RAANZ/SAC Part 103 on-condition engine escalation program

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Background

Part 103 microlight aircraft are powered by a wide variety of engines- 2-stroke, 4-stroke, ex-certified, uncertified, purpose designed aero, and various auto and utility conversions. Some have manufacturer recommended maintenance schedules, others do not.

The rule governing Part 103 engine maintenance is-

> 103.217 Maintenance and inspection requirements
> (a) An operator of a microlight aircraft must ensure that—
> (1) the aircraft is maintained in an airworthy condition; and
> (2) every applicable airworthiness directive is complied with in accordance with the requirements prescribed in Part 39; and
> (3) between required inspections, every defect is rectified.
> (b) An operator of a microlight aircraft that meets a type design standard listed in rule 103.207(a)(1), must ensure that the aircraft is maintained in accordance with the designer or kitset manufacturer maintenance requirements.

AC103-1 further clarifies this rule-

> 103.217(b) is also straight forward. Most modern microlights are provided with a manufacturer's service or maintenance manual. These manuals will spell out the required inspection intervals and what is required to be done at each of the intervals. If your aircraft was provided with such a document then it must be complied with.

CAA interprets this rule as "**if there exists an engine manufacturer's maintenance schedule, it must be complied with**".

This exposes two issues-

1. Many microlights are owner operated with typically low utilisation, and as a result reach calendar life limits well before TIS limits. There are many old, low time engines in service.
2. There are also many alternative installations (typically auto and utility engine conversions) with no recommended maintenance schedules.

This document aims to address both these issues by proposing a simple, generic maintenance program framework to be followed by the aircraft owner and Inspection Authority, covering all types and allowing extended operation beyond any manufacturer's TIS or calendar limits provided-

- the engine is maintained to a specified maintenance schedule and
- can be shown to be operating to established baseline parameters

= 'on-condition'.

The CAA document granting exemption from the manufacturer's TIS and calendar life limits and enabling this on-condition program is TBA**????**

What it is

From AC43-4:

> On condition maintenance is a preventative process that allows deterioration of components by monitoring those components for their continued compliance with a required standard. The continued satisfactory operation of the structure or component may be determined by inspection, operation, or examination in-situ without detailed dismantling. The necessity to bay service, recondition, overhaul, or repair is made dependent on the condition.
>
> On condition maintenance should include the assessment of pilot monitored performance, functional checks, and scheduled maintenance, and use circumstantial servicings to carry out opportunity assessments of components. The circumstantial assessments result from other component failures, routine component replacement due to life limitations, and from accidents.

Note: 'Circumstantial' is understood in this context to be 'unscheduled event-driven maintenance'.

For Part 103 aircraft this program makes provision for aircraft engines and their associated components to continue operation beyond manufacturer's recommended TIS or calendar life provided they can be shown to be performing to previously established performance or wear limits.

It also provides for engines without a manufacturer's maintenance schedule or TIS/calendar life limits to enter the program and be maintained and monitored to a common set of standards across the Part 103 fleet.

The aim is to ensure safety and reliability while minimising operating costs by

- avoiding unnecessary work on otherwise serviceable components,
- using evidence based decision making on replacement or overhaul of components.

What is it not

From AC43-4:

> On condition is not fit until failure or fit and forget

It is not a licence to take shortcuts, ignore problems, or defer necessary maintenance actions.

How it works

The Part 149 organisations will provide a suite of **routine maintenance schedules** and **performance/wear limits** to cover the variety of engine types fitted. Most of these will be derived directly from the engine manufacturer's published maintenance schedules, others will be more generic covering those engines with no manufacturer's schedule (eg auto conversions, utility engines, special conversions, etc).

The Part 149 organisations will appoint **Authorising IAs** who may inspect and sign off engines to enter this program. They will also specify the routine maintenance schedule and performance and wear limits appropriate to the engine. These Authorising IAs must have the confidence of the Part 149 organisation, and proven experience with the engine types they sign off. They are the gatekeepers into this program.

The **aircraft operator** may then operate the aircraft, following the specified maintenance schedule, measuring and recording the performance/wear measurements.

The aircraft must undergo an **annual inspection** by an IA, who must be satisfied from the maintenance records and/or by direct inspection, that all necessary maintenance has been carried out and the engine performance/wear is within the specified limits and can reasonably be expected to perform to specification for the next maintenance period.

Insurance considerations

Some insurers may require that the manufacturer's maintenance schedule be strictly followed, or may impose a premium or excess for engines operating under an on-condition program beyond manufacturer's limits. It is advisable to check with your insurer before entering this program.

Routine maintenance requirements

All engines must be under a routine maintenance schedule as specified by the Authorising IA, with key items being measured, inspected, adjusted or replaced at periodic intervals.

These items will typically be consumables and components that wear with time and use (oil, fluids, filters, plugs, points, rubbers, hoses, valve clearances, etc). The intervals for each component should be selected such that inspections and replacement will occur well before the expected life of each component.

These schedules will typically cover 25/50/100 hour checks as well as annual items.

If a manufacturer's maintenance schedule exists, it should be used as a basis.

Appendix 1 lists some prototype routine maintenance schedules. These are indicative only- more detailed schedules will be developed by the Part 149 organisations.

If a component is scheduled for replacement, but on inspection shows no sign of degradation and can reasonably be expected to perform to specification for the next inspection interval, it may be returned to service.

Maintenance activities, measurements and refit/replace decisions must be recorded in the engine log for review by the IA at annual inspection time.

Components with finite life

Components identified by the manufacturer as having a finite life must be replaced as specified,

unless there is an approved test which monitors performance or wear and can reliably detect or predict the onset of accelerated degradation or failure. Such tests and exclusions must be documented in the on-condition maintenance schedule.

Establishing baseline performance

The condition of an engine can be reliably monitored by identifying critical parameters and wear points, and tracking them through the life of an engine to detect and predict any impending degradation or failure.

The routine maintenance schedule should identify those critical parameters and their wear limits appropriate to the engine installation, and those measurements be recorded in the engine maintenance log.

In most cases the engine manufacturer will have published performance parameters and critical wear limits- these should be used where available.

It is recommended that these baseline measurements be taken from new to establish a robust baseline and history of engine performance.

For older engines it is recommended that 100 hours of measurements be used to establish baseline performance, or draw from similar engine installations. If such data is not available, the baselines should be established from similar aircraft/engine/propeller installations.

Appendix 2 lists some prototype baseline performance parameters and wear limits. These are indicative only- more detailed schedules will be developed by the Part 149 organisations.

Entering the 'on condition' program

The Authorising IA is the gatekeeper into the program.

To enter the program the Authorising IA must-

- review the maintenance history
- perform a thorough 100 hour level inspection of the engine
- satisfy him/herself of the airworthiness of the engine and its components
- select the appropriate maintenance schedule, performance/wear limits for the engine
- check conformance to those specified performance/wear limits
- and if acceptable, sign the engine off to enter the program

Commercial operations exclusion

Aircraft used for hire or reward, including private aircraft placed on line for casual use, are excluded from this program. Private or club owned aircraft operations only.

Engines with undocumented history

An aircraft engine that has an unknown or poorly documented maintenance history must first be

assessed on its present condition and reliability before entering the program.

The steps required are-

- The Authorising IA must
  - review the maintenance history (if available)
  - perform a thorough 100 hour level inspection of the engine
  - satisfy him/herself of the airworthiness of the engine and its components
  - specify the appropriate maintenance schedule, performance/wear limits for the engine
  - authorise an endurance test schedule as per 103.211
- On completion of the endurance testing the Authorising IA must
  - repeat a thorough 100 hour level inspection of the engine
  - check conformance to the specified performance/wear limits
  - and if acceptable, sign the engine off to enter the program

Remaining in the 'on condition' program

An engine will remain in this program provided the maintenance logbook carries the following evidence -

- an entry sign-off by an Authorising IA
- a routine maintenance program and performance/limits specified by the Authorising IA
- all such routine maintenance has been carried out
- all such routine performance/wear measurements have been logged
- a current annual inspection has been signed off by an IA
- the aircraft owner remains a member or client of the appropriate Part 149 organisation

Maintenance documentation

All maintenance documentation must be recorded and retained in a maintenance logbook.
Such documentation must include-

- the entry sign-off by the Authorising IA
- the routine maintenance program and performance/wear limits specified by the Authorising IA
- all maintenance actions and decisions
- all annual inspection sign-offs

It is recommended that as well as recording the performance/wear measurements in the maintenance log, they should be recorded on a graph with the limit clearly marked This helps to track performance and predict the onset of failure.

Appendix 3 shows some sample performance/wear graphs.

To facilitate such record keeping the Part 149 organisations may provide logbook inserts with the appropriate routine maintenance schedules, program entry sign-off records, performance/wear limit logs and graphs, and annual inspection forms with fields for recording performance/wear measurements.

Issue/defect reporting

The owner or IA must report to the appropriate Part 149 organisation any significant issues or defects found on engines under this program.

Part 149 organisation responsibilities

- Provide and maintain routine maintenance schedules for various specific and generic engine types.
- Provide and maintain performance/wear limits or various specific and generic engine types.
- Appoint and equip Authorising IAs.
- Educate and advise members and IAs.
- Review defect reports and issues
- Monitor and assess the on-condition program.

Authorising IA responsibilities

- Gate-keeping entry sign-off into the program.
- Specify appropriate routine maintenance schedules and performance/wear limits.
- Report issues back to Part 149 organisation.

IA responsibilities

- Annual inspections and review of performance/wear limits.
- Sign-off for continuation in the program.
- Report issues back to Part 149 organisation.

Aircraft owner responsibilities

- Maintain the engine in accordance with the specified routine maintenance program
- Monitor and record performance/wear limits as specified.
- Report issues back to Part 149 organisation and IA

Appendix 1 Sample routine maintenance items

- These are indicative only- more detailed schedules will be developed by the Part 149 organisations.
- If a manufacturer's schedule exists, it should be used as a basis.
- For specific installations, add or remove inspection items as appropriate.
- If a component is scheduled for replacement, but on inspection shows no sign of degradation and can reasonably be expected to perform to specification for the next inspection interval, it may remain in service.
- ***** inspect
- **R** replace

2-stroke engines

ITEM	25hr	50hr	100hr	Ann.	Comment
Spark-plugs	*	R			
Air filter	*				
Gearbox oil	*		R		
Rotary valve oil	*		R		
Belt tensions	*				
Throttle cables	*				
Propeller bolts/tracking	*				
Coolant	*		R		
Fuel filter		*			
Decarb piston/head		*			
Carb idle/balance		*			
Piston rings		*			
Fuel pump		*			
Carb rubber boots				*	
Head/exhaust bolts				*	
Rubbers, hoses, mounts				*	

4-stroke engines

ITEM	50hr	100hr	500hr	Ann.	Comment
Magnetic plugs	*				
Air filter	*	R			
Spark-plugs	*	R			
Fuel filter	*	R			
Engine oil/filter	R				

Belt tensions	*				
Spark-plugs		R			
Carb rubber boots				*	
Rubbers, hoses, mounts				*	

Appendix 2 Sample baseline parameters and limits

- These are indicative only- more detailed tables will be developed by the Part 149 organisations.

2-stroke engines

ITEM	LIMIT	Comment
Static WOT RPM	<90% of baseline	Indicates engine delivering expected power
Piston end-play	>0.008mm	Rotax specified big end/crank-pin wear limit
Compression test	<90% of baseline	Indicates cylinder/ring seal/wear
Gearbox backlash	>110% of baseline	Crankshaft locked, measure at prop tip

4-stroke engines

Static WOT RPM	<90% of baseline	Indicates engine delivering expected power
Leak-down or Compression test	<90% of baseline	Indicates cylinder/ring/valve seal/wear
Oil filter inspection	No evidence of metal	Indicates internal wear
Magnetic sump plugs	No evidence of metal	Indicates internal wear
Oil pressure @ cruise	<90% of baseline	Indicates internal wear/oil pump performance
Oil consumption	>110% of baseline	Indicates internal wear
Fuel pressure @ WOT	<90% of baseline	Fuel pump performance
Gearbox backlash	>110% of baseline	Crankshaft locked, measure at prop tip

Appendix 3 Performance and wear monitoring graph examples