



U.S. Department
of Transportation
**Federal Aviation
Administration**

Memorandum

Subject: **ACTION:** Review and Concurrence, Equivalent Level of
Safety for Digital N2 and FF on Cessna Model 510,
Project TC3801WI-A ELOS ACE-05-08

Date: April 8, 2005

From: Associate ACO Manager, Mechanical Systems and
Propulsion, Wichita Aircraft Certification Office,
ACE-116W

Reply to James Galstad
Attn. of: 316-946-4135

To: Manager, Small Airplane Directorate Project Support
Office, ACE-112

Reference

SAD Memo dated August 27, 1998, Subject: Information: Small Airplane
Directorate Recommended Format for Equivalent Level of Safety Findings

Background

Cessna has requested an equivalent level of safety for the digital indication of N2
and FF for the Model 510. AC 23.1311-1A specifies the factors to be considered
to obtain an ELOS for digital only Powerplant displays. ELOS's for digital only
N2 and FF indications have been granted for numerous turboprop powered Part 23
and Part 25 airplanes, including the Cessna Models 525, 525A, and 525B.

Cessna concurs with Issue Paper P-2, Subject: Digital Indication of N2 and Fuel
Flow, dated March 14, 2005.

Applicable Regulations

§21.21(b)(1), §23.1305(c)(5) and (c)(2), and §23.1549

Regulations Requiring an ELOS

§23.1305(c)(5) and (c)(2), and §23.1549

Description of Compensating Features

The Cessna Model 510 Citation Mustang incorporates a digital only High-Pressure
Turbine Rotor (N2) indicator required by 14 CFR 23.1305(c)(5). The N2 indicator
is a digital numeric display only. The N2 rotor speed indicator is located on the

left hand side of the Multi-Functional Display (MFD), which is located in the center of the cockpit instrument panel.

The Model 510 engine requires the use of high-pressure rotor speed information for overspeed monitoring only. The Pratt & Whitney Canada PW615F engine utilizes a dual channel Full Authority Digital Electronic Control (FADEC), which automatically schedules fuel flow and ignition during engine starting. Therefore, N2 display is not required during engine starting as was previously needed for hydro-mechanical controlled turbine engine installations. The digital N2 speed display has green numerals against a black background positioned on the LH side of the MFD, which is centrally located in the instrument panel. The limits and usage of this parameter are defined by the PWC, PW615F engine installation manual. The PW615F Engine Installation Manual defines the maximum N2 operating limit of 100.0% N2. There are no cautionary N2 rotor speed ranges defined by the PW615F Engine Installation Manual. The N2 display provides digital readout from 0-120% N2 with a resolution of 0.1%. The digital N2 speed display has green digits against a black background when the N2 speed is less than or equal to the maximum N2 rotor speed of 100%. The digital display changes from green to red when N2 exceeds this value plus the display resolution limit, which meets the intent of 14 CFR 23.1549(a)(b)(c) and (d).

The FADEC engine control system incorporates software logic, which monitors N2 rotor speed and automatically limits fuel flow to the engine if the N2 rotor speed exceeds the maximum limit. This feature will prevent N2 overspeed and is considered a compensating feature.

The location of the N2 display is such that trend or rate of change information can be quickly discerned, including information during engine starting. The location of the N2 speed indicator will be shown by flight test demonstration to meet the requirements for visibility, including appropriate conditions of lighting and panel vibration.

DISPLAY OF ENGINE FUEL FLOW (FF)

The Model 510, Citation Mustang uses electronic displays for the powerplant instrument required by 14 CFR 23.1305(c)(2). The fuel flow indicator is a digital only presentation.

Each engine installation incorporates a Cessna installed, temperature compensated, fuel flow measuring device, which provides the signal for the digital fuel flow display. The digital only fuel flow indication is displayed on the MFD, which is centrally located on the instrument panel. Engine operation fuel flow may be used as a verification of engine control system operation by providing indication of the initiation of fuel flow to the engine during starting (prior to ITT rise), for maintenance or for supplemental fuel consumption information. The Pratt & Whitney Canada PW615F engine installation manual and engine operating manual

do not contain any maximum or minimum operating limits, restricted operating ranges, or specific usage instructions including requirements for trend requirements for fuel flow or fuel flow indication. Therefore, fuel flow is a parameter where limits, trend, or rate of change information are not considered an important requirement.

The display provides a green digital, numeric readout against a black background, with a range from 0 to 1990 PPH (0 to 995 KGH) and a resolution of 10 PPH (5 KGH). The indication is individually displayed for each engine and is identified by a white FUEL label in the normal and compressed display modes above the fuel instrument displays. A white "PPH" label is located between the display indications for each engine. Since no engine-operating limit is defined or required by the Engine Installation Manual or Operating Manual, the digits remain green during operation. If fuel flow information is unavailable to the avionics system due to a system fault, a red X is displayed. Response of the display system is such that fuel flow information is easily discerned for each engine during both transient and steady state operation and, with the logical display location, comparison of engine-to-engine data can be quickly compared.

Explanation of Equivalency

The description of the compensating features above show how the N2 and FF indications are acceptably located. Location and vibration in flight test, and rate-of-change indications are adequate. The proximity to an indicated limit is addressed via FADEC control that prevents operation above the limit for N2 and that there is no limit FF. The side to side left and right indications provide for quick and accurate engine-to-engine data comparison. The compensating features of the combined FADEC control and caution / limit definitions (including lack of need for) show equivalency to forewarning the crew prior to reaching a limit.

ACO Recommendation

The Wichita ACO requests Small Airplane Directorate concurrence with the requested equivalent level of safety.

James M. Peterson
James M. Peterson
Associate ACO Manager
Mechanical Systems & Propulsion, ACE-116W

4/8/05
Date

Concurrence

The Small Airplane Directorate concurs with and grants ELOS ACE-05-08 for the Cessna Model 510.

John Colomy
John R. Colomy
Acting Manager
Standards Office, ACE-110

6/22/05
Date

John Colomy
for Kim Smith
Acting Manager
Small Airplane Directorate

6/23/05
Date