
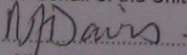


Stinson Oil Cooler modification

This is a copy of the modification application which successfully obtained United Kingdom Civil Aviation Authority Minor Modification Approval for the Pacific Oil Coolers non-PMA'd oil cooler. This was fitted to G-BRZK, a Stinson S108-2 fitted with a Franklin 6A4 engine. The CAA minor mod approval is on this page, the application (18 pages of it !) follows. It was written by Guy Gratton, email guy@gratton.flyer.co.uk, albeit with the very able help of Tom Woodhouse at Personal Plane Services at Booker, and fellow owner Bob Davey.

As an application, it is a one-off and only applies to G-BRZK. However, hopefully it might be of use to some other Stinson owners, so is freely shared. Please feel free to ask for any questions about it – but ultimately you are on your own between you and your authority. It is also perhaps slightly overkill – but it did work.

Guy Gratton.

Civil Aviation Authority United Kingdom		
APPROVAL OF MINOR MODIFICATION TO NON EASA AIRCRAFT		
MM.00025		
Pursuant to the National Regulations being in force at this time and subject to the exceptions, conditions and limitations specified below, the Civil Aviation Authority in accordance with UK National Procedures hereby advises:		
Personal Plane Services Ltd Wycombe Air Park Booker Marlow Buckinghamshire SL7 3DS		
The change in the Type Design to the following product, as specified herein, with the noted exceptions meets the appropriate BCAR requirements.		
Basic Product	Type Certificate Number: Type: Variant:	FAA A-767 Stinson 108-2
Aircraft Registration:	G-BRZK	Serial Number: 108-2846
Modification Number:	PPS-2011-01	
Title:	Replacement of Heat Exchangers Inc. 102C Oil Cooler with Pacific Oil Cooler Service Inc. 102C Experimental Unit	
Conditions and Limitations:	None	
Technical Documentation	G-BRZK Oil Cooler Mod Application Issue 1 dated 22 June 2011	
Date of application:	05/07/2011	Date of issue: 13/07/2011
Statement of Approval		
The United Kingdom Civil Aviation Authority hereby advises that the applicant has presented satisfactory evidence of compliance with the applicable airworthiness requirements in respect of the change identified above.		
Signed, for and on behalf of the United Kingdom Civil Aviation Authority		
Name:	 Nigel Davis	Date of Signature: 13/07/2011

Modification application

Minor Modification for G-BRZK (Stinson S108-2 Voyager); fitment of a non-approved oil cooler.

For attention of Mr Nigel Davis, UK CAA

Introduction

G-BRZK, a 1947 built S108-2 fitted with a Franklin 6A4 engine was found during annual inspection in early 2011 to suffer a non-repairable core-leak in the oil cooler, which is located immediately below the main engine block. Investigations have shown that a replacement certified (FAA PMA or original) part is not available. Requests for assistance from the Type Certificate Holder (Univair Aircraft Corporation, Colorado, USA) were not answered, and requests for assistance from Franklin Engines have also been ignored.

A non-certified part was available from Pacific Oil Coolers of California (see Appendix G). This replacement part is designed to be identical in form fit and function to the original part, although is fabricated from an aluminium alloy, rather than the steel and copper of the original part. It is stated to be approximately 4lb lighter. The part obtained has part number G727585 and serial number 2400, labelled with a manufacturing date of 27 August 2010.

In fitment, the part was able to be fitted in place of the original part, except that whilst it matched the attachment points, it was slightly smaller in other dimensions requiring modification of some hose lengths to be fitted. The part as fitted is illustrated



View from in front of nose



View from near starboard main gear



View from to port of nose, looking slightly forward



View from in front and slightly to port, with original unit held below it.

Proposed approval basis

The TCDS for the Stinson S108¹ shows the approval basis for all variants as CAR-3². This is a predecessor of the current FAR-23³. CAR-3 will be used as the primary approval basis, with a cross-check at each point to FAR-23 and where a higher standard is used in the current version of FAR-23, that higher standard will be applied. (In practice, they are identical, except for greater detail within FAR-23).

The following requirements were identified as relevant to this modification.

Para no.	CAR-3	FAR-23
3.73	<p>Empty weight. The empty weight and corresponding center of gravity location shall include all fixed ballast, the unusable fuel supply (see § 3.437), undrainable oil, full engine coolant, and hydraulic fluid. The weight and location of items of equipment installed when the airplane is weighed shall be noted in the Airplane Flight Manual.</p>	<p>Sec. 23.29 Empty weight and corresponding center of gravity.</p> <p>(a) The empty weight and corresponding center of gravity must be determined by weighing the airplane with--</p> <p>(1) Fixed ballast;</p> <p>(2) Unusable fuel determined under Sec. 23.959; and</p> <p>(3) Full operating fluids, including--</p> <p>(i) Oil;</p> <p>(ii) Hydraulic fluid; and</p> <p>(iii) Other fluids required for normal operation of airplane systems, except potable water, lavatory precharge water, and water intended for injection in the engines.</p> <p>(b) The condition of the airplane at the time of determining empty weight must be one that is well defined and can be easily repeated.</p> <p>[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964; 30 FR 258, Jan. 9, 1965, as amended by Amdt. 23-21, 43 FR 2317, Jan. 16, 1978]</p>
3.172	<p>Factor of safety. The factor of safety shall be 1.5 unless otherwise specified.</p>	<p>Sec. 23.303 Factor of safety.</p> <p>Unless otherwise provided, a factor of safety of 1.5 must be used.</p>
3.173	<p>Strength and deformations. The structure shall be capable of supporting limit loads without suffering detrimental permanent deformations. At all loads up to limit loads, the deformation shall be such as not to interfere with safe operation of the airplane. The structure shall be capable of supporting ultimate loads without failure for at least 3 seconds, except that when proof of strength is demonstrated by dynamic tests simulating actual conditions of load application, the 3-second limit does not apply</p>	<p>Sec. 23.305 Strength and deformation.</p> <p>(a) The structure must be able to support limit loads without detrimental, permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.</p> <p>(b) The structure must be able to support ultimate loads without failure for at least three seconds, except local failures or structural instabilities between limit and ultimate load are acceptable only if the structure can sustain the required ultimate load for at least three seconds. However when proof of strength is shown by dynamic tests simulating actual load conditions, the three second limit does not apply.</p> <p>[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964; 30 FR 258, Jan. 9, 1965, as amended by Amdt. No. 23-45, 58 FR 42160, Aug. 6, 1993]</p>

3.292	<p>Materials and workmanship. The suitability and durability of all materials used in the airplane structure shall be established on the basis of experience or tests. All materials used in the airplane structure shall conform to approved specifications which will insure their having the strength and other properties assumed in the design data. All workmanship shall be of a high standard.</p>	<p>Sec. 23.603 Materials and workmanship.</p> <p>(a) The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must--</p> <p>(1) Be established by experience or tests;</p> <p>(2) Meet approved specifications that ensure their having the strength and other properties assumed in the design data; and</p> <p>(3) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.</p> <p>(b) Workmanship must be of a high standard.</p> <p>[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-17, 41 FR 55464, Dec. 20, 1976; Amdt. 23-23, 43 FR 50592, Oct. 10, 1978]</p>
3.293	<p>Fabrication Methods. The methods of fabrication employed in constructing the airplane structure shall be such as to produce consistently sound structure. When a fabrication process such as gluing, spot welding, or heat-treating requires close control to attain this objective, the process shall be performed in accordance with an approved process specification.</p>	<p>Sec. 23.605 Fabrication methods.</p> <p>(a) The methods of fabrication used must produce consistently sound structures. If a fabrication process (such as gluing, spot welding, or heat-treating) requires close control to reach this objective, the process must be performed under an approved process specification.</p> <p>(b) Each new aircraft fabrication method must be substantiated by a test program.</p> <p>[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964; 30 FR 258, Jan. 9, 1965, as amended by Amdt. 23-23, 43 FR 50592, Oct. 10, 1978]</p>
3.294	<p>Standard fastenings. All bolts, pins, screws, and rivets used in the structure shall be of an approved type. The use of an approved locking device or method is required for all such bolts, pins, and screws. Self-locking nuts shall not be used on bolts subject to rotation during the operation of the airplane.</p>	<p>Sec. 23.607 Fasteners.</p> <p>(a) Each removable fastener must incorporate two retaining devices if the loss of such fastener would preclude continued safe flight and landing.</p> <p>(b) Fasteners and their locking devices must not be adversely affected by the environmental conditions associated with the particular installation.</p> <p>(c) No self-locking nut may be used on any bolt subject to rotation in operation unless a non-friction locking device is used in addition to the self-locking device.</p> <p>\$Amdt. 23-48, 61 FR 5148, Feb. 9, 1996\$</p>
3.296	<p>Inspection provisions. Adequate means shall be provided to permit the close examination of such parts of the airplane as require periodic inspection, adjustments for proper alignment and functioning, and lubrication of moving parts.</p>	<p>Sec. 23.611 Accessibility provisions.</p> <p>For each part that requires maintenance, inspection, or other servicing, appropriate means must be incorporated into the aircraft design to allow such servicing to be accomplished.</p> <p>\$Amdt. 23-48, 61 FR 5148, Feb. 9, 1996\$</p>
		<p>Sec. 23.943 Negative acceleration.</p> <p>No hazardous malfunction of an engine, an auxiliary power unit approved for use in flight, or any component or system associated with the powerplant or auxiliary power unit may occur when the airplane is operated at the negative accelerations within the flight envelopes prescribed in Sec. 23.333. This must be shown for the greatest value and duration of the acceleration expected in service.</p>

		[Amdt. 23-18, 42 FR 15041, Mar. 17, 1977, as amended by Amdt. 23-43, 58 FR 18971, Apr. 9, 1993]
3.561	Oil system. Each engine shall be provided with an independent oil system capable of supplying the engine with an ample quantity of oil at a temperature not exceeding the maximum which has been established as safe for continuous operation. The oil capacity of the system shall not be less than 1 gallon for every 25 gallons of fuel capacity. However, in no case shall the oil capacity be less than 1 gallon for each 75 maximum continuous horsepower of the engine(s) involved unless lower quantities can be substantiated.	<p>Sec. 23.1011 General.</p> <p>(a) For oil systems and components that have been approved under the engine airworthiness requirements and where those requirements are equal to or more severe than the corresponding requirements of subpart E of this part, that approval need not be duplicated. Where the requirements of subpart E of this part are more severe, substantiation must be shown to the requirements of subpart E of this part.</p> <p>(b) Each engine must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.</p> <p>(c) The usable oil tank capacity may not be less than the product of the endurance of the airplane under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling.</p> <p>(d) For an oil system without an oil transfer system, only the usable oil tank capacity may be considered. The amount of oil in the engine oil lines, the oil radiator, and the feathering reserve, may not be considered.</p> <p>(e) If an oil transfer system is used, and the transfer pump can pump some of the oil in the transfer lines into the main engine oil tanks, the amount of oil in these lines that can be pumped by the transfer pump may be included in the oil capacity.</p> <p>[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-43, 58 FR 18973, Apr. 9, 1993]</p>
3.570	Oil system lines, fittings, and accessories. Oil lines shall comply with the provisions of § 3.550, except that the inside diameter of the engine oil inlet and outlet lines shall not be less than the diameter of the corresponding engine oil pump inlet and outlet.	<p>Sec. 23.1017 Oil lines and fittings.</p> <p>(a) Oil lines. Oil lines must meet Sec. 23.993 and must accommodate a flow of oil at a rate and pressure adequate for proper engine functioning under any normal operating condition.</p> <p>(b) Breather lines. Breather lines must be arranged so that--</p> <ol style="list-style-type: none"> (1) Condensed water vapor or oil that might freeze and obstruct the line cannot accumulate at any point; (2) The breather discharge will not constitute a fire hazard if foaming occurs, or cause emitted oil to strike the pilot's windshield; (3) The breather does not discharge into the engine air induction system; and (4) For acrobatic category airplanes, there is no excessive loss of oil from the breather during acrobatic maneuvers, including short periods of inverted flight. (5) The breather outlet is protected against blockage by ice or foreign matter. <p>[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13094, Aug. 13, 1969; Amdt. 23-14, 38 FR 31823, Nov. 19, 1973]</p>
3.550	Fuel system lines, fittings, and accessories. Fuel lines shall be installed and supported in a manner which will prevent	<p>Sec. 23.993 Fuel system lines and fittings.</p> <p>(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.</p>

	<i>excessive vibration and will be adequate to withstand loads due to fuel pressure and accelerated flight conditions. Lines which are connected to components of the airplane between which relative motion might exist shall incorporate provisions for flexibility. Flexible hose shall be of an acceptable type.</i>	<p>(b) Each fuel line connected to components of the airplane between which relative motion could exist must have provisions for flexibility.</p> <p>(c) Each flexible connection in fuel lines that may be under pressure and subjected to axial loading must use flexible hose assemblies.</p> <p>(d) Each flexible hose must be shown to be suitable for the particular application.</p> <p>(e) No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after engine shutdown.</p> <p>[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-43, 58 FR 18973, Apr. 9, 1993]</p>
3.572	Oil radiators. Oil radiators and their support shall be capable of withstanding without failure any vibration, inertia, and oil pressure loads to which they might normally be subjected.	<p>Sec. 23.1023 Oil radiators.</p> <p>Each oil radiator and its supporting structures must be able to withstand the vibration, inertia, and oil pressure loads to which it would be subjected in operation.</p>
3.581	General. The power-plant cooling provisions shall be capable of maintaining the temperatures of all power-plant components, engine parts, and engine fluids (oil and coolant), at or below the maximum established safe values under critical conditions of ground and flight operation.	<p>Sec. 23.1041 General.</p> <p>The powerplant and auxiliary power unit cooling provisions must maintain the temperatures of powerplant components and engine fluids, and auxiliary power unit components and fluids within the limits established for those components and fluids under the most adverse ground, water, and flight operations to the maximum altitude and maximum ambient atmospheric temperature conditions for which approval is requested, and after normal engine and auxiliary power unit shutdown.</p> <p>[Amdt. 23-43, 58 FR 18973, Apr. 9, 1993, as amended by Amdt. 23-51, 61 FR 5137, Feb. 9, 1996]</p>
3.582	Cooling tests. Compliance with the provisions of § 3.581 shall be demonstrated under critical ground, water, and flight operating conditions. If the tests are conducted under conditions which deviate from the highest anticipated summer air temperature (see § 3.583), the recorded power-plant temperatures shall be corrected in accordance with the provisions of §§ 3.584 and 3.585. The corrected temperatures determined in this manner shall not exceed the maximum established safe values. The fuel used during the cooling tests shall be of the minimum octane number approved for the engines involved, and the mixture setting shall be those appropriate to the operating conditions. The test procedures shall be as outlined in §§ 3.586 and 3.587.	<p>Sec. 23.1043 Cooling tests.</p> <p>(a) General. Compliance with Sec. 23.1041 must be shown on the basis of tests, for which the following apply:</p> <p>(1) If the tests are conducted under ambient atmospheric temperature conditions deviating from the maximum for which approval is requested, the recorded powerplant temperatures must be corrected under paragraphs (c) and (d) of this section, unless a more rational correction method is applicable.</p> <p>(2) No corrected temperature determined under paragraph (a)(1) of this section may exceed established limits.</p> <p>(3) The fuel used during the cooling tests must be of the minimum grade approved for the engine.</p> <p>(4) For turbocharged engines, each turbocharger must be operated through that part of the climb profile for which operation with the turbocharger is requested.</p> <p>(5) For a reciprocating engine, the mixture settings must be the leanest recommended for climb.</p> <p>(b) Maximum ambient atmospheric temperature. A maximum ambient atmospheric temperature corresponding to sea level conditions of at least 100 degrees F must be established. The assumed temperature lapse rate is 3.6 degrees F per thousand feet of altitude above sea level until a temperature of -69.7 degrees F is reached, above which altitude the</p>

3.583	<p>Maximum anticipated summer air temperatures. The maximum anticipated summer air temperature shall be considered to be 100° F, at sea level and to decrease from this value at the rate of 3.6° F, per thousand feet of altitude above sea level.</p>	<p>temperature is considered constant at -69.7 degrees F. However, for winterization installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea level conditions of less than 100 degrees F.</p> <p>(c) Correction factor (except cylinder barrels). Temperatures of engine fluids and powerplant components (except cylinder barrels) for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature for the relevant altitude for which approval has been requested and the temperature of the ambient air at the time of the first occurrence of the maximum fluid or component temperature recorded during the cooling test.</p> <p>(d) Correction factor for cylinder barrel temperatures. Cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum ambient atmospheric temperature for the relevant altitude for which approval has been requested and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.</p> <p>[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13094, Aug. 13, 1969; Amdt. 23-21, 43 FR 2319, Jan. 16, 1978; Amdt. 23-51, 61 FR 5137, Feb. 9, 1996]</p> <p>Sec. 23.1047 Cooling test procedures for reciprocating engine powered airplanes.</p> <p>Compliance with Sec. 23.1041 must be shown for the climb (or, for multiengine airplanes with negative one-engine-inoperative rates of climb, the descent) stage of flight. The airplane must be flown in the configurations, at the speeds and following the procedures recommended in the Airplane Flight Manual, that correspond to the applicable performance requirements that are critical to cooling.</p> <p>[Amdt. 23-51, 61 FR 5137, Feb. 9, 1996]</p>
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Compliance Report

CAR-3 Para No.	Means and statement of compliance
3.73	Given that it is over 10 years since G-BRZK was last re-weighed, it was decided, rather than to modify an existing W&CG report for the changed oil cooler to re-weigh the aircraft. The new weight and balance report is shown at appendix A and has been included in the aircraft manual.
3.172	A factor of safety of 1.5 has been applied to operating limit loads to provide an ultimate value; compliance was then demonstrated by test and inspection in the following manner:
3.173	
<p>(1) Maximum oil pressure is 55 psi; multiplied by 1.5 this gives an ultimate value of 83psi; to allow for some gauge error, a pressure test was carried out to 90psi. This was satisfactory, and results are shown in Appendix D.</p> <p>(2) Mass of the new oil cooler, when full of oil, was found to be 1.26kg. This gives rise to the following limit loads</p> <ol style="list-style-type: none"> a. Forward: $1.26 \times 6.0^1 \times g = 75 \text{ N}$ b. To starboard: $1.26 \times 1.0 \times g = 13 \text{ N}$ c. To port: $1.26 \times 1.0 \times g = 13 \text{ N}$ d. Upwards: $1.26 \times 2.0^2 \times g = 25 \text{ N}$ e. Downwards: $1.26 \times 3.8^3 \times g = 47 \text{ N}$ <p>(3) Based upon (2) above, the following minimum ultimate loads were determined, each being the limit load multiplied by 1.5:</p> <ol style="list-style-type: none"> a. Forward: 113N (26 lbf) b. To starboard: 20N (5 lbf) c. To port: 20N (5 lbf) d. Upwards: 38N (9lbf) e. Downwards: 71N (16 lbf) <p>By use of a load spreader, suitable straps, and a handheld load cell, each of these cases was tested for a minimum of 3 seconds, and then the oil cooler and surrounding structure were inspected and conformed free of any damage of deformation. A fuller report of this test is contained in Appendix E.</p> <p><i>(All calculations above rounded up to the nearest integer.)</i></p>	
3.292	(1) The core of the oil cooler was manufacturer by a subsidiary of aerospace company Meggit, who have supplied a Certificate of Conformity to their company quality assurance systems. A copy of this certificate is included at Appendix C.
3.293	
<p><u>(2) Statement of inspection</u></p> <p>The manufactured and installed system, including a ground run, has been inspected and overseen by the undersigned. In both engineers' opinions, the</p>	

¹ In the absence of other requirements, the 9g ultimate forward was load taken from FAR 23.561(b)(ii), making 6.0 limit load, assuming the standard 1.5 safety factor from 23.303.

² In the absence of other requirements, the 3g ultimate upward was load taken from FAR 23.561(b)(i), making 2.0 limit load, assuming the standard 1.5 safety factor from 23.303.

³ +3.8g = N₁

	<p>installation was satisfactory and conforms to normal aeronautical engineering good practice.</p> <table border="1" style="width: 100%;"> <tr> <td style="text-align: center;"></td> <td></td> </tr> <tr> <td> GB Gratton CEng Eur.Ing.BEng(Hons) PhD FRAeS FIMechE Chartered Aeronautical Engineer EC UK No. 475173 </td> <td> ST Gilbert Part 66 licenced Engineer CAA AML/234985K </td> </tr> </table> <p>(3) An identical installation has previously been made to Stinson S108-2 registration N9419K which has subsequently run without failure or other difficulties for in excess of 65 tacho hours (~75 engine running hours). Documentary evidence of this is shown at Appendix B.</p>			GB Gratton CEng Eur.Ing.BEng(Hons) PhD FRAeS FIMechE Chartered Aeronautical Engineer EC UK No. 475173	ST Gilbert Part 66 licenced Engineer CAA AML/234985K
					
GB Gratton CEng Eur.Ing.BEng(Hons) PhD FRAeS FIMechE Chartered Aeronautical Engineer EC UK No. 475173	ST Gilbert Part 66 licenced Engineer CAA AML/234985K				
3.294	All fasteners used in the installation of this oil cooler are standard “AN” aircraft fasteners identical in specification to those used for the original part installation. Logbooks are available for the full life of the aeroplane (1947 to 2011), without record of failure of these. No parts rotate in use. All parts are standard aeronautical fasteners. Therefore, this requirement is considered to be met.				
3.296	The oil cooler is mounted within an engine compartment whose cowlings are readily and routinely removed for inspection and maintenance. Therefore this requirement is considered to be met.				
3.561	The internal oil capacity, and hose lengths and diameters, of this oil cooler are unchanged from the original equipment. Therefore this requirement is considered met to an identical degree to that of the original equipment.				
3.570	The type and configuration of oil hoses and attachments / fittings is substantially similar (only hose lengths being changed) to that of the original installation, which was considered satisfactory at original approval in 1947, and has not proved problematic since. Therefore this requirement is considered met to an identical degree to that of the original equipment.				
3.550					
3.572	An identical installation has previously been made to Stinson S108-2 registration N9419K which has subsequently run without failure or other difficulties for in excess of 65 tacho hours (~75 engine running hours). Documentary evidence of this is shown at Appendix B. Therefore this requirement is considered met through operational experience with an identical installation.				
3.581	It is well established that for conventionally cooled piston engine aeroplanes, the critical case for cooling is on the ground – any system capable of adequately cooling any part of the engine on the ground at both idle, and maximum power, will also do so whilst airborne. Therefore, a ground test alone was used to demonstrate compliance with these requirements.				
3.582					
3.583					
	<p>This test was conducted at Wycombe Air Park on 21 June 2011, outside air temperature was 18°C / 64°F. An initial ground test was carried out at low powers, followed by a visual inspection which confirmed no leaks. Subsequently the main test was carried out. At the end of twelve minutes of idle (or slightly above whilst taxiing) running, followed by a further seven minutes at 1600RPM which is the maximum permitted by the operators manual for continuous ground running (maximum achievable 2300rpm in a</p>				

30 second test, maximum permitted 2800rpm), the following results were obtained;

	After 12 minutes low power, °F	After 5 minutes 1600 RPMe, °F	Limit, °F	Smallest Margin below maximum limit
Cylinder Head Temperature	290	300	520	220
Oil Temperature	120	130	310	180

(Full results in Appendix G)

The smallest margin of any available engine temperature during this test was 180°F below the limit. The difference between the standard test temperature of 100°F and the outside air temperature during the test of 18°C, which is 64°F, is 36°F. Therefore during this ground test, cooling capacity was in the order of 144°F better than required. This is not a flight test, and higher revs were not used because of a POH prohibition, but the margin is large enough that an oil temperature exceedence during take-off or any subsequent flight manoeuvre appears extremely unlikely.

Regrettably the previous oil cooler was insufficiently serviceable to allow a comparison test but the opinion of the author, and that of the pilot who conducted the ground test, both of whom have over 100hrs on type, is that these values are less than would probably have been experienced with the previous cooler.

Therefore, it is proposed that the oil cooling capability of this system is satisfactory, fit for purpose, and compliant with the certification basis.

It is therefore proposed that this modification fully complies with the certification basis and is fit for approval on airframe G-BRZK.



GB Gratton
 CEng Eur.Ing.BEng(Hons) PhD FRAS FIMechE
 Chartered Aeronautical Engineer
 EC UK No. 475173

Appendix A – New Weight and Balance Report for G-BRZK

Weight and balance report

Basic Details

Type	Stinson S108-2 Voyager
Registration	G-BRZK
Weight at	Wycombe Air Park (Hangar of Personal Plane Services)
Weighing Date	3 June 2011
Equipment installed	<ul style="list-style-type: none"> - Propeller, fixed pitch, metal - Starter, Delco-Remy - Carburettor Air Heater and control - Carburettor Air Filter - Cabin Heater and Control - Firestone Wheels and Brakes - Parking Brake - Wheel pants (spats) - Generator, Delco-Remy - Battery 6TS-9F - Landing Light - Auxiliary fuel tank (empty and disabled) - NARCO MK12D TSO combined VHF/VOR receiver + CDI + antennas - Garmin GPS55 + bracket - Garmin GTX320 Mode-C transponder + antenna - Sicill P11 Fire Extinguisher - <i>Weighed with fuel fully drained, maximum hydraulic fluid and maximum (9 quarts) permitted engine oil.</i>
Equipment removed	<ul style="list-style-type: none"> - <i>Original oil cooler removed</i>
CG Datum	Wing leading edge
Weighing attitude	Defined by mainwheel axle being 1” forward of a line dropped from the wing leading edge (illustrated below)
Report prepared by	GB Gratton, CEng FRAeS ECUK No. 475173, CAA CP/287529B/A, BMAA Senior Inspector No. 466
Scales	Teroka 3 platform digital weighing indicator. Last calibrated by EH Oakley, Aylesbury, 10 March 2011 as accurate to within 0.1kg over full range



Weighing

	Weight (lb)	Moment Arm (" AoD)	Moment (lb.")
Mainwheels	306.0kg x 2 = 612kg =1,349lb	-1.04	-1,403
Tailwheel	35kg =77lb	219.95	16,936
Add in unuseable fuel (not present):4 gal at 6lb/gal	24lb	22	528

Leaving empty weight and Moment

Empty aircraft:	1,450	16,061
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Empty CG Range permitting 9.9-14.4" Aft of Datum

Weight and balance form

	Weight (lb)	Moment Arm (" AoD)	Moment (lb.") = weight x moment arm
Empty Aircraft	1,450	11.07	16,061
Front Seat		16	
Rear Seat		48	
Baggage		75	
Fuel (6lb/US gal) (Full is 36gal/216lb)		22	
Totals:			

Total weight:	lb
CG = Moment / Weight	

Maximum Take-Off Weight: 2230lb (Normal Category)

CG Limits: 10.6" – 21.6" Aft of Datum.

Signed:



**GB Gratton
4 June 2011**

Appendix B – Summary of Operating Experience

The following are from the aircraft technical logbook for S108-2 registration N9419K which fitted an identical cooler to this item on June 11 2010 with 700.4 tacho time, and it was still fitted and serviceable on May 21 2011 with 765.49 tacho time. The tacho on this aircraft is set to read 100% time increment at max RPM, so this shows that the cooler has operated for over 65.09 tacho hours without failure (probably about 75 hours, but this cannot be stated with certainty).

DATE	RECORDING TACH TIME	TODAYS FLIGHT	TOTAL TIME IN SERVICE	DESCRIPTION OF INSPECTIONS, TESTS, REPAIRS AND ALTERATIONS ENTRIES MUST BE ENDORSED WITH NAME, RATING AND CERTIFICATE NUMBER OF MECHANIC OR REPAIR FACILITY. (SEE BACK PAGES FOR OTHER SPECIFIC ENTRIES.)
2009/10				
12	676.79		2208.89	REPAIR BROKEN BRACKET ON OIL COOLER.
10				REPLACE SEAL ON DIPSTICK.
2009				I CERTIFY THIS ENGINE HAS BEEN INSPECTED IN ACCORDANCE WITH ANNUAL INSPECTION PROCEDURES AND IS IN AIRWORTHY CONDITION
				Barry Hameson A&P 2193890 IA
JUNE 11	700.4			REPLACED OIL COOLER WITH UNIT MADE TO ORIGINAL SPECS. PROVIDED BY OWNER. THIS QUALIFIES AS AN OWNER MANUFACTURED PART.
2010				THERE ARE NO ORIGINAL OIL COOLERS AVAILABLE TO Hameson A&P 2193890

DATE	RECORDING TACH TIME	TODAYS FLIGHT	TOTAL TIME IN SERVICE	DESCRIPTION OF INSPECTIONS, TESTS, REPAIRS AND ALTERATIONS ENTRIES MUST BE ENDORSED WITH NAME, RATING AND CERTIFICATE NUMBER OF MECHANIC OR REPAIR FACILITY. (SEE BACK PAGES FOR OTHER SPECIFIC ENTRIES.)
2010				
Aug 26, 2010	733.1			Drain engine oil, Replace oil Filter (Tempest AA48109), Add Bets Aeroshell W80 Plus, Test Run, Checks OK, Aircraft returned to service. Robert J. Pusterl ATP1980790
Nov 18, 2010	752.5			Drain engine oil, Replace oil Filter (Tempest AA48109), Add Bets Aeroshell 15-50, Test Run, Checks OK. Aircraft returned to service. Robert J. Pusterl ATP1980790
MAY 21 2011	765.49			TIME SMOH IS 769.39 TOTAL TIME IS 1287.39 COMPRESSION IS #1 62/80 #2 76/80 #3 64/80 #4 73/80 #5 68/80 #6 70/80 REPLACED EXHAUST SUPPORT RUBBERS WITH NEW PARTS FROM UNIVAIR REPLACED SCATTUBE FROM COWL INLET TO CABIN HEAT MUFF AIR INLET

CONTINUED NEXT PAGE

Appendix C – Certificate of Conformity for Cooler Core

MEGGITT

CERTIFICATE OF COMPLIANCE

8/20/2010 _____ DATE	5 _____ QUANTITY SHIPPED
3789 _____ PURCHASE ORDER	CORE MATRIX _____ PART NAME
045546 _____ SHIPMENT NUMBER	G727585 _____ MEGGITT (TROY), INC. PART NUMBER G727585-NE _____ CUSTOMER P/N (if applicable)
<p><u>SERIAL NUMBER(s) CORE NUMBER 2391, 2400-2403</u></p>	

It is hereby certified that the material shown herein meets the requirements of all drawings and specifications listed on the above purchase order, including special processes, as applicable. It is further certified that the articles shown herein have been dimensionally inspected and functionally tested, as applicable, and found to meet these requirements. It is certified that the Meggitt (Troy), Inc. Quality Management System meets the requirements of AS9100 and ISO9001 and/or FAA Regulation 21.

Welding, brazing and other special processes required in manufacturing the articles have been performed according to the applicable, current government or industry specifications by certified personnel, as required.

Required surface finish processes have been performed according to the applicable, current government or industry specifications for cleaning and pretreatment, plating, anodizing or alodine, as required.

Substantiating data, including chemical and physical analysis results and inspection and test results, as applicable, are on file and available for inspection or transmittal upon request.

This part is not to be intended as a modification or replacement part for a type certificated product and shall not be installed on a type certificated product.

John Ryan

Quality Engineer

Meggitt (Troy), Inc. is Certified to AS9100 & ISO 9001. Certificate #CERT-0026862 by SAI Global.

FCS-004-No PMA
Rev: 8-3-10

Meggitt Control Systems
Industrial Drive, Troy IN 47568, USA
Meggitt (Troy), Inc. is a Meggitt Control Systems

Tel: +1 (812) 547 7071
Fax: +1 (812) 547 2408
www.meggitt.com

Appendix D – Pressure Test Calculations and Results for new Oil Cooler

Maximum oil pressure in service = 55psi, this will be taken as limit load

Safety factor is 1.5.

Therefore ultimate oil pressure is $55 \times 1.5 = 83$ psi

Allowing for instrument error, a value of 90psi was used. The oil cooler was tested to this for 10 minutes, and subsequently inspected and found to have suffered no damage – there was no leakage during the pressure test.

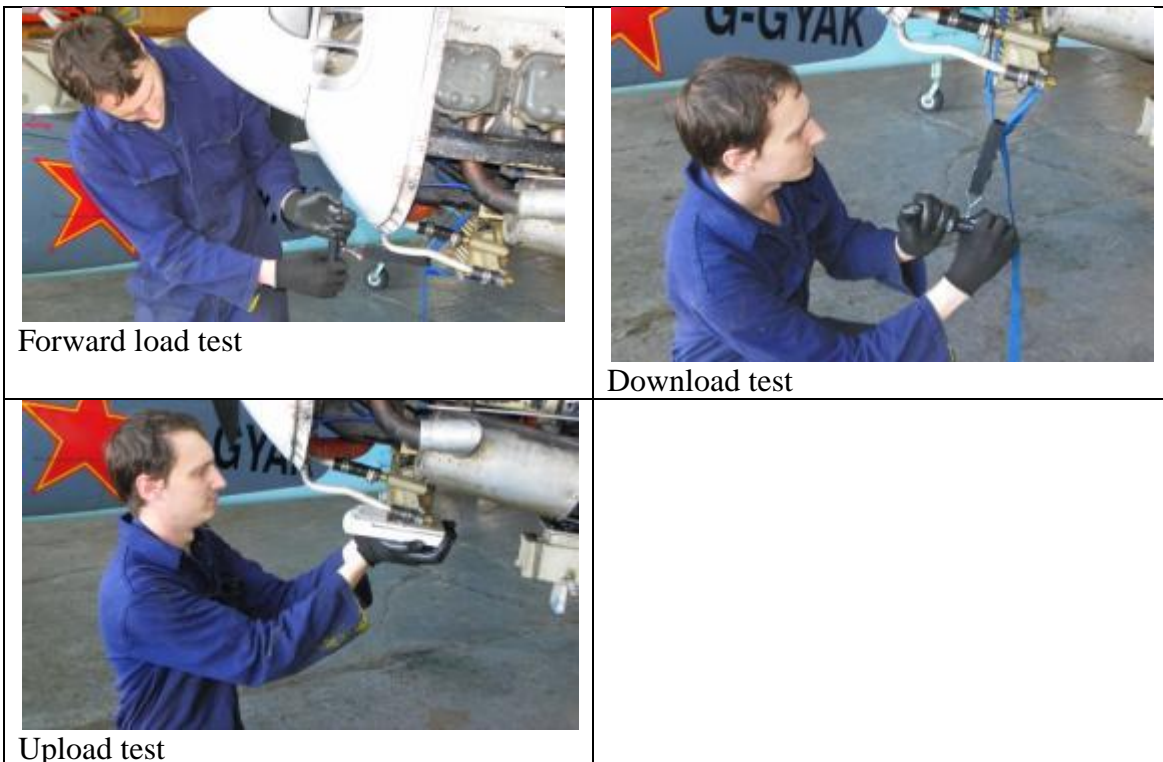
This test was conducted by Personal Plane Services, Wycombe Air Park.

Appendix E – Oil cooler installed ultimate load test

- Forward: 113N (26 lbf): Actual test: 30lbf for 10 seconds
- To starboard: 20N (5 lbf): Actual test: 10lbf for 10 seconds
- To port: 20N (5 lbf) : Actual test: 10lbf for 10 seconds
- Upwards: 38N (9lbf) : Actual test: 12lbf for 10 seconds
- Downwards: 71N (16 lbf) : Actual test: 20lbf for 10 seconds

Thus all certification requirements are exceeded by a factor of over 1 for load, and 3 for time.

Examples of load tests are shown below. A calibrated load cell was used for pull tests, and an office mail scale was used for upload (push) testing.



Appendix F – Suppliers documentation for oil cooler

PACIFIC OIL COOLER SERVICE, INC.

1677 CURTISS COURT
LA VERNE, CA 91750-5848
USA

Voice: 909.593.8400
Fax: 909.593.8499

INVOICE

Invoice Number: 171459
Invoice Date: May 18, 2011
Page: 1

Duplicate

Bill To:
GUY GRATTON BUILDING 125 CRANFIELD UNIVERSITY CRANFIELD, UK MK430AL BEDFORDSHIRE

Ship to:
BUILDING 125 CRANFIELD UNIVERSITY CRANFIELD, UK MK430AL BEDFORDSHIRE

Customer ID	Customer PO	Payment Terms	
GRATTON, GUY		Prepaid	
Sales Rep ID	Shipping Method	Ship Date	Due Date
THOMAS, WAYNE	UPS-EXPEDITED	5/18/11	5/18/11

Quantity	Item	Description	Unit Price	Amount
1.00	102C EXPERIMENTAL	EXPERIMENTAL ALUMINUM REPLACEMENT FOR P/N 102C S/N 2400 W/O 78674	1,049.00	1,049.00
Subtotal				1,049.00
Sales Tax				
Freight				174.88
Total Invoice Amount				1,223.88
Payment/Credit Applied				1,223.88
TOTAL				0.00

Check/Credit Memo No: MC025730

Overdue invoices are subject to late charges.

Appendix G – Oil Cooler Ground Test Results (main results on second page)

Test proforma: G-BRZK – Stinson S108-2, for testing of new oil cooler.

Test carried out by R. DAVEY at Wycombe Air Park on 21/6/11 (date)

Time of engine start: <u>1600</u>	Time of shutdown: <u>1605</u>	Outside Air Temperature: <u>18 °C</u> °F	Wind: <u>235 ° 15</u> kn
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Part 1 – low power (ground idle or taxiing power only), minimum 10 minutes

Time (mins)	RPM	CHT (°F)	Oil Temp (°F)	Notes
0	<u>0</u>	<u>OFF SCALE</u>	<u>60</u>	
1	<u>1100</u>	<u>160</u>	<u>60</u>	
2	<u>1100</u>	<u>225</u>	<u>70</u>	
3	<u>1000</u>	<u>240</u>	<u>80</u>	
4	<u>1100</u>	<u>250</u>	<u>110</u>	
5				
6				
7				
8				
9				
10				
11				
12				

Part 2 – max 30 seconds at full throttle, aircraft chocked, into wind, parking brake on, mixture rich.

Max RPM	CHT (°F)	Oil Temp (°F)	Notes

Part 3 – aircraft chocked, into wind, parking brake on, mixture as required, 1600rpm, minimum 5 minutes (compass heading: _____°)

Time (mins)	RPM	CHT (°F)	Oil Temp (°F)	Notes
0				
1				
2				
3				
4				
5				
6				
7				

Part 3 – aircraft returned and shut-down

Any observations? INITIAL RUN TO CHECK FOR LEAKS/PROBLEMS

This is certified a true record of the test:

Signed: R. Davey Name: ROBERT DAVEY Licence No(s): UK/PP1362720/A

Test proforma: G-BRZK – Stinson S108-2, for testing of new oil cooler.

Test carried out by R. DAVEY at Wycombe Air Park on 21/6/11 (date)

Time of engine start: <u>1615</u>	Time of shutdown: <u>1638</u>	Outside Air Temperature: <u>18 °C</u> °F	Wind: <u>235 ° / 15 kn</u>
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Part 1 – low power (ground idle or taxiing power only), minimum 10 minutes

Time (mins)	RPM	CHT (°F)	Oil Temp (°F)	Notes
0	<u>0</u>	<u>140</u>	<u>80</u>	
1	<u>1100</u>	<u>190</u>	<u>95</u>	
2	<u>1100</u>	<u>225</u>	<u>105</u>	
3	<u>1100</u>	<u>250</u>	<u>110</u>	
4	<u>1100</u>	<u>260</u>	<u>120</u>	
5	<u>1100</u>	<u>265</u>	<u>120</u>	
6	<u>1400</u>	<u>260</u>	<u>105</u>	
7	<u>1100</u>	<u>270</u>	<u>105</u>	
8	<u>1500</u>	<u>280</u>	<u>120</u>	
9	<u>1500</u>	<u>290</u>	<u>120</u>	
10	<u>1200</u>	<u>290</u>	<u>120</u>	
11	<u>1200</u>	<u>290</u>	<u>120</u>	
12	<u>1260</u>	<u>290</u>	<u>120</u>	

Part 2 – max 30 seconds at full throttle, aircraft chocked, into wind, parking brake on, mixture rich.

Max RPM	CHT (°F)	Oil Temp (°F)	Notes
<u>2300</u>	<u>310</u>	<u>140</u>	

Part 3 – aircraft chocked, into wind, parking brake on, mixture as required, 1600rpm, minimum 5 minutes (compass heading: 230 °)

Time (mins)	RPM	CHT (°F)	Oil Temp (°F)	Notes
0	<u>1600</u>	<u>300</u>	<u>120</u>	
1	<u>1600</u>	<u>300</u>	<u>125</u>	
2	<u>1600</u>	<u>300</u>	<u>125</u>	
3	<u>1600</u>	<u>300</u>	<u>125</u>	
4	<u>1600</u>	<u>300</u>	<u>125</u>	
5	<u>1600</u>	<u>300</u>	<u>130</u>	
6	<u>1600</u>	<u>300</u>	<u>130</u>	
7	<u>1600</u>	<u>300</u>	<u>130</u>	

Part 3 – aircraft returned and shut-down

Any observations?

This is certified a true record of the test:

Signed: RADAVEY Name: ROBERT DAVEY Licence No(s): UK/PP236272D/A

Appendix H - References

- ¹ US Federal Aviation Administration, Aircraft Specification No. A-767, Rev.27 dated 14 Jul 2005
- ² US Civil Aeronautics Board, civil air regulations part 3—airplane airworthiness—normal, utility, acrobatic, and restricted purpose categories as amended to November 1, 1949
- ³ US Federal Aviation Administration, airworthiness standards: normal, utility, acrobatic, and commuter category airplanes, 14 CFR part 23 amended to Jan 1 2010