



# Advisory Circular

**Subject: Amateur-built Aircraft Fuel Systems**

Issuing Office:	Civil Aviation, Standards	Document No.:	AC 549-001
File Classification No.:	Z 5000-34	Issue No.:	01
RDIMS No.:	18923173-V11	Effective Date:	2023-10-01

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## 1.0 Introduction

- (1) This Advisory Circular (AC) is provided for information and guidance purposes. It describes an example of an acceptable means, but not the only means, of demonstrating compliance with regulations and standards. This AC on its own does not change, create, amend or permit deviations from regulatory requirements, nor does it establish minimum standards.

### 1.1 Purpose

- (1) The purpose of this document is to inform builders of amateur-built aircraft of the elements of a safe fuel system. It also serves to inform Transport Canada Civil Aviation (TCCA) inspectors and Minister's Delegates - Recreational Aviation (MD-RA) of considerations related to fuel systems when inspecting an aircraft for the purpose of issuing a Special Certificate of Airworthiness - Amateur-built.

### 1.2 Applicability

- (1) This document applies to all designers and builders of amateur-built aircraft, and to TCCA Inspectors and MD-RAs authorized by the Minister to issue Special Certificates of Airworthiness - Amateur-built.

### 1.3 Description of changes

- (1) Not applicable.

## 2.0 References and requirements

### 2.1 Reference documents

- (1) It is intended that the following reference materials be used in conjunction with this document:
  - (a) *Aeronautics Act* (R.S.C., 1985, c. A-2);
  - (b) Part V Subpart 7 of the *Canadian Aviation Regulations* (CARs) — Flight Authority and Certificate of Noise Compliance;
  - (c) Part V Subpart 49 of the CARs — Amateur-Built Aircraft;
  - (d) Part VI Subpart 5 of the CARs — Aircraft Requirements;
  - (e) Standard 507 of the CARs – Flight Authority and Certificate of Noise Compliance;
  - (f) Chapter 549 of the *Airworthiness Manual* (AWM) – Airworthiness Standards - Amateur-Built Aircraft;
  - (g) Exemption 012-2009 from Section 549.01 of the CARs and Chapter 549 of the AWM – Airworthiness Standards - Amateur-Built Aircraft – dated April 02, 2009; and
  - (h) AC 43.13-1B - Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair, Chapter \* Section 2 Fuel Systems.

### 2.2 Cancelled documents

- (1) By default, it is understood that the publication of a new issue of a document automatically renders any earlier issues of the same document null and void.

## 2.3 Definitions and abbreviations

- (1) The following **definitions** are used in this document:
  - (a) **Amateur:** an individual who engages in an activity on an unpaid, non-commercial basis;
  - (b) **Amateur-built aircraft:** an aircraft, the major portion of which is constructed or assembled individually by an amateur or group of amateurs, as a non-commercial activity and as a unique project, either from raw materials or by completion of a kit;
  - (c) **Builder:** in the context of issue of a Special Certificate of Airworthiness - Amateur-built, the individual or group of individuals who constructs or assembles an amateur-built aircraft, or who oversees the construction or assembly by other persons, of an amateur-built aircraft; excludes commercial entities;
  - (d) **Exemption:** in this advisory circular means the Exemption from Section 549.01 of the *Canadian Aviation Regulations* and Chapter 549 of the Airworthiness Manual – Airworthiness Standards - Amateur-built aircraft, dated April 2, 2009;
  - (e) **Filter Assembly:** a canister or assembly designed for the removal of contaminants from the flow of fuel, accommodating a permeable medium usually serviceable only by replacement;
  - (f) **Fuel strainer:** an assembly that combines a fuel screen, usually serviceable by cleaning, with a water and sediment separator, and a drain; and
  - (g) **Gascolator:** a generic industry term for a part that combines a fuel screen, a water and sediment separator, and a drain.
- (2) The following **abbreviations** are used in this document:
  - (a) **AC:** Advisory Circular;
  - (b) **CARs:** *Canadian Aviation Regulations*;
  - (c) **MD-RA:** Minister's Delegate – Recreational Aviation; and
  - (d) **TCCA:** Transport Canada Civil Aviation.

## 3.0 Background

- (1) As a condition of issue of a Special Certificate of Airworthiness - Amateur-built flight authority, an amateur-built aircraft will be inspected by a TCCA delegate when construction is complete.
- (2) The inspecting delegates, usually Minister's Delegates - Recreational Aircraft (MD-RA), are assigned to amateur-built projects by a company called MD-RA Inspection Services that has a formal agreement with TCCA to administer the amateur-built program.
- (3) When performing inspections, the MD-RA delegate follows guidance provided by TCCA regarding acceptable designs, methods and practices.
- (4) The objectives of the inspections are to verify that the aircraft meets the standards for design and construction of either CAR Standard 549 or TCCA Exemption 012-2009 from Section 549.01 of the CARs and Chapter 549 of the AWM – Airworthiness Standards - Amateur-Built Aircraft, and:
  - (a) to verify the workmanship and general serviceability;
  - (b) to detect apparent and obvious unsafe features; and
  - (c) to provide reasonable confidence of safe operation.

- (5) The builder of an amateur-built aircraft is responsible for the design and construction of the amateur-built aircraft, and will ensure that:
  - (a) the materials and methods of construction of the aircraft are adequate for the purpose;
  - (b) the methods of construction and assembly, and the workmanship, are appropriate to the aircraft design and conform to accepted aviation standard practices; and
  - (c) the materials used are appropriate to the aircraft design and where necessary conform to aviation quality specifications.
- (6) Because each amateur-built aircraft is unique, a design choice that is found to be acceptable in one aircraft will not necessarily be found acceptable in other, similar aircraft in the future.
- (7) A Special Certificate of Airworthiness – Amateur-built flight authority will not be issued to an aircraft that has features that do not provide reasonable confidence of safe operation, or which are apparently and obviously unsafe.
- (8) An abundant supply of clean fuel is fundamental to aircraft engine operation, and safety of flight. The fuel system of an amateur-built aircraft is to be constructed and arranged to ensure an abundant flow of clean fuel at the rate and pressure necessary for proper engine operation in all aircraft ground and flight attitudes and engine power settings. As such, there needs to be means to detect and remove water or contaminated fuel prior to flight.
- (9) Before first flight, the aircraft fuel and vent systems should be functionally tested to ensure adequate fuel is constantly supplied to the engine in all flight attitudes.

#### **4.0 Fuel system**

- (1) The fuel system has four major functional sections;
  - (a) Fuel tank or tanks: to store fuel,
  - (b) Fuel system drains: for removal of water contamination,
  - (c) Fuel lines and hoses: to convey fuel from the tank to engine and return, when necessary
  - (d) Fuel strainer or filter assembly: to remove particulate contaminants.
- (2) Also incorporated in the system should be;
  - (a) A fuel valve to shut off supply to the engine.
  - (b) In accordance with section 605.14 of the Canadian Aviation Regulations, a means for the flight crew, when seated at the flight controls, to determine the fuel quantity in each main fuel tank.
  - (c) An auxiliary pump and a fuel pressure gauge, if the engine requires a fuel pump to operate.

#### **4.1 Fuel tanks**

- (1) Each fuel tank should be able to withstand without failure the vibration, inertia, fluid, and structural loads that it may be subjected to in operation.
- (2) Each fuel storage tank should have a drainable sump that allows for the collection and drainage of any hazardous quantity of water from any part of the tank.
- (3) Each fuel tank or interconnected set of tanks should be reliably vented to prevent formation of a vacuum as fuel is consumed, and to relieve excess pressure.

#### 4.2 Fuel system drains

- (1) At low points of the system where hazardous quantities of water are likely to collect, a drain should be installed.
- (2) Each drain should:
  - (a) Be readily accessible;
  - (b) Operable without the use of tools, or by using only the simple tools typically used for operating fuel drains;
  - (c) discharge clear of all parts of the aircraft;
  - (d) positively lock in the closed position;
  - (e) allow the fuel to be caught to check for water or sediment;
  - (f) be observable for proper closing; and
  - (g) be located or protected to prevent accidental fuel spillage.

#### 4.3 Fuel lines and hoses

- (1) Flexible hoses and rigid lines should be rated by their manufacturer for fuel use.
- (2) Methods of installation should be appropriate for the material used.
- (3) Plastic or other non-metal rigid fuel lines are not normally acceptable in the engine compartment.
- (4) Flexible fuel hoses in the engine compartment should be suitable for the particular application and properly installed.
- (5) Non-metal rigid fuel lines may be acceptable within the fuselage and wings, provided that they are made of an appropriate fuel-resistant material and are properly installed with due attention paid to their environment, including abrasion, impact, puncture and degradation considerations.
- (6) Metal fuel lines should be electrically bonded to the aircraft's metallic structure.
- (7) A hose or line should not pass through a hole in the firewall. Metal fittings, commonly known as "bulkhead fittings", are required.
- (8) Fuel return lines, vent lines, interconnect lines and check or selector valves should be suitable for the application and properly installed.
- (9) Fire sleeves covering fuel and oil lines and hoses within the engine compartment are advisable.
- (10) Fuel lines and hoses should be routed below electrical wires and be protected in areas that may become hot.

#### 4.4 Fuel strainer or filter assembly

- (1) The aircraft should have at least one fuel strainer or filter assembly between the fuel tank outlet(s) and the engine(s).
- (2) A fuel strainer or filter assembly should be:
  - (a) accessible for draining and cleaning;
  - (b) capable of trapping sediment, and be easily serviceable to remove the sediment;
  - (c) mounted so that its weight is not supported by the connecting lines.
- (3) The fuel strainer or filter assembly function should;

- (a) provide a screen or element which is easily removable;
  - (b) be capable of removing contaminants while providing a sufficient flow of clean fuel to the engine;
  - (c) be rated to withstand expected fuel flows and pressures.
- (4) A fuel strainer will normally have an integral water separator with a drain valve, and will be installed at a low point between the tank and the engine.
- (5) If a filter assembly is used instead of a fuel strainer, and the filter vessel does not include a drain or it is not installed at a low point, then the provision of drains at low points of the fuel system, including between the tank and the engine, should be carefully considered to allow checking for and removal of hazardous quantities of water or contaminants.

#### **4.5 Gascolators**

- (1) The recommended and most commonly adopted way of fulfilling the capabilities required of the fuel strainer or filter assembly is to install a single unit commonly known as a “gascolator”.
- (2) “Gascolator” is a generic industry term for a unit that combines a fuel screen, a water and sediment separator, and a drain.
- (3) Gascolators are normally installed at a low point in the fuel plumbing to also serve as a low point drain.
- (4) The Exemption from Section 549.01 of the Canadian Aviation Regulations, Part 3, Para. 26 (J) states that an amateur-built aircraft shall have a “gascolator” located at the lowest point of the fuel system.
- (5) The inclusion of a “gascolator” as part of an aircraft’s fuel system has been repeatedly examined, validated and recommended by TCCA and industry technical working groups.

#### **4.6 Gascolator alternatives**

- (1) In some aircraft designs, installation of a ‘gascolator’ as a unit may not be possible or practical.
- (2) Other means of achieving the necessary capabilities of the Fuel Strainer or Filter Assembly may be employed if, for reasons of practicality, the builder chooses to develop an alternate design that performs the same functions and meets the intent of this guidance.
- (3) The builder of the aircraft should be prepared to demonstrate that whatever means are employed, an adequate supply of filtered fuel, free of water and sediment, to the engine is assured, and that there are sumps and drains that will allow the capture, detection, and removal of contaminated fuel prior to flight, with reasonable ease.
- (4) Readily accessible and serviceable in-line filters of sufficient capacity, together with separate water drains at low points, may be employed.
- (5) Paper filter elements are not acceptable, unless they are rated by their manufacturer for airborne aviation fuel use.

### **5.0 Information management**

- (1) Not applicable.

## 6.0 Document history

- (1) Not applicable.

## 7.0 Contact us

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