Federal Aviation Agency

ADVISORY CIRCULAR

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	AIRCRAFT
EFFECTIVE:	12/23/65

SUBJECT: AUTOMATIC PILOT SYSTEMS APPROVAL (NON-TRANSPORT)

1. PURPOSE. This circular sets forth an acceptable means by which compliance with the automatic pilot installation requirements of FAR 23.1329 may be shown. Due consideration will be given to any other means of determining compliance the applicant elects to present.

2. REGULATIONS AFFECTED. These acceptable means of compliance refer to certain provisions of the recodified Federal Aviation Regulations (FARs) Part 23. They may be used in showing compliance with the corresponding provisions of the former Civil Air Regulations (CARs) in the case of aircraft to which those regulations are applicable. For convenience, the CAR reference is shown in parenthesis, following the FAR reference.
FAR 23.1301 Equipment, Function, and Installation (CARs 3.651 and 3.652)
FAR 23.1329 Automatic Pilot System (CAR 3.667)
FAR 23.1351 Electrical Systems and Equipment (CAR 3.681)
FAR 23.1431 Electronic Equipment (CAR 3.721)

3. DISCUSSION.

   a. A three-second delay between airplane response to an automatic pilot malfunction and pilot corrective action has been considered an acceptable value on past type certification programs for Part 23 category aircraft. The airplane response has been determined by use of an accelerometer or other instrumentation. In normal operations, the pilot does not have the instrumentation available by which to recognize airplane response. The first indication a pilot has of a malfunction of the autopilot is from either a deviation of the airplane from the intended flight path, abnormal control movements, or a reliable failure warning system. An essential safety consideration is that at least one pilot monitor the behavior of the airplane and associated autopilot performance at all times. The three-second delay applied in normal climb, cruise, and descent, and the one-second delay applied during low approaches are, therefore, reasonable delay times, provided that pilot recognition of the malfunction is the basis of these time delays.

b. The area of normal maneuvering flight (turning flight) has not been specified for evaluation of the effects of autopilot malfunctions. Autopilots are being used in turning flight. A one-second delay is considered a reasonable time prior to undertaking corrective action provided the pilot recognizes that a malfunction has occurred.

4. ACCEPTABLE MEANS OF COMPLIANCE. The following are acceptable means of showing compliance with FAR 23.1329 (CAR 3.667).

a. Malfunction Tests. (see paragraph 4c., also)

(1) Climb, cruise, and descent flight regimes.

(a) The more critical of the following should be induced into the automatic pilot system. If autothrottles are installed, they should be operating, and vertical gyro mechanical failures should not be considered.

1 A signal about any axis equivalent to the cumulative effect of any single failure, including autotrim, if installed.

2 The combined signals about all affected axes, if multiple axis failures can result from the malfunction of any single component.

(b) Corrective action should not be initiated until three seconds after the pilot has become aware, either through the behavior of the aircraft, or a reliable failure warning system, that a malfunction has occurred. The simulated failure and the subsequent corrective action should not create loads in excess of structural limits or beyond an envelope of 0 to 2g, or speeds beyond V_{NE}, whichever is appropriate, or result in dangerous dynamic conditions or deviations from the flight path. The positive "g" limitation may be increased up to the positive design limit maneuvering load factor if it has been previously determined analytically that neither the simulated failure nor subsequent corrective action would result in loads beyond the design limit loads of the airplane. The power or thrust for climb should be the most critical of (a) that used in the performance climb demonstrations, (b) that actually used for operational climb speeds, or (c) that used in the longitudinal stability tests. The altitude loss should be measured.

(2) Maneuvering Flight. Malfunctions should also be induced into the automatic pilot system similar to paragraph a.(1). When corrective action is taken one second after the result of the malfunction has alerted the pilot, the resultant loads and speeds should not exceed the values in paragraph a.(1). Maneuvering flight tests should include turns with the malfunction induced when maximum bank angles for normal operation of the system have been established and in the critical airplane configurations and/or stages of flight likely to be encountered when using the automatic pilot. The altitude loss should be measured.

b. Recovery to flight control. Recovery should be demonstrated either by overpowering or by manual use of an emergency quick-disconnect device after the appropriate delay. The pilot should be able to return the airplane to its normal flight attitude under full manual control without exceeding the loads or speed limits defined in this paragraph and without engaging in any dangerous maneuvers during recovery. It should be possible to overpower servo forces plus resultant airloads in all configurations and attitudes of flight demonstrated, including maximum speed for which approval is sought, and without exceeding the following control forces measured at the pilot's controls; pitch 50 pounds; roll 30 pounds (force applied at rim); yaw 150 pounds. These forces are applicable only to initially overpowering the autopilot. If disconnect is not provided, the prolonged forces should not exceed those specified in FAR 23.143(c). The maximum servo forces used for these tests should not exceed those values for which substantiation has shown to be within the structural limits for which the airplane was designed. The maximum altitude loss experienced during these tests should be measured.

c. Automatic pilot or coupled approach approval.

(1) Throughout an approach, no signal or combination of signals, simulating the cumulative effect of any single failure or malfunction in the automatic pilot system, should provide hazardous deviations in the flight path, or any degree of loss of control, if corrective action is initiated one second after the pilot has become alerted to the malfunction.

(2) The aircraft should be flown down the ILS in the configuration and at the approach speed specified by the applicant for approach. Simulated autopilot malfunctions should be induced at critical points along the ILS, taking into consideration all possible variations in autopilot sensitivity and authority. The malfunctions should be induced in each axis. While the pilot may know the purpose of the flight, he should not be informed when a malfunction is to be or has been applied except through airplane action, control movement, or other acceptable warning devices.

(3) For multiengine aircraft, an engine failure during a normal ILS approach should not cause a lateral deviation of the airplane from the flight path at a rate greater than three degrees per second or produce hazardous attitudes.

(4) If approval is sought for ILS approaches initiated with one-engine inoperative, the automatic pilot should be capable of conducting the approach.

(5) Recoveries should be initiated one second after the pilot recognizes the failure. The altitude loss should be measured as the vertical distance between the glide slope path and the lowest point in the recovery maneuver.

(6) A malfunction of the autopilot during a coupled ILS approach should not place the airplane in an attitude which would preclude conducting a satisfactory go-around, or landing.

d. Servo Stall Forces. The automatic pilot system should be installed and adjusted so that the servo stall forces established during certification tests can be maintained in normal operation. This may be assured by conducting flight tests throughout the envelope of servo stall forces. Those tests conducted to determine that the automatic pilot system will adequately control the aircraft should establish the lower stall force limit; and those tests to determine that the automatic pilot will not impose dangerous loads or deviations from the flight path, should be conducted at the upper stall force limit. Appropriate aircraft loadings to produce the critical results should be used.

e. Airplane Flight Manual Information. The following information should be placed in the airplane flight manual or presented to the pilot in the form of placards.

(1) In the Operating Limitations Section, the airspeed limitations and other applicable operating limitations.

(2) In the Operating Procedures Section, the normal operating information.

(3) In the Emergency Operation Procedures Section:

(a) A statement of the altitude loss in the cruise, climb, and descent configurations and the maneuvering flight configuration in accordance with paragraphs 4a(1) and 4a(2) of this advisory circular.

(b) A statement of the altitude loss in the approach configuration, as defined in paragraph 4c(5).

George S. Moore
Director
Flight Standards Service

2139

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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: INSTALLATION APPROVAL ON TRANSPORT CATEGORY AIRPLANES OF CARGO UNIT LOAD DEVICES APPROVED AS MEETING THE CRITERIA IN NAS 3610

1. PURPOSE. This circular sets forth an acceptable means, but not the sole means, of complying with the requirements of the Federal Aviation Regulations (FAR's) applicable to the installation on transport category airplanes of cargo unit load devices approved as meeting the criteria in NAS 3610.

2. REFERENCE REGULATIONS. FAR 25, Section 25.1301.

3. DEFINITIONS. For the purpose of this advisory circular, a cargo unit load device is a device for grouping, transferring, and restraining cargo for transit. For example, it may consist of a pallet and net, or it may be a container.

4. BACKGROUND. Under Flight Standards Order 8110.5, dated 15 October 1969, the FAA provided for the use of National Aerospace Standard NAS 3610, "Cargo Unit Load Devices - Specification For," as an acceptable basis for the approval of pallets, nets, and cargo containers for use on transport category airplanes. However, Order 8110.5 does not provide for the installation of the cargo unit load devices on the airplane.

5. ACCEPTABLE MEANS OF COMPLIANCE. The installation of a cargo unit load device on a transport category airplane is acceptable under FAR 25, Section 25.1301 when -

   (a) The airplane is type certificated with a cargo restraint system that is compatible with specification NAS 3610, and the manuals referenced in the type certificate data sheet include (by NAS 3610 classification identifier) the cargo unit load device that may be installed, its appropriate load rating, and instructions and limitations on its use. For example, in the case of a pallet-net cargo unit load device, the manuals should identify the pallet-net combination that is compatible under the criteria of NAS 3610;

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(b) The cargo unit load device is approved as meeting the applicable criteria in specification NAS 3610 and is identified with the appropriate classification identifier set forth in NAS 3610, and any components such as a pallet or net are individually identified (components of a cargo unit load device such as a pallet or net may be approved separately); and

(c) The installed cargo unit load device can be secured in accordance with the instructions contained in the manuals referenced in the type certificate data sheet, and is within the allowable geometrical profile (of the aircraft interior) established by the airplane manufacturer.

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