Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

Vortex Generators and Aerodynamic Configuration Control for Small Single and Twin Engined Aircraft	**AWB** 02-056	**Issue** : 1
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1. Effectivity

All small twin and single engined aeroplanes which have, or are about to have, vortex generators (VG) or other aerodynamic enhancements installed under a Supplementary Type Certificate (STC).

2. Purpose

To advise operators and maintainers regarding possible unsafe conditions, including loss of control (LOC) which may result from one or any combination of the following:

(a) Subtle wing surface defects upstream of the VG array.

(b) Possible unfavourable interaction between unapproved configurations or combinations of aerodynamic performance enhancing STCs.

(c) An incorrectly configured aircraft, including manufacturer's boundary layer control devices, i.e. leading edge stall strips, and engine configuration.

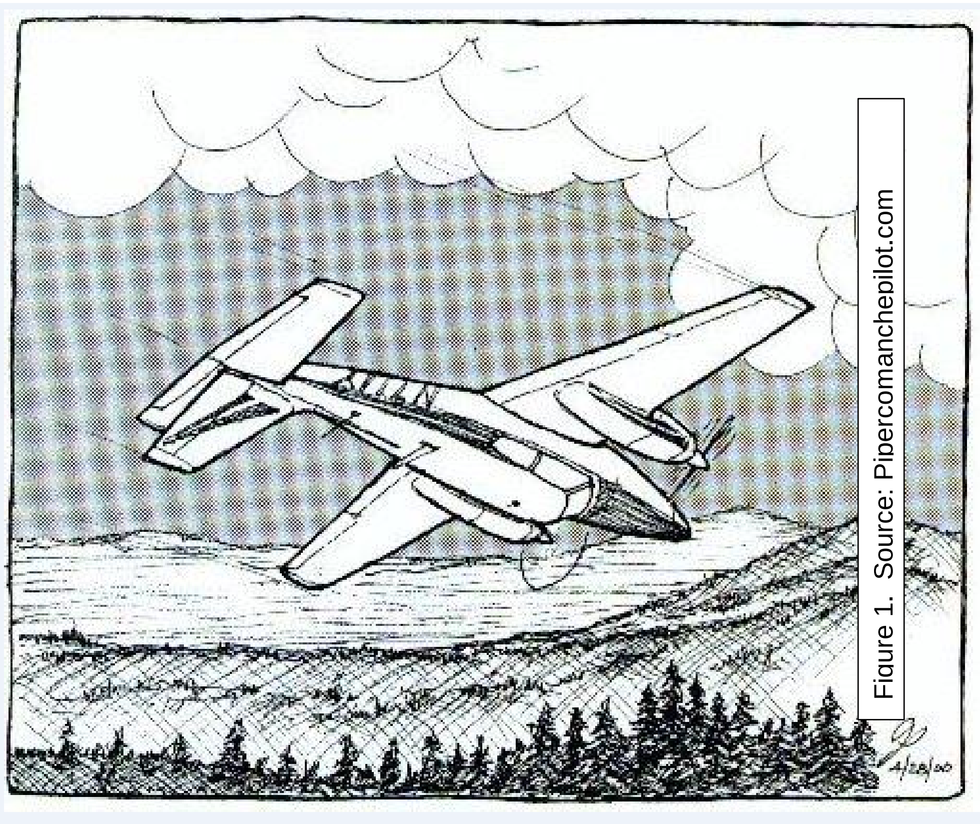

Figure 1. Source: Pipercomanchepilot.com

3. Background

(a) Vortex Generators.

Several STC airflow enhancing kits in the form of vortex generator arrays are available for installation on wings and other flying surfaces of light single and twin engined aeroplanes. Vortex generators essentially direct high energy airflow into the stagnating boundary layer behind them, so that the boundary layer on that surface will tend to remain laminar when approaching high angles of attack, thus delaying stall conditions. A vortex generator installation typically offers the advantages of reduced stall speeds, reduced minimum single engine control speed (Vmc), improved take-off and landing performance and increased maximum take-off weight. The actual gains available and the operating procedures are specified in the STC Flight Manual Supplement.

CASA received a report that an aircraft which had been modified with a wing vortex generator STC had not achieved the reduced stall speeds published in the Flight Manual Supplement and, more importantly, that the stall handling qualities had become degraded, below acceptable limits, including severe wing drop when approaching the stall.

An investigation was made to determine whether this type of modification should continue to be approved and involved flight assessments of other similarly modified aircraft, and consultation with the STC holder and the FAA.

While the investigation revealed there was no problem with any particular wing vortex STC, and that the basic concept was safe, that an unsafe condition can occur when the airflow ahead of the vortex generators becomes turbulent or behaves in an unforeseen manner at the higher angles of attack achievable with vortex generators installed, and before the stalling speed for the aircraft configuration published in the STC has been reached.

It was suspected that the sudden wing-drop had been caused by an old, unused wing de-ice boot with a leak toward the aft section of the lower surface. When this hole had become exposed to the (new) higher angle of attack, it appears that impact air pressure partially inflated the boot, disturbing the airflow ahead of the vortex generator array, and which resulted in asymmetric stall. Such a hole would have previously gone unnoticed at the lower angles of attack during take-off and landing, before the vortex generator STC was installed.

(b) Wing Leading Edge Stall Strips / Wing Fences etc.

Another cause of unanticipated asymmetric wing stalling and LOC events at slow speed operations can be due to subtle changes of the external wing contours following repairs, and/or due to items such as the wing leading edge stall strips being omitted or incorrectly installed. This can happen when the de-ice boots have been removed (which had the stall strips attached) or removing and not re-installing the stall strips following repainting, or an incorrect stall strip configuration. Also refer: AD/CESSNA 150/45 STOL Conversion Wing Stall Fence and AWB 57-009 PA31 Series Wing Leading Edge Stall Strip Configuration. Many different aircraft types and models use stall strips for improved low speed handling and avoid LOC.

While the basic Piper PA31 Series wing leading edge stall strip installation, like most single and twin engined aeroplanes, is specific to each aircraft model and airframe by serial number, some performance enhancing STCs - which may or may not include a vortex generator arrangement - can include wing fences and may require the removal of a specific stall strip and a reduction in the aircraft all up weight (AUW).

Safe low-speed operation of small single and twin-engined aeroplanes is dependent upon having the correct aircraft configuration. This may include a counter-rotating propeller, wing leading edge stall strips, control surface gap seals, vortex generators, etc.

"A Cessna P210 impacts the ground in an aerodynamic spin. Witnesses observed the airplane in a spin and near-vertical trajectory just prior to impact. Post-accident examination revealed the plane's aerodynamic configuration and weight distribution were significantly modified via several supplemental type certificates (STCs)." (Frankenplane! - The hidden dangers of layering STC's. FAA News safety briefing 2014.

It is absolutely essential that there is no conflict between any airflow or aerodynamic performance enhancing STCs and the aircraft manufacturer's configuration, and that the aircraft is operated in accordance with the applicable flight manual supplement.

(c) Continuing Airworthiness of aircraft modified by high lift devices

The aircraft manufacturer's maintenance inspection schedules are designed for unmodified aeroplanes. Those aircraft that have been modified to alter the aircraft design, gross weight or aircraft performance may need to be inspected more frequently, or may even have a reduced fatigue/retirement life. Examples of common STC's not covered by manufacturers maintenance schedules include wing extensions, winglets, speed brakes, short take-off and landing (STOL) conversions, under-wing and wing-tip tanks, and nonstandard engines, as well as vortex generators.

4. Recommendations

Because an aircraft may have wing asymmetries or other aerodynamic configuration problems which may only become evident during flight at slow speeds and the higher angles of attack achievable with vortex generators etc., installed, CASA recommends that:

(a) Devices such as de-ice boots (if installed) are carefully inspected for damage and as a possible source of wing asymmetry.

(b) Any wing or flying surface damage has been carefully and accurately repaired. Check both wings have the same or specified washout (twist) from wing root to tip, for example.

(c) The configuration of any wing leading edge stall strips is strictly in accordance with the manufacturer’s data, or as required by or in conjunction with the applicable STC(s).

(d) Aircraft flight control surface rigging is within the allowable limits for the aircraft configuration

(e) With regard to twin engined aeroplanes, consider adopting the engine configuration which will provide the highest safety margins.

(f) The interaction and possible conflict between various STCs, modifications and aircraft manufacturers Service Letter installation requirements, are carefully assessed and resolved before operating a modified or de-modified aircraft.

(g) The aircraft owner and/or maintenance organisation should contact the STC holder(s) or modification originator to obtain the approved inspection data.

(h) All aircraft configuration irregularities and/or any suggestion of anomalous flight characteristics following a repair or the installation of an STC or approved modification involving any form of aerodynamic or performance enhancement should be carefully and properly investigated by suitably qualified personnel.

5. Reporting

Report all defects in relation to abnormal flight characteristics including those associated with the installation of vortex generators, or aircraft configuration anomalies to CASA via the defect reporting system.

6. Enquiries

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link e-mail address:

AirworthinessBulletin@casa.gov.au

or in writing, to:

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Standards Division
Civil Aviation Safety Authority
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