



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

Advisory Circular

Subject: STANDARDIZATION GUIDE
FOR INTEGRATED COCKPITS IN PART 23
AIRPLANES

Date: DRAFT

Initiated By: ACE-100

AC No: 23-23

Change:

1. WHAT IS THE PURPOSE OF THIS ADVISORY CIRCULAR (AC)?

The purpose of this AC is to acknowledge the General Aviation Manufacturers Association (GAMA) Publication #12, “Recommended Practices and Guidelines for an Integrated Cockpit/Flightdeck in a Part 23 Airplane,” as an acceptable means for showing compliance with the requirements for electronic displays in part 23. (GAMA Publication #12 is available from GAMA. Their website is www.gama.aero.) GAMA Publication #12 provides minimum standardization for display and control functions for integrated electronic cockpits. This standard provides commonality between integrated cockpits to minimize required training, ease pilot workload, and improve safety. This document is the result of a combined industry and FAA development effort.

2. WHAT IS AN INTEGRATED COCKPIT?

An integrated cockpit is a system that integrates/handles basic/all flight guidance, and control items into a minimum number of interdependent electronic displays. Specifically, this includes flight instruments, navigation, and communication. It may also include surveillance and system controls.

3. WHAT DOES THE GAMA DOCUMENT PROVIDE?

The guidance provided in GAMA Publication #12 is intended to streamline the certification process. The industry/FAA team that composed GAMA Publication #12 addressed specific issues that are frequently raised by FAA flight test and human factors personnel on individual projects. The goal with the GAMA document is that evaluation of issues like those addressed in GAMA Publication #12 will no longer need multiple pilot/human factors evaluations. Aircraft Certification Organization (ACO) pilots and engineers using this guidance can make the compliance finding to § 23.1311 on their own. This does not mean that all issues are addressed because it is not possible or desirable for some issues; there is room for innovation.

4. WHAT DO THE APPENDICES CONTAIN?

a. Appendix 1 provides guidance for the conduct of a multiple pilot evaluation to address many of the subjective features contained in new integrated cockpits. The GAMA Publication #12 should streamline certification, but there may still be a need for either a limited pilot or human factors evaluation, or both. Appendix 1 describes a standardized process for that evaluation.

b. Appendix 2 provides standardized run cards intended to be used by the person who conducts the flight test, as applicable. These run cards are based on the FAA's practical test standards for both the commercial and instrument pilot performance requirements. While there may be specific flight tests needed for unique features or intended functions, these run cards are intended to keep the flight test evaluation within practical operational scenarios.

5. TO WHOM DOES THIS AC APPLY?

a. This AC, and the associated GAMA Publication #12, applies if you are developing or installing an integrated cockpit system into any small airplane.

b. GAMA Publication #12 guidance was developed based on a minimum display set of a Primary Flight Display (PFD)/Navigation Display (ND) and Multifunction Display (MFD). The document applies to "integrated cockpit" installations in older airplanes as well as new airplanes. Moreover, GAMA Publication #12 may be used for partial "integrated cockpit" equipment installations where the guidance is applicable.

6. ARE THERE ANY REFERENCES FOR THIS AC?

GAMA Publication #12, Recommended Practices and Guidelines for an Integrated Cockpit/Flightdeck in Part 23 Airplanes.

DRAFT

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APPENDIX 1—Multiple Pilot Evaluations of Qualitative/Subjective Design and Features

a. Purpose. A multiple-expert-opinion evaluation may be used for determining compliance of controversial qualitative flight test certification design and operational features. This type of evaluation should be employed on an agency-wide basis whenever regional personnel feel that the issue is subject to controversy, precedent-setting, and/or transcends the local region's concern, for which specific guidelines and criteria have yet to be developed and issued.

(1) Determination of 14 CFR part compliance on an "equivalent level of safety basis" usually involves a qualitative analysis of an aircraft that possesses design features that do not meet the "letter of the regulation" or are not clearly covered in the applicable regulations.

(2) Determination of compliance in such instances is based on meeting the intent and objective of the applicable regulations and whether compensatory factors exist or operational limitations are applied that will result in an "equivalent" safe operation.

b. Responsibility. The responsibilities of the affected region are (1) to determine that the design feature in question involves the conditions of paragraph "a" and warrants this type of evaluation; (2) to initiate and implement the procedure; and (3) to work with the Small Airplane Directorate to include pilots from other regions who have experience and background applicable to the program.

c. Procedure. The judgments of at least three FAA pilots with applicable experience should be used to make a determination of compliance with regulations involving qualitative/subjective standards when there appears to be a possible unsafe feature, a requirement application susceptible to nonstandard inter-regional administration, or when a marginal equivalent level of safety design feature is involved.

(1) Following determination that a multiple pilot opinion compliance evaluation is necessary, a written request is to be forwarded by the ACO to the Small Airplane Directorate specifying the nature of the design feature and the details for the participation needed. In determining the participation needed, system worthiness is to be considered. For example, Operations, Research/Development, Air Traffic, and Airports representatives should be invited to participate in the evaluation when the item in question affects their areas of responsibility.

(2) The Flight Test Manager for the region involved, or other team leader appointed by them, will direct and manage the team's activities while at the applicant's facility. They will be responsible for all meetings and discussions held between the applicant and the FAA and for meetings held by FAA personnel only. They will be the spokesman for the FAA at the conclusion of the investigation and will initiate action to inform the applicant of the findings as soon as possible.

(3) An initial meeting will be held with the applicant and all FAA participants to describe the purpose of the evaluation and to schedule the program.

(4) Each evaluator will be supplied with an issue paper or similar document prepared by the team leader. The format will include at least the following:

- (a) Reference regulation
- (b) Problem
- (c) Findings
- (d) Recommendations

(e) This check sheet will be completed, signed, and returned to the team leader. The consolidated report will then become a part of the TIS, Part II.

(5) After all FAA participants have independently reached a conclusion, the team leader shall convene the FAA personnel, independent of the applicant's personnel, to establish the conclusion(s) of the majority and minority, if any, of the team members.

(6) The applicant may be orally informed of the team's findings and recommendations, subject to written confirmation and higher approval.

d. Report.

(1) A written report of the team's findings will be forwarded to the applicant, the Small Airplane Directorate flight test personnel, and to the pilots participating in the evaluation. This report is to be forwarded not more than five working days after the conclusion of the evaluation.

(2) If the team has determined that, due to the results of the evaluation, guidance material and/or a regulation is needed, such recommendations should be incorporated in the report and the team will initiate appropriate action.

Run #	SHORT-FIELD TAKEOFF AND MAXIMUM PERFORMANCE CLIMB
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Test Procedure and Performance Criteria

- 1) Establish and maintain the most efficient lift off attitude.
- 2) Lift off at the recommended airspeed and accelerate to recommended obstacle clearance airspeed, or V_X .
- 3) Establish a pitch attitude that will maintain the recommended obstacle clearance airspeed, or V_X , +5/-0 knots, until the obstacle is cleared, or until the airplane is 50 feet (20 meters) above the surface.
- 4) After clearing the obstacle, establish the pitch attitude for V_Y , accelerate to V_Y , and maintain V_Y , ± 5 knots, during the climb.
- 5) Retract the landing gear, if appropriate, and flaps after clear of any obstacles or as recommended by manufacturer.
- 6) Maintain takeoff power and V_Y , ± 5 knots to a safe maneuvering altitude.

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent "round-dial" instrument panel.

Pilot performance	LOW		AVG		HIGH
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Pilot workload	LOW		AVG		HIGH
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Notes and Comments

Run #	<i>SHORT-FIELD APPROACH AND LANDING</i>
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Test Procedure and Performance Criteria

- 1) Establish the recommended approach and landing configuration and airspeed; adjust pitch attitude and power.
- 2) Maintain a stabilized approach at the recommended approach airspeed or, in its absence, not more than $1.3 V_{SO}$, ± 5 knots, with wind gust factor applied.
- 3) Make smooth, timely, and correct control application during the roundout and touchdown.
- 4) Touch down smoothly at minimum control airspeed.
- 5) Touch down at or within 100 feet (30 meters) beyond a specified point, with no side drift, minimum float and with the airplane's longitudinal axis aligned with and over the runway center/landing path.

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent "round-dial" instrument panel.

Pilot performance	LOW		AVG		HIGH
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Pilot workload	LOW		AVG		HIGH
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Notes and Comments

Run #	POWER-OFF 180° ACCURACY APPROACH AND LANDING
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Altitude – 1000 ft AGL
Airspeed – best glide - _____

Test Procedure and Performance Criteria

- 1) Position airplane on downwind leg, parallel to landing runway, and not more than 1000 feet AGL.
- 2) Abeam the specified touchdown point, close throttle and
- 3) Establish appropriate glide speed. ±10 knots
- 4) Complete final airplane configuration.
- 5) Touch down in a normal landing attitude, at or within 200 feet (60 meters) beyond the specified touchdown point.

Secondary Tasks - None

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
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Pilot workload	LOW		AVG		HIGH
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Notes and Comments

Run #	<i>STEEP TURNS</i>
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Altitude – not less than 3000 feet AGL
Airspeed - _____

Test Procedure and Performance Criteria

- 1) Establish the manufacturer’s recommended airspeed or, if one is not stated, a safe airspeed.
- 2) Roll into a coordinated steep 360° turn with at least a 50° bank, followed by a 360° steep turn in the opposite direction.
- 3) Divide attention between airplane control and orientation.
- 4) Maintain the entry altitude, ±100 feet (30 meters), airspeed, ±10 knots, bank, ±5°; and roll out on the entry heading, ±10°.

Secondary Tasks - None

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
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Pilot workload	LOW		AVG		HIGH
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Notes and Comments

Run #	<i>STEEP SPIRAL</i>
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Altitude – not less than 3000 feet AGL
Airspeed - _____

Test Procedure and Performance Criteria

- 1) Select a suitable ground reference point.
- 2) Apply wind-drift correction to track a constant radius circle around selected reference point with bank not to exceed 60° at steepest point in turn.
- 3) Divide attention between airplane control and ground track, while maintaining coordinated flight.
- 4) Maintain the specified airspeed, ±10 knots, roll out toward object or specified heading, ±10°.

Secondary Tasks - None

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
Pilot workload	LOW		AVG		HIGH

Notes and Comments

Run #	<i>CHANDELLES</i>
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Altitude – not less than 3000 feet AGL
Airspeed - _____

Test Procedure and Performance Criteria

- 1) Establish the recommended entry configuration, power, and airspeed.
- 2) Establish the angle of bank at approximately 30°.
- 3) Simultaneously apply power and pitch to maintain a smooth, coordinated climbing turn to the 90° point, with a constant bank.
- 4) Begin a coordinated constant rate rollout from the 90° point to the 180° point, maintaining power and a constant pitch attitude.
- 5) Complete rollout at the 180° point, ±10° just above a stall airspeed, and maintain that airspeed momentarily avoiding a stall.
- 6) Resume straight and level flight with minimum loss of altitude.

Secondary Tasks - None

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
Pilot workload	LOW		AVG		HIGH

Run #	<i>MANEUVERING DURING SLOW FLIGHT</i>
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Altitude – not less than 3000 feet AGL
Airspeed - _____

Test Procedure and Performance Criteria

- 1) Establish and maintain an airspeed at which any further increase in angle of attack, increase in load factor, or reduction in power, would result in an immediate stall.
- 2) Accomplish coordinated straight-and-level flight, turns, climbs, and descents with landing gear and flap configurations.
- 3) Maintain the specified altitude, 50 feet (15 meters); specified heading, $\pm 10^\circ$; airspeed, ± 5 knots, and specified angle of bank, $\pm 5^\circ$.

Secondary Tasks - None

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
Pilot workload	LOW		AVG		HIGH

Notes and Comments

Run #	<i>POWER-OFF STALLS and POWER-ON STALLS</i>
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Altitude – not less than 3000 feet AGL
Airspeed - _____

Test Procedure and Performance Criteria

- 1) Establish a stabilized descent in the approach or landing configuration.
- 2) Transition smoothly from the approach or landing attitude to a pitch attitude that will induce a stall.
- 3) Maintain a specified heading, $\pm 10^\circ$ in straight flight; maintain a specified angle of bank, not to exceed $\pm 15^\circ$; $\pm 20^\circ$ in turning flight while inducing the stall.
- 4) Recognize and recover promptly as the stall occurs by simultaneously reducing the angle of attack, increasing power to maximum allowable, and leveling the wings to return to a straight-and-level flight attitude with a minimum loss of altitude appropriate for the airplane.
- 5) Retract the flaps to the recommended setting, retract the landing gear if retractable after a positive rate of climb is established.
- 6) Accelerate to V_X or V_Y speed before the final flap retraction; return to the altitude, heading, and airspeed specified by the examiner.

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
Pilot workload	LOW		AVG		HIGH

Run #	<i>INSTRUMENT FLYING</i>
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Test Procedure and Performance Criteria

Maneuver the aircraft, after reaching the authorized MDA and maintain that altitude within +100 feet (30 meters), -0 feet and a flight path that permits a normal landing on a runway at least 90° from the final approach course.

Secondary Tasks

Radio calls

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
Pilot workload	LOW		AVG		HIGH

Notes and Comments

Run #	<i>STEEP TURNS</i>
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Altitude – not less than 3000 feet AGL
Airspeed - _____

Test Procedure and Performance Criteria

- 1) Maintain altitude within ±100 feet (30 meters),
- 2) Airspeed within ±10 knots,
- 3) ±5° of specified bank angle, and
- 4) Roll out within ±10° of the specified heading

Note: This is also addressed in the commercial PTS run cards. The difference is that this run should be done solely by reference of the flight instruments.

Secondary Tasks - None

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
Pilot workload	LOW		AVG		HIGH

Notes and Comments

Run #

*RECOVERY FROM UNUSUAL FLIGHT
ATTITUDES*

Altitude – not less than 3000 feet AGL

Airspeed - _____

Test Procedure and Performance Criteria

Use proper instrument cross-check and interpretation, and apply the appropriate pitch, bank, and power corrections in the correct sequence to return the aircraft to a stabilized level flight attitude.

Secondary Tasks - None

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance

LOW		AVG		HIGH
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Pilot workload

LOW		AVG		HIGH
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Notes and Comments

Run #

**INTERCEPTING AND TRACKING
NAVIGATIONAL**

SYSTEMS AND DME ARCS

Altitude – not less than 3000 feet AGL

Airspeed - _____

Test Procedure and Performance Criteria

- 1) Tune and correctly identify the navigation facility.
- 2) Set and correctly orient the radial to be intercepted into the course selector or correctly identify the radial on the RMI.
- 3) Intercept the specified radial at a predetermined angle, inbound or outbound from a navigational facility.
- 4) Maintain the airspeed within ± 10 knots, altitude within ± 100 feet (30 meters), and selected headings within $\pm 5^\circ$.
- 5) Apply proper correction to maintain a radial, allowing no more than three-quarter-scale deflection of the CDI or within $\pm 10^\circ$ in case of an RMI.
- 6) Intercept a DME arc and maintain that arc within 1 nautical mile.
- 7) Recognize navigational receiver or facility failure, and when required, report the failure to ATC.

Secondary Tasks

- Change radio frequency
- Put away old approach chart and get a new one

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance

LOW		AVG		HIGH
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Pilot workload

LOW		AVG		HIGH
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Run #

NONPRECISION INSTRUMENT APPROACH

Altitude – not less than 3000 feet AGL
Airspeed - _____

Test Procedure and Performance Criteria

- 1) Establish a rate of descent and track that will ensure arrival at the MDA prior to reaching the MAP with the aircraft continuously in a position from which descent to a landing on the intended runway can be made at the normal rate using normal maneuvers.
- 2) Allow, while on the final approach segment, no more than a three-quarter-scale deflection of the CDI or within $\pm 10^\circ$ in case of an RMI, and maintain airspeed within ± 10 knots.
- 3) Maintain the MDA, when reached, within +100 feet, -0 feet to the MAP.

Secondary Tasks

Radio calls

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
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Pilot workload	LOW		AVG		HIGH
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Run #

PRECISION ILS INSTRUMENT APPROACH

Altitude – as appropriate
Airspeed - _____

Test Procedure and Performance Criteria

- 1) Maintain, prior to beginning the final approach segment, altitude within ± 100 feet (30 meters), heading or course within $\pm 10^\circ$, and airspeed within ± 10 knots.
- 2) Allow, while on the final approach segment, no more than three-quarter-scale deflection of either the localizer or glide slope indications, and maintain the specified airspeed within ± 10 knots.
- 3) Avoid descent below the DH before initiating a missed approach procedure or transitioning to a normal landing approach.

Secondary Tasks

Radio calls

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
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Pilot workload	LOW		AVG		HIGH
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Notes and Comments

Run #	<i>MISSED APPROACH</i>
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Altitude – as appropriate
Airspeed - _____

Test Procedure and Performance Criteria

Maintain:

- 1) airspeed within ± 10 knots;
- 2) heading, course, or bearing within $\pm 10^\circ$; and
- 3) altitude(s) within ± 100 feet (30 meters) during the missed approach procedure.

Secondary Tasks

Radio calls

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW	AVG	HIGH
Pilot workload	LOW	AVG	HIGH

Notes and Comments

Run #	<i>CIRCLING APPROACH</i>
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Altitude – as appropriate - _____
Airspeed - _____

Test Procedure and Performance Criteria

Maneuver the aircraft, after reaching the authorized MDA and maintain that altitude within +100 feet (30 meters), -0 feet and a flight path that permits a normal landing on a runway at least 90° from the final approach course.

Secondary Tasks

Radio calls

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW	AVG	HIGH
Pilot workload	LOW	AVG	HIGH

Notes and Comments

Run #	<i>AHRS/ADAHRS Failure</i>
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Test Procedure and Performance Criteria

This test procedure depends on system architecture and also on the installation. All instruments should be evaluated for transition from the primary display.

Secondary Tasks

Radio calls

Data Requirements –

Record the number and magnitude of variations from performance criteria

Pilot self-assessment

LOW		AVG		HIGH
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Pilot workload

LOW		AVG		HIGH
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Notes and Comments

Run #	<i>Air Data Failure</i>
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Test Procedure and Performance Criteria

Secondary Tasks

Radio calls

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance

LOW		AVG		HIGH
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Pilot workload

LOW		AVG		HIGH
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Notes and Comments

Run #	<i>Generator/Battery Failure</i>
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Test Procedure and Performance Criteria

Secondary Tasks

Radio calls

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
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Pilot workload	LOW		AVG		HIGH
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Notes and Comments

Run #	<i>Identification of PFD Failure Modes and Corrective Actions</i>
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Test Procedure and Performance Criteria

- 1) Fail the PFD using a circuit breaker or similar device
- 2) Pilot immediately selects (or system auto selects) reversionary mode
- 3) Basic flying tasks as well as one approach should be evaluated

Secondary Tasks

Radio calls

Pilot Rating

Pilot should be rated against the practical test standard criteria in the procedures. Workload is rated relative to an equivalent “round-dial” instrument panel.

Pilot performance	LOW		AVG		HIGH
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Pilot workload	LOW		AVG		HIGH
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Notes and Comments

Run #	<i>Autopilot Programming, Modes, and Annunciators</i>
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Test Procedure and Performance Criteria

- Control Wheel Steering
- LNAV and VNAV Programming
- Vertical Speed and Altitude Hold
- Navigation Modes
- Coupled Approach Modes
- Auto Trim Mode
- Flight Director/PFD interface
- Pilot Flight Display