PRISM Solutions

Research Brief

Research Request:

Electronic Flight Bag (EFB) Standards

Research Response:

The benefits of reducing or eliminating paper in the cockpit has long been recognized. EFB devices can display a variety of aviation data and may perform various specific aircraft operating calculations.

Highlights of FAA Advisory Circular 120-76B

The following text was extracted from the subject FAA circular.

10. EFB HARDWARE CONSIDERATIONS

a. Paper Date Removal. At least two portable EFBs are required to remove paper products that contain aeronautical charts, checklists, or other data required by the operating rules. The design of the system architecture requires that no single failure, or common mode error, may cause the loss of required aeronautical information.

b. Electrical Backup Power Source. System design must consider the source of electrical power, the independence of the power sources for multiple EFBs, and the potential need for independent battery source. EFBs that do not have battery backup, and that are used to remove paper products required by the operating rules, are required to have at least one EFB connected to an aircraft power bus.

> **Note:** Class 1 and Class 2 EFB electrical power source provisions that are certified on part 25 airplanes are required to follow the policy outlined in the Transport Airplane Directorate policy statement, ANM-01-111-165, Power Supply Systems for Portable Electronic Devices, unless an alternative method is proposed by the operator and approved by AIR.

c. Battery Backup. Some applications, especially when used as a source of required information, may require that the EFB use an alternate power supply to achieve an acceptable level of safety. The operator is also responsible to ensure the replacing of batteries is completed as required, but no less often than the EFB manufacturer's recommended interval.

d. Battery Replacement. If the EFB manufacturer has not specified a battery replacement interval, then the original battery (or cell) manufacturer's specified replacement interval should be adhered to.

e. Lithium Batteries. Rechargeable lithium-type batteries are becoming more common as a standby or backup power source used in EFBs. The users of rechargeable lithium-type batteries in other industries, ranging from wireless telephone manufacturers to the electric vehicle industry, have noted safety concerns. These concerns are primarily the result of overcharging, over-discharging, and the flammability of cell components. Lithium-ion or lithium-polymer (lithium-ion polymer) batteries are two types of rechargeable lithium batteries commonly used to power EFBs. These types of batteries are capable of ignition and subsequent explosion due to the flammability of cell components. They are also vulnerable to overcharging and over-discharging, which can, through internal failure, result in overheating. Overheating may result in thermal runaway, which can cause the release of either molten burning lithium or a flammable electrolyte. Once one cell in a battery pack goes into thermal runaway, it produces enough heat to cause adjacent cells to also go into thermal runaway. The resulting fire can flare repeatedly as each cell ruptures and releases its contents. The word "battery" used in this AC refers to the battery pack, its cells, and its circuitry. The rechargeable lithium-type battery design should be compliant with the provisions of Institute of Electrical and Electronic Engineers (IEEE) 1625, IEEE Standard for Rechargeable Batteries for Portable Computing. This standard drives design considerations for system integration, cell, pack, host device, and total system reliability. It also covers how to maintain critical operational parameters with respect to time, environment, extremes in temperature, and the management of component failure. There are other regulations that may apply to the use of lithium batteries onboard aircraft, including the Department of Transportation (DOT) regulations for air travel found in Title 49 of the Code of Federal Regulations (49 CFR) part 175, § 175.10. DOT regulations do not allow more than 25 grams of equivalent lithium content (ELC) or 300 watt hours (WH) per battery pack in air travel. For more information see http://safetravel.dot.gov. DOT regulations apply to the shipment of lithium ion batteries, not to batteries installed in PEDs. However, if spare batteries are carried, operators should refer to current DOT regulations.

f. Lithium Battery Cautions. Due to their proximity to the flightcrew and potential hazard to safe operation of the aircraft, the use of rechargeable lithium-type batteries in EFBs located in the aircraft cockpit call for the following standards:

(1) Safety and Testing Standards. Operators should test EFB batteries and recharging systems to ensure safety and reliability. Operators must use one of the following safety and testing standards as a minimum for determining whether rechargeable lithium-type batteries used to power EFBs are acceptable for use and for recharging:

(a) Underwriters Laboratories (UL). UL 1642, Lithium Batteries; UL 2054, Household and Commercial Batteries; and UL 60950-1, Information Technology Equipment - Safety;

(b) International Electrotechnical Commission (IEC). International Standard IEC 62133, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications;

(c) United Nations (UN) Transportation Regulations. UN ST/SG/AC.10/11/Rev.5—2009, Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, Fifth revised edition; or

(d) RTCA/DO-311, Minimum Operational Performance Standards for Rechargeable Lithium Battery Systems. An appropriate airworthiness testing standard such as RTCA/DO-311 can be used to address concerns regarding overcharging, over-discharging, and the flammability of cell components. RTCA/DO-311 is intended to test permanently installed equipment; however, these tests are applicable and sufficient to test EFB rechargeable lithium-type batteries. If RTCA/DO-311 is used, then RTCA/DO-311 Table 4-1 and appendix C should be used for guidance on applicable testing.

(2) Showing Compliance. The operator provides the principal inspector (PI) with records of compliance to these battery standards during the authorization to use the EFB. These records may be available from the battery's Original Equipment Manufacturer (OEM).

g. Rechargeable Lithium-Type Battery Maintenance, Storage, and Functional Check. Operators should have documented maintenance procedures for their rechargeable lithium-type batteries. These procedures should meet or exceed the OEMs recommendations. These procedures should address battery life, proper storage and handling, and safety. There should be methods to ensure that the rechargeable lithium-type batteries are sufficiently charged at proper intervals and have periodic functional checks to ensure that they do not experience degraded charge retention capability or other damage due to prolonged storage. These procedures should include precautions to prevent mishandling of the battery, which could cause a short circuit or other unintentional exposure or damage that could result in personal injury or property damage. All replacements for rechargeable lithium batteries must be sourced from the OEM and repairs must not be made.

h. Use of Aircraft Electrical Power Sources. Aircraft electrical power outlets are part of the type design of the aircraft and require airworthiness certification. Appropriate labels should identify the electrical characteristics (e.g., 28VDC, 115VAC, 60 or 400 Hz, etc.) of electrical outlets. Rechargeable lithium-type batteries pose a much higher safety hazard when recharging than other battery chemistries. The aircraft electrical power provisions for recharging lithium-type batteries in the aircraft cockpit should address battery sensitivity to voltage and current parameters. Do not connect to the electrical outlet if the connection label does not exactly match the power requirements, both voltage and amperage, of the lithium batteries' charging system. Conduct an electrical load analysis to replicate a typical EFB to ensure that powering or charging the EFB will not adversely affect other aircraft systems and that power requirements remain within power load budgets. There is a requirement for a certified means (other than a circuit breaker) installed in accordance with applicable airworthiness regulations for the flightcrew to de-power the EFB power source or system charger. Additional actions and application of airworthiness regulations are not applicable to the internal elements of Class 1 and Class 2 EFBs unless specified in this AC.

i. Environmental Hazards Identification and Qualification Testing. Certain environmental hazards must be evaluated for Class 1 and Class 2 EFBs to ensure their safe use in anticipated operating environments. Evaluate Class 1 and Class 2 EFB system RF emissions data needs in accordance with AC 91.21-1 and this AC. Class 1 and Class 2 EFBs should demonstrate that they meet appropriate industry-adopted environmental qualification standards for radiated emissions for equipment operating in an airborne environment. It is necessary to demonstrate that any Class 1 or Class 2 EFB used in aircraft flight operations will 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. Test for possible interference while moving a portable EFB about in the cockpit. Additionally, altitude and rapid decompression testing may need to be accomplished to demonstrate Class 1 or Class 2 EFB operation in the anticipated operating envelope of the aircraft in which they will be used.

(1) Non-EFB Non-Interference Testing. It is the user's/operator's responsibility to determine that the operation of a PED will not interfere, in any way, with the operation of aircraft equipment. AC 91.21-1 addresses non-interference testing for non-critical phases of flight only and is not adequate when Type B applications can be used during all phases of flight. Class 1 and Class 2 EFB require additional guidance for non-interference testing contained in subparagrahs 10k and l, in addition to the guidance in AC 91.21-1.

(2) EFB PED Non-Interference Compliance Test Method. In order to operate a PED in other than a non-critical phase of flight, the user/operator is responsible for ensuring that the PED will not interfere in any way with the operation of aircraft equipment. The following methods are applicable to Class 1 and Class 2 EFBs with Type B applications required for use during all phases of flight. The user/operator may use either Method 1 or Method 2 for non-interference testing.

(a) The two following steps complete Method 1 for compliance with PED non-interference testing for all phases of flight.

1. Step 1 is to conduct an electromagnetic interference (EMI) test in accordance with RTCA/DO-160, section 21, paragraph M. An EFB vendor or other source can conduct this Step 1 test for an EFB user/operator. An evaluation of the results of the RTCA/DO-160 EMI test can be used to determine if an adequate margin exists between the EMI emitted by the PED and the interference susceptibility threshold of aircraft equipment. If Step 1 testing determines adequate margins exist for all interference, both front door and back door susceptibility, then method 1 is complete. It is necessary to complete Step 2 testing if Step 1 testing identifies inadequate margins for interference, or either front door or back door susceptibility.

2. Step 2 testing is specific to each aircraft model in which the PED will be operated. Test the specific PED equipment in operation on the aircraft to show that no interference of aircraft equipment occurs from the operation of the PED. Step 2 testing is conducted in an actual aircraft and credit may be given to other similarly equipped aircraft of the same make and model as the one tested.

(b) Method 2 for compliance with PED non-interference testing for all phases of flight is a complete test in each aircraft using an industry standard checklist. This industry standard checklist should be of the extent normally considered acceptable for non-interference testing of a PED in an aircraft for all phases of flight. Credit may be given to other similarly equipped aircraft of the same make and model as the one tested.

(3) Transmitting Portable Electronic Devices (T-PED). In order to operate a T-PED in other than a non-critical phase of flight, the user/operator is responsible to ensure the T-PED will not interfere with the operation of the aircraft equipment in any way. The following method is applicable to all Class 1 or Class 2 EFBs with Type B applications required for use during all phases of flight. Non-interference testing for T-PEDs consists of two separate test requirements.

(a) Test Requirement 1. Each T-PED should have a frequency assessment based on the frequency and power output of the T-PED. This frequency assessment should consider Federal Communications Commission (FCC) frequency standards and be in accordance with applicable processes set forth in RTCA/DO-294C, Guidance on Allowing Transmitting Portable Electronic Devices (T-PEDs) on Aircraft. This frequency assessment must confirm that no interference of aircraft or ground equipment will occur as a result of intentional transmissions from these devices.

(b) Test Requirement 2. Once a frequency assessment determines there will be no interference from the T-PED's intentional transmissions, test each T-PED while operating using either Method 1 or Method 2 for basic non-interference testing requirements described above. This basic non-interference testing is applicable to both an EFB integrated, T-PED and a T-PED that is remote to an EFB. When a T-PED is EFB integrated complete the basic non-interference testing both with and without the T-PED function being operative. If a T-PED is located remote from the EFB, the T-PED basic non-interference testing is independent from the EFB non-interference testing. T-PED position is very critical to T-PED non-interference testing. Clearly define and adhere to the operating/testing locations of a T-PED in T-PED operating procedures.

(4) Rapid Depressurization Testing.

(**a) Environmental Tests.** Other environmental testing, specifically testing for rapid depressurization, may be needed. However, since many Class 1 and Class 2 EFBs were originally COTS electronics adopted for aviation use, testing done on a specific EFB model configuration may be applied to other aircraft and these rapid decompression tests need not be duplicated. It is the responsibility of the operator to provide documentation that these tests have been accomplished on a representative sample of the EFB. The testing of operational EFBs should be avoided when possible to preclude the infliction of unknown damage to the unit during testing.

(b) Rapid Decompression Testing. Determining an EFB device's functional capability requires rapid decompression testing when utilizing Type B software applications in pressurized aircraft unless alternate procedures or paper backup is available. When using only Type A applications on the EFB, rapid decompression testing is not required. The information from the rapid decompression test is used to establish the procedural requirements for the use of that EFB device in a pressurized aircraft. Rapid decompression testing must comply with RTCA DO-160 guidelines for rapid decompression testing up to the maximum operating altitude of the aircraft in which the EFB is to be used. Similarity of a particular EFB to a unit already tested may be used to comply with this requirement. It is the responsibility of the operator to provide the rationale for the similarity.

1. **Pressurized Aircraft.** It is necessary to conduct rapid decompression testing for Class 1 and/or Class 2 EFB devices when the EFB has Type B applications and is used to remove paper-based aeronautical charts in a pressurized aircraft in flight. When a Class 1 or Class 2 EFB demonstrates rapid decompression while turned on and remains reliably operating during the rapid decompression test, then no mitigating procedures need be developed beyond dual redundancy. If a Class 1 or Class 2 EFB device demonstrates rapid decompression testing while turned off and is fully functional following rapid decompression, then procedures will need to be developed to ensure that one of the two EFBs onboard the aircraft remains off or configured so that no damage will be incurred should rapid decompression occur in flight above 10,000 feet mean sea level (MSL).

2. **Un-Pressurized Aircraft.** Rapid decompression testing is not required for a Class 1 or Class 2 EFB used in an un-pressurized aircraft. It is required that the EFB be demonstrated to reliably operate up to the maximum operating altitude of the aircraft. If EFB operation at maximum operating altitude is not attainable, procedures must be established to preclude operation of the EFB above the maximum demonstrated EFB operation altitude while still maintaining availability of required aeronautical information.

j. EFB Mounting Devices.

(1) Design of Mounting Device. Position the EFB mounting device (or other securing mechanism) in a way that does not obstruct visual or physical access to aircraft controls and/or displays, flightcrew ingress or egress, or external vision. The design of the mount should allow the user easy access to the EFB controls and a clear view of the EFB display while in use. Consider the following design practices:

(a) The mount 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) Mounting devices should be able to lock in position easily. Selection of positions should be adjustable enough to accommodate a range of flightcrew member preferences. In addition, the range of available movement 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 device when in use.

(c) A method should be provided to secure, lock, or stow the mount in a position out of the way of flightcrew member 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 mount, the cable should not hang loosely in a way that compromises task performance and safety. Flightcrew members 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 mount should be of sufficient length to perform the intended tasks. Cables that are too long or too short could present an operational or safety hazard.

(2) Placement of Mounting Device. Mount the device so that the EFB is easily accessible. When the EFB is in use and is being viewed or controlled, it should be within 90 degrees on either side of each pilot's line of sight. If using an EFB 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 SA, then such information needs to be in the pilot's primary field of view (FOV). This requirement does not apply if the information is not being directly monitored from the EFB during flight. For example, an EFB may generate takeoff and landing V-speeds, but these speeds are used to set speed bugs or are entered into the FMS, and the airspeed indicator is the sole reference for the V-speeds. In this case, the EFB need not be located in the pilot's primary FOV. 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).

(3) Mounting EFB Equipment. An unsafe condition may be inadvertently 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 mount alone may be light enough to be insignificant. The mount must be installed in accordance with applicable airworthiness regulations. Design approval for a yoke-mounted EFB must specify the size, shape, weight, and attachment means of any portable device mounted on the flight control yoke. EFB equipment, when mounted and/or installed, should not present a safety-related risk or associated hazard to any flightcrew member. It is necessary to provide a means to store or secure the device when not in use. 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.

k. Stowage Area for EFB. EFB stowage is required for all EFBs not secured in or on a mounting device. If an EFB mounting device is not provided, designate an area to stow the EFB. Stowage requires an inherent means to prevent unwanted EFB movement when not in use. Do this in a manner that prevents the device from jamming flight controls, damaging flight deck equipment, or injuring flightcrew members should the device move about as a result of turbulence, maneuvering, or other action. Acceptable stowage locations for a Class 1 EFB includes the inside compartments of the pilot's flight kit.

l. Data Connectivity with Aircraft Systems (Wired or Wireless). This section applies to both portable and installed EFBs. Typically, installed EFBs will have an interface protection built into the installed EFB, while portable EFBs will have a separate data connectivity provision installed in the aircraft. All EFBs using data connectivity provisions to aircraft systems must incorporate an interface protection device (e.g., physical partitioning or read-only access) to ensure that the data connection required by the device, and its software applications, have no adverse effects on other aircraft systems. EFBs having data connectivity to aircraft systems, either wired or wireless, may read or transmit data to and from aircraft systems, provided the connection and interface protection device is defined as part of the aircraft type design. This connectivity includes data bus and communication systems access (e.g., through an avionics data bus, server, network interface device, or wireless network). Use the following guidance for read-only and transmit-receive data interface protection devices:

(1) Read-Only Access. The design of interface protection devices that provide read-only access must ensure protection by using one-way communication of data.

(2) Transmit-Receive Access. The design of interface protection devices that provide transmit (talk) and receive (read) capability must include:

(a) Partition. The design must provide a means of partition for applications that have not been approved from installed systems on the aircraft.

(b) Non-Interference. The design must include a means to ensure that EFB operation, malfunction, or failure does not adversely affect other installed aircraft systems to which a connection is made (i.e., non-essential, essential, and critical).

(c) Security Considerations. The design of interface protection devices enabling connection of EFBs to existing aircraft equipment, systems, data buses, or networks must not introduce potential security vulnerabilities and threats in terms of computer viruses, worms, unauthorized access, and malicious access. Design the data interface protection device to prevent any potential security threats. Provide plans for verifying and maintaining the security protection mechanisms and functionality to adequately address each threat.

DOT-VNTSC-FAA-00-22: Human Factors Considerations in the Design and Evaluation of Electronic Flight Bags.

This report contains elements for consideration in the subject areas of System Considerations, Electronic Documentation, Electronic Checklists, and Flight Performance Calculations. SOPs may be developed from the boxed items in this publication with the following suggested parameters contained in the document:

- Requirements are shaded and boxed with a bold outline. These are the items the authors feel are mandatory. However, it should be noted that this is not a regulatory document and that any application of these requirements is the responsibility of the appropriate regulatory agency (such as the FAA in the United States).

- Recommendations are boxed within a bold outline. These are preferred methods or mechanisms.
- Good practices are boxed within a thin outline. These are suggestions based on industry practices.
- Issues are boxed within a double line. These point out design tradeoffs and other related factors in an open-ended statement.

Highlights of FAA Advisory Circular 120-64

The following text was extracted from the subject FAA circular.

"Operators under FAR parts 91 may also use the criteria of this AC to the extent that provisions of this AC are pertinent to their aircraft and operations."

7. FLIGHTCREW QUALIFICATION FOR THE USE OF ECL's.

a. General. U.S carriers must address the following ECL flightcrew qualification issues:

(1) Initial qualification.

(2) Differences qualification (if applicable).

(3) Recurrent qualification.

(4) Currency.

(5) Requalification.

8. METHODS FOR USE OF ECL.

a. Standard Practices. *To fully benefit from the advantages of ECL technology, OEM's and operators should establish standard practices and methods for flight deck use of electronic checklists. These standards, as a minimum, should specifically address crew coordination methods for normal and non-normal/emergency checklists, callouts, use of open/closed loop items, use of deferred items and/or operational notes, if applicable, and the method for determining and declaring that a checklist item or entire checklist is complete.*

b. Impact on Crew Workload. *Operators should consider the impact on crew workload in determining the method of ECL use. Maximum advantage should be taken of the*availability of closed loop sensing, appropriate use of checklist deferred items, and automatic annunciation of the completion of checklist items or entire checklists. For example, a requirement to call out or manually check off each item when a system can automatically annunciate completion may simply add workload and distraction without increasing benefits relative to the use of a paper checklist. However, in some limited cases, callout of certain completed items or checklists may be necessary to ensure total crew awareness of system or airplane status.

Example SOP written for the Fujitsu ST4121 Tablet PC with Jeppview3 Software

These procedures are listed only to provide a conceptual template and have not been verified, validated, or exercised by PRISM in any way.

General

1. Only the PNF will operate the EFB, unless a positive exchange of controls has taken place.
2. Stow the unit with the cover closed. vertically, between the seat and the center console, with the handle facing forward. The EFB shall always be stowed during takeoff and landing.
3. The screen format is set to Landscape (the horizontal distance is greater than the vertical distance.) This permits the width of the EFB screen to be visible while resting on the lap of PNF.
4. Always stow the pen device in it’s holster immediately after use, and prior to stowing the EFB.

Taxiing

1. Anticipate your taxi route. The PNF will brief the PF regarding the taxi route, and both pilots shall verify and agree on the route before proceeding.
2. Utilize the zoom feature to expand the taxi route, zoom into runway incursion hot spots, and other features on the taxi chart.
3. Maintain a “sterile cockpit” during taxi.
4. The PF should transfer aircraft controls with a positive exchange prior to focusing on details inside the aircraft.
5. While moving on the ground, the PNF will have custody, and when in use, will hold the EFB. The Airport Diagram will be displayed and Taxi Progress monitored by the PNF. Prior to takeoff the PNF will select and display the appropriate chart for the procedure being flown. (I.e. Departure Procedure, Departure Alternate or Return Procedure)

Takeoff

Prior to takeoff, the PNF shall stow the EFB. When SID instructions need to be reviewed, the SID procedure may be read directly from the EFB. The EFB unit must then be stowed prior to beginning the takeoff roll. Takeoff Operation: From "Line Up" on the runway until completion of the second segment, the EFB shall be stored in the designated storage location.

Climb

During climb, the EFB can be looked at, and data from the electronic enroute charts can be verified. Segments of the departure procedures can be read and verified, and enroute VOR frequencies can be looked up and entered into the VHF radios.

Cruise

During the cruise or enroute phase of flight, the EFB may remain stored in the designated storage location prescribed for each aircraft. Flightcrews shall select and review the anticipated arrival and approach procedures for the destination airport, leaving the next needed chart displayed.

Descent

The EFB can be used during this portion of the flight.

Approach

Terminal Arrival Operation: If a published Arrival Procedure is being flown, the PNF will have custody and will hold the EFB. The Arrival Procedure will be displayed and position on the procedure monitored by the PNF. During the approach phase of flight, the EFB should be referred to prior to beginning the final approach for landing. Terminal and Approach data from the EFB is to be copied on paper and used during an instrument approach briefing in IMC. The copied briefing shall contain at least: COMM Frequencies, NAV Frequencies, Inbound Course, DH or MDA. The EFB shall be stowed no later than the beginning of the final approach segment. If the EFB unit fails during this phase of flight, it should be stowed until the completion of the flight. After Landing: Follow the procedure in the Taxiing section above.

Post Flight

Upon completion of the flight, the JeppView application should be closed by clicking on the X in the upper right-hand corner. When prompted to save the route, choose NO. After the application closes, stow the pen in the holster, turn the EFB off, by pressing the silver power button in the upper corner of the unit, and close the case. Stow the unit vertically between the seat and the center console, with the carrying handle facing forward, or remove it from the aircraft if parking where extreme (colder than 32°F or greater than 100°F) temperatures are expected.

Extracted from http://www.tomgorski.com/asr/asr.htm