



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

Advisory Circular

Subject: ATTITUDE INDICATOR

Date: 6/25/03

AC No.: 91-75

Initiated By: AFS-400

Change:

1. PURPOSE. The purpose of this advisory circular (AC) is to provide a method to substitute an approved attitude indicator for the rate-of-turn indicator mandated by Title 14 of the Code of Federal Regulations (14 CFR) part 91, section 91.205(d)(3). This AC excludes airplanes covered by section 91.205(d)(3)(i) and (ii). This AC is applicable to part 23-certificated airplanes (or airplanes certificated under earlier equivalent regulations) that weigh less than 12,500 pounds and are operated under part 91. Like all advisory material, this AC is not in itself mandatory and does not constitute a regulation. One may follow an alternate FAA-approved method. Mandatory words such as “shall” or “must” apply only to those who seek to demonstrate compliance to a specific rule by use of a method prescribed in this AC without deviation.

2. RELATED READING MATERIALS.

- a.** Sections 23.1303(f), 23.1331(b), and 91.205(a) and (d).
- b.** AC 23-17A, Systems and Equipment Guide for Certification of Part 23 Airplanes, section 23.1331.
- c.** TSO-C4c, Bank and Pitch Instruments. This document may be ordered from: The U.S. Department of Transportation, Subsequent Distribution Center, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785.
- d.** SAE AS396B, Bank and Pitch Instruments (Indicating Stabilized Type) (Gyroscopic Horizon, Attitude Gyro). This document may be ordered from: SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.
- e.** Safer Skies, Weather Joint Safety Implementation Team Final Report, Intervention 2-2b, March 2000.

3. BACKGROUND.

a. Section 91.205(a) requires “instruments and equipment ... or FAA-approved equivalents...” A Safer Skies initiative recommendation authored by the Federal Aviation Administration (FAA) and industry highlighted vacuum system failures as a significant cause or contributor to fatal accidents in instrument meteorological conditions (IMC). Additionally, the FAA and the Aircraft Owners and Pilots Association (AOPA) have conducted research to further analyze the potential hazards of partial panel operations in IMC. The FAA’s Civil Aeromedical Institute conducted simulations studying pilot responses to vacuum system failures. These studies included pilots with varying experience levels in both high-performance and low-performance aircraft. AOPA’s Air Safety Foundation conducted parallel flight studies in a Piper Archer and a Beech Bonanza.

b. Those studies showed that a vacuum system or gyro failure is insidious because the gyro fails slowly, making the failure difficult to recognize. Data indicates that pilots may not have the proficiency to safely recover and land the airplane, even though instrument-rated pilots receive partial panel training. This is particularly true in high-performance airplanes.

4. DISCUSSION.

a. The attitude indicator is centrally located in the pilot’s primary field of view. It provides easily interpreted pitch and bank information in one instrument. For this reason, most pilots tend to rely heavily on the attitude indicator in IMC to maintain aircraft control. Most small general aviation airplanes typically have an attitude and heading indicator powered by a single vacuum source. These airplanes normally do not have redundant vacuum systems or a second attitude indicator. Therefore, to recognize that a failure condition exists and isolate which instrument has failed, the pilot must cross-check other instruments that indicate pitch or bank information.

NOTE: Standby vacuum pumps and attitude indicators with failure warning flags are available in newer model aircraft and are slowly making their way into the general aviation fleet as retrofits. Many of the newly manufactured aircraft intended for use in IMC are being delivered with these systems. Additionally, some new aircraft only have electric gyro instruments and are equipped with redundant, independent electrical power sources. The systems described above offer mitigation to the risk of pilots being misled by a failed attitude indicator.

b. The rate-of-turn indicator (either a turn coordinator or turn and bank indicator) is used to cross-check the attitude indicator and directional gyro for bank information. Turn coordinators also include a failure warning flag that provides an indication if the gyro power source is lost. The rate-of-turn indicator typically has an independent power source to provide redundancy for the attitude indicator and directional gyro. However, the rate-of-turn indicator only provides information that the aircraft is in a turn and whether the turn is at the standard rate (a standard rate turn is 3 degrees per second, or 2 minutes for a full 360-degree circle). It does not provide information on the bank angle.

c. A disagreement between the vacuum-powered gyro instruments and the rate-of-turn indicator is typically the first indication of a failure condition. To confirm which gyro has failed, the pilot must cross-check other flight instruments.

d. Loss of aircraft control can occur:

(1) When the pilot does not recognize that a failure condition exists and continues following erroneous instrument indications.

(2) During the time it takes the pilot to determine which system has failed.

(3) During subsequent partial panel instrument flying, which can be confusing if the pilot cannot cover the failed instrument(s).

e. Loss of control is most likely to happen during a high workload environment such as instrument departure or instrument approach. The risk increases in aircraft with higher complexity and speed.

5. RATIONALE FOR CHANGE.

a. Substituting a second attitude indicator (with a power source independent from the primary attitude indicator) for the rate-of-turn indicator will provide an increased level of safety. It will replace a gyro that only indicates direction and rate of turn with one instrument that presents turn direction, bank angle, and pitch attitude information. Also, a second attitude indicator will be less confusing during partial panel operations because it presents pitch and bank information in the same manner as the primary attitude indicator. The pilot's scan and instrument interpretation during partial panel operations becomes easier because pilots will still be able to rely on an attitude indicator for pitch and bank reference just as they did during full panel operations. Recognition time that a failure condition exists will be equivalent to current system configurations.

b. Replacing the rate-of-turn indicator will mean losing an easy reference for standard rate turns. However, in today's air traffic control system, there is little need for precisely measured standard rate turns or timed turns based on standard rate. Maintaining a given bank angle on the attitude indicator for a given speed will result in a standard rate turn. Pilots using this AC to substitute an attitude indicator for their rate-of-turn indicator are encouraged to know the bank angle needed for a standard rate turn.

NOTE: The FAA preamble language for the 1970 amendment to section 91.33, re-codified to section 91.205, states: "[T]he FAA believes, and all other commenters apparently agree ... the rate-of-turn indicator is no longer as useful as an instrument which gives both horizontal and vertical attitude information."

6. COMPLIANCE REQUIREMENTS.

a. This AC is only applicable to part 23-certificated airplanes of less than 12,500 pounds operated under part 91, subparts A through D that do not require more than one crewmember.

b. This AC provides an Administrator-approved method of compliance with the requirement to have a gyroscopic rate-of-turn indicator specified by section 91.205(d)(3), excluding aircraft covered by section 91.205(d)(3)(i) and (ii).

c. Part 91 airplanes with an FAA-approved minimum equipment list (MEL) must have the MEL modified to reflect changes accomplished under this AC.

d. An FAA-approved attitude indicator with a failure warning flag that monitors power supply is acceptable under this AC. This attitude indicator must have an independent power source from the primary attitude indicator. This provides an equivalent level of safety to existing rate-of-turn gyro arrangements.

If your airplane is equipped with...	Then the rate-of-turn indicator may be replaced with...
vacuum-powered primary attitude indicators and electrically-powered rate-of-turn indicators	• an electrically-powered attitude indicator, or • a vacuum- or pressure-powered attitude indicator that is connected by independent lines to a second, independent vacuum or pressure pump
pressure-powered primary attitude indicators and electrically-powered rate-of-turn indicators	• an electrically-powered attitude indicator, or • a vacuum- or pressure-powered attitude indicator that is connected by independent lines to a second, independent vacuum or pressure pump
all-electric gyro systems that have two independent electrical power sources in accordance with AC 23-17A, section 23.1331	an electrically-powered attitude indicator
electrically-powered primary attitude indicators and vacuum- or pressure-powered rate-of-turn indicators	a vacuum- or pressure-powered attitude indicator
electrically-powered primary attitude indicators and vacuum- or pressure-powered rate-of-turn indicators and has two independent electrical power sources in accordance with AC 23-17A, section 23.1331	an electrically-powered attitude indicator

e. An attitude indicator installed in accordance with this AC must be located within the pilot's primary field of view.

f. The slip/skid indicator required by section 91.205(d)(4) must be permanently mounted on the panel or on a flight instrument within the pilot's primary field of view.

g. Aircraft with autopilots that receive inputs from a turn coordinator require that the applicant do one of the following:

(1) Obtain a new Supplemental Type Certificate for the autopilot system to receive inputs from an electrically powered attitude indicator;

(2) Deactivate or remove the autopilot in a manner acceptable to the Administrator; or

(3) Relocate the rate-of-turn instrument and maintain the autopilot connection in accordance with data acceptable to the Administrator (generally viewed as a **MINOR** alteration).

7. RECOMMENDATIONS. To provide an increased level of safety, the FAA recommends, but does not require, the following:

a. An approved second attitude indicator with a failure warning flag that monitors both gyro revolutions per minute (RPM) and power supply.

b. A primary attitude indicator that has a failure warning flag.

c. A blinking, low-vacuum indicator light located in the pilot's primary field of view.

d. A vacuum gauge located in the pilot's primary field of view.

e. A method to cover failed gyro instruments.

f. The slip/skid indicator should be mounted:

(1) Internally in the lower portion of the electric attitude indicator;

(2) Externally on the lower bezel of the electric attitude indicator; or

(3) On the panel directly underneath the electric attitude indicator.

/s/ John M. Allen for
James J. Ballough
Director, Flight Standards Service