Federal Aviation Administration

Memorandum

Date: December 7, 2012

To: Manager, Small Airplane Directorate, ACE-100

From: Manager, Project Support Branch, ACE-112

Prepared by: Doug Rudolph, Aerospace Engineer, Project Support Branch, ACE-112

Subject: Equivalent Level of Safety (ELOS) Finding to HAFEI Aviation Industry Co., Ltd.(HAIC) Y12F, to the Provisions of 14 CFR, part 21, § 21.21(b)(1), part 23, §§ 23.1305(a)(2), (a)(3), (c)(2) and (c)(5), and §§ 23.1549 (a), (b) and (c), Engine Display Requirements

ELOS Memo#: ACE-13-04

Regulatory Ref: 14 CFR, part 21, § 21.21(b)(1), 14 CFR, part 23, §§ 23.1305(a)(2), (a)(3), (c)(2) and (c)(5) at Amendment 23-52 and §§ 23.1549 (a), (b) and (c) at Amendment 23-45.

This memorandum requests your office to review and provide concurrence with the proposed finding of Equivalent Level of Safety (ELOS) to the display requirements of 14 CFR, part 23, §§ 23.1305(a)(2), (a)(3), (c)(2) and (c)(5) at Amendment 23-52, and §§ 23.1549(a), (b) and (c) at Amendment 23-45 for the HAFEI Y12F Model airplane.

Background

HAFEI is requesting an ELOS finding to 14 CFR, part 23, §§ 23.1305(a)(2), (a)(3), (c)(2) and (c)(5), and 23.1549 on the Model Y12F airplane for the digital, numeric-only display of engine speed (NG), propeller speed (NP), fuel flow, oil pressure and oil temperature.

Airplane overview:

The HAFEI Y12F is a non-pressurized, twin engine turbopropeller, 14 CFR part 23 commuter category airplane. The airplane is designed for twocrew and a maximum of 19 passengers with a maximum takeoff weight of 8,400 kg (18,519 lbs). The Y12F is powered by two wing mounted Pratt & Whitney Canada PT6A-65B engines with five bladed Hartzell HC-B5MP-3/M10876AN(K)(S) propellers.

The aircraft is predominantly metallic construction. Composite materials are used for the ailerons, rudder, elevator, cowlings, and doors. The Y12F is a conventionally configured high

wing monoplane with a single vertical fin and retractable tricycle landing gear. The aircraft is multi-piloted and equipped with the Honeywell Primus Apex™ electronic flight instrument system (EFIS).

Apex is a fully-integrated four-screen EFIS that provides the following:

a. Primary flight displays (PFD) (left and right sides).
b. Communication and navigation functions.
c. Map display.
d. Safety systems.
e. Flight configuration displays.
f. Engine instruments.
g. Fuel system instruments.
h. Crew alerting system.

The engine instrument display is located in the upper inboard corner of the PFD and is shown below. For displaying engine parameters, there is not enough room for layout of all engine parameters using graphical arcs, because of the limit of engine parameters page size. So, HAFEI can only design the torque (TRQ) and interstage turbine temperature (ITT) parameters display in manner of using graphical arcs and the other parameters in manner of using digital only, including the engine speed (NG), propeller speed (NP), fuel flow, oil pressure and oil temperature.

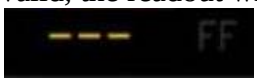
To comply with FAR § 23.1549, HAFEI proposes to use the green color for engine parameters in the normal operating range. Below is a sample of the engine window showing the various engine parameters in green color in the normal operating range.

For engine digital readout, when operating in the normal ranges, the reading is green with black background.

When any of the readings crosses a caution threshold, the corresponding monitors' trip and the readout is showing in black numbers with an amber background. In addition we get an associate amber CAS message.

When any of the readings crosses a warning threshold, the corresponding monitors' trip and the readout is showing in white numbers with a red background. In addition we get an associate red CAS message.

When any of the engine readings go invalid, the readout will be showing as Amber dashes.



When the engine dial readout is invalid, the readout is amber dashed and an amber X is placed over the dial.

Below are samples of the entire engine window showing all the above cases:

Example 1:

Example 2:

Example 3:

HAFEI believes this design which is using green digits to indicate a normal operating condition for all the powerplant parameters in the engine window and using digits instead of graphical arcs, or lines to display the parameters including the engine speed (NG), propeller speed (NP), fuel flow, oil pressure and oil temperature can achieve an equivalent level of safety.

Applicable Regulations

14 CFR, part 21, § 21.21(b)(1)
14 CFR, part 23, §§ 23.1305 and 23.1549

Regulations Requiring an ELOS

14 CFR, part 23, § 23.1305:

The following are required powerplant instruments:

(a)For all airplanes.

…

(2) An oil pressure indicator for each engine.

(3) An oil temperature indicator for each engine.

…

(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.

…

14 CFR, part 23 § 23.1549 at Amendment 23-45 reads as follows:

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

…

Description of Compensating Design Features

For Y12F engine speed (NG), propeller speed (NP), oil pressure and oil temperature parameters the digitals are displayed in color green, when the value displayed is within the normal operating range and changes to amber, when entering the cautionary range(s) before changing to red when the value is at or exceeds the maximum or minimum limit. The color changes forewarn the crew before an operating limit is reached as follows:

NG — The normal (green) range is from greater than 56% to less than 103.5%. The caution range is from 0% to 56% and from 103.5% to 104%. The red range is 104% and greater. Whenever the reading crosses the caution or the red threshold, a corresponding caution and red CAS messages are triggered, thus giving the pilot additional warning.

NP — The normal (green) range is from 0 to 400 RPM and from 901 to 1169 RPM, and from 1401 to 1699 RPM. The caution range is from 401 to 900 RPM and 1170 to 1400 RPM. The red range is 1700 RPM and greater. Whenever the reading

crosses the caution or the red threshold, a corresponding caution and red CAS messages are triggered, thus giving the pilot additional warning.

Oil Pressure The normal (green) range is from 90 psi to 134 psi. The caution range is from 60 psi to 89 psi. The red range is less than 60 psi and greater than 135 psi. Whenever the reading crosses the caution or the red threshold, a corresponding caution and red CAS messages are triggered, thus giving the pilot additional warning.

Oil Temp The normal (green) range is from 10°C to 98°C. The caution range is from -39°C to 9°C. The red range is less than -40°C and greater than 99°C. Whenever the reading crosses the caution or the red threshold, a corresponding caution and red CAS messages are triggered, thus giving the pilot additional warning.

The engine speed (NG), propeller speed (NP), oil pressure and oil temperature readout is showing in green color, when these parameters are in the normal operating range. When any of the readings crosses a warning threshold, the corresponding monitors' trip and the readout is shown in white numbers with a red background and there is an associate red CAS message in the CAS window. In addition, the two master warning lights are flashing in red until acknowledged on the instrument panel on both the pilot and co-pilot sides. When any of the readings crosses a caution threshold, the corresponding monitors' trip and the readout is shown in black numbers with an amber background and there is an associate amber CAS message. In addition the two master caution lights are flashing in amber, until acknowledged on the instrument panel on both the pilot and co-pilot sides.

These features will prevent exceeding critical engine limitations and are considered compensating features. These parameter limitations exceeding warnings given to the pilot provides an equivalent level of safety to § 23.1549(a) and (c), and are therefore in agreement with paragraph 9.4(c) and (e) of Advisory Circular (AC) 23.1311-1B.

The location of these parameters for each engine is such that trend or rate of change information can be quickly and accurately used to compare engine-to-engine data. This location will be shown by flight test demonstration to meet the requirements for visibility including appropriate conditions of lighting and panel vibration. The display is in agreement with the guidance material contained in paragraph 9.4 (b) and (d) of AC 23.1311-1B. The green digits will be verified to be in agreement with the guidance material contained in paragraph 9.4(a) of AC 23.1311-1B and meet the intent of a green arc or green radial required by § 23.1549(b), thus an equivalent of safety to § 23.1549(b) can be shown.

The Y12F engine installation has no restrictions because of excessive vibration stresses. Therefore, an equivalent level of safety is not required for § 23.1549(d).

For Y12F fuel flow digital only numeric indication is displayed in color green within the whole operating range from 0 to 300 kg/H. Any reading less than 30 Kg/H will be shown as 0 and any reading above 300 Kg/H will be shown as 300. In the event of a failure, the reading will display amber dashes.

For Y12F engine there is no maximum or minimum operating limits, restricted operating ranges, or specific usage instructions including trend requirements for fuel flow or fuel flow indication. Therefore, fuel flow is a parameter where limits, trend, or rate-of-change information may not be considered an important requirement.

Since no engine operating limit is defined or required, the digits remain green during operation. Response of the digital 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. The fuel flow display location will be shown by flight test demonstration to meet the requirements for visibility including appropriate conditions of lighting and panel vibration. Because no redline or red radials are required, an ELOS to § 23.1549(a), is not required and paragraph 9.4 (c) & (e) of AC 23.1311-1B do not apply. The display design features are in agreement with paragraph 9.4 (b) and (d) of AC 23.1311-1B.

The green digits will be verified to be in agreement with the guidance material contained in paragraph 9.4(a) of AC 23.1311-1B, and meet the intent of a green arc, or green radial required by § 23.1549(b), thus an ELOS to § 23.1549(b) can be shown.

As previously stated, no takeoff or precautionary range for fuel flow is required by the engine operating instructions, or by the installation of the engine in the aircraft. Therefore, § 23.1549(c) does not apply.

In addition to the above compensation features for § 23.1549 (a) – (c), the system also shows equivalency for 14 CFR, part 23, §§ 23.1305(a)(2), (a)(3), (c)(2) and (c)(5) at Amendment 23-52.

The Civil Aviation Administration of China (CAAC) agrees with HAFEI's analysis and believes this meets requirements for an ELOS for the above listed regulations. This was documented in FAA Issue Paper S-13 at Stage 4.

Explanation of Compensating Design Features

Digital Engine Speed (NG)

Regulation: § 23.1305(c)(5)

Explanation of ELOS

The trend information of the indicator required by the regulation can be equivalently provided by the change in digital value, and the change in digit color of the digital only indication. This also includes the rate of change information for engine speed for this airplane. This has been evaluated during flight testing and found to be acceptable.

Digital Propeller Speed (NP)

Regulation: § 23.1305(c)(5)

Explanation of ELOS

The trend information of the indicator required by the regulation can be equivalently provided by the change in digital value, and the change in digit color of the digital only indication. This also includes the rate of change information for propeller RPM for this airplane. This has been evaluated during flight testing and found to be acceptable.

Digital Fuel Flow

Regulation: § 23.1305(c)(2)

Explanation of ELOS

The fuel flow parameter does not have a cautionary range or high or low limit values defined by the engine manufacturer. Therefore, no caution or limit markings are required, and there is no associated pilot action. As a result, the limited rate-of-change and trend information available from the changing green digital display is adequate and the available trend information is equivalent to that required of the analog indicator. This has been evaluated during flight testing and found to be acceptable.

Digital Oil Pressure

Regulation: § 23.1305(a)(2)

Explanation of ELOS

The trend information of the indicator required by the regulation can be equivalently provided by the change in digital value, and the change in digit color of the digital only indication. This also includes the rate of change information for oil pressure for this airplane. This has been evaluated during flight testing and found to be acceptable.

Digital Oil Temperature

Regulation: § 23.1305(a)(3)

Explanation of ELOS

The trend information of the indicator required by the regulation can be equivalently provided by the change in digital value, and the change in digit color of the digital only indication. This also includes the rate of change information for oil temperature for this airplane. This has been evaluated during flight testing and found to be acceptable.

After reviewing the submitted data and analysis for this project, the FAA believes the applicant can demonstrate an equivalent level of safety to 14 CFR, part 23, §§ 23.1305(a)(2), (a)(3), (c)(2)

and (c)(5), and §§ 23.1549(a), (b) and (c) for the digital, numeric-only display of the following engine parameters: engine speed (NG), propeller speed (NP), fuel flow, oil pressure and oil temperature.

The basis of this ELOS Memorandum was developed from the FAA Issue Paper S-13 at Stage 4, which documented the agreement with the CAAC and HAFEI.

In addition, this Apex system has been previously approved in other part 23 airplanes with this system and has shown no unsafe conditions.

FAA Approval of the ELOS Finding

The Small Airplane Directorate concurs with the requested ELOS for the HAFEI Y12F Model airplane finding to 14 CFR, part 23, §§ 23.1305(a)(2), (a)(3), (c)(2) and (c)(5), and §§ 23.1549(a), (b) and (c) for the digital, numeric-only display of engine speed (NG), propeller speed (NG), fuel flow, oil pressure and oil temperature.

Earl Lawrence	*12-7-12*
Manager, Small Airplane Directorate, Aircraft Certification Service	Date

ELOS Originated by ACE-112	Manager, Project Support, William Timberlake	Routing Symbol: ACE-112