

Cancelled 6/6/66 see AC 120-20

Federal Aviation Agency

ADVISORY CIRCULAR



AC NO: AC 20-31

AIRCRAFT

EFFECTIVE :

December 4, 1964

SUBJECT : APPROVAL BASIS FOR CATEGORY II INSTALLATION OF AIRBORNE NAVIGATION, INSTRUMENT, AND FLIGHT CONTROL SYSTEMS IN TRANSPORT CATEGORY AIRCRAFT

1. **PURPOSE.** This advisory circular contains criteria for the approval of airborne equipment and their installations when the applicant desires to have a statement in approved flight manuals that his equipment meets Category II performance.
2. **GENERAL CRITERIA.** The type certification approval for the equipment, system installations and test methods should be based on a consideration of factors such as the intended function of the installed system, its accuracy, reliability, failsafe features, and clarity of normal and abnormal displays to the flight crew. In addition, approval should be based on demonstrated compatibility with ground facilities for navigation and landing assistance and with the Air Traffic Control System. The guidelines and procedures contained herein are considered acceptable methods of determining transport category airplane airworthiness for use in Category II IFR operations. Alternatively, approval for Category II installations may be obtained by meeting the requirements set forth in the advisory circular pertinent to operational criteria. Type certification based on other criteria may also be considered acceptable when found to be equivalent and approved by the Chief, Engineering and Manufacturing Division/Branch, of the cognizant regional office.
3. **DEFINITIONS.**
 - a. Angle of Attack Indicator indicates the angle between the wing mean chord plane and the relative wind.
 - b. Automatic Pilot/Coupler is a combination of an approach coupler and an automatic pilot system which is capable of using navigation information from localizer and glide slope receiving equipment to furnish appropriate signals through the coupler to the automatic pilot resulting in control response as needed to fly the airplane on the instrument landing system approach path.

12/4/64

- c. Automatic Throttle System is a system which automatically actuates the throttle(s) (power lever(s)) control system based on its own computation and feedback from appropriate data sources.
- d. Category II Operation is airplane operation down to minima below 200 feet and 2600 feet runway visual range and to as low as 100 feet and 1200 feet runway visual range.
- e. Difference of Depth of Modulation (ddm) is the percentage of modulation of the strongest signal minus the percentage of modulation of the weaker signal, divided by 100.
- f. Disconnect is to interrupt a functional continuity between equipment or systems either manually or automatically.
- g. Disengage is to interrupt a functional continuity between equipment or systems either manually or automatically.
- h. Engage is to complete the functional continuity between systems or sub-systems.
- i. Flight Director is a flight indicator system providing command information obtained from such input information sources as vertical gyros, compass systems, radios, navigation systems and/or other sources.
- j. Go-Around is an airplane maneuver following an uncompleted approach which involves transition to a climbing flight path.
- k. Hardover is an unintentional and undesired response of a system at the maximum rate toward its maximum deflection.
- l. ILS Facility Performance Category II is an ILS which provides guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the glide path at a height of 50 feet or less above the horizontal plane containing the ILS runway.
- m. Malfunction is a change in an equipment, system or installation which prevents continued performance of intended functions.
- n. Override is to manually apply a control force which exceeds the authority of an automatic control system or to manually intervene in an otherwise automatic sequence.
- o. Runway Visual Range (RVR) is an instrumentally-derived value, based on standard calibrations, that represent the horizontal distance a pilot will see down the runway from the approach end.

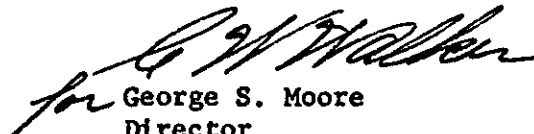
- p. Split Axis is the use of either the autopilot pitch or roll axis, with the other axis controlled manually.
 - q. Technical Standard Order is one of several official Federal Aviation Agency documents contained in Part 514 of the Regulations of the Administrator, which provide minimum performance standards and specifications of materials, parts, processes, and appliances used in aircraft.
 - r. Windshear is an atmospheric phenomenon resulting in the change of the velocity vector of the wind relative to the flight path.
4. REFERENCES. Civil Air Regulations, Part 4b, 40, 41, 42.
5. EQUIPMENT APPROVAL CRITERIA. Airborne navigation instrument and/or flight control equipment may be eligible for installation approval as part of an installed system when it is:
- a. Found to comply with the requirements of an applicable technical standard order or type certificate, or
 - b. Found to comply with applicable Civil Air Regulations and approved as part of an airplane under a type certificate or supplemental type certificate, or
 - c. Found to comply with other pertinent specifications adopted by the Administrator; e.g., military standards or a foreign government's validation which has been found to be compatible with the intent of the appropriate Civil Air Regulations.
6. INSPECTION AND TEST PROGRAM. Agreement should be reached with the applicant on his proposed flight test program, which should be conducted to determine compliance with the requirements of this document of the pertinent systems installed. Upon completion of Federal Aviation Agency engineering design and ground testing program evaluations on the combination of systems proposed as a basis for a Category II installation indicating that the system will meet the prescribed criteria, a Type Inspection Authorization, or similar document should be issued. This document will specify the necessary conformity inspections and tests to be conducted, both on the ground and in flight. It should include determination of satisfactory installation practices, freedom from interferences, compatibility with ground navigation facilities and the Air Traffic Control System, and performance of intended functions. Performance testing in flight should cover representative and critical phases of operation including malfunction simulation.

12/4/64

7. FUNCTION AND RELIABILITY TESTING. In addition to the inspection and test program, a program of function and reliability flight testing may be required for the purpose of supplementing analytical and test data, such as fault analysis and reliability studies, with accelerated service experience (such testing if practicable may be done, by arrangement, during normal airline operations not predicated on use of the system undergoing test). The extent of the additional tests depends upon the complexity, number, nature of (or novel) design features incorporated in the system and the record of previous tests and experience.
8. APPROVED AIRPLANE FLIGHT MANUAL. The Federal Aviation Agency approved airplane flight manual or supplement thereto should include pertinent material as required to define the normal and emergency operating procedures and applicable operating limitations associated with system performance in Category II operation.
9. SYSTEMS PERFORMANCE REQUIREMENTS. For the combination of systems to provide the level of accuracy, reliability, and compatibility needed to assure an approach capability which is considered acceptable to the Administrator, each individual system should be found to perform its intended function in accordance with the following:
 - a. Data Display. All displays of information essential for the use of the flight crew in a Category II installation should incorporate such markings and lighting as will permit accurate and timely utilization of such information and recognition of malfunctions by pilots of average skill and reaction time.
 - b. Control Functions. All systems which furnish signals directly to the airplane flight control system or the propulsion thrust control system should be so designed that if malfunction occurs, such malfunction does not result in an unsafe configuration. Means for quick disengaging or overriding of each automatic control function should be immediately available to the flight crew without requiring the application of excessive forces and the assuming of any unusual position.
 - c. Malfunction of Monitoring Functions. A reasonable probable malfunction in any monitoring sub-system should be incapable of causing a malfunction of any essential system unless such essential system malfunction is indicated to the flight crew.
10. COMBINED SYSTEMS CRITERIA.
 - a. Eligibility for Category II operations includes compliance with applicable sections of Civil Air Regulations, Part 4b.

12/4/64

- b. A combination of airborne navigation, instrument, and flight control systems, having individual system installation approvals, may be eligible for Category II installation approval when:
- (1) Found to provide information to the flight crew with sufficient accuracy, reliability, clarity, and timeliness to permit, without reference to any cues outside the cockpit, the manual control of the airplane along the flight path within prescribed limits. (See Appendix 1)
 - (2) Or found to provide signals to the airplane flight control systems with sufficient accuracy, and reliability to maintain the aircraft along the approach flight path within prescribed limits. (See Appendix 1)
 - (3) Or found to provide a combination of automatic flight, propulsion control, and other information to the flight crew to permit manual control of the aircraft, supplemented by automatic control, along the approach flight path within prescribed limits. (See Appendix 1)
 - (4) And found to provide the capability of transition to satisfactory go-round flight performance from any point in the approach down to the minimum decision altitude.
11. INDIVIDUAL SYSTEM CRITERIA. Individual systems (such as in Appendix 1) to be used for Category II operation should comply with pertinent sections of this circular and the performance criteria as set forth in Appendix 1. Deviations from specific requirements of Appendix 1 are allowed if the combined system requirements of paragraph 2, 9, and 10 are met.


for George S. Moore
Director
Flight Standards Service

APPENDIX 1. APPROVAL BASIS FOR CATEGORY II INSTALLATION
OF AIRBORNE NAVIGATION, INSTRUMENT AND FLIGHT
CONTROL SYSTEMS

1. LOCALIZER. The localizer system installation should comply with the following:
 - a. The localizer equipment should meet or exceed the minimum performance standards set forth in Federal Aviation Agency Technical Standard Orders C36, C36a, C36b, or RTCA Paper 20-63/DO-115, dated February 14, 1963, "Minimum Performance Standards - ILS Localizer Receiving Equipment."
 - b. The localizer system installation should meet or exceed the minimum performance standards set forth in RTCA Paper 69-60/DO-102, dated April 12, 1960, "Minimum In-Flight Performance Standards - ILS Localizer Receiving Equipment."
 - c. Display to the pilot positive visual indication to show degradation of localizer system performance under the following conditions:
 - (1) The absence of either or both modulation signals.
 - (2) The reduction of both modulation signals to one half the normal 20%.
 - (3) When a difference of depth of modulation equal to 0.093 ± 0.002 produces an output of less than one half normal response to this standard localizer deviation signal.
 - d. The localizer receiving centering error should be within 5 ua on a 95% probability basis under the following conditions, using a standard test signal:
 - (1) Variation of R. F. signal level from 50 to 1,000 uv.
NOTE: This represents the variation of R. F. signal level expected during the final phase of an ILS approach.
 - (2) Variation of DC power over the range of 24 to 28 volts or AC power over the range of 105 to 120 volts.
 - (3) Variation of ambient temperature over the limited range expected during a normal ILS approach. The nominal ambient temperature range is defined as $+10^{\circ}$ C. to $+40^{\circ}$ C. Operation over a different temperature range in a particular airplane will require special coordination.

- e. The localizer receiving equipment should be adjusted in accordance with RTCA Paper 23-63/DO-117, dated March 14, 1963, "Standard Adjustment Criteria for Airborne Localizer and Glide Slope Receivers."
2. GLIDE SLOPE. The glide slope system installation should comply with the following:
 - a. The glide slope equipment should meet or exceed the minimum performance standards set forth in Federal Aviation Agency Technical Standard Orders C34, C34a, C34b, or RTCA Paper 21-63/DO-116, dated February 14, 1963, "Minimum Performance Standards - ILS Glide Slope Receiving Equipment."
 - b. The glide slope system installation should meet or exceed the minimum performance standards set forth in RTCA Paper 233-59/DO-101, dated December 8, 1959, "Minimum In-Flight Performance Standards - ILS Glide Slope Receiving Equipment."
 - c. Display to the pilot positive visual indication to show degradation of glide slope system performance under the following conditions:
 - (1) The absence of either or both modulation signals.
 - (2) The reduction of both modulation signals to one-half of their normal 40%.
 - (3) When a difference of depth of modulation equal to $0.091 \pm .002$ produces an output of less than one-half normal response to this standard glide slope deviation signal.
 - d. Centering Error: - The glide slope centering requirements outlined in RTCA Paper 222-58/DO-89 are applicable for Category II installation approval.
 - e. The glide slope receiving equipment should be adjusted in accordance with RTCA Paper 23-63/DO-117, dated March 14, 1963, "Standard Adjustment Criteria for Airborne Localizer and Glide Slope Receivers."
 3. AUTOMATIC PILOT/COUPLER. When an automatic pilot/coupler system is used as part of a Category II installation, it should, in addition to complying with applicable TSO and CAR/CAM material, provide the following performance under the test condition stated:
 - a. Airplane Speed - Maximum and minimum design approach speeds.

- (3) Maintain stable short period and phugoid airplane modes for all intended flight situations during manual and automatic flight control.
- b. Malfunction of any part of the system should not restrict either pilot from maintaining safe control of the airplane or engines.
 - (1) Disconnect switch(es) readily accessible to both pilot and copilot should be provided.
 - (2) The throttle drive mechanism should be designed to permit manual over-riding without application of excessive throttle forces.
 - (3) The maximum servo velocity attainable should be positively limited by design to that required for adequate performance.
 - (4) Appropriate indication of system engagement and disengagement should be provided.
6. RADIO ALTIMETER. The radio altimeter system should provide the following performance under the test conditions stated:
 - a. Display to the flight crew clearly and positively the altitude information in flight which indicates the airplane main landing gear wheel height above terrain.
 - b. Under the measurement conditions described, the flight crew presentation should:
 - (1) Display altitude to an accuracy of ± 5 feet or $\pm 5\%$ of altitude, whichever is greater, under the following conditions:
 - (a) Pitch angle zero $\pm 5^\circ$ about the mean approach attitude
 - (b) Roll angle zero to $\pm 20^\circ$
 - (c) Forward velocity from minimum approach speed up to 200 knots
 - (d) At altitudes from 100 to 200 feet with sink rates of zero to 15 feet/second
 - (2) Over level ground the altimeter should track the actual altitude of the airplane without significant lag or oscillation.

- (3) With the airplane at an altitude of 200 feet or less, any abrupt change in terrain representing no more than 10 percent of the airplane's altitude should not cause the altimeter to unlock, and indicator response to such changes should not exceed 0.1 seconds. If the system unlocks, it should reacquire the signal in less than one second.
- (4) Systems which contain a push-to-test feature should test the entire system (with or without antenna) at a simulated altitude of less than 500 feet.
- (5) Failure Warning - The system should provide to the flight crew a positive failure warning display any time there is a loss of power or absence of ground return signal within the specified range of operating altitudes.