



AEROSPACE INFORMATION REPORT

AIR1660™**REV. C**

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Superseding AIR1660B

(R) Fuel Level Control Valves and Systems

RATIONALE

This revision to the Fuel Level Control Valve/System addresses the addition of more valve technologies and the interface of the refuel valves with the refuel system, including the Fuel Quantity Indication System.

1. SCOPE

A fuel level control valve/system controls the quantity of fuel in a tank being filled or emptied on the aircraft. This document provides a general familiarization with these mechanisms (e.g., forms they take, functions, system design considerations). This document provides the aircraft fuel system designer with information about these mechanisms/devices, so that he can prescribe the types of level control valves/systems which are best suited for his particular fuel system configuration.

The scope has been expanded as different aircraft manufacturers may use different type of fuel system architectures. Their refueling and defueling systems may take different configurations, may require different types of fuel control valves and may require different types of interface with the onboard Fuel Measurement System. They must also limit pressure surges and be compatible with ground refueling equipment which have varying surge potentials and create surges.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR1615 Thesaurus for Fuel System Components

AIR5691 Guidance for the Design and Installation of Fuel Quantity Indicating Systems

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Documents

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2.1.2 FAA Publications

14 CFR Part 23, 25, 27, 29 Airworthiness Standards.

2.1.3 EASA Publications

Certification Specifications CS-23, CS-25, CS-27, CS-29

2.2 Definitions

AIR1615 - Thesaurus for Fuel System Components contains many definitions that are applicable to level control valves/systems. The following definitions are those commonly used to describe the design features of level control valves/systems.

OPERATOR - The dynamic element which collects or generates the force required to open and close the flow control mechanism

OVERBALANCE - The ratio of the force (or moment) tending to close the shutoff valve to the force (or moment) tending to open the shutoff valve.

OVERSHOOT - The volume of liquid that passes through the shutoff valve after the shutoff valve has been signaled to close.

SENSING LEVEL - The liquid level at which the sensing element is actuated.

FINAL LEVEL - The liquid level after final closure of the shutoff valve; this level is a function of the liquid surface area versus the liquid height above/below the sensing level. This differs from the sensing level because of the influence of the overshoot of the shutoff valve.

SURGE-PRESSURE RELIEF - A mechanism that prevents propagation of high pressure waves by limiting or absorbing, preferably at or near the event source. Surge pressure suppression can be accomplished by limiting the pressure in the operator chamber of the shutoff valve (usually accomplished by the use of a small, spring-loaded relief valve). When this scheme is used, the shutoff valve will reopen when excessive pressure is introduced at the inlet. Pressure fueling system surge pressure regulatory requirements are defined by CS/14 CFR 23/25/29.979.

SURGE-PRESSURE CONTROL - Avoidance of surge pressure events by controlling the rate of flow orifice change and/or sequencing closure of system valves. This scheme is also called "variable-orifice surge control", and, when this scheme is used, the shutoff valve will remain closed when excessive pressure is introduced at the inlet.

PRECHECK - A feature in level control valves/systems that permits external actuation of the level control valves/systems for checking operation with a non-full tank or for holding the valve closed for some other fuel management consideration.

NEGATIVE-"g" – The reversal of gravitational acceleration effects. It gives similar effects to flying inverted, and is applicable to the complete fuel system, including level sensing devices and brings about a mode change (Level sensing devices using a float element are, by design, orientation-sensitive.)

PILOT LINE - The conduit that connects a hydromechanical shutoff valve to a pilot float valve or a fluidic level-sensor.

PILOT HEAD - The difference in vertical elevation between the elements connected by a pilot line. It is a static head.

DUAL CONTROL/SYSTEM - A level control valve/system that has redundant, parallel/series elements that provide mode control independently (e.g., two float valves in the same package controlling two operators that independently operate a single poppet in the shutoff valve).

FUEL-NO-AIR (AIR-LOCKOUT) - A level control valve/system that closes to the passage of gas and opens to permit the passage of liquid

NON-MODULATING - A level sensing device that provides controlled changes in response to predetermined liquid levels or has built-in hysteresis such that it opens and closes at significantly different liquid levels.

FQIS - Fuel Quantity Indication System (see AIR5691)

FQMS – Fuel Quantity Management System (see AIR5691)

3. TYPES

3.1 Types of Shutoff Valves

Diaphragm Type - The operator is a flexible membrane.

Piston Type - The operator is a piston.

Ball Type – The operator is a rotating sphere with an internal passage the same diameter as the pipe

Tank-Mounted - The valve has one port (inlet or outlet) open to the tank. This port will not accommodate the attachment of a conduit.

Line-Mounted - The valve has inlet and outlet ports both of which can accommodate the attachment of conduits. (Note: this type may be located inside a fuel tank, but it is not a tank-mounted type.)

Normally-Open - This type opens when pressure is applied in the applicable direction. (Note: this type may be closed when at rest with no pressure applied.) The cracking/opening pressure can be specified.

Normally-Closed - This type closes or remains closed when pressure is applied in the applicable direction.

Hydromechanical - Mode control is accomplished by blocking/opening the pilot port(s) or by applying/removing pressure to/from the pilot port(s).

Electromechanical - Mode control is accomplished by introduction/removal of an electric signal.

Plug-In - Refers to types that can be installed/removed into/from tanks or lines without disconnecting the aircraft conduit connections and with minimal leakage from the undrained tanks/lines through the incorporation of self-sealing connections

Integral - The shutoff valve and sensing element are a single, manufactured assembly (i.e., one part number).

Remote - The shutoff valve and sensing element are in individual components (i.e., two or more part numbers). The shutoff valve and sensing element(s) are installed individually, and maybe replaced independently of each other.

3.2 Types of Sensing Elements

Float Valve - A small shutoff valve that gains mode control by submergence or unsubmergence of a float in liquid.

Float Switch - An electric switch that gains mode control by submergence or unsubmergence in liquid.

Fluidic Level-Sensor - A pressure transmitter that transmits pressure when not submerged in a liquid, and does not transmit pressure when submerged in a liquid.

Miscellaneous - Fuel Quantity Management Systems (FQMS) can provide electrical signals at predetermined fuel quantities to control the mode of the shutoff valve. Level sensing can also be provided by an element independent from the FQMS and using various technologies such as:

- Capacitive technology (similar to classic FQIS technology)
- Thermistor-based technology