Federal Aviation Administration

Memorandum

Date: August 14, 2014

To: Manager, Aircraft Certification Office, ASW-150

From: Manager, Small Airplane Directorate, ACE-100

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Subject: Extension of Equivalent Level of Safety (ELOS) Finding for SyberJet Aircraft Avionics System Upgrade on Model SJ30-2ASV, FAA Project # AT2244AC-A

ELOS Memo#: ACE-01-02A

Regulatory Ref: 14 CFR 23.1305(c)(2) and (c)(5), 23.1311(a)(6) and (a)(7), and 23.1549

This memorandum informs ASW-150 of an evaluation made by ACE-100 on the establishment of an equivalent level of safety (ELOS) finding for the SyberJet Aircraft (SJA) Model SJ30-2ASV airplane. This ELOS finding pertains to the use of a digital display for engine high-pressure turbine speed (N2) and Fuel Flow required by §§§ 23.1305(c)(2), (c)(5), 23.1311 (a)(6), (a)(7), and 23.1549 for this aircraft.

Background:

SyberJet Aircraft (SJA) has requested an ELOS to §§§ 23.1305(c)(2), (c)(5), 23.1311(a)(6), (a)(7), and 23.1549, as required by 14 CFR 21.21(b), on the SJA Model SJ30-2ASV, which is the Model SJ30-2 with Avionics System Upgrades. This ELOS is an extension of ELOS Memo ACE-01-02, dated April 18, 2001, for the Model SJ30-2 with the original Honeywell Primus EPIC CDS electronic multi-function display system. That ELOS was requested for the use of direct-reading digital only displays for high-pressure turbine speed (N2) and fuel flow. SJA has installed in the Model SJ30-2ASV a Honeywell Apex electronic multi-function display system that also displays engine instruments N2 and fuel flow information in a digital only format, and therefore, they have requested an ELOS for the new airplane model.

Discussion

Turbine engine powered part 23 aircraft are required to have powerplant instruments to display the rotor speed and fuel flow for each engine per § 23.1305(c)(5) and (c)(2), respectively. Section 23.1305, in pertinent part, states:

§ 23.1305 Powerplant Instruments).

> *"(c) For turbine engine-powered airplanes. In addition to the powerplant instruments required by paragraph (a) of this section, the following powerplant instruments are required:*
>
> *(2) A fuel flowmeter indicator for each engine.*
>
> *(5) A tachometer indicator (to indicate the speed of the rotors with established limiting speeds) for each engine."*

Also, § 23.1311(a)(6) and (a)(7) define requirements for electronic display instrument systems, such as those incorporated in the Model SJ30-2ASV, and specifically states:

§ 23.1311 Electronic Display Instrument Systems.

> ***"****(a) Electronic display indicators, including those with features that make isolation and independence between powerplant instrument systems impractical, must:*
>
> *(6) Incorporate sensory cues that provide a quick glance sense of rate and, where appropriate, trend information to the parameter being displayed to the pilot.*
>
> *(7) Incorporate equivalent visual displays of the instrument markings required by §§ 23.1541 through 23.1553, or visual displays that alert the pilot to abnormal operational values or approaches to established limitation values, for each parameter required to be displayed to the pilot."*

Furthermore, these N2 and Fuel Flow instruments are required to have specific markings defining minimum and maximum operating limits and specific operating ranges per § 23.1549, which states:

§ 23.1549 Powerplant and Auxiliary Power Unit Instruments.

> "*For each required powerplant and auxiliary power unit instrument, as appropriate to the type of instruments –*

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;
(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;
(c) Each takeoff and precautionary range must be marked with a yellow arc or a yellow line; and"

Advisory Circular (AC) 23.1311-1C, Installation of Electronic Display in part 23 Airplanes, paragraph 9.4c, defines the specific information that must be addressed to obtain an ELOS for use of digital only displays. These items are presented in the "Description of Compensating Design Features" portion of this memorandum.

In addition, AC 23.1311-1C, paragraph 9.5, indicates that AC 20-88A, Guidelines on the Making of Aircraft, provides alternate methods of marking electronic powerplant displays for which an ELOS may be granted.

It is worth mentioning that several other airplanes have been granted an ELOS for direct reading digital only displays for N2 and fuel flow. Examples that are very similar to the SJA SJ30-2ASV are the original SJ30-2, and the Raytheon Model 390, which is also a part 23 airplane, and uses the same Williams FJ44-2A engine. Other examples include 14 CFR part 25 airplanes such as Cessna Models 550, S550, 552, and 560 (Type Certificate Data Sheet (TCDS) A22CE) and on TCDS T700007WI for Cessna Model 750 airplane. It should be noted that the §§ 23.1549 and 25.1549 regulations are identical.

Applicable Regulation(s):

Sections 21.21(b)(1), 21.261, 23.1305, 23.1311, 23.1321, & 23.1549, National Policy Ref. AC 20-88A, AC 23.1311-1C.

Regulation(s) Requiring an ELOS Finding:

Sections 23.1305(c)(2),(c)(5), 23.1311(a)(6), (a)(7), and 23.1549.

Description of Compensating Features Which Allow the Granting of the ELOS:

AC 23.1311-1C, paragraph 9.4b, notes that in accordance with § 23.1311(a)(6), Amendment 23-62, the electronic display system should have the ability to provide trend or rate-of-change information unless a finding of equivalence is made for direct-reading alphanumeric displays. It also notes that § 23.1311(a)(7), requires incorporated equivalent visual displays of the instrument markings required by §§ 23.1541 through 23.1553, or visual displays that alert the pilot to abnormal operational values, or approaches to established limitation values for each parameter

required to be displayed by this part. AC 23.1311-1C, paragraph 9.4c, lists several compensating factors that should be considered. These factors are listed below with the associated AC 23.1311-1C paragraph number, along with the applicant's position of compensating factors.

Also, AC 23.1311-1C, paragraph 9.5, states that "AC 20-88A provides alternate methods of marking electronic powerplant parameters." A finding of equivalence for other methods of marking the displays can be made on a case-by-case basis. AC 20-88A outlines some factors to be considered for an ELOS, which are contained within the explanation of compensating factors as appropriate.

Explanation of How Design Features Provide an ELOS:

SJA describes compensating factors below to the following AC 23.1311-1C paragraphs, which identify factors for consideration and evaluation on a case-by-case basis and to § 23.1549, which describes powerplant and auxiliary power unit instrument marking requirements.

Paragraph 9.4c(1) states:

> *"The visibility and relative location of the indicated parameter should be reviewed, including the appropriate conditions of lighting and instrument panel vibration."*

SJA Compensating Factors:

Digital N2 and Fuel Flow are presented in a vertical stack of primary engine instruments for both the left and right engine. This is shown in Figure 1 below. This stack is displayed in a window on the upper outboard corner of the Primary Flight Displays (PFDs - pilot and copilot sides). The center of the PFD display is located as close to the center of the pilot's field of view as practical. The outboard location of the engine display permits positioning of attitude, airspeed, altitude, and heading information within the view angle limits defined in AC 23.1311-1C. Locating the powerplant instruments immediately adjacent to the primary flight information provides adequate visibility for the engine instruments. Due to the nature of electronic displays no pointer vibration will occur. Lighting and instrument panel vibration will have no appreciable effect on any of the engine displays.

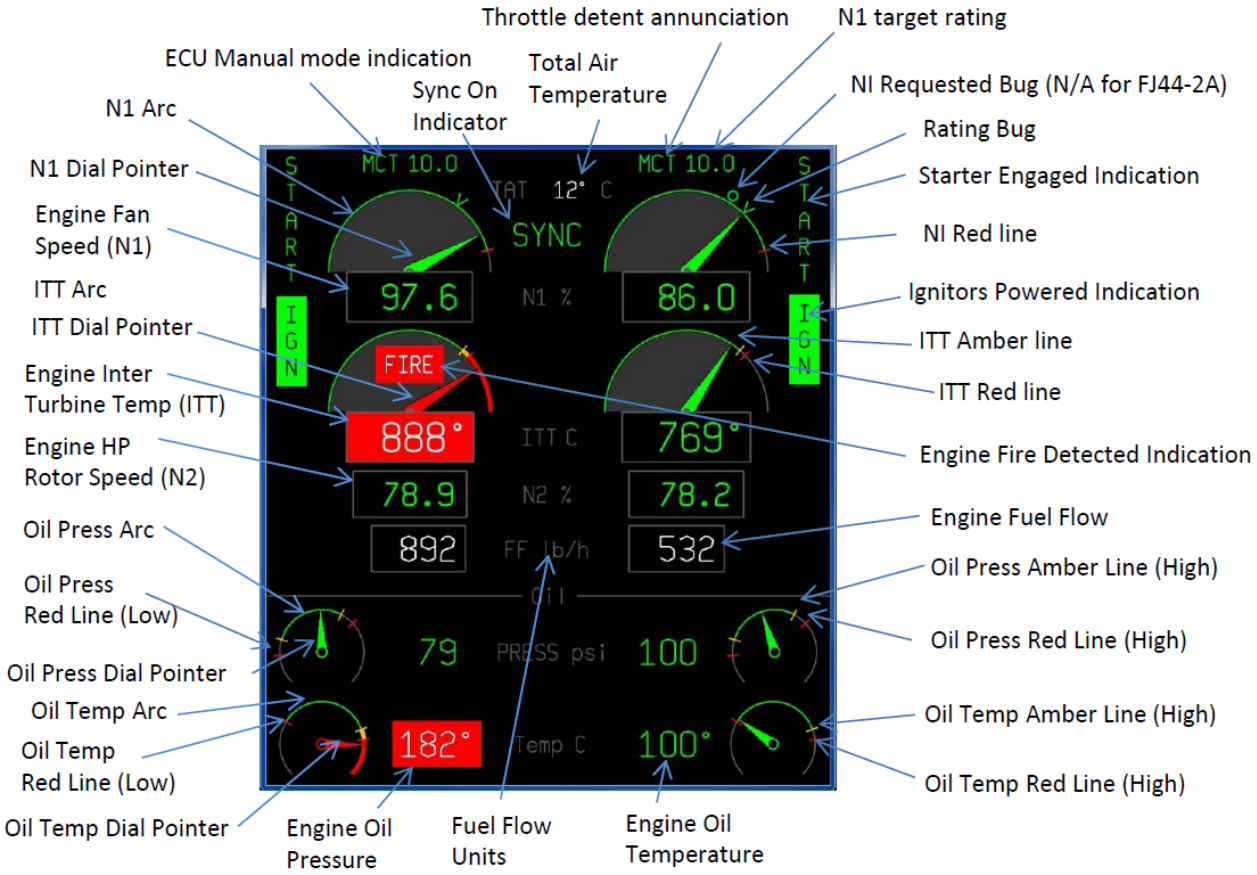

Figure 1 – Primary Flight Display – Engine Indicating System Window

Paragraph 9.4 c(2) states:

> *"The ability to quickly assess necessary trend or rate-of-change information, particularly during in-flight restarts, must be considered."*

SJA Compensating Factors:

N2 is used as a primary parameter only during starts of the Williams FJ44-2A engine. The start procedures outline a range of acceptable N2 values, which are wide enough to allow for variation in assessing N2 rate-of-change information. The only pilot action for the SJ30-2 during engine start that requires assessing N2 is throttle movement from CUTOFF to IDLE. IGN activation/deactivation and starter disengagement is automatically controlled once the throttle is at the idle position and engine start begins. Refer to ELOS Memo ACE-01-02 for engine starting procedures of the Model SJ30-2, which will be unchanged for the Model SJ30-2ASV.

Fuel flow is not required to be monitored during engine starts or other engine operations as specified in ELOS Memo ACE-01-02 for engine starting procedures for the Model SJ30-2, which will remain unchanged for the Model SJ30-2ASV. Fuel flow rate-of-change information also does not provide any safety enhancement during engine starts.

Paragraph 9.4c(3) states:

"The ability to assess how close the indicated parameter is relative to a limit."

SJA Compensating Factors:

Compensating factors for N2 include the fact that the design of the engine is such that the limiting N2 cannot be reached before exceeding the N1 or ITT limits as previously stated in ELOS Memo ACE-01-02. In addition, the critical parameters (N1, ITT) relative to the N2 limit issue have both analog and digital displays as shown in Figure 1.

Also, during engine starts where N2 is a primary parameter, those values will be much less than the N2 limit and thus will not require pilot action based on N2.

An additional compensating feature is that the N2 limit value is a fixed number (98.8%) as listed in the FJ44-2A Operating Instructions and the Model SJ30-2 Airplane Flight Manual (AFM) and does not change due to altitude, temperature, or speed.

Fuel Flow compensating factors include the fact that there are no minimum or maximum limits to Fuel Flow as stated in the Model SJ30-2 AFM and the Williams FJ44-2A Operating Instructions. Therefore, § 23.1549(a) is not applicable to Fuel Flow.

Paragraph 9.4c(4) states:

"For multi-engine aircraft, the value of the crew to quickly and accurately compare engine-to-engine data for multi=engine aircraft."

SJA Compensating Factors:

The design of the SJ30-2 primary engine instrument stack (Figure 1) shows that left and right engine digital parameters are adjacent to each other, allowing for extreme ease in comparison of engine parameters including Fuel Flow and N2.

Paragraph, 9.4c(5) states:

"Engine design features or characteristics that would forewarn the crew prior to the parameters reaching the operating limits (for example, redline)."

SJA Compensating Factors:

N2 compensating factors include the fact that the design of the engine is such that the limiting N2 cannot be reached before exceeding the N1 or ITT limits as previously described in ELOS Memo ACE-01-02. The critical parameters (N1, ITT) have both analog and digital displays as shown in Figure 1.

In addition, when exceeding the N2 redline limits, the N2 digital display changes from a normal indication color "GREEN" to "RED" with blinking reverse video presentation for five seconds. This feature is documented in Section 1.1.3 of SyberJet Aircraft Engine Indicating System Software Requirements Document for the Model SJ30-2ASV.

Fuel Flow compensating factors include that there are no operating limits to Fuel Flow as stated in the Williams FJ44-2A Operating Instructions and the SJ30-2 AFM.

Paragraph 9.4c(6) states:

"The use of color in accordance with § 23.1549 to indicate the state of operation: a green indication would indicate normal operation, a yellow indication would indicate operation in a takeoff or precautionary range, and a red indication would indicate operation outside of the safe operating limits."

SJA Compensating Factors:

The digital N2 display is shown in the color "GREEN" when the value is in the normal range, as are all other engine parameters with assigned minimum or maximum limit values. Fuel Flow, however, is displayed in "WHITE" digits, since there are no limiting values to define a normal range.

Paragraph 9.5.

This paragraph notes that AC 20-88A provides alternate methods of marking electronic powerplant displays. When AC 20-88A is not strictly adhered to, an ELOS or other methods would be required. In regards to 23.1549, (a) through (c) are addressed as follows.

Section 23.1549(a) states:

"Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;"

SJA Compensating Factors:

Compensating factors for digital N2 include those previously outlined in 9.4c(3) and 9.4c(4) such as;

The design of the engine is such that the limiting N2 cannot be reached before exceeding the N1 or ITT limits as stated in ELOS Memo ACE-01-02.

In addition, the digital display changes from a normal indication color "GREEN" to "RED" when exceeding N2 redline limits. This feature is documented in Section 1.1.3

of SyberJet System Software Requirements Document for the Engine Indication System of the Model SJ30-2ASV. This feature meets the criteria specified under AC 20-88A, paragraphs 6(c) and (d).

Fuel Flow compensating factors include the fact that there are no operating limits to Fuel Flow as stated in the Williams FJ44-2A Operating Instructions.

Section 23.1549(b) states:

"Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;"

SJA Compensating Factors:

The digital N2 display is shown in the color "GREEN" when the value is in the normal range, as are all other engine parameters with assigned minimum or maximum limit values. Fuel Flow, however, is displayed in "WHITE" digits, since there are no limiting values to define a normal range.

Compensating factors for this color presentation are addressed in both AC 20-88A and AC 23.1311-1C as follows:

AC 20-88A, Section 6(d) states: "A concept has been developed where normal engine operating conditions are not identified and only abnormal conditions are designated by colored markings. If all abnormal conditions are adequately indicated by specific design features, green markings are unnecessary based on finding of equivalency. Yellow and Red markings used may be subdued until the parameter monitored reaches the caution or warning value. At that time, the respective color is highlighted in some manner to alert the flight crew."

However, SyberJet has elected to use the color "GREEN" to indicate powerplant parameters within a normal operating range, that is more in keeping with § 23.1549(b). Hence, when in the normal operating range, N2 digits are "GREEN" color.

Section 23.1549(c) states:

> *"Each takeoff and precautionary range must be marked with a yellow arc or a yellow line;"*
>
> SJA Compensating Factors:
>
> There is no defined takeoff or precautionary range for N2 or Fuel Flow as listed in the Williams International Operating Instructions and the Model SJ30-2 AFM.

Applicable regulations and guidance material regarding use of digital (direct-reading alphanumeric) displays were reviewed. Specific guidance is contained in AC 20-88A and AC 23.1311-1C.

AC 23.1311-1C, Section 9.4 c, items (1) through (6), and Section 9.5 define the specific factors that should be considered when seeking an ELOS for use of digital only displays. These items have been addressed in the compensating factors discussion above. Therefore, the Model SJ30-2ASV powerplant instrument displays meet the level of safety intended by §§ 23.1305(c)(2), (c)(5), 23.1311(a)(6), (a)(7), and 23.1549**.** As noted in AC 23.1311-1C, use of these alternative methods of compliance require an ELOS finding.

FAA Approval and Documentation of the ELOS Finding:

The Federal Aviation Administration has approved the aforementioned ELOS to §§ 23.1305(c)(2), (c)(5), 23.1311(a)(6), (a)(7), and 23.1549 paragraphs (a) through (c), as required by part 21.21(b) for the SyberJet Model SJ30-2ASV airplane. This memorandum provides standardized documentation of the ELOS finding that is non-proprietary and can be made available to the public. The Small Airplane Directorate has assigned a unique ELOS Memorandum number to facilitate archiving and retrieval of this ELOS. This ELOS Memorandum number should be listed in the Type Certificate Data Sheet (TCDS) under the Certification Basis section for this Amended Type Certificate (ATC). An example of an appropriate statement is provided below.

There have been no unsafe conditions documented to this data that would warrant not issuing this ELOS for this airplane.

ELOS findings has been made for the following regulations of 14 CFR part 23:

> §§ 23.1305, Powerplant instruments, paragraphs (c)(2) and (c)(5); 23.1311, Electronic Display Instrument Systems, paragraphs (a)(6) and (a)(7); and 23.1549, Powerplant and Auxiliary Power Unit Instruments, paragraphs (a) through (c).

(Documented in ELOS Memo ACE-01-02A)

Earl Lawrence — 8-14-14

Earl Lawrence, Manager
Small Airplane Directorate
Aircraft Certification Service

Date

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