Federal Aviation Administration

Memorandum

Date: May 1, 2015

To: Manager, Wichita ACO, ACE-115W

From: Manager, Transport Airplane Directorate, ANM-100

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Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for Powerplant Valve Indication on a Cessna Model 680 (S/N 680-0501 and on) and 680A Airplanes, FAA Project # Cessna-072100

ELOS Memo #: Cessna-072100-P-4

Regulatory Ref: 14 CFR 21.21(b)(1) and 25.1141(f)(2)

This memorandum informs the certificate management aircraft certification office of an evaluation made by the Transport Airplane Directorate (TAD) on the establishment of an equivalent level of safety (ELOS) finding for Cessna Model 680 (S/N 680-0501 and on) and 680A airplanes.

Background

Amendment 25-72 of Title 14, Code of Federal Regulations (14 CFR) 25.1141(f)(2) requires power assisted valve controls located in the cockpit to have a means to indicate to the flightcrew when a valve is:

i. in the fully open or fully closed position, or

ii. moving between the fully open and fully closed position.

The aircraft utilizes Run/Stop switches located in the cockpit to control power assisted valves such as the hydromechanical unit (HMU) within the Pratt & Whitney Canada PW306D1 engines. These switches do not provide valve position indications in accordance with the requirement of § 25.1141(f)(2).

Traditionally, Cessna part 25 aircraft full-authority digital engine control (FADEC) engine shutdown commands were initiated by placing the engine thrust lever angle (TLA) into a cutoff

position or selecting the illuminated FIRE button switch. The TLA operated a quadrant mounted switch which provided inputs to the engine FADEC which commanded an engine shutdown.

The aircraft utilizes a shutdown means where engine stoppage is selected by a left hand (LH) or right hand (RH) engine Run/Stop switch that controls the engine HMU.

Power Assisted Valve Operation Description:

During engine operation, multiple valves within the HMU are involved in a normal engine shutdown, fuel flow is physically shutoff to the nozzles by either closing the fuel metering valve (MV) or closing the minimum pressure valve (MPV). The MPV is mechanically operated by fuel pressure and spring force. The cockpit mounted control, a pair of Run/Stop switches, sends engine shutdown signals to the FADEC which commands fuel shutoff in the HMU, closing the MV or the overspeed solenoid valve (OSV).

1. When the MV is commanded fully shut by the FADEC, the metering port is totally sealed off, shutting off fuel flow and shutting the engine down. The MPV will also close as the HMU fuel pressure decreases during the shutdown.
2. The OSV and MPV work together to shutoff fuel. The OSV controls fuel shutoff by biasing fuel to the MPV via an internal HMU fuel circuit. When the OSV diverts fuel, fuel pressure at the MPV drops and the MPV fully closes providing a positive shutoff of fuel flow to the nozzles.

Alternately, the engines can be shutdown utilizing the aircraft fuel system firewall shutoff valves, which are activated by cockpit mounted engine FIRE switches. Each FIRE switch is an illuminated push to operate switch, which when pushed, commands the firewall SOV to close. A closed firewall SOV terminates fuel flow to the HMU which shuts down the engine due to fuel starvation. Operation of the firewall SOV is a non-normal occurrence as it is detrimental to engine components.

In either mode of shutdown operation, the applicable valve position (Open/Closed) or movement to either position is not indicated to the flightcrew.

Applicable regulation(s)

14 CFR 21.21(b)(1) and 25.1141(f)(2)

Regulation(s) requiring an ELOS finding

14 CFR 25.1141(f)(2)

Description of compensating design features or alternative Methods of Compliance (MoC) which allow the granting of the ELOS (including design changes, limitations or equipment needed for equivalency)

During normal engine shutdowns on the ground, the FADEC checks the health status of the overspeed protection system, and periodically checks the HMU MV shutoff capability. If the overspeed shutdown fails to shutdown the engine, the FADEC then closes the HMU MV and posts a fault that will not clear until a subsequent successful shutdown is performed. In both cases an ENG CTRL FAULT CAS message is posted which results in a no dispatch condition. The crew can also shutoff fuel flow to the engine via the firewall shutoff valve by pressing the ENG FIRE switch. When the engine is not running, the MV and OSV default position is closed.

When the engine is running, the MV positioning is dynamic and readily ascertained from engine indications and from engine behavior. Pilot control of the MV is essentially controlled by moving the throttle lever. The engine thrust is directly related to N1 speed. The FADEC calculates the appropriate N1 speed setting corresponding to the TLA position selected. The FADEC then governs to this N1 through the control of the metering valve. If the N1, N1 BUGS, N2, and interstage turbine temperature (ITT) are in the normal range then the metering valve is operating properly. If any of these parameters fall out of normal limits, crew alerting system messages are annunciated, there are associated abnormal engine indication system (EIS) indications, and faults posted. Flightcrew corrective actions are addressed in the Airplane Flight Manual (AFM) procedures.

Explanation of how design features or alternative Methods of Compliance (MoC) provide an equivalent level of safety to the level of safety intended by the regulation

The intent of § 25.1141(f)(2) is to mitigate the potential for the flightcrew to select an inappropriate position for, or be unaware of the position of, powerplant valves that are controlled from the flight deck.

The FADEC's monitoring of the operating condition of valves with the HMU with associated flightcrew procedures, and the ability to operate the aircraft safely without an indication of valve position or movement provide an equivalent level of safety as that established by § 25.1141(f)(2).

FAA approval and documentation of the ELOS finding

The FAA has approved the aforementioned ELOS finding in project issue paper P-4. This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The TAD has assigned a unique ELOS memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS memorandum number must be listed in the Type Certificate Data Sheet under the Certification Basis section. An example of an appropriate statement is provided below.

Equivalent Level of Safety Findings has been made for the following regulation(s):

14 CFR 25.1141(f)(2) Powerplant controls: general

(documented in TAD ELOS Memorandum Cessna-072100-P-4)]

MAY 0 1 2015

Transport Airplane Directorate,
Aircraft Certification Service

Date

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