



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

Memorandum

Subject: ACTION: Equivalent Level of Safety, Beechcraft E33, FAR
23.1545, Monochromatic Airspeed Data; ACE-98-5

Date: NOV 27 1998

From: Manager, Special Certification Office, ASW-190

Reply to
Attn. of: Aaron Cornelius
(817) 222-4637

To: Manager, Small Aircraft Directorate, ACE-100
THRU: Manager, Standards Office, ACE-110

This memorandum requests your office to review and provide concurrence to the proposed findings of equivalent level of safety to the airspeed indicator requirements of FAR 23.1545.

Background:

This project will install a Model 600 Head-Up-Display (HUD) System on a Model Raytheon/Beech BE-33 aircraft which the applicant makes reference to as a general aviation type HUD. The HUD will provide basic navigation information which provides guidance equivalent to existing standard navigational instruments in the cockpit.

Applicable Regulation:

FAR 23.1545 entitled, Airspeed indicator, states:

- (a) Each airspeed indicator must be marked as specified in paragraph (b) of this section, with marks located at the corresponding indicated airspeeds.
- (b) The following markings must be made:
 - (1) For the never-exceed speed, V_{ne} , a radial red line.
 - (2) For the caution range, a yellow arc extending from the red line specified in paragraph (b)(1) of this section to the upper limit of green arc specified in paragraph (b)(3) of this section.
 - (3) For the normal operating range, a green arc with the lower limit at V_{s1} with maximum weight and with landing gear and wing flaps retracted, and the upper limit at the maximum structural cruising speed V_{no} established under FAR 23.1505(b).
 - (4) For the flap operating range, a white arc with lower limit at V_{so} at the maximum weight, and the upper limit at the flaps-extended speed V_{fe} established under FAR 23.1511.

Applicant Position:

Compliance with the mentioned FAR is not possible; the Model 600 HUD will use a monochromatic display. As a result, it will not be possible to comply with the requirements of FAR 23.1545.

The HUDs offer several advantages considered as safety benefits over conventional instruments:

Reduced pilot workload - Pilot workload is reduced when the overall piloting tasks require head-up, outside-the-cockpit flight reference.

Increased flight precision - The expanded flight data format allows the pilot to fly instrument tasks more precisely. The overlay of HUD-presented flight data on the external visual scene allows the pilot to fly visual tasks more precisely.

Direct visualization of trajectory - A conformal display allows the pilot to directly assess aircraft performance relative to the real world.

Increased flight safety - Essential flight information on the HUD reduces eyes-in-the-cockpit during flight in congested traffic patterns.

Rationale for deviation: Since the standard airspeed indicator will be retained, an equivalent level of safety will be maintained. Several features are being incorporated to promote airspeed awareness. These include adding high and low speed awareness arcs that grow in length as the airspeed approaches either high or low speed limits; an airspeed deviation cue (speed worm) to show deviation from optimum approach speed during landing approaches, and a discrete "FAST" or "SLOW" message as appropriate.

There are several civil HUDs FAA certified which display monochromatic airspeed. They are Flight Dynamics HGS-1000, Sundstrand MD-80 HUD, JET Model 9000 HUD, and Flight Visions Model FV-2000 HUD. There is no record of any reported incidents or accidents involving these airplanes related to the airspeed display.

Crew Systems feels that the absence of any reported problems, incidents, or accidents related to the monochromatic airspeed presentation is significant in support of this request for an equivalency. If necessary, cockpit and flight evaluation of the HUD heading arrangement can be included during certification flight tests of the Model 600.

An early consideration on this equivalent level of safety determination is requested.

FAA Position:

The proposed design implementation will provide awareness cues, speed arcs, deviation cue, and discrete messages to meet the FAR 23.1545 objectives. These design features promote flight safety. Additionally consider that the normal airspeed instruments will remain in the cockpit. The design should apply sectional arcs to cue the pilot for aircraft design limit speeds as follows:

$V_{nc}(\max)$ to V_{no} up to maximum speed, add arc symbol to denote approaching never-to-exceed speed.

$V_{no}(\max)$ to V_{s1} for cruise conditions, add arc symbol to denote approaching maximum speed for flaps.

$V_{fc}(\max)$ to V_{s0} for flap operations, add arc symbol to denote approaching stall speed.

There may be a possibility to initiate a flashing indication of the arc symbol when approaching critical flight speeds that could have adverse effects, if not corrected. Flight manuals should emphasize that normal airspeed instruments should always be used to verify HUD presentations. Also the flight manuals should ensure that the normal instruments are in working order to preclude using the HUD as a primary display.

Compensating Features:

- a. The implementation of the awareness cues, and speed cues.
- b. The discrete messages which appear to alert pilot of pertinent speed conditions.
- c. The existing airspeed indicator in the aircraft.

Recommendation:

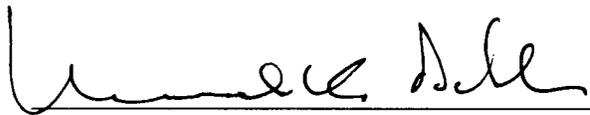
We concur with the applicant's position that the design proposal will provide an equivalent level of safety as envisioned in the regulations and thus meets the requirements of FAR 23.1545(a)(b).

Concurred by:



Manager, Special Certification Office, ASW-190

11-27-98
Date



Manager, Standards Office, ACE-110

2/19/99
Date



Manager, Small Airplane Directorate, ACE-100

2/19/99
Date