DUKEPILOT™ • HOFFMAN AVIATION, INC.

Cowl Flaps, Oil Cooler Baffles

B60 Duke cowl flaps, Photo by Robert Hoffman

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Blank

Cowl Flaps

Introduction

The Lycoming TIO-541 aircraft engine is cooled by fuel, engine oil, and air flow over and around the cylinders and engine accessories. The engine cowl, baffles, and cowl flaps are components of the air cooling system. Air cooling is achieved through the forward motion of the aircraft, forcing air into the forward engine cowling, causing a high pressure area between the engine cowl and the cylinder fins. Engine baffles are installed in the top of the engine compartment to build pressure between the cowling and engine cylinders, thus forcing airflow down and through the engine cylinders and oil cooler fins. Cooling air flows down and aft through the lower engine compartment providing accessory and wiring cooling before exiting the lower nacelle.

Cowl flaps are engine cooling devices, which when extended, further increase airflow through the engine compartment by decreasing air pressure in the lower aft nacelle. The following components are cooled by the combined action of ram air, cowling, baffles, and cowl flaps:

- Engine Cylinders
- Engine Oil Cooler
- Engine Starter
- Pneumatic Pressure Pumps
- Generator / Alternator
- Wiring Harnesses
- Various System Accessories

System Description

Cowl flaps are installed on the bottom aft portion of each engine nacelle. The cowl flap consists of a 20.0 inch by 20.0 inch door which is secured to the lower nacelle by two hinge assemblies using standard aviation hardware. A third hinge assembly, located at the door midpoint and aft of the forward hinges, provide an attach point for the cowl flap actuator. When closed, the door is flush with the bottom of the nacelle. When fully open, the doors trailing edge extends 11.4 inches below the nacelle. The door is controlled by an actuator fixed to the midpoint hinge assembly. The actuator is electrically controlled from the flight deck by switch(s) located on the pilots left lower side panel.

System Components

The cowl flap system consists of the following components:

- Cowl Flap Door
- Cowl Flap Hinges
- Cowl Flap Actuator(s)
- Cowl Flap Control Switch(s)

Cowl Flap Door

The cowl flap is a hinged door, measuring 20.0 inches by 20.0 inches, affixed to the lower nacelle. When fully closed, the door is flush with the lower nacelle, when fully open the trailing edge of the door extends 11.4 inches below the nacelle.

Cowl Hinges

Three hinges secure the door to the bottom of the engine nacelle, two forward, and one at the midpoint of the door structure.

Cowl Flap Actuator

An electric motor housed within the actuator drives a rod, which in turn opens and closes the cowl door. The top of the actuator is secured to the engine nacelle structure, the bottom to the door midpoint hinge. The actuator incorporates two internal limit switches, which when activated, removes power from the motor when the actuator rod is fully extended or retracted.

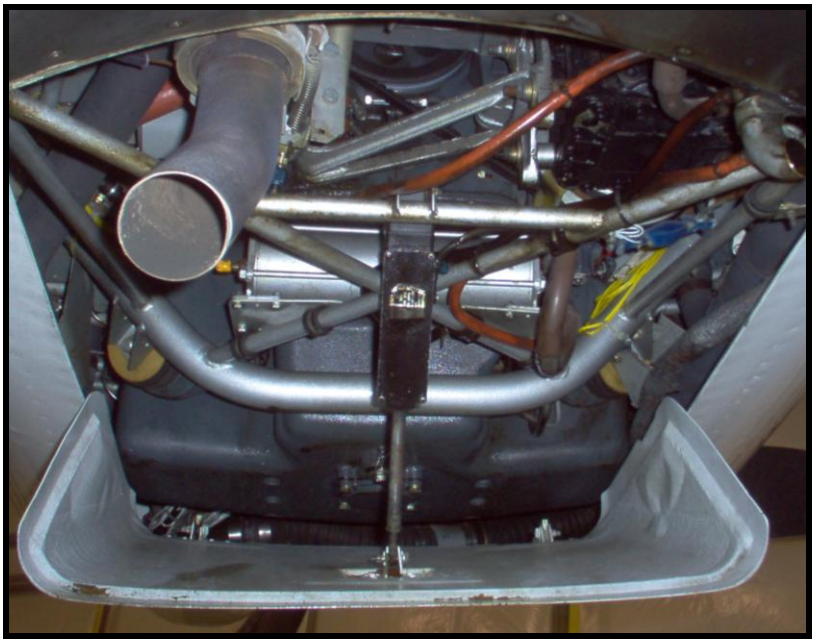

Figure 1: Cowl Flap Actuator. Photo by Robert Hoffman

Electrical Power

The actuator(s) receive power from the left power bus through a single 5A circuit breaker, P-4 to P-61, or from the respective left and right power bus, through individual 3A circuit breakers, P-62 to P-594. Cowl flap circuit breaker(s) are located on the Co-Pilot's Right Upper Side Panel, bottom two rows, labeled: Engine & Fuel Systems. Circuit breakers are the push to reset type and may be reset once.

Figure 2: Cowl Flap Circuit Breakers - Engine & Fuel System - Row 8 & 9, Photo by Robert Hoffman

Cowl Flap Control

Cowl flap controls are located on the pilots left lower side panel. The controls consist of two, three position switches labeled: OPEN-OFF-CLOSED. The aft position is OPEN, center OFF, forward CLOSED.

Figure 3: Cowl Flap Control, Photo by Robert Hoffman

Cowl Flap Indication

Position indicators are not provided. The cowl flap actuator(s) require approximately 14 seconds to fully OPEN or CLOSE the door. Timing actuator action through the COWL FLAP switches is a technique used to achieve intermediate flap positions. When positioned fully CLOSED, the trailing edge of the door is nearly flush with the bottom of the nacelle. When positioned fully OPEN, the door is deflected approximately 30 degrees below the nacelle. By selecting the COWL FLAP switch(s) from CLOSED to OPEN for seven seconds, thence OFF, positions the door to the 15 degree position, colloquially known as the TRAIL position. TRAIL may be confirmed when the cowl flap(s) begin to become visible beneath the nacelle. Intermediate door position(s) may be achieved using this technique.

Limitations

The manufacturer publishes no limitations regarding the use of cowl flaps. Likewise, cowl flaps are not listed in the aircraft equipment list, or the FAA type certificate data sheet. Cowl flaps are NOT required to be selected OPEN / CLOSED for a specific flight operation.

Normal Operation

Operators are encouraged to treat AFM/POM normal operating procedures section of the AFM as advisory only.

Regarding the use of cowl flaps for takeoff; the Beech factory training center, and all major training providers since 1968 advise cowl flaps CLOSED for takeoff.

Cowl flaps are a high altitude cooling tool. Fuel is the engines primary cooling agent during takeoff and climb, thus negating cowl flap usefulness below FL180. During extended climbs above FL180 cowl flaps assist in keeping cylinder head and oil temperatures within acceptable operating perimeters.

Ground Operations

Cowl flaps should be OPEN during all ground operations without regard to outside air temperature. This technique prevents localized hot spots around the engine accessories and associated wiring. Operators in the northern latitudes during extreme cold conditions report keeping the cowl flaps CLOSED on the ground to facilitate oil warming.

Takeoff and Climb

Cowl flaps should be CLOSED for every takeoff and climb and incrementally OPEN in the climb to maintain cylinder head temperatures below 205° Celsius, or the oil temperatures below 104° Celsius. With or without intercoolers, these engine parameters should not be reached, even on the hottest day, until climbing through +/- FL18.

Cruise, Descent, Approach and Landing

Cowl flaps will normally be CLOSED during cruise, descent, approach and landing, since air flow provides sufficient cooling during these phases of flight.

Performance

Cowl flaps on a Duke are enormous. The increased wetted area of fully extended cowl flaps increases induced drag. Think of the drag created by a flat plate, 3.25 inch tall, by 20.0 inches wide affixed below and perpendicular to each engine nacelle. This induced drag increases takeoff distances, significantly decreased single and two engine climb performance, and decreases cruise true airspeed.

Normal Takeoff

The manufacturer's Normal Take-off performance charts list cowl flaps OPEN. Performance chart ASSOCIATED CONDITIONS must not be interpreted as limiting. For instance; NORMAL TAKE-OFF charts, ASSOCIATED CONDITIONS list only paved, level, dry surfaces. The fact that wet or sloped surfaces are not listed does not preclude a take-off from a wet or sloped surface. Likewise, the NORMAL TAKE-OFF chart considers "TAKEOFF POWER SET PRIOR BRAKE RELEASE", which in no way limits an operator from conducting a rolling, or standing takeoffs.

Obstacle Takeoff (P-4 to P-246)

The manufacturer's Obstacle Takeoff charts, under Associated Conditions, list the cowl flaps CLOSED. The chart also lists flaps set to APH (15 degrees).

Single Engine Climb

The manufacturer's Single Engine Climb chart, Associated Conditions, lists the cowl flaps OPEN. Independent flight testing confirms that single engine climb performance increases 150 feet per minute when the cowl flaps are closed.

Two Engine Climb

The manufacturer's two engine climb charts assume the cowl flaps OPEN. Operator experience indicates two engine climb performance increases over charted data with the cowl flaps CLOSED.

Cruise

The manufacturer's Cruise Control charts state: "Cowl flaps full OPEN reduce true airspeed by approximately 10 knots." This data was derived at an average cruise weight of 6,125 lb. Independent flight test data (FL250/ +6,500 lb. /cowl flaps OPEN) resulted in true airspeed penalties well in excess of 10 knots.

The Lycoming Operator's Manual and Service Instruction publications provide operators with specific guidance not found in the AFM/POM. Operators should consider Lycoming guidance regarding cylinder, oil, and turbine inlet temperatures controlling for maximum service life.

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9. For maximum service life, maintain the following recommended limits for continuous operations.

- **Engine power setting - 65% of rated or less**
- **Cylinder head temperature – 400f/204c , or below**
- **Oil temperature – 165f/74c - 220f/104c**
- **Turbine inlet temperature - maintain 100f/38c on rich side of maximum allowable. (1650f/899c- 100f/38c = 1550f/861c)**

Emergency

The EMERGENCY section of the AFM/POM lists two procedures related to cowl flap operation.

- **ENGINE FAILURE AFTER LIFT-OFF OR IN FLIGHT** / Secure inoperative engine: / f. Cowl Flap - CLOSED.
- **MAX GLIDE (FORCED LANDING)** Feather the propellers, retract the wing flaps, landing gear, and (CLOSE) cowl flaps.

Maintenance

The maintenance manual advises cowl flap actuator overhaul on condition. The Illustrated Parts Catalog lists the cowl flap actuator as P/N 96-380021-15, alternately, P/N 102-389013-1.

Operators report cowl flap actuators are easy to trouble shoot, disassembled and overhaul.. All the parts, brushes, bearings, armatures, etc. are available through aerospace parts providers. (Electromech Technologies, Wichita, KS).

Common service difficulties:

- Cowl flap stuck in retract or extend position due to jammed or failed internal limit switch(s).
- Electric motor failure due to failed internal components

Finally, cowl flaps should not remain OPEN for cooling in cruise flight. High cylinder head and / or oil temperatures are symptomatic of worn engine baffles, failing ignition components, fuel metering, or internal engine issues. Pilots should control high temperatures with any means possible, including higher fuel flows, increased air flow, lower manifold pressure, or by selecting a lower altitude. Persistent cylinder head temperatures above 205 degrees Celsius or oil temperatures above 104° Celsius in cruise flight (65% power) should be discussed with your maintenance provider. Preventive maintenance is always less costly than the alternative.

Oil Cooler Baffles

Introduction

The Lycoming TIO-541E1C4 engine is certificated for operations from -1,000 msl and +50 degrees Celsius, to FL300 and -50 degrees Celsius. To achieve this envelope, the engine must be managed to maintain cylinder head and oil temperatures within a defined range described in the Lycoming Operator's Manual. Death Valley temperatures seldom tax engine limits, however, prolonged operations in extreme low temperatures have been known to cause engine failures. Warm oil is the life blood of this engine. Without warm oil, the turbocharger, waste gate, propeller and propeller governor will fail: followed closely by a catastrophic internal engine seizure.

System Description

Oil cooler baffles are devices which restrict cooling air flow over the oil coolers. The restricted air flow increases oil temperature allowing operation in extremely low outside air temperatures.

System Components

Oil cooler baffles consist of the following components:

- Baffle
- Baffle Placard
- Mounting Hardware / Fasteners

Baffles

The baffles consist of a flat plate measuring 9¾ in. × 3½ in. A 90° lip measuring 9¾ in. × ¾ in. which includes two holes, equally spaced from each end for securing the baffle to the oil cooler structure.

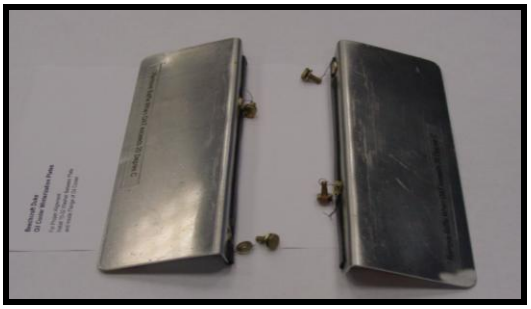

Figure 4: Oil Cooler Baffles, Photo by Ray Assmar

Figure 5 Oil Cooler Baffles, Photo by Ray Assmar

Baffle Placard

A warning placard is affixed to the top of the baffle in plain view of the installer:

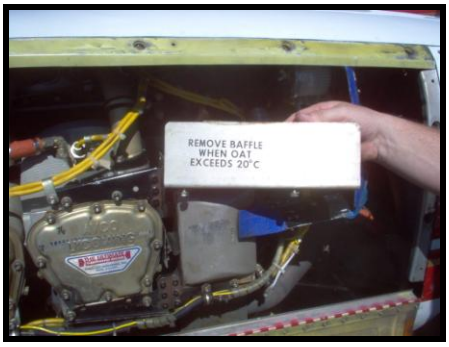

Figure 6: Baffle Placard, Photo by Robert Hoffman

Mounting Hardware

Beech used standard aviation hardware to mount the baffle to the oil cooler frame. The baffle is difficult to install and remove without mechanical ability. An alternate method, developed through operator experience, is to lay the baffle inside the oil cooler frame, securing the baffle to the frame with a nylon tie wrap. This method allows easy installation and removal requiring only a pocket knife.

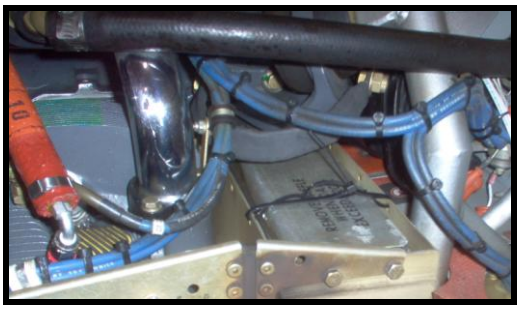

Figure 7: Oil Cooler Baffles Installed, Photo by Robert Hoffman

Operating Procedure

Lycoming is clear regarding minimum, desired, and maximum oil temperature for various operating temperatures. These operating instructions are published in the Lycoming Operator's Manual, Section 3: Operating Instructions, page 3-5.

Lycoming Recommended Oil Temperatures – OPERATOR'S MANUAL		
OAT °C	**DESIRED**	**MAXIMUM**
Above -1	**82**	**118**
-17 to +21	**76**	**107**
Below -12	**71**	**98**
Maximum Life 65%	**74**	**104**
Not below 60°C during continuous operations		

Limitations

Although not an operating limitation, Lycoming is clear that the engine oil temperature should not be allowed to decrease below 60 degrees Celsius during continuous operations. To do so, allows unfiltered oil to circulate through the oil cooler and oil filter bypass, potentially causing component failures. Oil cooler baffles must be installed if minimum temperature cannot be achieved. The baffles must be removed when the OAT exceeds 20 degrees Celsius.

Instrument Markings

Cylinder head and oil temperature limitations published in the LIMTATIONS section in the AFM/POM and replicated on the face of the respective engine instrument are regulatory and must not be exceeded. These limits, however, should not be interpreted as safe or efficient operating parameters. We encourage operators to consult the Lycoming Operator's Manual and Lycoming Service Instructions for specific operating technique.

B60 AFM/POM LIMITATIONS – INSTRUMENT MARKINGS		
OAT °C	**OIL TEMPERATURE**	**Cylinder Head Temperature**
Minimum - Red Radial	**38°C**	**NA**
Normal - Green Arc	**38°C-118°C**	**121°C-232°C**
Maximum - Red Radial	**118°C**	**246°C**
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Figure 8: Engine Gage - Beech Analog, Photo by Robert Hoffman

Review

Cowl Flaps

Cowl flaps are engine cooling devices used for ground operations and extended high altitude climbs. Cowl flaps should be closed prior to each take-off, and opened after landing. The AFM/POM does not require the cowl flaps open for take-off or climb. Closed cowl flaps will increase single engine climb performance by as much as 150 feet per minute over published AFM/POM values.

Temperature Limits

The Lycoming Operator's Manual should be your primary reference regarding cylinder head and oil temperature limitations. Cylinder head temperatures should be limited to less than 205° C. Oil temperatures during continuous operations should not be allowed to decrease below 60° C, 74° C desired, or increase above 104° C for maximum service life.

Oil Cooler Baffles

Install oil cooler baffles to achieve desired operating temperatures of at least 74° C desired for maximum service life. Remove oil cooler baffles when the OAT exceeds +20° C.