U.S. Department of Transportation
Federal Aviation Administration

Policy Statement

Subject: Replacement of Vacuum Driven Attitude Indicators in 14 CFR, Part 23/CAR 3 Airplanes

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Initiated By: ACE-114

Summary

This policy statement describes acceptable compliance methods for replacing vacuum-driven attitude instruments with electronically-driven replacement indicators. Electronically-driven attitude indicators include indicators that use electrical power to (1) excite an internal gyro, or (2) replace the operation of the gyro with microelectronics. Electronically-driven attitude indicators may replace the existing attitude indicators used in VFR or IFR airplanes.

Definition of Key Terms

Attachment 1 explains the specific meaning of the terms "must," "should," and "recommend" used in this policy statement.

Current Regulatory and Advisory Material

The regulation applicable to the subject is Title 14 of the Code of Federal Regulations (14 CFR) 23.1311. Section 23.1311 describes the regulatory basis for installation of the subject in part 23 and Civil Air Regulation, part 3 (CAR 3) airplanes.

The following Advisory Circulars (ACs) also apply:

- AC 23.1311-1C, *Installation of Electronic Display in Part 23 Airplanes*.
- AC 23-17C, *Systems and Equipment Guide for Certification of Part 23 Airplanes and Airships*.

Background

Current part 23 regulations require electronic displays to have independent sources of altitude, airspeed, and attitude instrumentation to comply with § 23.1311. Section 23.1311 addressed concerns related to in-service reliability of Primary Flight Displays (PFDs) first introduced into part 23 aircraft. The intent of the instrument independence requirement in § 23.1311 was to allow the pilot to have the ability to continue safe flight and landing if the integrated displays fail. However, § 23.1311 has an unintended consequence as a barrier to the installation of electronically-driven attitude indicators that are a direct replacement for vacuum-driven attitude indicators. These indicators referred to in § 23.1311 are often incorrectly classified as Electronic Flight Instrument Systems (EFIS) because they combine other functions with basic display of attitude.

The cost of maintaining vacuum-driven systems in legacy CAR 3 and part 23 aircraft has reached a point where owners and operators prefer to replace their vacuum-driven attitude indicators with newer electronically-driven attitude indicators that fit in the existing instrument panel hole. This is largely due to diminishing parts availability and the frequency of failure. Section § 23.1311 requires the addition of a stand-by attitude indicator when installing electronic display instrument systems. Additionally, the language in the rule allows the replacement of vacuum-driven indicators with electronically-driven attitude indicators without the need of a standby attitude instrument, and these electronically-driven attitude indicators are often a form-fit-function replacement for older vacuum-driven attitude indicators that may be less reliable and more expensive to maintain.

The intent of the Aircraft Certification Service is to improve general aviation safety. There is data showing that the mean time between failures of traditional vacuum-driven attitude indicators is only a few hundred hours. There is also data showing that the mean time between failures of modern electronically-driven attitude indicators may be substantially higher, making them more reliable. This policy allows the direct replacement of vacuum-driven attitude indicators with electronically-driven attitude indicators, and provides relief in very specific situations (such as the installation of an EFIS system) from having to install an independent standby attitude instrument required by § 23.1311.

Relevant Past Practice

The FAA's Safer Skies initiative from 2001 identified vacuum system failures as a significant cause or contributor to fatal accidents in instrument metrological conditions (IMC). The study showed vacuum systems have a high failure rate and the failures tend to be insidious because they degrade slowly, making the potential for failure difficult to recognize. Additionally, data indicates that pilots may not have the proficiency to safely recover and land the airplane, in spite of instrument-rated pilots receiving partial-panel training.

The most common failure mode for a gyro indicator is a failed bearing. In vacuum indicators, the primary cause for failure is bearing contamination due to a dirty air supply. The pump can fail around 500 hours necessitating an overhaul of the instrument. Electronically-driven attitude indicators eliminate this type of failure. In addition, they provide more precise attitude

indication, greater internal error-checking ability, and internal redundancy, improving functionality over vacuum driven attitude systems.

Policy

For part 23/CAR 3 aircraft under 6,000 pounds with vacuum-driven attitude instruments, it is acceptable to replace vacuum-driven attitude instruments with electronically-driven attitude indicators under the following conditions:

1. A single function vacuum-driven attitude indicator may be replaced with a single primary function electronically-driven attitude indicator. A single function vacuum-driven attitude indicator may also be replaced with an electronically-driven attitude indicator that provides a secondary (advisory) function (such as turn & slip indication).

2. The electronically-driven attitude indicator has an independent standby battery that is capable of meeting the intent of §23.1331 and § 23.1353(h) to independently power the new instrument in the event of a loss of primary electrical power. It may not be acceptable to use the start battery as a backup power source for the electronically-driven attitude indicator unless its state of charge can be verified at takeoff.

3. The final installation and arrangement must allow for use of partial panel techniques in the event of a loss of the electronically-driven attitude indicator source.

4. Compliance must meet all other applicable regulations (i.e., §§ 23.1381, 23.1331, and 23.1353).

To install an electronically-driven attitude indicator as a minor alteration, the above conditions and the following additional regulations must be met:

1. The electronically-driven attitude indicator must fit into the existing location of the vacuum-driven attitude indicator and be properly set to indicate level flight. The existing airspeed, altitude, and turn/bank indicators must remain in their originally certificated or basic “T” locations. If any additional openings or modifications to the instrument panel are required to install the electronic instrument, the following requirements must be met:

   i. The instrument panel cannot be part of the aircraft primary structure; or

   ii. If the instrument panel is part of the aircraft primary structure, the aircraft manufacturer's instructions must include instrument panel modification instructions.

2. The electronically-driven attitude indicator requires only minor changes to the existing electrical and vacuum connections to the aircraft, per part 43.

3. The electronically-driven attitude indicator must be powered from a new, dedicated circuit breaker (or other appropriate circuit protection device), and it must be powered by a standby (backup) power source.

Effect of Policy

The general policy stated in this document does not constitute a new regulation. Agency employees and their designees and delegations must not depart from this policy statement without appropriate justification and concurrence from the FAA management that issued this policy statement. The authority to deviate from this policy statement is delegated to the Small Airplane Standards Office Manager (ACE-110).

Whenever a proposed method of compliance is outside this established policy, the project aircraft certification office (ACO) must coordinate it with the appropriate directorate using an issue paper. Similarly, if the project ACO becomes aware of reasons that an applicant's proposal that meets this policy should not be approved, the ACO must coordinate its response with the appropriate directorate. Applicants should expect that the certificating officials will consider this information when making findings of compliance relevant to new certificate actions. In addition, as with all guidance material, this statement of policy identifies one means, but not the only means, of compliance.

Implementation

This policy discusses compliance methods that should be applied to Type Certificate, Amended Type Certificate, Supplemental Type Certificate, and Amended Supplemental Type Certification programs. The compliance methods apply to those programs with an application date that is on or after the effective date of the final policy. If the date of application precedes the effective date of the final policy, and the methods of compliance have already been coordinated with and approved by the FAA or its designee, the applicant may choose to either follow the previously acceptable methods of compliance or follow the guidance contained in this policy.

Conclusion

Based on this policy, vacuum-driven attitude indicators can be directly replaced with electronically-driven attitude indicators to enhance small aircraft safety. These alterations can be approved through the Amended Type Certificate, Supplemental Type Certificate, Amended Supplemental Type Certificate, Field Approval (Form 337), or Minor Alteration processes, as appropriate. However, the intent of this policy is to communicate that most replacements can likely be done as minor changes.

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Attachment

Terms

Table A-1 defines the use of key terms in this policy statement and the associated functional impact.

Table A-1 Definition of Key Terms

Subject	Regulatory Requirements	Acceptable Methods of Compliance (MOC)	Recommendations
Language	Must	Should	Recommend
Meaning	Refers to a regulatory requirement that is mandatory for design approval	Refers to instructions for a particular MOC	Refers to a recommended practice that is optional
Functional Impact	No Design Approval if not met	Alternative MOC has to be approved by issue paper.	None, because it is optional