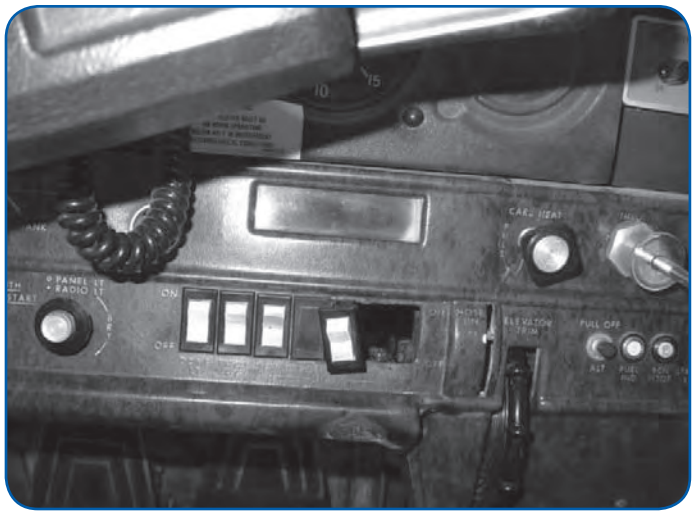
MAINTENANCE AND CERTIFICATION

Smoke in the Cabin—Landing Light Switch Failure

The following occurrence resulted in two aviation safety advisories from the Transportation Safety Board of Canada (TSB).

Background

On September 24, 2007, a Cessna 152 aircraft took off from the Oshawa Municipal Airport, Ont., with the pilot and passenger on board, destined to Kingston, Ont. Just after clearing the control zone, the pilot and passenger noticed an electrical odour and observed a small fire and smoke emanating from the bottom of the left dash panel where the aircraft lighting switches were located. The passenger, sitting in the right front seat, reached for and discharged the fire extinguisher. The fire was quickly extinguished, but the extinguishing agent clouded the cockpit, reducing visibility. The cockpit windows were opened and visibility improved considerably. The aircraft returned to the Oshawa airport and landed without further incident. The pilot suffered a minor burn to his leg when the plastic instrument panel melted and dripped onto his jeans. The TSB issued Final Report A07O0264 on January 14, 2009, regarding this occurrence.



Front of instrument panel

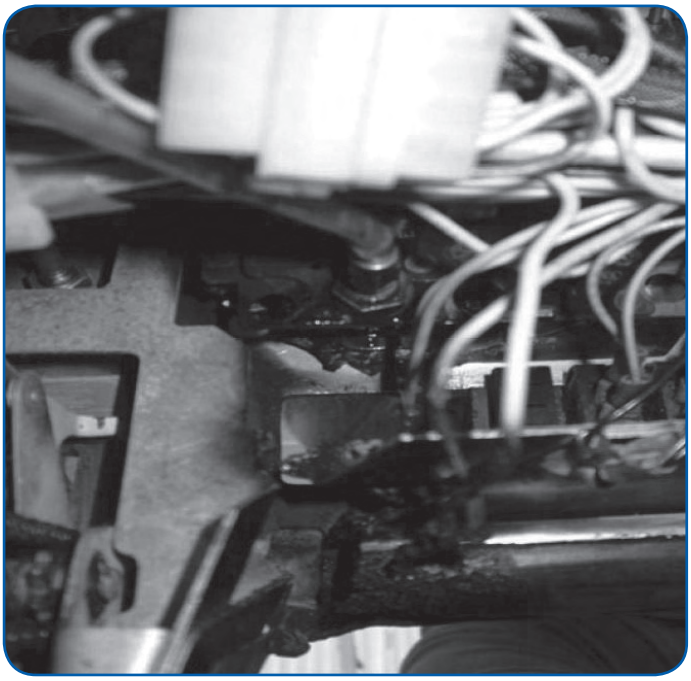
The TSB determined that the landing light switch installed in the occurrence aircraft was beyond its design capability and therefore was unsuitable for the circuit it was controlling. Excessive heat from arcing and oxidization within the switch weakened the switch structure and contact support, allowing the contacts to fall out or be exposed. Arcing from the contacts caused oil residue to flash, which ignited a nearby dust accumulation and started the fire. Combustion was sustained by the plastic instrument panel. The TSB stated that similar landing light switch systems are incorporated on most of the Cessna 100-series aircraft, thereby increasing the likelihood of a similar event. The TSB issued two aviation safety advisories as a result of their investigation.

Advisory No. 1: Landing light switch failure

The landing light electrical circuit is composed of a 15-amp push-to-reset circuit breaker in series with a single pole, single throw rocker switch, which is in series with a 28 VDC 250-watt incandescent lamp. The switch and the circuit breaker are located on the lower instrument panel to the right of and above the pilot's knee when seated in the left-hand seat. The engine oil pressure and temperature gauges are located directly above the landing light switch. The oil pressure gauge is connected to the oil-carrying pressure line, which is directly connected to the engine. This type of circuit and instrument panel layout are common amongst the 100-series Cessna aircraft.

The switch was identified as a rocker-style switch rated at 10A 250VAC, 15A 125VAC, 3/4HP125-250 VAC. No DC ratings were found for this switch. The switch showed evidence of melt damage beginning at the base and progressing upward on both sides. The same damage was evident on the interior of the switch. The switch exterior had a thick coating of dust and an oily residue, which was also found inside the switch. A scanning electron microscope (SEM) and energy dispersive spectroscopy (EDS) analysis of the residue indicated that it might have been engine oil.

The landing light circuit wires remained attached to the contact but showed evidence of fire damage near where the contact enters the switch. The contact was coated with the plastic casing material and when the surface was examined there was evidence of repeated arcing, which had severely eroded the contact's surface. Arcing within the landing light switch could have provided the ignition source necessary for a fire to start. The dust covering evident on the switch and the oil residue provided by possible seepage from the oil pressure gauge line located above the switch may have provided the kindling necessary to start a fire. The oil would consistently reach its flash point when exposed to arcing, and when it was in proximity to the dust it would cause the dust to ignite. A small section of the plastic instrument panel was tested for flammability by introducing a direct flame to the



Rear of instrument panel

plastic. The piece of panel readily ignited and sustained flame. It also produced gases that were quite harsh when inhaled, and without sufficient ventilation may cause some incapacitation to the pilot.

According to the U.S. Federal Aviation Administration (FAA) Advisory Circular 43.13-1B, chapter 11 (pages 11–17), because of the initial current encountered by switches controlling 28 VDC lamp loads (incandescent lamps), the switches should have a derating factor of 8. This aircraft's switch controls a 250-watt lamp in a circuit powered by 28 VDC, and should have a minimum DC current rating of 71 amps. The switch from the aircraft had an AC rating. The Advisory Circular has a warning that reads "**Do not use AC derated switches in DC circuits. AC switches will not carry the same amperage as a DC switch.**" The switch manufacturer was contacted and provided with the landing light circuit and switch information. After evaluating the information, they confirmed that the switch was not designed to handle the lamp loads described.

The circuit breaker was identified as a 15-amp push-to-reset circuit breaker (CB), Cessna part number S1360-15L. The purpose of the CB in the circuit is to protect the circuit wiring, not the components attached to the wiring. The 15-amp thermal-type CB was found to be suitable for the circuit. The CB did not trip after the occurrence but, being the thermal-type of CB, it does not react instantaneously to an over-current condition. This feature is necessary because when the light switch is selected "ON", the initial current can be as high as 15 times its rated load. If the CB were to react instantly to the initial current it would trip every time the switch was selected "ON".

A search of the FAA's service difficulty report (SDR) database by the TSB revealed 23 events similar to this occurrence. The common terms were: smell or smoke in cockpit, landing light switch hot, landing light switch arcing, landing light switch melted, and circuit breaker did not trip.

Due to the number of these aircraft presently in use worldwide, including in flight training schools, the possibility that this type of event may recur on aircraft that have the AC-rated landing light switch installed cannot be discounted. If this type of event were to occur to an inexperienced pilot, or to a student-pilot on a solo flight, the pilot's attention could be diverted from flying the aircraft to focus on extinguishing the fire, with possible dire consequences.

The TSB suggested that Transport Canada (TC), in co-ordination with the FAA and the aircraft manufacturer, may wish to take action to mitigate or eliminate the threat of fire caused by AC-rated switches in the landing light DC circuit of Cessna 152 aircraft.

Advisory No. 2: Smoke-in-cabin emergency procedures

The pilot and passenger followed the emergency procedures for an electrical fire in the cabin, as per the pilot's operating handbook (POH). The procedures were performed from memory only. Acting on their own instincts, they decided to open the two cabin windows to quickly improve visibility and improve air quality in the confined area of the cockpit. Their quick actions were successful and the pilot was able to re-channel his full attention to safely flying the aircraft back to the airport.

Reported cases of smoke in the cockpit abound in various types of general aviation (GA) aircraft worldwide. A pilot's ability to fly the aircraft safely is degraded by the presence of smoke and extinguishing agents in the cockpit. Taking action to remove the smoke and fumes from extinguishing agents would increase visibility and improve the air quality within the aircraft.

To ensure that pilots can quickly eliminate smoke and extinguishing agent fumes from the cockpit, further checklist or procedural items may be required. The TSB therefore suggested that TC, in concert with manufacturers and the regulatory authorities of other countries, may wish to review emergency checklist procedures dealing with smoke and fire on GA aircraft and to include an additional step to eliminate smoke or fumes.

Safety action taken

TC contacted the FAA, the authority for the state of design, requesting their position and possible corrective action. The FAA approached Cessna who developed a corrective action plan.

Landing light switch

The FAA took action to mitigate or eliminate the threat of fire caused by AC-rated switches in the landing light DC circuit of Cessna 152 aircraft. Cessna co-operated with the FAA by issuing Mandatory Service Bulletins MEB09-3 and SEB09-6 dated May 11, 2009, to remove and replace all subject switches used in the landing light as well as the taxi light and rotating beacon circuits in the 100-, 200- and 300-series Cessna models with service life greater than four years. This includes the Cessna 152-series aircraft. These bulletins are to be accomplished within the next 400 hours of operation, or 12 calendar months, whichever comes first. A review of the database shows less than 1 percent of the fleet has been affected by this type of failure. Therefore, the FAA's course of action has been to disseminate the concern by issuing a Special Airworthiness Information Bulletin (SAIB) CE-09-42, which is available at www.faa.gov/aircraft/safety/alerts/SAIB/.

Smoke-in-cabin emergency procedures

The FAA took action by reviewing the emergency checklist procedures dealing with smoke and fire in GA aircraft and including additional steps to eliminate smoke or fumes. The FAA's course of action has been to disseminate this information by issuing SAIB CE-10-04, which is available at www.faa.gov/aircraft/safety/alerts/SAIB/. It recommends that owners and operators check their POH or aircraft flight manual (AFM) and add a statement: "to remove smoke and fumes from the cockpit, do the following…" If such a statement does not exist in their POH or AFM, owners and operators are encouraged to contact the aircraft manufacturer for checklist instructions for the removal of smoke or fumes from the cockpit (e.g. closing or opening heating, air-conditioning, or air vents).

Considering the FAA's issuance of the corresponding SAIB and that Cessna has forwarded the applicable service information to all subscribers of such publications, TC has not taken any additional action at this time.

In closing, TC would like to remind the community that defects, malfunctions and failures occurring on aeronautical products should be reported to Transport Canada, Continuing Airworthiness in accordance with Canadian Aviation Regulation *(CAR) 521 mandatory SDR requirements. These reports will serve as supporting documentation to present to the authority for the state of design or the manufacturer when corrective action is necessary.* △