**SERIOUS INCIDENT**

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| **Aircraft Type and Registration:** | Socata TB10 Tobago, G-RIAM |
| **No & Type of Engines:** | 1 Lycoming O-360-A1AD piston engine |
| **Year of Manufacture:** | 1982 |
| **Date & Time (UTC):** | 27 July 2011 at 1545 hrs |
| **Location:** | Coventry Airport |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 2 Passengers - 2 |
| **Injuries:** | Crew - None Passengers - None |
| **Nature of Damage:** | Smoke and heat damage to windscreen and underneath inspection panel |
| **Commander's Licence:** | Private Pilot's Licence |
| **Commander's Age:** | 21 years |
| **Commander's Flying Experience:** | 86 hours (of which 15 were on type)<br>Last 90 days - 3 hours<br>Last 28 days - 3 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and additional AAIB inquiries |

**Synopsis**

The occupants were on a local flight at 2,500 ft when they noticed smoke entering the cabin around the base of the windscreen. The aircraft diverted into Coventry Airport, with the intensity of the smoke increasing and affecting visibility, and made a safe landing. The smoke was caused by an internal failure in the alternator regulator and one Safety Recommendation is made to the EASA, to review this installation.

**History of the flight**

Whilst cruising at 2,500 ft during a local flight from Leicester, the aircraft occupants noticed smoke entering the cabin from around the base of the windscreen. The pilot handed control of the aircraft to the front seat passenger, who held an Airline Transport Pilot's Licence (ATPL) and who had flown more than 7,000 hours, including 13 on type. A MAYDAY was declared and the new handling pilot decided to divert to Coventry, which the aircraft had just passed. This pilot, having extensive commercial operating experience, carried out the Emergency Checklist items from memory; this document was otherwise not directly referred to during the incident. The actions included turning off the alternator field switch and closing the cabin air vents. The battery master was also turned off but was periodically turned back on to allow radio communication with Coventry Tower. During the descent the smoke increased in intensity and the pilot who had been initially in command opened the 'storm panel' in the left side window. He also briefed the passengers in the rear of the aircraft on the brace position and the evacuation procedure to be followed after landing. By this time the smoke was affecting visibility and causing everyone on board to choke. On the instructions of the handling pilot, he then opened the left-hand door in an attempt to dissipate the smoke and used the aircraft's dry powder fire extinguisher in an attempt to contain the problem.

The aircraft made a rapid descent and landed, safely, at 90 kt. After coming to a halt on the apron the doors were immediately opened and the engine shut down; the aircraft was then vacated.

**The investigation**

Examination of the aircraft revealed that there had been an internal failure of the alternator regulator, with the underside of the casing having sustained visible heat damage (Figure 1). The regulator was located behind the engine compartment firewall and in front of the instrument panel. Access was gained by means of a panel in the nose close to the right side of the windscreen. It was apparent that the smoke had originated from a layer of cabin insulation material that was in close proximity to the regulator. This material exhibited extensive charring, with the smoke having left visible residue on the inside of the windscreen.

When the aircraft was examined by its maintenance organisation, it was noted that the 60 amp alternator circuit breaker had tripped and that the battery had boiled. It was not known if the breaker had tripped during the incident or had been pulled by an unknown person after the aircraft had landed. However the aircraft wiring loom had remained unaffected.

An engineer from the maintenance organisation commented that it was possible that this regulator had been installed on the aircraft at build.

An examination of the regulator was limited as the cavity that contained the internal circuitry had been filled with potting resin at manufacture, a process often used on this type of component. Whilst the resin, after setting, is intended to protect the electronic components against moisture and vibration, it effectively renders them subsequently inaccessible. It was thus not possible to identify the failure mode of the regulator, although the depth of charring that had occurred within the resin was indicative of the high temperatures that had been generated.

**Similar occurrences**

A search of the UK CAA Occurrence Database was conducted, which looked for any similar incidents involving the Socata TB series of aircraft over the last 25 years. Eleven events concerning a variety of electrical problems were listed, with one incident being apparently similar to the subject occurrence. This

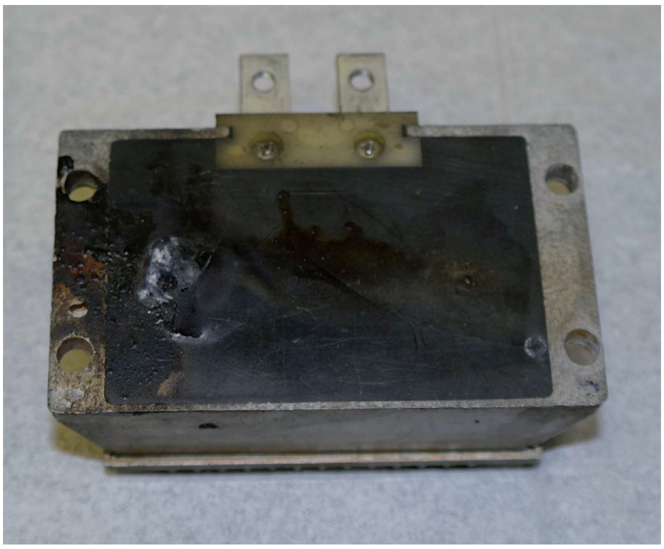

**Figure 1**

View of underside of regulator, showing heat damage occurred to another TB10 on 15 November 1996 and was not investigated by the AAIB. The report stated:

> *'Burning smell in cockpit accompanied by apparent loss of comms. A/c continued to Shoreham & landed without further incident'*

The report narrative concluded as follows:

> *'Investigation found voltage regulator intermittent & relay unserviceable, resulting in cooked battery & failure of both VHF radios.'*

The other listed incidents mostly consisted of battery or alternator failures, with one case of *'poorly regulated power supply'* causing instrument failures. No other incidents involved smoke or fumes.

The subject incident was similar in many respects to one that occurred to a Cessna 172, G-BHDZ, on 28 October 2006, and which was reported in AAIB Bulletin 7/2007. In that case, a failure of the voltage regulator caused the 60 amp alternator circuit breaker to trip. The pilot reset the breaker after he noticed that the radios had failed. However, this resulted in the melting of the brass and copper terminal fittings of the feed wires close to the circuit breaker casing, and associated melting of the insulation of much of the instrument panel wiring. Smoke and flames immediately issued from behind the instrument panel, with the pilot subsequently having to conduct a forced landing.

Examination of the regulator revealed that the failure had left evidence of heat damage on some of the internal components, although the alloy casing appeared unmarked.

**Certification requirements**

A significant difference between the Cessna 172 and TB10 is that the regulator on the Cessna is located in the engine compartment, mounted on the engine firewall. Although this is arguably a harsher environment than that of the TB Series regulators, which are on the cabin side of the firewall, it is at least clear of potentially combustible materials in the event that an internal failure results in the generation of intense heat.

The current European Aviation Safety Agency (EASA) certification standards for this type of equipment are covered by Certification Specification (CS) CS23, which is similar to the Federal Aviation Requirements (FAR) Part 23. The Type Certificate Data Sheet indicated that the TB10 was certificated in November 1975, with the applicable requirements being FAR (Federal Airworthiness Requirements) Part 23, Amendments 1 to 16 dated 14 February 1975.

The current FAA Code of Federal Regulations (CFR), Subpart F – Equipment, Systems and Installations, Section 23.1309 includes the following requirements:

> *'(2) When systems and associated components are considered separately and in relation to other systems;*
>
> *(i) The occurrence of any failure condition that would prevent the continued safe flight and landing of the airplane must be extremely improbable; and*
>
> *(ii) The occurrence of any other failure condition that would significantly reduce the capability of the airplane or the ability of the crew to cope with adverse operating conditions must be improbable.'*

This was last amended in 1996.

However, the version that was in force at the time of type certification was effective from December 1973 and stated:

> *'(a) Each item of equipment, when performing its intended function, may not adversely, affect:*
> *(1) The response, operation, or accuracy of any equipment essential to safe operation; or*
> *(2) The response, operation, or accuracy of any other equipment unless there is a means to inform the pilot of the effect.*
>
> *(b) The equipment, systems, and installations of a multiengine airplane must be designed to prevent hazards to the airplane in the event of a probable malfunction or failure.*
> *(c) The equipment, systems, and installations of a single-engine airplane must be designed to minimize hazards to the airplane in the event of a probable malfunction or failure.'*

The nature of the occurrence to G-RIAM suggests that the regulator installation would not meet the current requirements.

**Checklist information**

The relevant section of the TB10 Emergency Checklist is as follows:

**ELECTRICAL FIRE IN FLIGHT**

*If Fire is in Engine Compartment*

Master Switch........................................................ Off

Cabin Air ............................................... Fire Shut Off

*LAND AS SOON AS POSSIBLE*

*If Fire Is In Cabin*

Master Switch......................................................... Off

Alternator Switch. ................................................. Off

All Electrical Switches (Except Magnetos) ........... Off

Cabin Air ................................................Fire Cut Off

Fire Extinguisher. ................................................ Use

The pilots' accounts suggest that they were confident that all these actions were completed and that they checked the circuit breakers, finding that none had tripped.

**Discussion**

This event occurred following the failure of the alternator regulator, which generated sufficient heat to cause charring in an adjacent layer of cabin insulation. The resulting smoke presented a genuine emergency for the inexperienced pilot, who was fortunately able to hand control of the aircraft to his front seat passenger, an experienced professional pilot. The latter's experience may have contributed to his decisive handling of the emergency, which included expediting the landing at Coventry after the smoke increased in intensity. But for his intervention, the outcome may have been more serious. In order to limit the extent of any fire, it is important to perform the items listed in the Emergency Checklist. Although this document was not referred to during the incident, it was apparent that many of the items were actioned.

Comparison with the Cessna 172 incident suggests that location of the regulator, aft of the firewall, was a significant factor in the G-RIAM event. The regulator in the Cessna failed in a way that similarly generated heat (although this is not necessarily an inevitable consequence of a regulator failure) but its location in the engine compartment did not directly lead to the in-flight fire; that was due to the injudicious resetting of the alternator circuit breaker.

**Safety Recommendation**

Certification requirements are continually evolving; thus the aircraft to which they apply are likely to become increasingly distant from the current standard as long as they remain in service. Generally, it is not a practical proposition to modify such aircraft to later requirements due to the associated cost and perhaps only marginal safety improvements to be gained. In this case however, the regulator failure resulted in a serious threat to the safety of the flight. The following Safety Recommendation is therefore made to the European Aviation Safety Agency:

**Safety Recommendation 2012-022**

It is recommended that the European Aviation Safety Agency review the alternator regulator installation of the SOCATA TB series of single-engine aircraft, with a view to reducing the risk to the operation of the aircraft as a result of smoke/fire arising from a failure of this component.