in limiting the extreme ends of travel of the engine.

Pre-Flight Inspection

2. Inspect rubber isolators to identify missing, compressed or any parts showing signs of cracking or deterioration.
3. Inspect washers, noting any that are bent or compromised in any way.

Service

2. Consider immediate replacement of the compromised rubber parts.
3. Replace bent or compromised washers at the earliest convenience.

Air Filter

Discussion

The air filter only serves to remove particulate from the air being ingested by the engine. It is a simple foam element that uses special filter oil to capture dust and dirt entering the engine. A fine mesh screen element, a prefilter, is fitted over the foam element to prescreen larger debris to reduce the time between cleanings needed as well as protect the foam element from rubbing which can occur on surrounding hardware. The foam element is reusable by a simple cleaning and re-oiling process. If high engine speed performance is reduced, consider a dirty air filter element to be restricting airflow.

Spare parts recommendation: The air filter is washable/reusable however, iIt may be useful to have a spare Air Filter assembly on-hand and pre-oiled to speed troubleshooting with a simple air filter assembly replacement while performing field operations.

Pre-Flight Inspection

1. Ensure the air filter is snapped firmly onto the intake horn.
2. Inspect to prefilter for integrity and not excessively dirty.
    a. If there are any holes worn into the prefilter then also inspect the foam element for integrity. Replace the prefilter at the soonest available time.
3. If the engine does not reach its usual peak RPM on pre-flight runup, clean or replace the filter assembly to rule out a clogged/dirty air filter as a cause.

100-hour Service

1. Clean and re-oil (or replace) the filter every 100 hours

The Air Filter is serviced by washing and re-oiling the foam element.

Tools & Materials Required:

Wire cutting pliers or snips
Latex gloves (for oiling air filter)
Bel-Ray filter cleaner & degreaser
A source of running water to flush the foam element
Bel-Ray spray air filter oil – MCMUCM10
Safety wire or thin zip-tie(s)
Replacement air filter (ECAX0099)*
Replacement pre-filter (ECAX0080)*

*Optional

CAUTION:

Pay particular attention to clean any particles from the surrounding area prior to removing the air filter. These contaminants may enter the unprotected engine inlet while the air filter is removed.

⚠ WARNING

Do not clean the air filter with gasoline or other highly volatile petroleum product. Bel-Ray filter cleaner & degreaser is preferred but hot soapy water or mild degreaser can be used when needed.

9. Remove the air filter assembly from the engine by pulling upward on the filter base (not the foam) to release the filter from the intake manifold.
10. Inspect the inlet throat and throttle body butterfly for any signs of dirt or debris. If any is present, the engine should be taken out of service immediately.
11. Cover the inlet if the air filter will be left off for any length of time, or if the engine is being worked on in a dusty or dirty environment.
12. Remove the pre-filter from the foam element.
    a. This may require cutting a zip tie or lockwire that may be used to retain the prefilter on the air filter.
13. Apply the filter cleaner & degreaser liberally to the foam element, work through then flush with water.
14. Allow the filter to dry completely**.**

NOTE: It's very important to oil your filter consistently each time because varied amounts of oil could affect the engine's calibration.

15. Locate the Bel-Ray foam filter oil.

16. Spray the filter with the oil and get oil coverage on par with the following image.

17. Use your fingers (gloved if you don't like waxy/sticky residue on your hands) to "smoosh" the foam element thoroughly and evenly distribute the oil throughout the surface of the filter. It should be an even purple color when done. Apply touch-up sprays on areas until the color is even.

18. Reinstall the prefilter over the foam element and install two zip ties loosely over:

    a. The zip tie groove on the rubber cone of the filter element (this may still be present if not cut or removed earlier in this process)

    b. Under the elastic band on the fine mesh black sock

19. Put the filter element back on the intake of the throttle body. Ensure the snaps neatly into the groove on the printed throttle body inlet. Once on, tighten the zip tie holding the element to the inlet and only snug the zip tie securing the fine mesh sock to the element. Trim both.

Fuel Filter

Discussion

It is good practice to fuel the aircraft with fuel that has been filtered to 10 microns. This cannot always be the case and there still exists circumstances where dirt can enter the fuel even if this is done. The fuel filter captures any stray dirt or debris that gets introduced in the fuel to prevent it from entering both the fuel pump and the fuel injector. Because the fuel pump is a precision machine, the fuel filter needs to be installed prior to the fuel pump inlet. The fuel filter provided with the A33 is a 30-micron unit that is sized to allow a generous service life. In situations where the approved/provided fuel filter needs to be substituted, a minimum 30-micron filter is expected to be used. Give consideration that extra small filter elements will also clog more quickly and easily.

The fuel filter body is semi-clear and should be inspected regularly for evidence of dirt and debris that has reached the filter. Dirt in the filter is not necessarily a reason to replace it immediately but it will make the user aware of a potential problem that exists in the fuel tank or delivery system. Inspecting the fuel filter may require the ability to rotate the filter to inspect it as debris will migrate to the lowest point in the filter which may not be visible as installed.

A clogged or clogging fuel filter is not always noticed by inspection. Particles that are small enough to fill the pores of the filter element are unlikely to be large enough to witness visually. Typically, fuel filter clogging is noticed during the pre-flight engine runup to WOT. If the filter is clogging it will prove difficult for the fuel pump to maintain fuel rail pressure at high engine speed and may drop below 280kPa If this is the case, it is most expedient to replace the fuel filter and notice if the problem disappears. The fuel filter is not considered a serviceable component. Service is conducted by replacing the component.

Spare parts recommendation: spare fuel filters should be available for troubleshooting and service while in the field.

⚠ WARNING

Always exercise great care when working on or around fuel systems. Gasoline is extremely flammable.

Pre-Flight Inspection

1. Inspect the filter noting if any dirt or debris is present in the filter.
2. Replace the filter if the fuel rail pressure drops below 280kPs on pre-flight max engine speed check.

100-hour Service

1. Replace the filter every 100 hours or if the fuel rail pressure drops below 280kPs on pre-flight max engine speed check. Whichever occurs first.

Spark Plug

Discussion

A new spark plug should be gapped at 0.018” (0.46mm). The spark plug used on the A33 should arrive new pre-gapped however it is good practice to check the gap in any case prior to installation. Simply dropping a spark plug (bare or still inside the box) can close the gap significantly and cause a performance drop. Gaps that are too large are also undesirable. Growing gaps begin to stress the CD (Capacitive Discharge) ignition units even before the gaps get large enough to induce misfire. As such, the upper gap limit specification on the spark plug is set at 0.025” (0.65mm) to minimize stress on the CD ignition units that may result in their latent failure. A good beginning for spark-plug replacement is every 50 hours. Many customers may find their spark plugs have not exceeded the maximum gap in that

time. If this is determined to be true, then the end user can use this upper gap limit specification to determine their own replacement interval.

It is NOT recommended to remove the spark plug for inspection on a regular basis. Spark plug gap and deposit condition inspections are generally only performed in conjunction with a change interval or troubleshooting system problems.

When removing the spark plug it is best practice to do so on a fully cooled engine (ambient temperature) for operator safety as well as to mitigate the chance for galling and/or cross threading the spark plug in the aluminum cylinder head.

The spark plug mostly a non-serviceable part and replacement is the means to service them.

Spare parts recommendation: Spare spark plugs should be on hand for field operations to reduce impact to operations when service is needed.

Pre-Flight Inspection

1. Inspect the base of the spark plug (top of the cylinder head) for evidence of oil/exhaust weeping which may indicate a loose spark plug.

50-hour Service

1. Replace the spark plug every 50 hours or when the spark plug gap exceeds 0.025” (0.65mm) whichever comes first
    a. Gap specification

NEW / MIN	0.018”	0.46mm
USED / MAX	0.025”	0.65mm

Tools & Materials Required:

Spark plug socket (14mm deep well)
Spark plug gap measuring tool
Spark plug (ECAX0015)

⚠ WARNING

Ensure the engine is not powered on when working with the spark plug and CDI ignition. The CDI is a high voltage device that may deliver an electric shock while powered on.

CAUTION:

Only use the socket wrench to loosen and final torque the spark plug. Removing and installing by hand will eliminate the chance of cross threading.

Removal

1. Snip/cut the zip tie fixing the spark plug cap to the cooling cowl.
2. Remove the spark plug cap.
3. Using the spark plug socket, loosen the spark plug.
4. Remove the spark plug by hand.

⚠ WARNING

***DO NOT* use the Denso U20M-U as a replacement plug. This plug runs much cooler than recommended, and it is very prone to fouling.**

Installation

1. Install the spark plug by hand and thread until the plug bottoms out.
    a. For NEW spark-plug/washer turn the plug with a socket an additional ⅛ to ¼ turn
    b. If the spark-plug/washer is new or used a torque of 40 to 50 in-lbs can be used
2. Replace the spark plug cap.
3. Install the spark plug cap securing zip tie and trim when done.

CDI, Spark Plug Cap

Discussion

The A33 propulsion unit uses a CDI (Capacitive Discharge Ignition) for its ignition system. The CDI is generally a non-serviceable part, but steps can be taken to improve the reliability of the CDI's.

The ground path for the high voltage spark is through the cap and including the braided cover on the high-tension line (spark plug wire) connecting the spark plug cap to the metallic coated case. To maintain performance of the CDI unit, the ground path must remain intact. A bad ground path will cause many problems including:

- Ignition Misfires
- Primary coil failures in the CDI
- EMI affecting servo operation
- EMI affecting the engine speed sensing signal

In addition, these problems may manifest intermittently further complicating the troubleshooting process. The ignition units fitted to the A33 propulsion unit will have had a self-sealing silicone wrap applied to its high tension lead. The goal of the wrap is to protect the braided line that serves as a ground path to the CDI box. It provides a surface that is less easily damaged by zip ties and also keeps the braid intact under vibration by providing some stiffness to the high-tension lead to mitigate shaking. Wear on the silicone tape is not a problem but will alert you to impending wear on the braided jacket. Keep the braided jacket covered by repairing the wear as it appears. This silicone tape is readily available and can be purchased from Cobra-AERO in addition to being sourced commercially.

When the spark plug cap is installed on the spark plug, use the provided zip-tie bosses to keep the cap held down on the spark plug. This mitigates the chance the cap can shake free from the spark plug which will cause an engine outage. In addition, the zip-tie reduces how much the cap rotates on the spark plug. A rotating cap will wear the inside of the cap against the spark plug hex and create a metal dust in the cap that begins to provide an alternate ground path for the spark. Even with the fixing zip-tie, this fretting dust will still occur and occasional cleaning the inside surface of the spark plug cap with a small wire brush can restore the grounding contact path between the cap and spark plug hex.

Because the CDI is a mostly non-serviceable component, it is good practice to have spare units available during operations for troubleshooting and reducing operations down time when problems surface.

NOTE:

Wear and or damage on the metal over-braid does not guarantee the CDI/ignition unit will cease functioning. Rather, maintenance of the ground path is the best insurance against problems experienced with the CDI units.

Pre-Flight Inspection

1. Inspect the high tension lead (spark plug wire) along its length and ensure the metal braid is protected with self-sealing silicone wrap or an equivalent.
    a. Correct any wear spots or damage when found.

⚠ WARNING

Ensure the engine is not powered on when working with the spark plug and CDI ignition. The CDI is a high voltage device that may deliver an electric shock while powered on.

Service

1. If some of the problems listed in the discussion are experienced, the following are recommended.
    a. Remove the spark plug cap and note the condition inside spark plug cap. A wire brush can be used to clean the lower inside of the spark plug cap that is in contact with the hex on the spark plug.

    b. If cleaning the cap does not correct the problem, the protective layer on the high-tension lead may need to be removed so that the length of the lead can be inspected for any breaks in the metal braid or factors that affect the ground path.

        i. In this example image, the metal braid nearest the cap is in very poor condition. This particular unit functions well however the damage is indication that the braid is being un-necessarily stressed under vibration in its current installation. The issue causing this fraying should be mitigated for the CDI to continue functioning at peak performance.

ii. Complete breaks in the ground path to the CDI case should be reason to remove the CDI from service until corrected. In this example, the pinch clamp (oetiker clamp) no longer holds the braid to the spark plug cap.

iii. The earliest indication of an issue with chafing that may turn to braid wear and/or fraying is evidenced by the silver-colored plating being worn away from the copper braid on the high tension line.

iv. Eventually the strands in the copper braid will wear through and begin to fray

v. If left unchecked, the fraying will continue until the ground path is broken. Re-apply self-sealing silicone tape (or similar) to the affected area will stop the fraying from propagating.

Mufflers (section under construction)

Discussion

Most of the mufflers fitted to the A33 propulsion system are generally maintenance free. Inspections to the mufflers are primarily to ensure the muffler remains securely fastened to the engine. To reduce the weight of the muffler systems, aluminum is frequently used. This metal, under the thermal loads imposed by the exhaust system, tends to creep over time. The result of this is a gradually loosening of the clamp load the fasteners provide on the exhaust system. This is independent of the fastener *rotating* loose. Stated differently, if operators put torque stripe on the muffler fasteners, a loosening will be noted over time despite the torque stripe showing that no fastener rotation occurred.

There are 5 fasteners holding the muffler to the engine in all but one A33 propulsion unit configuration.

- 2 M5 fasteners at the cylinder exhaust outlet (muffler inlet) and
- 3 M4 fasteners that hold the muffler body to the crankcase.

These latter 3 fasteners are the most important because they keep the muffler body moving with the engine case as the engine shakes on the vibration mount. When these fasteners become loose, the mass of the muffler volume becomes unconstrained. This leaves the 2 remaining M5 fasteners and the inlet of the muffler to resist all shaking movements. The aluminum near the 2-M5 screws will quickly fatigue, crack and then fail.

The rate of the creep of the aluminum depends somewhat on the duty cycle of the propulsion unit. A good beginning for muffler bolt torque checks is every 50 hours. If you find your fasteners do not rotate under a torque check for two consecutive cycles (100 hours) then the inspection interval may be extended. Conversely, if the bolts are found to rotate more than ~1/16th of a turn at the first 50-hour inspection, the inspection frequency should be increased to not allow them to become so loose.

NOTE: Always consider that when Loctite thread-locker is applied, it functions optimally after it first dries. If the fasteners are rotated after applied Loctite has set-up or dried, the thread-locking property is compromised to some degree. When performing a torque check on a fastener using Loctite (which includes all fasteners on the A33 exhaust system) consider removing and reapplying Loctite to any fastener that rotates significantly for peak thread-locking ability.

Pre-Flight Inspection

1. On a cold engine (ambient temperature) push/pull the exhaust system feeling for anything that indicates loose fasteners

50-hour Service

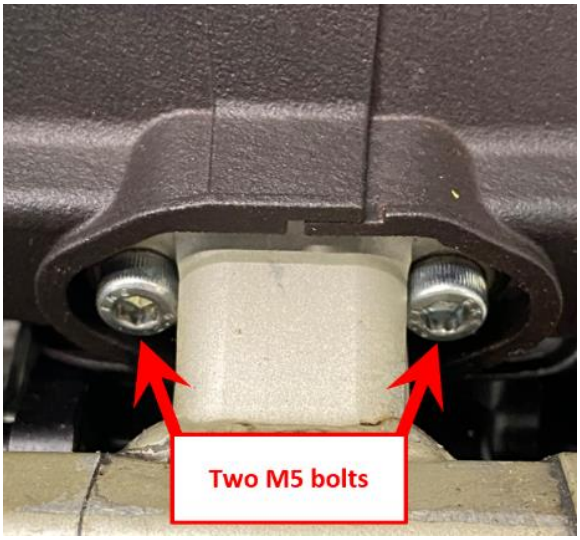
2. Remove the spinner/propeller/backplate and torque check the 5 fasteners (where applicable) on the exhaust system.

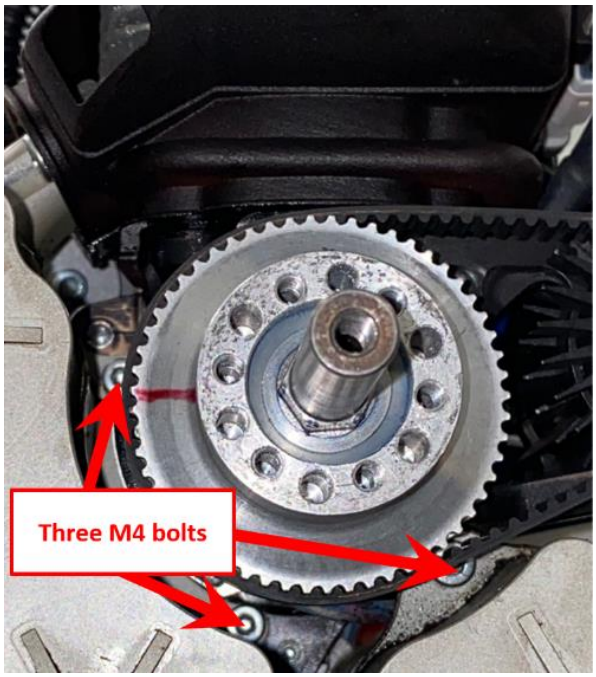
a. Torque specifications

Two M5 bolts	30 in-lbs
Three M4 bolts	40 in-lbs

Tools & Materials Required:

~6” long 3mm socket head allen wrench
~2” long 4mm socket head allen wrench
Torque wrench capable of at least 30 to 60 in-lbs range
Loctite 2422 (high temperature medium blue)





Prop Strikes and Hard Landings

Discussion

Occasionally, incidents occur (hard landings or crashes) where the propulsion system is subjected to external impacts outside of the design intent. There also exist conditions where the engine may be running when something interferes with the propeller (prop strike). These incidents can introduce the possibility for latent failures of the propulsion system with subsequent running. Full engine replacement may be considered too costly to scrap the entire propulsion unit when performance criteria is still met. To continue safely operating a propulsion unit that has experienced these conditions, the end user must now increase inspections on the propulsion unit to identify an actual latent failure that may be progressing.

Impacts from crashes or hard landings introduce the possibilities of bearings and/or races in the engine and/or generator incurring dents on impact. The likelihood of this bearing damage is greater when the engine is not running on impact. In this case, there exists a possibility of slow degradation of the bearing as those dents spread defects throughout the races and balls of the bearing. This failure mode can take tens or even hundreds of hours to manifest and as such, this failure mode can be identified and removed from service before full catastrophic failure takes place provided careful monitoring exists. It is recommended to have the propulsion system returned to the manufacturer for qualified inspection of the engine prior to returning it to service.

Prop strikes also have the issue of potential damage to the crankshaft bearings as do hard landings or crashes. In addition, a prop strike can cause the crankshaft to twist under the sudden deceleration. If this is the case the engine will become severely out of balance and severely overstress the crank-train bearings. In the case of prop strike conditions, it should be considered required to send the engine to the manufacturer for inspection as the latter condition can be considered especially dangerous. Propeller cages and special safety measures are needed to evaluate engines that may have excessive vibration.

⚠ WARNING

Make sure you operating procedures ensure the engine is disabled during the following for inspector safety!

Special Pre-flight Inspections

1. The engine must be hand cranked with care taken to note any indexing or ratcheting in the rotation that might suggest dented balls or races.
2. Move the spinner (or starting nut or propeller) axially and radially (in/out and up/down, left/right) to feel for excessive bearing clearances.

If either of the above conditions are noted then the engine must be removed from service and a full rebuild, or engine core replacement, is likely to be needed.