



U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

**Subject: GUIDELINES FOR THE
CERTIFICATION, AIRWORTHINESS,
AND OPERATIONAL APPROVAL OF
ELECTRONIC FLIGHT BAG
COMPUTING DEVICES**

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Change:**

1. PURPOSE. This joint Flight Standards Service (AFS) and Aircraft Certification Service (AIR) advisory circular (AC) provides an acceptable method of compliance for the certification, airworthiness, and the operational approval of both portable and installed Electronic Flight Bag (EFB) aircraft computing devices. This AC does not constitute a regulation but sets forth an acceptable means, but not the only means, for operators conducting flight operations under Title 14 of the Code of Federal Regulations (14 CFR) Part 91, 121, 125, 129, or 135, to obtain both certification and approval for the operational use of EFBs. This guidance material also applies to operators of large and turbine-powered multi-engine aircraft operating under 14 CFR Part 91 where the operating regulations require specific functionality and/or equipment. Other Part 91 operations do not require any specific authorization or aircraft certification design approval for EFB operations provided the EFB does not replace any system or equipment required by the regulations.

2. APPLICABILITY. One of the major motivators for using an EFB is to reduce or eliminate the need for paper and other reference materials in the cockpit. This AC describes the EFB functions, features, and selected hosted applications, and applies to the certification and operational approval of both portable (Class 1 and 2) and installed (Class 3) EFBs. Appendix A provides examples of EFB applications classified as “Class 1” portable electronic devices (PED). Appendix B provides examples of EFB applications classified as “Class 2” PEDs connected to an aircraft mounting device. Appendix C provides an overview of EFB applications classified as “Class 3” installed electronic devices that require an aircraft certification design approval.

3. RELATED 14 CFR REFERENCES.

a. Airworthiness Regulations. These acceptable means of compliance refer to the applicable sections of 14 CFR Parts 21, 23, 25, 27, and 29.

(1) Part 21, § 21.303;

(2) Part 23, §§ 23.771, 23.773, 23.777, 23.1301, 23.1303, 23.1309, 23.1311, 23.1321, 23.1322, 23.1331, 23.1351, 23.1353, 23.1357, 23.1359, 23.1361, 23.1365, 23.1367, 23.1381, 23.1431, 23.1501, 23.1523, 23.1529, 23.1541, 23.1543, 23.1559, 23.1581, 23.1583, 23.1585;

(3) Part 25, §§ 25.303, 25.305, 25.562, 25.625, 25.771, 25.773, 25.777, 25.789, 25.863, 25.1301, 25.1303, 25.1309, 25.1321, 25.1322, 25.1331, 25.1351, 25.1353, 25.1357, 25.1431, 25.1523, 25.1529, 25.1543, 25.1581, 25.1583, 25.1585, 25.1587;

(4) Part 27, §§ 27.303, 27.305, 27.562, 27.625, 27.771, 27.773, 27.777, 27.863, 27.1301, 27.1303, 27.1309, 27.1321, 27.1322, 27.1351, 27.1353, 27.1357, 27.1523, 27.1529, 27.1543, 27.1581, 27.1583, 27.1585, 27.1587; and

(5) Part 29, §§ 29.303, 29.305, 29.562, 29.625, 29.771, 29.773, 29.777, 29.863, 29.1301, 29.1303, 29.1309, 29.1321, 29.1322, 29.1331, 29.1351, 29.1353, 29.1357, 29.1431, 29.1523, 29.1529, 29.1543, 29.1581, 29.1583, 29.1585, 29.1587.

b. Operating Regulations. These acceptable means of compliance refer to the applicable sections of Parts 91, 121, 125, and 135.

(1) Part 91, §§ 91.9, 91.21, 91.103, 91.503, 91.605, 91.611;

(2) Part 121, §§ 121.117, 121.133, 121.135, 121.137, 121.139, 121.141, 121.306, 121.549, 121.565, 121.571, 121.681, 121.683, 121.687, 121.689, 121.693, 121.695, 121.701, 121.709;

(3) Part 125, §§ 125.23, 125.71, 125.73, 125.75, 125.204, 125.215, 125.323, 125.327, 125.383, 125.403, 125.405, 125.407, 125.411; and

(4) Part 135, §§ 135.21, 135.23, 135.63, 135.81, 135.83, 135.144, 135.179, 135.293.

4. RELATED READING MATERIALS. See Appendix D for an extensive list of related reference materials.

5. DEFINITIONS. The following definitions are specific to this AC and may differ with those definitions contained in other published references.

a. Aircraft Administrative Communications (AAC). AAC data link receive/transmit information that includes, but is not limited to, the support of applications identified in Appendixes A and B.

b. Applicant. Anyone seeking product and installation certification of an EFB. In this context, “product” refers to hardware and software, whether sold separately or embedded in an EFB system.

c. Electronic Flight Bag (EFB). An electronic display system intended primarily for cockpit/flightdeck or cabin use. EFB devices can display a variety of aviation data or perform basic calculations (e.g., performance data, fuel calculations, etc.). In the past, some of these functions were traditionally accomplished using paper references or were based on data provided to the flightcrew by an airline’s “flight dispatch” function. The scope of the EFB system functionality may also include various other hosted databases and applications. Physical EFB displays may use various technologies, formats, and forms of communication. These devices are sometimes referred to as auxiliary performance computers (APC) or laptop auxiliary performance computers (LAPC).

d. Data Link Connectivity for Class 2 EFB Systems. Supports functions for which failures or design errors could not degrade aircraft capability or flightcrew ability.

e. Hosted Application. Software installed on an EFB system that allows specific operational functionality.

f. Interactive Information. Information presented on the EFB that, via software applications, can be selected and rendered in a number of dynamic ways. This includes variables in the information presented based on data-oriented software algorithms, concepts of decluttering, and “on-the-fly” composition as opposed to pre-composed information.

g. Portable Electronic Device (PED). Section 91.21 refers to PEDs. As defined in this AC, Class 1 and 2 EFBs are considered PEDs.

h. Pre-Composed Information. Information previously composed into a static composed state (non-interactive). The composed displays have consistent, defined and verifiable content, and formats that are fixed in composition.

i. “Flight Dispatch” Applications. Software installed on a basic EFB system that has traditionally been used by operators before flight for planning, scheduling, performance calculations, and administrative functions. Ground-use flight dispatch software is not currently required to meet the software guidelines of Radio Technical Commission for Aeronautics (RTCA)/DO-178B, Software Considerations in Airborne Systems and Equipment Certification.

6. BACKGROUND.

a. Operators have long recognized the benefits of using portable electronic computing devices, including commercially available portable computers, to perform a variety of functions traditionally accomplished using paper references. EFB systems may be approved for use in conjunction with or replace some of the hard copy material that pilots typically carry in their flight bags.

b. EFBs can electronically store and retrieve documents required for flight operations, such as the General Operations Manual (GOM), Minimum Equipment Lists (MEL), Operations Specifications (OpSpecs), and control documents. (Note that maintenance discrepancy logs need to be downloaded into a permanent record at least weekly.) EFB systems are being developed to support functions during all phases of flight operations.

7. SCOPE. This AC defines three functional classes of EFB systems and establishes certification, airworthiness/installation, and operational approval guidance for these Class 1, 2, and 3 EFB systems used by flightdeck crewmembers and other crewmembers in the cabin.

a. Class 1 and Class 2 EFB systems are generally commercial-off-the-shelf (COTS)-based computer operating systems and application programs that are used for aircraft operations. From an operational-use perspective, Class 1 EFB systems are portable, not attached to an aircraft-mounting device, and do not require an administrative control process for use in the aircraft. Class 2 EFB systems are portable systems that are connected to an aircraft mounting device during normal operation and require an administrative control process for use in the aircraft. Class 1 and 2 EFB systems are considered PEDs. Class 2 EFB system power, data link connectivity, and mounting devices require aircraft evaluation group (AEG) evaluation and certification approval from AIR.

b. Class 3 EFB systems are considered installed equipment and will require a Supplemental Type Certificate (STC) or certification design approval that includes, but is not limited to, conducting a functional hazard assessment and compliance with RTCA/DO-178B. The Class 3 EFB system certification requirements may enable additional functionality (e.g., Global Positioning System (GPS), or Automatic Dependent Surveillance-Broadcast (ADS-B), which are moving maps suitable for situational awareness or navigation). This AC does not supersede existing certification guidance material for the

approval of intended function for Communication, Navigation, and Surveillance (CNS) functions, but does provide criteria in determining EFB Class 3 functionality.

c. The primary guidance material described in this AC for the Class 1 and 2 EFB system functionality is for transition from the traditional flight bag paper products to an electronic format. This AC is intended to be used in combination with other material contained in current CNS ACs or other Federal Aviation Administration (FAA)-approved guidance material. For this reason, this AC is intended to provide specific guidance material for certain EFB applications and approvals. This AC does not provide airworthiness or guidance information for the principal inspector (PI) to evaluate many CNS functions including moving maps, aircraft/own-ship position, and interactive weather products.

d. This AC by itself may not be used to install additional CNS functionality on the Class 1 and 2 EFB systems other than what is described in Appendixes A and B. However, it may be used in combination with other FAA-approved guidance material to add CNS functionality for Class 1 and 2 EFB systems.

8. EFB CLASSIFICATIONS FOR AIRWORTHINESS CERTIFICATION AND OPERATIONAL APPROVAL. The EFB criteria listed in Table 1, combined with the text contained in the body of this AC, should be used to determine the EFB system classification and derived certification and operational approval basis. All applications and information contained in the EFB approved for operational use must be current and up-to-date. See Appendixes A through C for an extensive list of EFB system application examples. The following guidance is for determining EFB system classification and roles and responsibilities.

a. Class 1 EFB Systems. The operator should provide evidence to the Principal Operations Inspector (POI) demonstrating that the Class 1 EFB operating system and software for each hosted application meets the criteria for the appropriate intended function. Class 1 EFB functionality is more limited than the Class 2 EFB system functionality as portable devices because they are not secured by an aircraft mounting device and are required to be stowed for takeoff and landing. Also, power and data link connectivity for Class 1 EFB systems are not allowed during operational use.

(1) Class 1 EFB Systems:

- May be used on the ground and during flight as a source of *supplemental information*
- Do not connect to ship's power during normal use
- Batteries may be recharged onboard the aircraft
- May not provide any data link connectivity to other aircraft systems during flight
- May not use a GPS source

(2) Certificate holders should document EFB non-interference compliance in accordance with the guidance in AC 91.21-1, current version, Use of Portable Electronic Devices Aboard Aircraft.

b. Class 2 EFB Systems. Portable Class 2 EFB systems are attached to the aircraft by a structural mounting device. In addition to being attached to aircraft mounting devices, portable Class 2 EFB systems may connect to aircraft power and data link ports during normal operation and use. The EFB power and data link connectivity ports should be attached to the mounting device. The EFB should

connect to the mounting device to receive power or data link connectivity. Class 2 EFB systems with aircraft specific software applications will necessitate that operators establish a means to remove and reinstall this equipment.

(1) Certification, operational, and operator requirements need to be met before receiving approval to use this equipment, specifically:

- Class 2 EFB systems represent a class of COTS electronics equipment (i.e., “pen tablet computers”) that has been adapted for use in aircraft. The POI should document EFB Class 2 compliance for performing its intended function.
- The AEG will document EFB non-interference compliance in accordance with the guidance in AC 91.21-1, current version.
- AIR evaluation and design approval will be limited to airworthiness approval of the cradle (crashworthiness), data link connectivity, and EFB power connection(s).
- EFB data link ports require AIR approval to ensure non-interference and isolation from aircraft systems during transmission and reception. The EFB data link may receive information from any aircraft system as well as receive or transmit information for AAC purposes. Connectivity may be wired or wireless.
- Class 2 EFBs do not require an AIR design approval.
- Class 2 EFBs do not require compliance with RTCA/DO-178B software.
- Class 2 EFBs do not require compliance with RTCA/DO-160D, Environmental Conditions and Test Procedures for Airborne Equipment.
- Aircraft Flight Manual Supplement (AFMS) updates are not required for Class 2 EFB systems.
- Class 2 EFB systems are portable equipment and may be removed from the aircraft through an administrative control process (e.g., log book entry).
- Operators must determine non-interference with existing aircraft systems for all flight phases and ensure that the system performs the intended function.
- AFS initial operational approval will be granted, as appropriate, for hosted performance applications based on AEG recommendations to include flightcrew training, checking, and currency requirements per the draft Flight Standardization Board (FSB) Report.
- The POI will grant authority for a 6-month operational evaluation in OpSpec A025. This evaluation period requires both the EFB and paper copies before final approval allowing the EFB to reduce or eliminate paper copies on the flightdeck.
- Operators must submit a final report to the POI and the AEG after the 6-month evaluation period of the EFB system. Final approval will be granted through the FSB Report. The POI grants approval per OpSpec A025.

- AFS and AIR should conduct a human factors evaluation of the EFB mounting device and flightdeck location.
- Class 2 EFBs may be used to display flight critical pre-composed information such as charts or approach plates for navigation. Required flight information should always be presented during critical phases of flight.
- Operators must determine the use of hardware and/or software architectural features, people, procedures, and or equipment to eliminate, reduce, or control risks associated with an identified failure in a system.

(2) The operator should provide evidence to the POI (in conjunction with AEG) demonstrating that the Class 2 EFB operating system and hosted application software meet the criteria for the appropriate intended function and do not provide false or hazardously misleading information. This evidence includes a demonstration that software revisions will not corrupt the data integrity of the original software version when it was first installed and “baselined” and shown to meet its intended function.

(3) Interactive Weight and Balance Calculations.

- Operational procedures should be developed in accordance with § 121.133. These procedures should define the roles that the flightcrew and dispatch/flight-following have in creating, reviewing, and using performance calculations supported by EFBs.
- An EFB that provides interactive performance calculations must have its baseline software programs and functions evaluated by the AEG prior to FAA approval.
- FAA approval for the use of the EFB is based on the operator’s training and procedures, the AEG recommendation, and the FSB Report.
- FAA authorization for the use of EFBs for this intended function is indicated in OpSpec A025.
- If used for weight and balance calculations, OpSpec E096 should list the EFB in the approved method for weight and balance calculations.

(4) For Class 2 EFBs, panning, scrolling, zooming, or other active manipulation is not permissible for approach charts. Electronic navigation charts should provide a level of information integrity equivalent to paper charts.

c. Class 3 EFB Systems. All Class 3 EFB systems require an STC or certification design approval including, but not limited to, compliance with RTCA/DO-160D and RTCA/DO-178B. (Reference AC 20-115, Radio Technical Commission for Aeronautics, Inc. Document RTCA/DO-178B, current version.) This AC does not supersede any of the existing certification guidelines for airborne avionics but does provide criteria in determining EFB Class 3 functionality.

d. Table 1, EFB Classifications. This table provides criteria to aid in determining:

- EFB Type
- AIR Involvement

- AEG Involvement
- Operator Requirements
- Type of Data Functionality
- Principal Avionics Inspector (PAI) Involvement
- POI Acceptance/Approval Guidance Criteria

**TABLE 1.
EFB CLASSIFICATIONS**

EFB Type	AIR Involvement	AEG Involvement	Operator Requirements	Type of Data Functionality	PAI Involvement	POI Acceptance/Approval
<p>Class 1 EFB</p> <p>*Portable (battery powered)</p> <p>*EFB may not connect to ship's power during normal operational use</p> <p>*EFB power connectivity is limited to the battery charger</p> <p>*May be recharged when not in use</p> <p>*No data link connectivity</p> <p>*Required to be stowed for takeoff and landing (including charger)</p>	No – unless power connection and battery charger is installed	No	<p>Yes – non-interference testing required per § 91.21</p> <p>*Supplemental use only – must have “paper” onboard at all times</p> <p>*Non-interference with existing aircraft systems for all phases of flight</p>	<p>Reference materials and checklists in pre-composed information, and performance calculations</p> <p>(See Appendix A for examples of Class 1 hosted applications)</p>	Yes – for data updates according to the maintenance manual or inspection program, which includes all pre-composed information allowed on this EFB	<p><u>Part 91</u>: No requirement</p> <p><u>Parts 121, 125, and 135</u>: POI accepts data as presented</p> <p><u>Parts 121 and 135</u>: Training required as appropriate</p>

TABLE 1. Cont'd

EFB Type	AIR Involvement	AEG Involvement	Operator Requirements	Type of Data Functionality	PAI Involvement	POI Acceptance/Approval
<p>Class 2 EFB</p> <p>*Connects to the ship's power source during normal operational use</p> <p>*May be removed from aircraft</p> <p>*May have data link connectivity for "one-way"/read only reception</p> <p>*May have data link receive/transmit functionality to support Aircraft Operational Communications (AOC) functions</p>	<p>Yes – STC'd for:</p> <p>*Crashworthiness cradle</p> <p>*Power connection</p> <p>*Data link connectivity at aircraft connector, if installed</p> <p>*Will not verify EFB intended function or non-interference</p>	<p>Yes</p> <p>As defined in this AC for Class 2 (including software programs)</p> <p>*Functions will be evaluated by AEG FSB</p>	<p>Yes – non-interference testing required per § 91.21</p> <p>*Paper may not be required after successful operations evaluation time period</p> <p>*Operator must show non-interference w/existing aircraft systems for all phases of flight</p> <p>*Maintenance manual/ Inspection program to have procedures for removal/ installation</p>	<p>Reference materials and checklists using pre-composed information, approach plates, navigation charts, and performance calculations</p> <p>(See Appendix B for examples of Class 2 hosted applications)</p>	<p>Yes – for data updates according to the maintenance manual or inspection program (This includes all pre-composed information allowed on this EFB plus conformity inspection regarding STC or Designated Engineering Representative (DER) data)</p> <p>*Ensure the maintenance manual/inspection program has procedures for removal/installation (Note: aircraft specific)</p> <p>*Removal/ replacement of EFB does not constitute a maintenance function</p>	<p><u>Part 91:</u> No requirement</p> <p><u>Part 125:</u> *Testing as required by FSB Report</p> <p>*Approval by OpSpec A025</p> <p><u>Parts 121 and 135:</u> *Approves hosted applications based on AEG's recommendation</p> <p>*POI accepts data as presented – FSB Report</p> <p>*Training, checking, currency required per the FSB Report</p> <p>*Approval through OpSpec A025</p>
<p>Class 3 EFB</p>	<p>Yes</p>	<p>Yes</p>	<p>Per Cert & FSB documents</p>	<p>Per Cert & FSB documents. (See Appendix C for examples of Class 3 hosted applications)</p>	<p>Per Cert & FSB documents</p>	<p>Per Cert & FSB documents</p>

9. RISK MITIGATION FOR CLASS 2 AND 3 EFB SYSTEMS.

a. During the transition period to a true paperless cockpit, an operator will need to establish a reliable back-up means of providing the information required by the regulations to the flightcrew. During this period, an EFB system must demonstrate that it produces records that are as available and reliable as provided by the current paper information system. If an operator wants to transition to a paperless cockpit, an acceptable process should be developed with the operator's POI. Mitigation may be accomplished by a combination of the following, or by other risk mitigation procedures and techniques:

- (1) System design.
- (2) Separate and back-up power sources.
- (3) Redundant EFB systems.
- (4) Paper products carried by selected crewmembers.
- (5) Complete set of sealed paper back-ups in cockpit.
- (6) Procedural means.

b. If one or more onboard EFBs fail, resulting in loss of function or the presentation of false or hazardingly misleading information, a contingency plan or process will need to be in place to provide the required information. For example, as a back-up to eliminating printed approach charts, an acceptable transition to a "paperless cockpit" could include the following:

- (1) Carrying paper products for a given time period to validate EFB reliability by quantitative means;
- (2) Using an aircraft printing device to print all applicable data required for the flight; and
- (3) Using an aircraft fax machine to uplink equivalent paper documents to the cockpit.

c. Final approval for a Class 2 paperless cockpit requires:

- (1) An independent reliable EFB system for each flight crewmember;
- (2) A final FSB evaluation report; and
- (3) OpSpec A025 approval.

d. Final approval for a Class 2 "reduced paper" cockpit requires:

- (1) A single reliable EFB system;
- (2) One complete paper set of all applicable data;
- (3) Final FSB evaluation report; and
- (4) OpSpec A025 approval.

10. HUMAN FACTORS CONSIDERATIONS FOR PORTABLE AND INSTALLED CLASS 1, 2, AND 3 EFB SYSTEMS. The human factors/pilot interface characteristics of the EFB system should be evaluated. Special attention should be paid to new or unique features that may affect pilot performance.

a. Human Factors Guidance Documents.

(1) AC 23-1311, Installation of Electronic Displays in Part 23 Airplanes, current version.

(2) AC 25-11, Transport Category Airplane Electronic Display Systems.

(3) FAA Policy Statement ANM-99-2, Guidance for Reviewing Certification Plans to Address Human Factors for Certification of Transport Airplane Flight Decks. This document provides guidance for reviewing the human factors components of the certification plan for transport category airplanes, as well as defining what should be specifically included in these plans.

(4) FAA Policy Statement ANM-01-03, Factors to Consider When Reviewing an Applicant's Proposed Human Factors Methods for Compliance for Flight Deck Certification. This document provides additional guidance on factors to consider when reviewing an applicant's proposed method of compliance identified in a human factors or general certification plan. While this policy statement is tailored for Part 25 airplanes, much of the guidance is general and may prove useful regardless of the make, model, or class of aircraft.

(5) DOT-VNTSC-FAA-00-22, Human Factors Considerations in the Design and Evaluation of Electronic Flight Bags (EFBs), Version 1: Basic Functions. This reference is recommended as general guidance to ensure that human factors/pilot interface issues are resolved.

(6) RTCA/DO-257, Minimum Operational Performance Standards for the Depiction of Navigation Information on Electronic Maps.

b. EFB System Design and Usability.

(1) **Human/Machine Interface.** The EFB user interface should provide a consistent and intuitive user interface within and across various EFB applications. The interface design, including, but not limited to, data entry methods, color-coding philosophies, and symbology, should be *consistent* across the EFB and various hosted applications. These applications should also be *compatible* with other flightdeck systems. For Class 2 and 3 EFB systems, an independent EFB system for each flight crewmember is required to meet the requirements of the operational regulations.

(2) **Design of Structural Cradle.** The structural cradle (or other securing mechanism) that attaches or allows "docking" of the EFB system may not be mounted in a way that obstructs visual or physical access to aircraft controls and/or displays, flightcrew ingress or egress, or external vision. The design of the cradle should allow the user easy access to all EFB controls and a clear view of the EFB display. The following design practices should be considered:

(a) The cradle structure and associated mechanism should not impede the flightcrew in the performance of any task (normal, abnormal, or emergency) associated with operating any aircraft system.

(b) Cradle structures should be able to lock in position easily. Selection of locking positions must be fine enough to accommodate a range of flight crewmember preferences. In addition, the range of available selections should accommodate the expected range of users' physical abilities (i.e., anthropometric constraints). Locking mechanisms should be of the low-wear type that will minimize

slippage after extended periods of normal use. Crashworthiness considerations will need to be considered in the design of this device. This includes the appropriate restraint of any class device when in use.

(c) A provision should be provided to secure or lock the cradle structure in a position out of the way of flight crewmember operations when not in use.

(d) If the EFB requires cabling to mate with aircraft systems or other EFBs, and if the cable is not run inside the cradle structure, the cable should not hang loosely in a way that compromises task performance and safety. Flight crewmembers should be able to easily secure the cables out of the way during aircraft operations (e.g., cable tether straps).

(e) Cables that are external to the cradle structure should be of sufficient length to perform the intended tasks. Cables too long or short could present an operational or safety hazard.

(3) Placement of Structural Cradle. The cradle should be mounted so that the EFB is easily accessible when stowed. When the EFB is in use and is intended to be viewed or controlled, it should be within 90 degrees on either side of each pilot's line of sight. If an EFB is being used to display flight critical information such as for navigation, terrain and obstacle warnings that require immediate action, takeoff and landing V speeds, or for functions other than situational awareness, then such information needs to be in the pilot's primary field of view. A 90-degree viewing angle may be unacceptable for certain EFB applications if aspects of the display quality are degraded at large viewing angles (e.g., the display colors wash out or the displayed color contrast is not discernible at the installation viewing angle). In addition, consideration should be given to the potential for confusion that could result from presentation of relative directions (e.g., positions of other aircraft on traffic displays) when the EFB is positioned in an orientation inconsistent with that information. For example, it may be misleading if own aircraft heading is pointed to the top of the display and the display is not aligned with the aircraft longitudinal axis. Each EFB should be evaluated with regard to these requirements. (See §§ 23.1321 and 25.1321.)

(4) Legibility of Text. Text displayed on the EFB should be legible to the typical user at the intended viewing distance(s) and under the full range of lighting conditions expected on a flightdeck, including use in direct sunlight. Users should be able to adjust the screen brightness of an EFB independently of the brightness of other displays on the flightdeck. In addition, when automatic brightness adjustment is incorporated, it should operate independently for each EFB in the flightdeck. Buttons and labels should be adequately illuminated for night use. All controls must be properly labeled for their intended function. Consideration should be given to the long-term display degradation as a result of abrasion and aging.

(5) Approach/Departure and Navigation Chart Display.

(a) The approach, departure, and navigation charts that are depicted should contain the information necessary, in appropriate form, to conduct the operation to at least a level of safety equivalent to that provided by paper charts. It is desirable that the EFB display size be at least as large as current paper approach charts and that the format be consistent with current paper charts. Alternate approach plate presentations may be acceptable, but will need to be evaluated and approved by the FSB process for functionality and human factors.

(b) In contrast to Class 2 EFB systems that are evaluated by the AEG-FSB report process, Class 3 systems will require a certification evaluation and design approval. In all cases the FSB Report should include, but not be limited to, the following:

- Pilot workload in both single-pilot and multi-crew flown aircraft
- Size, resolution, and legibility of symbols and text
- Access to desired charts
- Access to information within a chart
- Grouping of information
- General layout
- Orientation (e.g., track-up, north-up)
- Depiction of scale information

(6) Responsiveness of Application. The system should provide feedback to the user when user input is accepted. If the system is busy with internal tasks that preclude immediate processing of user input (e.g., calculations, self-test, or data refresh), the EFB should display a “system busy” indicator (e.g., clock icon) to inform the user that the system is occupied and cannot process inputs immediately. The timeliness of system response to user input should be consistent with an application’s intended function. The feedback and system response times should be predictable to avoid flightcrew distractions and/or uncertainty.

(7) Off-Screen Text and Content. If the document segment is not visible in its entirety in the available display area, such as during “zoom” or “pan” operations, the existence of off-screen content should be clearly indicated in a consistent way. For some intended functions it may be unacceptable if certain portions of documents are not visible. This should be evaluated based on the application and intended operational function. If there is a cursor, it should be visible on the screen at all times while in use.

(8) Active Regions. Active regions are regions to which special user commands apply. The active region can be text, a graphic image, a window, frame, or other document object. These regions should be clearly indicated.

(9) Managing Multiple Open Applications and Documents. If the electronic document application supports multiple open documents, or the system allows multiple open applications, indication of which application and/or document is active should be continuously provided. The active document is the one that is currently displayed and responds to user actions. Under non-emergency, normal operations, the user should be able to select which of the open applications or documents is currently active. In addition, the user should be able to find which flightdeck applications are running and switch to any one of these applications easily. When the user returns to an application that was running in the background, it should appear in the same state as when the user left that application – other than differences associated with the progress or completion of processing performed in the background.

(10) Input Devices. In choosing and designing input devices such as keyboards or cursor-control devices, applicants should consider the type of entry to be made and flightdeck environmental factors, such as turbulence, that could affect the usability of that input device. Typically, the performance parameters of cursor control devices should be tailored for the intended application function as well as for the flightdeck environment.

c. Flightcrew Workload. EFB software should be designed to minimize flightcrew workload and head-down time. [See §§ 23.1523, 25.1523, 27.1523, 29.1523, and the associated AC, AC 25.1523-1, Minimum Flightcrew (much of the guidance in this AC is general and may prove useful for other aircraft categories as well).] The positioning of the use and stowage locations for the EFB should not result in unacceptable flightcrew workload. Complex, multi-step data entry tasks should be avoided during takeoff, landing, and other critical phases of flight. An evaluation of EFB intended functions should include a qualitative assessment of incremental pilot workload, as well as pilot system interfaces and their safety implications. If an EFB is to be used during critical phases of flight, such as during takeoff and landing or during abnormal and emergency operations, its use should be evaluated under simulations and actual aircraft depicting those conditions.

d. Messages and the Use of Colors.

(1) Messages and the Use of Colors. For any EFB system, EFB messages and reminders should meet the requirements in §§ 23.1322 or 25.1322, as is appropriate for the intended aircraft. While the regulations refer to lights, the intent should be generalized to extend to the use of colors on displays and controls. That is, the color “red” shall be used only to indicate a warning level condition. “Amber” shall be used to indicate a caution level condition. Any other color may be used for items other than warnings or cautions, providing that the colors used differ sufficiently from the colors prescribed to avoid possible confusion. EFB messages and reminders should be integrated with (or compatible with) presentation of other flightdeck system alerts. EFB messages, both visual and auditory, should be inhibited during critical phases of flight. Flashing text or symbols should be avoided in any EFB application. Messages should be prioritized and the message prioritization scheme evaluated and documented. Additionally, during critical phases of flight, required flight information should be continuously presented without un-commanded overlays, pop-ups, or preemptive messages, except those indicating the failure or degradation of the current EFB application. However, if there is a regulatory or Technical Standard Order (TSO) requirement that conflicts with the recommendation above, those supersede this guidance.

(2) System Error Messages. If an application is fully or partially disabled, or is not visible or accessible to the user, it may be desirable to have a positive indication of its status available to the user upon request. Certain non-essential applications such as e-mail connectivity and administrative reports may require an error message when the user actually attempts to access the function rather than an immediate status annunciation when a failure occurs. EFB status and fault messages should be prioritized and the message prioritization scheme evaluated and documented.

(3) Data Entry Screening and Error Messages. If user-entered data is not of the correct format or type needed by the application, the EFB should not accept the data. An error message should be provided that communicates which entry is suspect and specifies what type of data is expected. The EFB system and application software should incorporate input error checking that detects input errors at the earliest possible point during entry, rather than on completion of a possibly lengthy invalid entry.

e. Error and Failure Modes.

(1) Flightcrew Error. The system should be designed to minimize the occurrence and effects of flightcrew error and maximize the identification and resolution of errors. For example, terms for specific types of data or the format in which latitude/longitude is entered should be the same across systems. Data entry methods, color-coding philosophies and symbology should be as *consistent* as possible across the various hosted EFB applications. These applications should also be *compatible* with other flightdeck systems.

(2) Identifying Failure Modes. The effects of undetected errors in all EFB applications should be evaluated for each application. The assessment should address the adequacy of the human/machine interface, accessibility of controls, ability to view controls, annunciators, displays and printers, and the effect on flightcrew workload and head-down time. The assessment should also consider the effects of flightcrew (procedural) errors determined by comments from the professional pilot community. The EFB system should be capable of alerting the flightcrew of probable EFB application/system failures.

f. Procedures.

(1) Procedures for Using EFBs With Other Flightdeck Systems. Procedures should be designed to ensure that the flightcrew knows what aircraft system (e.g., Engine Indicating and Crew Alerting System (EICAS), Flight Management System (FMS), or EFB) to use for a given purpose, especially when both the aircraft and EFB systems provide information. Procedures should also be designed to define the actions to be taken when information provided by an EFB does not agree with that from other flightdeck sources, or when one EFB disagrees with another. If an EFB generates information that existing cockpit automation also generates, procedures should be developed to identify which information source will be primary, which source will be used for back-up information, and under what conditions to use the back-up source. Whenever possible and without compromising innovation in design/use, EFB/user interfaces should be consistent (but not necessarily identical) with the flightdeck design philosophy.

(2) Flightcrew Awareness of EFB Software/Database Revisions. The operator should have a procedure in place to allow flightcrews to confirm the revision numbers and/or dates of EFB flight databases and software installed on their units for each flight. However, flightcrews should not be required to confirm the revision dates for other databases that do not adversely affect flight operations, such as maintenance log forms, a list of airport codes, or the Captain's Atlas. An example of a date-sensitive revision is an aeronautical chart database on a 28-day revision cycle. Procedures should specify what action to take if the applications or databases loaded on the EFB are out-of-date.

(3) Procedures to Mitigate and/or Control Workload. Procedures should be designed to mitigate and/or control additional workloads created by using an EFB.

(4) Defining Responsibilities for Performance Calculations. Procedures should be developed that define any new roles that the flightcrew and dispatch may have in creating, reviewing, and using performance calculations supported by EFBs.

(5) Electronic Checklists. Guidance pertaining to electronic checklists is found in AC 120-64, Operational Use & Modification of Electronic Checklists.

11. EFB SYSTEM DESIGN CONSIDERATIONS.

a. Use of Aircraft Electrical Power Sources. Aircraft electrical power outlets are part of the type design of the aircraft and require airworthiness certification. Additionally, electrical outlet connections should be appropriately labeled to identify the electrical characteristics (e.g., 28VDC, 115VAC, 60 or 400 Hz., etc.).

NOTE: For Class 1 and 2 EFB systems, an electrical load analysis should be conducted to ensure that powering or charging the EFB will not adversely affect other aircraft systems and that power requirements remain within power-load budgets. A means (other than a circuit breaker) for the flightcrew to de-power the EFB power source or system charger may be desirable.

b. Electrical Back-up Power Source. Some Class 2 EFB applications, especially when used as a source of primary information, will require an alternate power supply to achieve an acceptable level of safety. Additionally, the applicant should ensure that any batteries contained in any EFB comply with Parts 21, 23, 25, 27, and 29, as applicable. The operator is also responsible for establishing a battery replacement schedule for each unit and ensuring that the batteries are replaced as required.

c. Environmental Hazards Identification and Qualification Testing. Class 1 and 2 EFB system radio frequency (RF) emissions data need to be evaluated in accordance with AC 91.21-1, current version. Class 1 and Class 2 EFB systems should demonstrate that they meet appropriate industry-adopted environmental qualification standards for radiated emissions for equipment operating in an airborne environment. Any Class 1 or Class 2 EFB used in aircraft flight operations should be demonstrated to have no adverse impact on other aircraft systems (non-interference). The manufacturer, installer, or operator may accomplish the testing and validation to ensure proper operation and non-interference with other installed systems. Possible interference when portable EFB systems are moved about in the cockpit should be addressed.

d. Rapid Depressurization Testing. Other environmental testing, specifically testing for rapid depressurization, may need to be performed. However, since many Class 1 and Class 2 EFBs were originally COTS electronic systems adopted for aviation use, testing done on a specific EFB model configuration may be applied to other aircraft installations and these generic environmental tests need not be duplicated. It is the responsibility of the operator seeking approval authorization to provide documentation that these tests have been accomplished.

e. EFB Retention Devices (e.g., Cradles, Docking Stations). An unsafe condition must not be created when attaching any EFB control yoke attachment/mechanism or mounting device. For example, the weight of the EFB and mounting bracket combination may affect flight control system dynamics, even though the cradle alone may be light enough to be insignificant. The equipment when mounted and/or installed should not present a safety-related risk or associated hazard to any flight crewmember. A means to store or secure the device when not in use should be provided. Additionally, the unit (or its mounting structure) should not present a physical hazard in the event of a hard landing, crash landing, or water ditching. EFBs and their power cords should not impede emergency egress.

f. Stowage Area for EFB Systems. A stowage area with a securing mechanism for these EFBs is recommended for storage of portable units when they are not in use. EFB systems that are not secured in a structural cradle during use should be designed and used in a manner that prevents the device from jamming flight controls, damaging flightdeck equipment, or injuring flight crewmembers should the device move about as a result of turbulence, maneuvering, or other action.

g. Class 2 and 3 EFB System Connections to Other Aircraft Systems. This includes data bus and communication systems access, e.g., through an avionics data bus, server, or wireless network.

(1) Class 2 EFB systems may be connected to non-essential data buses, file servers, printers, routers, etc. If the EFB is connected to a certified data link (either wired or wireless) where the data link, through the certification process, has an approved firewall protection to aircraft systems, then there is no further evaluation required prior to connecting the EFB to the data link port. If a Class 3 EFB is connected to an essential data bus, then compliance with lightning protection requirements should be demonstrated. If the Class 3 EFB is connected to a critical aircraft data bus, then compliance with High Intensity Radiated Fields (HIRF) and lightning protection requirements should be demonstrated. The safety and non-interference aspects of using portable and/or wireless technology connections to installed equipment will also need to be evaluated as part of the overall operational approval process.

(2) When connected to other aircraft data buses and/or communication systems, EFB failures should not adversely affect other installed aircraft communications systems. Class 2 EFB systems are limited to AAC. Class 3 EFB systems may be used for other aircraft data communication applications and subnetworks that interface with the EFB, but should not be disrupted by any of the following:

- (a) Excessive number of EFB message transactions;
- (b) EFB messages with improper format; and
- (c) EFB messages that contain erroneous data. The validity of this protection may be established by analysis and/or test for worst-case conditions.

h. Integrity Considerations. The software operating system and hosted-application software resident on Class 1 and 2 EFB systems do not require an airworthiness certification evaluation. The EFB system must be evaluated by the AEG and POI and demonstrated to meet its intended functions prior to their granting operational approval. Additionally, data contained in the data files must be of sufficient integrity to perform the intended functions without producing false or hazardously misleading information.

12. OPERATIONAL APPROVAL PROCESS. The introduction and use of EFBs in the cockpit and cabin of Part 121, 125, and 135 operations requires operational approval. This requirement includes FAA approval of all operating procedures, pertinent training modules, checklists, operations manuals, training manuals, maintenance programs, MELs, other pertinent documents, and reporting procedures. Legacy systems will need to be evaluated by the AEG and documented using historical approvals and the FSB Report process.

a. In contrast to Part 121, 125, and 135 operations, Part 91 operations do not specifically require operational approval.

b. Approval Process. FAA Order 8400.10, Air Transportation Operations Inspector's Handbook, Volume 3, chapter 9, Proving and Validation Test, contains instructions for the completion of a five-step approval process. The process leads to formal operational approval and consists of the following five phases:

(1) **Phase One.** Phase one of the approval process begins when an operator requests authorization from the FAA. The FAA and the operator must reach a common understanding of what the operator must do, what role the FAA will have, and what reports and documents must be prepared as part of the approval process.

(2) **Phase Two.** Phase two begins when the operator submits a plan to the FAA for formal evaluation. During this phase, the FAA must ensure that the plan is complete and in an acceptable format before it can conduct a thorough review and analysis. The operator coordinates the plan with the POI or other inspectors, as assigned. The POI or other assigned inspectors will facilitate coordination with the AEG and the Aircraft Certification Office (ACO), as necessary.

(3) **Phase Three.** Phase three begins when the FAA starts its in-depth review and analysis of the operator's plan for regulatory compliance, safe operating procedures, a logical sequence, and other areas (e.g., flightcrew and dispatcher qualifications, acceptable procedures, and schedules for accomplishment).

(4) **Phase Four.** Phase four is the major phase of the process and involves validation testing. In this phase, the operator conducts specific operations for the purpose of data collection or for

FAA observation purposes. Phase four concludes when the operator provides sufficient proof to satisfy the FAA's requirement for meeting all the plan objectives or when the operator is unable to complete them satisfactorily.

(5) Phase Five. Phase five begins after the successful completion (or termination) of the validation phase. In this phase, the FAA grants approval for those elements in the plan that were successfully completed and documented in the FSB Report, or sends the operator a letter of disapproval for those elements that were not completed or were terminated. The PI grants approval for the operational use of the EFB through the issuance of OpSpec A025.

c. Operational Procedures Development.

(1) The intended function(s) of EFBs may vary, depending on the device used and the software applications hosted by the computer. It is extremely important that the applicant and/or operator specifically define the intended EFB functions in a clear and concise manner. Operational procedures developed to achieve a specific intended function or use should consider the applications listed in the attached appendices.

(2) Operators will be expected to:

(a) Have procedures that define how the flightcrew is expected to use each EFB function during ground operations and under all flight conditions;

(b) Provide the procedures to flightcrews;

(c) Provide procedures for normal, abnormal, and emergency use; and

(d) Review and determine whether to modify those existing policies and procedures affected by the introduction of EFBs into line operations.

d. EFB Configuration Control. The make and model of the approved EFB equipment must be approved through the FSB process and the following information listed in OpSpec A025:

(1) Operating system to include version control;

(2) Application program version control;

(3) Approved source for the database updates; and

(4) Make and model of the EFB hardware, including a tracking process for major internal subcomponents whose replacement/upgrade may necessitate additional non-interference testing.

e. Database Update Process. The certificate holder or operator needs to establish specific procedures to verify that revisions to the database contained in its EFB are current, complete, and were authorized for release by the appropriate authority before distribution. Unauthorized modification or installation of any new database (e.g., approach plates, navigation charts) intended for operational use will not be permitted unless the new database has been demonstrated to comply with the original approval basis. Certificate holders and operators also need to establish revision control procedures so that flightcrews and others can ensure that the contents of the system are current and complete. These revision control procedures may be similar to the revision control procedures used for paper or other storage

media. For data that is subject to a revision cycle control process, it should be readily evident to the user which revision cycle has been incorporated in the information obtained from the system.

f. Software Revision Process.

(1) It is the responsibility of the applicant and/or the application software vendor to ensure that its operating system and application programs meet the intended function. Unauthorized modification of any database or the loading of any new or additional software intended for operational use must not be permitted unless that software is demonstrated to comply with the original approval basis. For Class 2 EFBs, the FSB Report will identify the formal approval for updates. For Class 3 EFBs, FAA-approved Service Bulletins or the minor change process defined in AC 21-40, Application Guide for Obtaining a Supplemental Type Certificate, will be used for EFB update approvals. In addition to the operator's responsibilities described in paragraph c(2) above, it is also the responsibility of the pilot-in-command (PIC) to verify that any EFB depiction of an en route, terminal area, approach, airport map, or sectional is current and up-to-date. One means for doing this is to ensure that each PIC becomes familiar with all available information concerning that flight, to include receipt of appropriate Notices to Airmen (NOTAM) prior to departure and prior to arrival.

(2) The operator should identify a means to demonstrate that adequate security measures are in place to prevent malicious introduction of unauthorized modifications to the EFB's operating system, its specific hosted applications, and any of the databases or data links used to enable its hosted applications. EFB systems need to be protected from possible contamination from external viruses.

g. Special Data Storage and Retrieval Considerations.

(1) The EFB system needs to permit any authorized representative of the Administrator or the National Transportation Safety Board (NTSB) to retrieve, view, or print the information contained in any EFB system, upon reasonable request. If the FAA or NTSB requires a certificate holder or operator to provide information, the certificate holder or operator should provide the data in a format that the requesting agency can use.

(2) Certificate holders and operators should establish procedures to archive or retain old data. The length of time that the data is kept is dependent on the kind of information being archived. Some information, such as maintenance historical data, should be kept for the life of the aircraft. It may also be necessary to keep old versions of software and operating systems to properly retrieve archived data. Maintenance discrepancy logs need to be downloaded into a permanent record at least weekly.

h. Training. Training should reflect the level of the functionality and complexity as agreed upon by the operator, the FSB Report, and the POI.

(1) Part 91 operations inspectors may wish to reference applicable FAA/Industry Training Standards (FITS) to determine the best practices for training and use of the EFB in a manner pertinent to their individual operation. The appropriate FITS program may be determined in consultation with the equipment manufacturer and/or AFS-800, General Aviation and Commercial Division, FAA Headquarters, Washington, DC.

(2) Certificated operators requesting to conduct operations using EFB cockpit applications should use the training guidance in FAA Order 8400.10, volume 3, chapter 2, Training Programs and Airman Qualification. All Part 121 and 135 operators will be required to develop a curriculum segment for the EFB system that consists of a ground training, simulation, and, if needed, a flight training segment. The EFB curriculum segment should include an outline of the training, appropriate courseware,

and the instructional delivery method. The following elements should be included in each EFB training module:

(a) A description of what an EFB is, its capabilities, and the applications for which the operator will use the EFB system and its components and peripherals. This should include theory of operation and the training should ensure that flightcrews understand the dependencies associated with the sources and limitations of the information.

(b) A description of EFB controls, displays, symbology, and failure modes. EFB failure modes and flightcrew procedures should include a description of the EFB aircraft system (e.g., EFB signal processor, switches, and installed databases, such as an airport surface or en route moving map). If color is a significant EFB application feature, then training materials should include color illustrations.

(c) An AFMS or other documentation that provides conditions, limitations, and procedures for the use of the EFB system and its associated equipment. For instance, operators should train flightcrews on how to ensure that the latest airport charts and manuals are installed, and what to do if they find that the software and/or databases are out-of-date. Only EFBs installed by an STC or an aircraft certification design approval will require an AFMS revision. Class 1 and 2 EFB systems will not require an AFMS revision. Class 1 and 2 EFB systems will require an alternative means of documentation that provides conditions, limitations, and procedures for the use of these EFB systems and associated software. Class 2 EFB systems will require training on how to ensure that the latest revisions are installed and on procedures to use when databases are out-of-date.

(d) Description of any special flight maneuvers, operations, and procedures that the operator is authorized to conduct when using an EFB.

(e) Any special pilot/controller procedures when using EFB-based information.

(f) Geographical areas authorized for specific EFB operations, if applicable.

(g) Authorized methods to defer inoperative EFB equipment.

(3) Operator training should also provide an opportunity for instruction, demonstration, and practice using the actual or simulated EFB equipment and displays. An EFB qualification curriculum segment (required for Part 121 and 135 operators) should be based on functionality and complexity as agreed upon by the operator and POI, or as may be required by an FSB evaluation of the EFB. In addition, a particular airplane's FSB Report may contain EFB training guidance if the EFB was evaluated as part of the STC or certification design approval.

(4) Part 121 and 135 operators are required to conduct initial fleet training. POIs will issue a letter of initial approval authorizing an operator to instruct personnel under the EFB curriculum segment, pending an evaluation of training effectiveness. This also allows FAA inspectors who are responsible for certificate management to become familiar with the operator's EFB system and equipment. After the POI evaluates the operator's EFB curriculum segment and determines that it is satisfactory, the POI issues approval to the operator. The approval authorizes the operator to continue training in accordance with the operator's approved training program.

i. Required Pilot Training and Testing.

(1) **Part 121 and 135 Operators.** Except when under the supervision of an appropriately trained check airman, the flightcrew will need to complete an approved training and testing program that includes

EFB equipment, operating practices, procedures, conditions, and limitations before being authorized to use the EFB equipment. However, flight crewmembers should have satisfactorily completed the ground school portion of the EFB training program before performing under the supervision of a check airman. Training as outlined in this AC is only applicable to those flight crewmembers who actually operate the equipment. Training is not required of crewmembers who are not authorized to use the equipment, even though it may be installed in the aircraft, unless it is operated under the supervision of a check airman. For air carrier operations, initial qualification with the EFB requires that the flight crewmembers demonstrate satisfactory proficiency with the EFB to an FAA inspector or check airman; this may be completed during a line check.

(2) Part 125 Operators. Although no training program requirements exist for Part 125 operators, the flight crewmembers should have satisfactorily completed the ground school portion of the EFB training program before performing under the supervision of a check airman (Part 125) or evaluation by an authorized instructor. The PI may authorize an individual (e.g., the company chief pilot, company check airman, or training course provider) to complete this evaluation. The flightcrew must have a satisfactory evaluation of their performance in the use of the EFB in flight before using the equipment in normal operations.

(3) Part 91 Operators. The primary source of operational and training guidance will be provided through the FITS, which can be obtained through the equipment manufacturer or AFS-800 at Washington Headquarters. The appropriate FITS program may be used to determine the appropriate best practices for familiarization and use of the equipment.

j. Simulator and Flight Evaluations.

(1) Simulator Evaluations. Simulators and other approved training devices (such as procedures trainers) may be used as a tool to evaluate the overall quality of the training given and/or evaluate EFB system performance before granting operational approval. The level of simulation fidelity required depends upon the type of use/credit being sought. Some of the EFB characteristics and flightdeck integration issues that should be evaluated via simulation include the flightcrew's use of displays, EFB control use, alert reactions, auto-ranging configuration, self-tests, flightcrew procedures, and failure mode analysis.

(2) Flight Evaluations.

(a) The number of flight evaluations required to validate a particular EFB system before operational approval, including its hosted applications, should be based on:

- The type of aircraft
- Aircraft system architecture
- Flightcrew workload considerations
- Credit given for previously certified installations
- Past simulator and ground testing

(b) The actual requirement for a flight test needs to be evaluated for each request. The POI will determine if such a demonstration may be accomplished using an approved training device or if an

actual flight evaluation is required. For example, first-time model installations and first-time hosted applications will generally require a flight test. Follow-on EFB systems that introduce changes in the EFB system, including software upgrades, may require flight testing if they cannot be adequately evaluated on the ground or in simulations.

k. Need for Approved Manuals. An FAA-approved AFMS must be carried in the aircraft at all times when the EFB equipment is installed in accordance with an STC or amended type certificate (TC). Notwithstanding, § 121.141 permits a certificate holder to carry a manual that meets the requirements of § 121.133 onboard a transport category airplane in lieu of the Airplane Flight Manual (AFM), provided that the manual contains all AFM/AFMS limitations and identifies them as AFM/AFMS requirements.

l. Instructions for Continued Airworthiness (ICA).

(1) On-going maintenance and support of EFB equipment needs to be considered. Although a source independent of the certificate holder or operator may provide maintenance and support for the system, the certificate holder or operator is responsible for compliance with all regulatory requirements.

(2) The maintenance or inspection program should identify inspection items, establish time-in-service intervals for maintenance and inspections, and provide the details of the proposed methods and procedures. The maintenance or inspection program should also include ICA for the STC or certification design approval.

(3) It is important for operators to coordinate early in the process with their PAI on the following airworthiness-related considerations to determine the appropriate authorizations necessary for each EFB application. Specific tasks should include:

(a) Ensuring, as necessary, that the EFB system is installed in compliance with the applicable requirements and that the maintenance program includes continuing airworthiness and maintenance personnel training requirements.

(b) Ensuring that all maintenance personnel are trained, qualified, and tested in the use, conditions, and requirements necessary to ensure continued airworthiness of the installed EFB system and components.

m. MELs and General Maintenance Manuals (GMM). Operators may update their MELs to reflect the installation of this equipment. Changes made to the operator's MEL must be made in accordance with the approved Master Minimum Equipment List (MMEL).

n. EFB Substitution/Use in More Than One Aircraft. Class 1 and 2 EFBs may be substituted for other EFBs for use in other aircraft, provided that the EFB is compatible for use in these other aircraft. Specific procedures need to be designed to ensure that a portable/removable Class 1 or Class 2 EFB system is fully compatible with other aircraft and their systems prior to placement into service. Procedures must also be developed to ensure that any data captured (in EFB memory) that is specific to one aircraft is duly archived for that aircraft if the EFB system is moved to another aircraft. For Class 3 replacement EFB systems, it will be necessary to ensure that the replacement systems are FAA-approved.

o. User Feedback. Part 121 and Part 135 operators should implement a formal process for gathering feedback. Such a process is recommended for use during design, installation, modifications, or improvements to procedures and/or training.

p. Operational Approval Authorization.

(1) The use of EFBs requires appropriate operational approval which will include a six-month operational test evaluation where the EFB system(s) with all paper products will be onboard. The operator will be required to issue a final report to the POI/AEG detailing the training effectiveness, operational effectiveness, and reliability of the EFB systems. For Part 121, 125, and 135 operators, final authorization takes the form of OpSpec A025 approval. FAA Order 8400.10, Volume 3, chapter 1, section 3, part A, Operations Specifications (121/135), and FAA Order 8700.1, Operations Inspector's Handbook, Volume 2, chapters 73 and 76, contain general policy guidance and requirements for issuing or amending OpSpecs paragraphs for Part 125 operators proposing to install and conduct operations using EFB systems and associated displays.

(2) The issuance of OpSpecs gives operational authorization for an air carrier or commercial operator who intends to use EFBs for flight operations. Other OpSpecs may need to be issued or amended, as appropriate.

q. Operator Job Aid. In addition to close coordination with the local Flight Standards District Office (FSDO), Certificate Management Office (CMO), and Certificate Management Unit (CMU), the following job aid is provided for use by the operator when seeking EFB authorization or approval. To obtain authorization and approval for EFB use, the following steps (in chronological order) are suggested:

- (1) Make application in a form and manner acceptable to the FAA.
- (2) Demonstrate a process of ensuring initial and continuing reliability for each specific unit.
- (3) Demonstrate that the radio magnetic interference/electromagnetic interference tests have been performed satisfactorily.
- (4) Demonstrate that the units can be properly stored or cradled in the aircraft.
- (5) Demonstrate that any electronic receptacles used for connection of the EFB to an aircraft system have been installed using FAA-approved procedures.
- (6) Develop a policy and procedures manual that may include, but is not limited to, the following:
 - (a) For single-pilot and multi-crew flown aircraft, appropriate procedures for EFB use during all phases of flight;
 - (b) Procedures to follow when one unit fails (where multiple units are carried onboard the aircraft);
 - (c) Procedures to follow when all units fail (the procedures should specifically identify what alternate means to use to obtain data);
 - (d) A revision process procedure/method that ensures appropriate database accuracy and currency;
 - (e) Courseware to be used while conducting training;

(f) Procedures that document the knowledge of the user (e.g., training received, evaluation forms, or test results, etc.);

(g) A list of the data loaded and maintained in each unit; and

(h) ICA in accordance with the manufacturer's recommendations. (Also include these instructions in the inspection/maintenance program.)

(7) For air carrier operators, the authorization must be granted via issuance of OpSpec A025. The OpSpec paragraph must reference the company documents, records, or manuals presented with the operator's application.

/s/ Nicholas A. Sabatini
Associate Administrator for Regulation and Certification

APPENDIX A.
EXAMPLES OF POSSIBLE CLASS 1 EFB APPLICATIONS

- Flight Operations Manuals (FOM)
- Company Standard Operating Procedures (SOP)
- Airport diversion policy guidance, including a list of Special Designated Airports and/or approved airports with emergency medical service (EMS) support facilities
- Operations Specifications (OpSpecs)
- Cockpit observer briefing cards
- Airplane Flight Manuals (AFM) and Airplane Flight Manual Supplements (AFMS)
- For smaller aircraft, Pilot Operating Handbooks (POH), including POH section IX supplements
- Aircraft performance data (fixed, non-interactive material for planning purposes)
- Airport performance restrictions manual (such as a reference for takeoff and landing performance calculations)
- Other aircraft performance data, including specialized performance data for use in conjunction with advanced wake vortex modeling techniques, land-and-hold-short operations (LAHSO) predictions, etc. (fixed, non-interactive material for planning purposes)
- Maintenance manuals
- Aircraft maintenance reporting manuals
- Aircraft flight log and servicing records
- Autopilot approach and autoland records
- Flight Management System/Flight Management and Guidance System problem report forms
- Aircraft parts manuals
- Service bulletins/published Airworthiness Directives, etc.
- Air Transport Association (ATA) 100 format maintenance discrepancy write-up codes
- Required VHF Omnidirectional Range (VOR) check records
- Minimum Equipment Lists (MEL)
- Configuration Deviation Lists (CDL)
- Federal, state, and airport-specific rules and regulations
- Airport/Facility Directory (A/FD) data (e.g., fuel availability, LAHSO distances for specific runway combinations, etc.)
- Noise abatement procedures for arriving and departing aircraft
- Published (graphical) pilot Notices to Airmen (NOTAM)
- International Operations Manuals, including regional supplementary information and International Civil Aviation Organization (ICAO) differences
- Aeronautical Information Publications (AIP)
- Aeronautical Information Manual (AIM)
- Pilot flight and duty-time logs
- Flightcrew required rest logs
- Flightcrew qualification logs (such as aircraft qualifications, Class II flightcrew qualifications, Category (CAT) III qualifications, high minimums logs, night currency logs, pilot-in-command (PIC) qualifications for special areas, routes and airports for Part 121 certificate holders, and special airports qualifications)
- Captain's report (i.e., captain's incident reporting form)
- Flightcrew survey forms (various)
- Flight Attendant Manuals
- EMS reference library (for use during medical emergencies)
- Trip scheduling and bid lists

- Aircraft's captain's logs
- Aircraft's CAT II/CAT III landing records
- Antiterrorism profile data
- Hazardous Materials (HAZMAT)/oxidizer look-up tables
- Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods (ICAO Doc 9481-AN/928)
- Customs declaration and United States Department of Agriculture (USDA) agriculture inspection/clearance form
- Special reporting forms, such as near mid-air collision (NMAC) reports, National Aeronautics and Space Administration's (NASA) Aviation Safety Reporting System (ASRS), bird and wildlife encounters, owner-initiated Service Difficulty Reports (SDR), etc.
- Incidents of interference to aircraft electronic equipment from devices carried aboard aircraft
- Current fuel prices at various airports
- Realistic training modules, including "PC at home" training applications, "off-duty" training materials review, and pre-flight "mission" rehearsals
- Check airman and flight instructor records
- Aircraft operating and information manuals (performance information, weight and balance, systems, limitations, etc.)
- Flight operations manuals including emergency procedures
- Airline policies and procedures manuals
- Aircraft Maintenance Manuals
- Title 14 of the Code of Federal Regulations (14 CFR)
- Look-up and completion of various reporting forms, e.g., company-specific forms, NASA's ASRS reports, NMAC reports, wildlife strike and hazard reports, etc.
- Maintenance personnel sign-off of discrepancy form. (Maintenance discrepancy logs need to be downloaded into a permanent record at least weekly.)
- Flightcrew qualifications recordkeeping, including aircraft qualifications, CAT II/III, high minimums, landing currency, flight and duty time, etc.
- PIC currency requirements
- The Flight Attendant Manual
- Passenger information requests – some are directed to the gate or to the agent meeting the flight (e.g., special meal requests, wheel chair requirements, unaccompanied minors, gate information for connecting flights, flights being held for connecting passengers, etc.)
- Cabin maintenance write-ups. (Maintenance discrepancy logs need to be downloaded into a permanent record at least weekly.)
- Approved electronic signature using public/private key technology (PKI)
- Take-off, en route, approach and landing, missed approach, go-around, etc., performance calculations. Data derived from algorithmic data or performance calculations based on software algorithms.
- Power settings for reduced thrust settings
- Runway limiting performance calculations
- Weight and balance calculations

APPENDIX B.
EXAMPLES OF POSSIBLE CLASS 2 EFB SYSTEM APPLICATIONS

1. Class 2 EFB systems may include all Class 1 EFB hosted applications.
2. Examples of Class 2 hosted applications:
 - Takeoff, en route, approach and landing, missed approach, go-around, etc., performance calculations. Data derived from algorithmic data or performance calculations based on software algorithms.
 - Power settings for reduced thrust settings
 - Runway limiting performance calculations
 - Cost index modeling
 - Master flight plan/updates
 - Plotting for Class II navigation
 - Oceanic navigation progress logs
 - Mission rehearsals
 - Weight and balance calculations
 - Maintenance discrepancy sign-off logs. (Maintenance discrepancy logs need to be downloaded into a permanent record at least weekly.)
 - Cabin maintenance discrepancy reporting forms/location codes (maintenance discrepancy logs need to be downloaded into a permanent record at least weekly)
 - Non-interactive electronic approach charts in a pre-composed format from accepted sources
 - Dynamic interactive electronic aeronautical charts (e.g., en route, area, and airport surface maps) including, but not limited to, centering and page turning, but without display of aircraft/own-ship position.
 - Electronic checklists, including normal, abnormal, and emergency. See AC 120-64, Operational Use & Modification of Electronic Checklists, for additional guidance. EFB electronic checklists cannot be interactive with other aircraft systems.
 - Applications that make use of the Internet and/or other aircraft operational communications (AOC) or company maintenance-specific data links to collect, process, and then disseminate data for uses such as spare parts and budget management, spares/inventory control, unscheduled maintenance scheduling, etc. (Maintenance discrepancy logs need to be downloaded into a permanent record at least weekly.)
 - Non-interactive weather and aeronautical data (via data link)
 - Cabin-mounted video and aircraft exterior surveillance camera displays

APPENDIX C. EXAMPLES OF CLASS 3 EFB APPLICATIONS

1. Class 3 EFB systems may include all Class 1 and Class 2 EFB hosted applications.

2. The following are examples of Class 3 applications that will require certification:

a. Aircraft System Performance Monitoring.

- (1) Aircraft health monitoring systems.
- (2) Engine and component parts monitoring.
- (3) Intelligent recordkeeping systems.

b. Interactive Information.

(1) En route, terminal area, and approach aeronautical charts, used for situational awareness or navigation. Panning, scrolling, zooming or other active manipulation may be permissible for approach charts. Electronic navigation charts should provide a level of information integrity equivalent to that found on paper charts.

(2) These approach charts could also have the capability of “underlying” color-coded terrain and obstacle data, especially at terrain-impacted airports.

(3) Other airspace-related database depictions, including:

- (a) Air traffic minimum vectoring altitudes (MVA).
- (b) Minimum sector altitudes (MSA) needed to obtain air traffic services.
- (c) Off-route obstruction clearance altitudes (OROCA).
- (d) Maximum elevation figures (MEF).
- (e) Special oceanic airspace (e.g., Minimum Navigation Performance Specification (MNPS), Reduced Vertical Separation Minimum (RVSM), Required Navigation Performance (RNP)).

(f) Communication frequency databases, including airport and en route fixes that determine specific air traffic sector geographic boundaries.

(4) Depictions of federally-regulated airspace data such as:

- (a) Class A, B, C, D, E, and G airspace.
- (b) Special Use Airspace (SUA). Includes lateral and vertical height dimensions and airspace such as Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) military training routes (MTR), refueling areas, low altitude tactical navigation areas (LATNA), ICAO danger areas, etc.
- (c) Air Defense Identification Zones (ADIZ).

(d) National Park prohibited areas.

(e) National wildlife areas, etc.

(5) Uncontrolled airport data such as VFR traffic pattern entry procedures, recommended traffic patterns, recommended traffic pattern altitudes (TPA), designated parachute jumping areas, etc.

(6) Airport surface maps that include own-ship position overlays onto 2-D and 3-D chart renderings.

(7) Airport features on airport map depictions, including runway and taxiway locations, runway gradients, Visual Approach Slope Indicator (VASI) locations, taxiway locations, runway lighting, etc. (any item that can be written in a NOTAM)

(8) Weather and aeronautical data/national airspace system (NAS) status information (via data link).

c. Terrain, Obstacle, and Noise Databases.

(1) Terrain and obstacle database depictions.

(2) Provisions for color-coded terrain and obstacle database underlays on en route and terminal area charts.

(3) Noise sensitive and noise abatement depictions, including airport specific noise abatement departure procedures and nearby noise sensitive areas.

(4) Engine run-up restrictions — restrictions on the location and time of engine run-up and/or facilities.

d. Traffic Information: ADS-B and Traffic Information Service-Broadcast (TIS-B) Traffic Surveillance.

e. Controller-Pilot Data Link Communications.

f. Interactive Electronic Checklists. Checklists, normal, abnormal, and emergency, including checklists that are invoked by logic (e.g., with cues from aircraft systems).

g. Depictions of Aircraft/“Own-Ship” Position Used For Situational Awareness or Navigation.

h. Miscellaneous Applications.

(1) Fuel remaining range-ring depictions, especially for use in small aircraft.

(2) Display of runway threshold winds.

(3) GPS-synched aircraft’s ship’s clock.

APPENDIX D. RELATED READING MATERIALS

Federal Aviation Administration (FAA) Advisory Circulars (AC), Orders, Policy Statements, and Technical Standard Orders (TSO). ACs, Orders, Policy Statements, and TSOs may be obtained from the U.S. Department of Transportation, Subsequent Distribution Center, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, Maryland, 20785.

a. Advisory Circulars (current version).

- (1) AC 20-115, Radio Technical Commission for Aeronautics, Inc., Document RTCA/DO-178B.
- (2) AC 20-140, Guidelines for Design Approval of Aircraft Data Communications Systems.
- (3) AC 21-33, Quality Assurance of Software Used in Aircraft or Related Products.
- (4) AC 21-35, Computer Generated/Stored Records.
- (5) AC 21-40, Application Guide for Obtaining a Supplemental Type Certificate.
- (6) AC 23.1309-1, Equipment, Systems, and Installations in Part 23 Airplanes.
- (7) AC 23.1311-1, Installation of Electronic Displays in Part 23 Airplanes.
- (8) AC 25-10, Guidance for Installation of Miscellaneous Nonrequired Electrical Equipment.
- (9) AC 25-11, Transport Category Airplane Electronic Display Systems.
- (10) AC 25-16, Electrical Fault and Fire Prevention and Protection.
- (11) AC 25.1309-1, System Design Analysis.
- (12) AC 25.1523-1, Minimum Flightcrew.
- (13) AC 25.1581-1, Airplane Flight Manual.
- (14) AC 27-1, Certification of Normal Category Rotorcraft.
- (15) AC 29-2, Certification of Transport Category Rotorcraft.
- (16) AC 91.21-1, Use of Portable Electronic Devices Aboard Aircraft.
- (17) AC 120-64, Operational Use & Modification of Electronic Checklists.
- (18) AC 120-69, Use of CD-ROM Systems.
- (19) AC 120-71, Standard Operating Procedures for Flightdeck Crewmembers.

b. FAA Orders, Policy Statements, and TSOs (current version).

- (1) Order 8110.4, Type Certification.
- (2) Order 8150.1, Technical Standard Order Program.
- (3) Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS).
- (4) Order 8300.10, Airworthiness Inspector's Handbook.
- (5) Order 8400.10, Air Transportation Operations Inspector's Handbook.
- (6) Order 8700.1, General Aviation Operations Inspector's Handbook.
- (7) Policy Statement No. ANM-99-2, Guidance for Reviewing Certification Plans to Address Human Factors for Certification of Transport Airplane Flight Decks.
- (8) Policy Statement No. ANM-01-03, Factors to Consider When Reviewing an Applicant's Proposed Human Factors Methods for Compliance for Flight Deck Certification.
- (9) TSO-C113, Airborne Multipurpose Electronic Displays.
- (10) TSO-C153, Integrated Modular Avionics Hardware Elements.

c. Other Documents.

- (1) "Human Factors Considerations in the Design and Evaluation of Electronic Flight Bags (EFBs), Version 1: Basic Functions," Chandra, Divya C., and Mangold, Susan J., DOT-VNTSC-FAA-00-22, September 28, 2000. Available on the internet at: <http://www.volpe.dot.gov/opsad/efb/>
- (2) "FAA and Industry Guide to Product Certification," January 25, 1999. Available on the internet at: <http://av-info.faa.gov/dst/CPIGUIDE.pdf>
- (3) "Human Factors for Flight Deck Certification Personnel," Technical Report DOT/FAA/RD-93/5, July 1993. Copies may be ordered from the National Technical Information Service (<http://www.ntis.gov/>).

d. Industry Documents (current version).

- (1) Technical Standards Documents. These documents are available from RTCA, 1828 L Street, NW, Suite 805, Washington, D.C., 20036.
 - (a) RTCA/DO-160, Environmental Conditions and Test Procedures for Airborne Equipment.
 - (b) RTCA/DO-178, Software Considerations in Airborne Systems and Equipment Certification.
 - (c) RTCA/DO-199, Potential Interference to Aircraft Electronic Equipment From Devices Carried Aboard.

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- (d) RTCA/DO-200, Standards for Processing Aeronautical Data.
 - (e) RTCA/DO-201A, Standards for Aeronautical Information.
 - (f) RTCA/DO-208, Minimum Operational Performance Standards for Airborne Supplemental Navigation Equipment Using Global Positioning System (GPS).
 - (g) RTCA/DO-233, Portable Electronic Devices Carried on Board Aircraft.
 - (h) RTCA/DO-242, Minimum Aviation System Performance Standards for Automatic Dependent Surveillance-Broadcast (ADS-B).
 - (i) RTCA/DO-249, Development and Implementation Planning Guide for Automatic Dependent Surveillance-Broadcast (ADS-B) Applications.
 - (j) RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware.
 - (k) RTCA/DO-255, Requirements Specification for Avionics Computer Resource (ACR).
 - (l) RTCA/DO-257, Minimum Operational Performance Standards for the Depiction of Navigation Information on Electronic Maps.
 - (m) RTCA/DO-264, Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by Data Communications.
 - (n) RTCA/DO-267, Minimum Aviation System Performance Standards (MASPS) for Flight Information Services-Broadcast (FIS-B) Data Link.
 - (o) RTCA/DO-272, User Requirements for Aerodrome Mapping Information.
 - (p) RTCA/DO-276, User Requirements for Terrain and Obstacle Data.
- (2) ARINC and Airlines Electronic Engineering Committee (AEEC) Documents. These documents are available from ARINC, 2551 Riva Road, Annapolis, Maryland, 21401-7465.
- (a) AEEC 424-15, Navigation System Database.
 - (b) AEEC 763-1, Network Server System.
 - (c) ARINC 660A, CNS/ATM Avionics, Functional Allocation and Recommended Architecture.
 - (d) ARINC 653, Application/Executive (APEX) Software Interface.
 - (e) ARINC 661, Cockpit Display System Interfaces to User Systems.
- (3) Society of Automotive Engineers (SAE) Documents. These documents are available from SAE, 400 Commonwealth Drive, Warrendale, Pennsylvania, 15096-0001.
- (a) ARP 4754, Certification Considerations for Highly Integrated or Complex Aircraft Systems.
 - (b) ARP 4761, Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment.
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