

## SECTION 2

### CHAPTER 22

# ELECTRONIC FLIGHT BAGS

## INTRODUCTION

1. There are significant operational advantages and efficiencies with using portable electronic devices, including commercially available portable computers, to perform a variety of functions traditionally accomplished using paper references in the cockpit environment. These systems are typically referred to as Electronic Flight Bags (EFB), and may be used in conjunction with or to replace some of the hard copy material that aircrew typically carry in their flight bags. An EFB is an electronic display system intended primarily for cockpit, flightdeck or cabin use. EFB devices can display a variety of aviation data or perform calculations (e.g. performance data, fuel calculations, etc.). In addition, some EFB's carry out more challenging functions not previously achievable with paper based products (e.g. interactive chart viewers, interactive checklists, navigation displays, datalink services, etc.). EFB systems are being developed to support functions during all phases of flight, including ground operations. These devices are sometimes referred to as Auxiliary Performance Computers (APC) or Laptop Auxiliary Performance Computers (LAPC).
2. Recent advancement of EFB systems has resulted in the aeronautical data (traditional paper references and digital aeronautical data) being used in more challenging and potentially hazardous ways by both civilian and military aircraft operators around the world. Furthermore, some EFB systems host functions or applications that were previously only available by dedicated integrated aircraft instrumentation and systems. Therefore there is an increasing imperative to assure that EFB systems are of an appropriate integrity for their intended function or application, and that relevant technical and operational considerations are addressed in the acceptance and management of these systems.

## SCOPE AND APPLICABILITY

3. This chapter provides guidance for the technical approval, service release and management of EFBs on ADF aircraft. The ADF guidance is based largely on the Federal Aviation Administration (FAA) approach to EFB approval, although in bringing the guidance into the ADF domain there are a number of important differences. While the guidance primarily focuses on technical issues, it also provides suggestions for operational management of EFBs where necessary to complement the technical requirements

## FAA APPROACH TO ELECTRONIC FLIGHT BAGS

4. The ADF approach to EFBs has many parallels with the FAA system. Therefore an understanding of the FAA approach provides valuable context to this chapter.
5. The Federal Aviation Administration (FAA) has developed guidelines for the certification and operational approval of both portable and installed EFBs. The FAA has published the following documents relating to EFB certification and approval:
  - a. Advisory Circular (AC) 120-76A – Guidelines for the Certification, Airworthiness, and Operational Approval of Electronic Flight Bag Computing Devices.
  - b. Advisory Circular (AC) 20-159 – Obtaining Design and Production Approval of Airport Moving Map Display Applications Intended for Electronic Flight Bag Systems.
6. AC 120-76A defines three types of software applications for use on EFB systems: Type A, B, and C. These software application types are afforded an increasing level of evaluation and approval by the FAA based on their functionality and potential failure conditions. The following specific applications are associated with each identified application type:
  - a. Type A applications include applications for display of pre-composed static manuals, procedures, publications and references; interactive look up and completion of forms and logs; and training modules, such as 'PC based' training applications, 'off-duty' training materials review, and pre-flight 'mission' rehearsals. Approval for Type A applications is provided by the Flight Standards District Office / Principle Inspector and is therefore a largely operational airworthiness approval (although it is supported by a number of technical determinations).

- b. Type B applications include applications for performance and associated calculations; charts, such as pre-composed or dynamic interactive electronic aeronautical charts (e.g. en route, area, approach, and airport surface maps) including, but not limited to, operator initiated centering and page turning but without display of aircraft/own-ship position or moving maps; electronic checklists; data services; and cabin and external video. Approval for Type B applications is provided by the Flight Standards District Office / Principle Inspector, with further evaluation by the Aircraft Evaluation Group. It is therefore both an operational and technical approval, albeit at a local level.
  - c. Type C applications include primary flight displays, navigation displays, moving maps, and so on. Approval for Type C applications is provided by the Aircraft Certification Office. It is an operational and technical approval, usually involving Supplemental Type Certification.
7. AC 120-76A also defines three hardware classes of EFB systems: Class 1, 2, and 3. These hardware classes are afforded an increasing level of evaluation and approval by the FAA. The three hardware classes are defined as follows:
- a. Class 1 EFBs are generally portable COTS based systems, and are not attached to a mounting device. They may be used to host Type A and B applications only. Some Class 1 EFBs are restricted to Type A applications only. Approval for Class 1 EFBs is provided by the Flight Standards District Office / Principle Inspector (a largely operational airworthiness approval, although a number of technical determinations support this).
  - b. Class 2 EFBs are also generally portable COTS based systems, and may be connected to an aircraft mounting device during normal operations. They may be used to host Type A and B applications, and Type C applications under very limited special circumstances. Approval for Class 2 EFBs is provided by the Flight Standards District Office / Principle Inspector, with further evaluation by the Aircraft Evaluation Group.
  - c. Class 3 EFBs are installed equipment incorporating Type C applications that requires Aircraft Certification Office approval (an operational and technical approval, involving supplemental type certification). They may also be used to host Type A and B applications, provided specific considerations for user modifiable software are addressed.
8. AC 20-159 was issued in response to a spate of runway incursions and other airfield, airport and ground operations related incidents and accidents. AC 20-159 provides guidance for obtaining design and production approval under Technical Standard Order (TSO) C-165 (*Electronic Map Display Equipment for Graphical Depiction of Aircraft Position*), for the software and database used to provide an Airport Moving Map Display (AMMD) (Type C application) intended for use on a Class 2 EFB for ground operations. This is a non-standard approach to a Technical Standard Order Authorisation (TSOA) as it effectively uses an incomplete TSOA for software without its associated hardware. The intended function of the AMMD is to help flight crews orient themselves on the airport surface and improve pilot positional awareness during taxi operations. The AMMD function is not intended to be used as the basis for manoeuvring, and the application is to be limited to ground operations only.

### **ADF APPROACH FOR ELECTRONIC FLIGHT BAGS**

9. Of the recognised civilian and military Airworthiness Authorities, the FAA has the most mature and available policy and guidance on the certification of EFBs. Furthermore, their policy has been shaped by the findings of several National Transportation Safety Board (NTSB) accident investigations. For these reasons, the ADF approach to EFB approvals has been derived from the FAA approach. As with the FAA approach for EFBs, this chapter defines a number of classes of EFB hardware systems, and three types of software applications – Type A, B, and C. However, in bringing the guidance into the military domain, there are some specific differences, and these are discussed in this section. In particular, the hardware classes and application types address the required approval authorities within the ADF framework.

#### **Hardware Classes of EFB Systems**

10. This chapter defines two hardware classes of EFB systems – Portable and Integrated EFBs. Portable EFBs are largely equivalent with FAA Class 1 and 2 EFB hardware, while Integrated EFBs are largely equivalent with FAA Class 3 EFB hardware. The FAA Class 1 and 2 EFB hardware classes have been amalgamated into one Portable hardware class on the basis that the differences between Class 1 and 2 EFB hardware classes predominantly relate to subtleties of the FAA approval delegations and framework, rather than relevant technical differences. The following paragraphs define the EFB hardware classes in further detail.

**11. Portable EFB Hardware.** Portable EFB hardware is characterised by the following:

- a. generally portable Commercial-Off-The-Shelf (COTS)-based computer systems, although Military-Off-The-Shelf (MOTS) or application specific hardware designs are acceptable;
- b. considered a Portable Electronic Device (PED) and should address the non-interference criteria of Section 2 Chapter 18 (note that Section 2 Chapter 18 advises that precautions such as prohibiting the use of PEDs during critical phases of flight (e.g. take-off and landing) should be considered, although this may not be possible as EFBs are often required to be used during these phases of flight);
- c. may be connected to an SPO approved aircraft mounting device (cradle or docking station) during normal operations (in cockpits with limited space and fitment of a mounting device is not possible (e.g. single crew fighter aircraft) then the EFB may also be arm-mounted or attached in place of a kneepad on an aircrew member with an AESSO-ALSE approved attachment strap or harness);
- d. shall have a designated means of stowage if not secured to an approved mounting device or attached to aircrew member with an attachment strap or harness for takeoff and landing;
- e. shall be stowed for take-off and landing if not attached to a mounting device;
- f. may be connected to aircraft power through an SPO approved power interface, that may also be used to recharge internal batteries;
- g. may have read-only data connectivity during flight to other aircraft systems through an SPO approved interface to aircraft data-bus with firewall (the interface should address normal aircraft requirements as defined within this publication, and the firewall should be part of aircraft equipment – a software firewall application hosted on the EFB is not by itself suitable);

*Note: The intention is to provide isolation from the aircraft systems by an appropriately designed and qualified interface (up to aircraft equipment standards) from the portable COTS equipment. For example, hardware arrangements may include optocouplers for electrical isolation, while interface software may provide one way filtering of messages, and prevention of the EFB sending data to other aircraft systems. Application level firewalls hosted on the EFB are not suitable as they are generally based on COTS applications, and are unlikely to meet the required assurance requirements for preventing failure or fault conditions. Further, it is not possible to demonstrate non-interference with other applications if the firewall is a software application on the EFB.*

- h. requires quick-disconnect from power and/or data sources for ground egress;
- i. shall be compatible with ejection where the aircraft is fitted with an ejection seat (including ensuring that the disconnection mechanism/procedure does not interfere with ejection, the attachment lead is not a snag hazard, and that the weight and mounting arrangements are assessed within the context of an ejection);
- j. may have receive/transmit data connectivity for aircraft data link, provided the use of data from the datalink is associated with approved application functionality only;
- k. may be used to host Type A and B applications, and Type C applications under special circumstances (refer to discussion under Type C applications);
- l. requires SPO approval for hardware environmental and interface requirements to aircraft (refer to para 22 for further information);
- m. requires SPO approval and configuration control of EFB operating system and applications (refer to paras 13-19 for further information);
- n. requires FEG or Wing level authorisation and configuration control/identification of source documents (manuals, references, publications, procedures, forms, logs) and databases (refer to para 30 for further information on databases); and
- o. requires operational control processes to add, remove, or use in the aircraft (operational procedures should address any required pre-flight or after-start/before-taxi functional checks of the EFB to ascertain serviceability prior to flight).

**12. Integrated EFB Hardware.** Integrated EFB hardware is an installed aircraft system and requires design approval and design acceptance as per any other flight display or aircraft instrument. The EFB hardware must therefore meet relevant aircraft standards, and be designed and built to a level of integrity commensurate with the system safety assessment findings. The term Integrated EFB is used to describe those installed aircraft systems (incorporating Type C applications such as a Flight Displays and Moving Maps) that also co-host Type A and B EFB applications. Specific hardware and software considerations for co-hosting Type A and B applications along with Type C applications, and other aircraft instrument functions are provided later in this chapter.

### Software Applications for EFB Systems

**13.** As with the FAA approach for EFBs, this chapter defines three types of EFB applications – Type A, B, and C; although in bringing the guidance into the military domain, there are some specific differences in the ADF context. Regardless of the type of software application, a safety assessment should be conducted to evaluate the potential effects of undetected errors in all EFB applications. The EFB system should be capable of alerting the aircrew to probable EFB application/system failures.

**14. Type A Software Applications.** Type A applications include applications for electronic display of pre-composed manuals, procedures, publications and references currently in paper format (e.g. Microsoft Word, Adobe Acrobat, Internet Explorer, Firefox, Document Viewers, etc.); interactive look up and completion of forms and logs (e.g. Microsoft Word, Excel, Access, Delrina Form Flow, etc.); and training modules, such as ‘PC based’ training applications, ‘off-duty’ training materials review, and pre-flight ‘mission’ rehearsals. A list of example Type A applications is included at Annex A. The following criteria apply:

- a. **Software Safety and Assurance.** The development of Type A software applications does not require the software assurance ‘Key Issues’ identified in Section 2 Chapter 7 to be specifically addressed, although the EFB operating system and hosted applications should be demonstrated to meet their intended function, be sufficiently robust and to not provide confusing or misleading information. As the majority of these applications will be COTS, the intended function and use of these applications on the EFB should be documented, and a verification program (functional and robustness) conducted. The verification program should pay particular attention to opportunities for confusing or misleading information to be presented. The verification program should seek to assess the accuracy, availability and timeliness of the EFB applications, and should address the following robustness criteria:
  - (1) interaction with other applications and the COTS OS hosted on the EFB during worst case loading conditions (memory usage, disk usage, device driver interaction, etc.) should be analysed to determine the acceptability of potential interactions;
  - (2) displayed resolution, legibility, true representation (e.g. correct layout and positioning of document objects and text) and navigation of pre-composed static documents during worst case zoom and resize conditions should be analysed to determine the acceptability of information presentation; and
  - (3) any other robustness criteria that the safety assessment determines may contribute to the accuracy, availability, and timeliness of information/functions provided should be analysed.
- b. Type A applications require SPO approval and configuration control.
- c. Type A applications require FEG or Wing authorisation and configuration control of source documents (manuals, references, publications, procedures, forms, logs) stored on the EFB.
- d. Type A applications may be hosted on Portable or Integrated EFBs.

**15. Type B Software Applications.** Type B applications include applications for performance, take-off, landing and associated calculations (e.g. Boeing Laptop Tool); chart viewers, such as pre-composed or dynamic interactive electronic aeronautical chart viewers (e.g. en route, area, approach, and airport surface maps) including operator initiated centering and page turning but without display of aircraft/own-ship position or moving maps; electronic checklists; data link services (e.g. email and messaging services, internet, weather information, aeronautical information, air and battle space information); and video (e.g. cabin and external). From a functionality perspective, Mission Planning Systems (MPS) such as Portable Flight Planning System (PFPS), Joint Mission Planning System (JMPS), Mission Data Preparation Equipment (MDPE) and Falcon View (without aircraft position and moving map) would generally be considered Type B applications. Real-time and/or continuous centring functions (whether operator initiated or not) are moving maps and are therefore considered Type C applications. A list of example Type B applications is included at Annex A. The following criteria apply:

- a. Software Safety and Assurance.** The development of Type B software applications should address the software assurance “Key Issues” identified in Section 2 Chapter 7. A safety assessment is required to assess the required software assurance level for Type B applications, however these applications typically require assurance commensurate to DO-178B Level D (i.e. a planned and structured software development process, that adequately defines high level requirements and sufficiently verifies against those requirements). This DO-178B Level D benchmark should be applied for any development of new or custom applications. However, it is also noted that the majority of Type B applications will be based on COTs applications, and will not have been developed specifically to DO-178B Level D. In this case the high level software requirements for the use of these applications on the EFB should be documented, and a verification program (functional and robustness) conducted. The verification program should pay particular attention to opportunities for confusing or misleading information to be presented. The verification program should seek to assess the accuracy, availability and timeliness of the EFB applications. The safety program should ensure that the required flight information will be presented for each applicable phase of flight. The EFB operating system and hosted applications should be demonstrated to meet their intended function, be sufficiently robust and to not provide confusing or misleading information. The following robustness criteria should be addressed:
- (1) interaction with other EFB applications and the COTS OS hosted on the EFB during the worst case loading conditions (memory usage, disk usage, device driver interaction, etc) should be analysed to determine the acceptability of potential interactions;
  - (2) for calculation applications: real and integer inputs should be exercised using equivalence class selection of invalid values;
  - (3) as displayed resolution, legibility and navigation of pre-composed static charts during worst case zoom, resize, rotation and translation algorithm conditions should be analysed to determine the acceptability of information presentation;
  - (4) accuracy and refresh of dynamic interactive vector charts and texture maps during worst case clutter, zoom, resize, rotation and translation algorithm conditions should be analysed to determine the acceptability of information presentation;
  - (5) checks should be made to ensure the protection mechanisms for exceeded timeframes respond correctly; and
  - (6) any other robustness criteria that the safety assessment determines may contribute to the accuracy, availability, and timeliness of information/functions provided should be analysed.
- b.** Type B applications require SPO approval and configuration control.
- c.** Type B applications require FEG or Wing authorisation and configuration control of associated databases stored on the EFB.
- d.** Type B applications may be hosted on Portable or Integrated EFBs.
- e.** Some EFB systems may also be capable of loading flight or mission data from a standard Mission Planning System (Type B application) onto the on-board Flight Management Systems (FMS) or Mission Computers (MC), via the aircraft interface. During flight, such functionality should be limited to Integrated EFBs, as Portable EFB hardware should only have read-only data connectivity during flight to other aircraft systems through an SPO approved interface. Data transfer to the aircraft should be limited to flight and mission data, and should not include executable code. The Integrated EFB and aircraft interface should ensure that there is a means to establish that the correct information is loaded into the FMS or MC following any data transfer. Furthermore, a means of ensuring the correct information has been entered into the MPS prior to upload to the FMS or MC should also be established. AAP7001.053 Section 2 Chapter 23 presents MPS guidance. Portable EFB hardware can be used to load flight or mission data from a MPS prior to flight, provided it can be demonstrated that this mode cannot be exercised during flight.

**16. Type C Software Applications.** Type C applications include Primary Flight Displays (PFD), Secondary Flight Displays (SFD), navigation displays, moving map displays, Airport Moving Map Displays (AMMD), Cockpit Display of Traffic Information (CDTI), separation support aids, etc. The following criteria apply:

- a. Software Safety and Assurance.** The development of Type C software applications should address the software assurance “Key Issues” identified in Section 2 Chapter 7. A safety assessment is required to assess the required software assurance level for Type C applications, however these applications

typically required assurance commensurate with DO-178B Level C through A, depending on functions hosted on the EFB. The safety program should ensure that the required flight information can be presented for each applicable phase of flight. The EFB operating system and hosted applications should be demonstrated to meet their intended function, be sufficiently robust and to not provide false or hazardously misleading information.

- b. Type C applications require SPO approval and configuration control of Type C applications and databases.
- c. Type C applications are hosted on Integrated EFBs, and Portable EFBs only as specifically defined in para 18. Further advice should be sought from DGTA regarding hosting Type C applications on Portable EFBs, as these will be critically assessed on the basis of rigorous system and software safety assessments.

**17. Co-hosting Type C Applications with Type A and B Applications.** Hardware and/or software partitioning (containment and mediation, including detection and fault handling) should be established to protect Type C applications from Type A and B applications, the COTS computing platform and COTS operating system. The preferred approach for achieving this is a dual microprocessor system in which the first microprocessor hosts the COTS OS and Type A and B applications, with the second microprocessor hosting an appropriately assured DO-178B Real Time Operating System (RTOS) (e.g. Green Hills Integrity, Lynx 178, etc.) and Type C applications. There are numerous commercially available EFB systems that adopt this approach. Other approaches using software partitioning are also possible, however DGTA should be engaged on any proposal to adopt a software partitioning approach.

**18. Special Considerations for Airport Moving Map Displays hosted on Portable EFBs.** An Airport Moving Map Display (AMMD) is intended to help aircrew orient themselves on the airport and airfield surface, to improve pilot positional awareness during taxiing. The AMMD function is not to be used as the basis for manoeuvring, and the application is to be limited to ground operations only. An AMMD (Type C application) may be hosted on a Portable EFB, provided the aforementioned criteria for Type C applications and the issues identified for COTS operating systems (para 28) are addressed. A number of functional safety requirements also apply to the AMMD. The AMMD should detect and fully remove depiction of own-ship position when:

- a. the position sensor horizontal positional accuracy exceeds a value that would ensure the own-ship position is depicted on the correct runway or taxiway, or when the position source becomes unavailable;
- b. the EFB's operating system attempts to corrupt memory allocation of the Type C application and data, or cause other erroneous information (e.g. task or interrupt conflicts); or
- c. airborne, or when taxi speed exceeds a maximum safe taxi speed, or speeds associated with the initial take-off role are exceeded.

**19. User-Modifiable Data.** Some applications store and retrieve data (e.g. saved settings, data or templates) that configure the EFB applications to the preferences and/or functions of an operator, including default or initial data. This data is referred to as user-modifiable data, or adaptation data in the CNS/ATM domain. The inclusion of relevant software requirements and associated verification for the scope (e.g. data types/sub-types, valid ranges or values, etc.) of user modifiable data should be addressed as part of the software application development and approval. However the development, configuration control and approval of the user-modifiable data itself is a FEG or Wing responsibility. Note that para 27 provides further information regarding the inclusion of design requirements to prevent the importing of stale user-modifiable data from previous flights or other aircraft.

## EFB SYSTEM DESIGN CONSIDERATIONS

**20.** Numerous considerations are relevant to the design and assessment of EFB systems. Many of these design considerations are common to criteria presented for role equipment (refer Section 2 Chapter 14) and portable electronic devices (Section 2 Chapter 18). However, several additional or more specific design considerations apply to EFB systems, and these are presented in this section.

**21. Use of Aircraft Electrical Power Sources.** Portable EFB systems may be connected in flight to aircraft power through an SPO approved power interface, which may also be used to recharge internal batteries. EFB power connections should be appropriately labelled to identify the electrical characteristics and keyed to prevent incorrect connection. They should also incorporate design features to prevent adverse effects in the event of any failure of the portable EFB system (e.g. short, excessive current draw, over-voltage, etc.). An electrical loads analysis should be conducted to ensure that powering or charging of the EFB will not adversely affect other aircraft systems and that power requirements remain within the available power budgets. Where the EFB power source incorporates a COTS

power supply or charger (e.g. a conventional laptop power supply/charger), then a means to isolate or de-power the power supply or charger should be incorporated. System Safety Analyses should be conducted when determining which aircraft power bus to power the EFB systems from, to ensure that the required information on EFB systems remains available after load-shedding during required critical phases of flight. Some applications, especially when used as a source of required information, may require that the EFB be capable of using an alternate power supply to achieve an acceptable level of safety.

**22. Batteries.** The criteria of Section 2 Chapter 5 should be addressed for EFB batteries. Some EFB functions, especially when used as a source of required information, may require that the EFB be powered from aircraft electrical power sources. This is to prevent EFB system shutdowns or resets due to low battery power, that might lead to EFB functions being unavailable, or data being inadvertently lost or reset.

**23. Environmental Hazards Identification and Qualification Testing.** Portable EFBs are considered Portable Electronic Devices (PEDs) and should address the non-interference criteria of Section 2 Chapter 18. Note that Section 2 Chapter 18 advises that precautions such as prohibiting the use of PEDs during critical phases of flight (eg. take-off and landing) should be considered. Such restrictions may not be directly suitable as EFBs are often required to be used during these phases of flight, and therefore particular attention should be paid to demonstrating non-interference. Particular emphasis should be placed on ensuring the EFB does not interfere with safety and mission critical cockpit equipment. Reliance on source-victim testing will not normally be adequate to ensure non-interference, since this approach does not account for variations across the fleet or system degradation over time. Rather, a combination of test and analysis will normally be required. Some COTS systems incorporate wireless devices, and thus the non-interference assessment should specifically consider this technology, and its potential effect on aircraft systems. Additional environmental qualification analyses and testing (vibration, temperature, humidity, rapid depressurisation, etc.) may be required, particularly if the EFB system provides required information during certain phases of flight, in which case the criteria of Section 2 Chapter 3 for Environmental Design Requirements should be addressed. Rapid depressurisation testing is particularly relevant to COTS electronic systems, as rarely are COTS systems designed with consideration for this environmental condition.

**24. EFB Mounting Devices.** AC 120-76A provides design and operational considerations for mounting devices, and these are equally relevant to the ADF. The following design practices, summarised from AC 120-76A, should be considered:

- a. The mounting device (or other securing mechanisms) that attaches or allows mounting of the EFB system must not be positioned in a way that obstructs visual or physical access to aircraft controls and/or displays, external vision, or aircrew ingress, egress, and ejection seat arrangements.
- b. The EFB system when mounted and/or installed should not present a safety hazard to any aircrew member, including during a crash landing.
- c. The design of the mount should allow the operator easy access to EFB controls and a clear view of the EFB display while in use.
- d. The mount and associated mechanism should not impede the aircrew in the performance of any task (normal, abnormal, or emergency) associated with operating any aircraft system.
- e. Mounting devices should lock into position easily. Selection of positions should be adjustable enough to accommodate a range of aircrew preferences. In addition, the range of available movement should accommodate the expected range of aircrew anthropometrics. Locking mechanisms should be of the low wear type to minimise slippage after extended periods of normal use.
- f. A provision should be provided to secure, lock, or stow the mounting device in a position out of the way of aircrew operations when not in use.
- g. If the EFB requires wiring to mate with power, aircraft systems or other EFBs, and if the wiring is not run inside the mount, the cable should not hang loosely in a way that compromises task performance and safety. Aircrew should be able to easily secure the cables out of the way during aircraft operations. Wiring that is external to the mount should be of sufficient length to perform the intended tasks, as wiring that is too long or too short could present an operational or safety hazard.

**25. Human Machine Interface (HMI).** Section 2 Chapter 13 provides design requirements for human factors, HMI and workload. That chapter should be assessed in conjunction with AC 120-76A which provides human factors considerations for portable and installed EFB systems. These include:

- a. placement of mounting device,

- b. legibility of text,
- c. approach/departure and navigation chart display,
- d. responsiveness of applications,
- e. off-screen text and content,
- f. active screen regions,
- g. managing multiple open applications and documents,
- h. use of input devices,
- i. workload,
- j. messages, warnings and the use of colours, and
- k. data entry screening and error messages.

26. The EFB 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, colour-coding philosophies, and symbology, should be consistent across the EFB and various hosted applications. These applications should also be compatible with other cockpit systems (e.g. calculation units, presentation of information, etc).

27. The HMI should be resistant to the operator inadvertently importing or using stale data from previous flights or aircraft. This is a known contributor to several accidents and incidents involving the Boeing Laptop Tool (BLT). While reasonability checking should be introduced into the software application, such features only provide a coarse value check, and may not provide complete detection of stale data scenarios. Precise value checks are only possible with an accurate reference and cross check arrangement (such as that provided by redundancy or diversity). Therefore a method should also be prescribed (automated or procedural) for cross checking calculations against alternate references.

28. **COTS Operating Systems.** COTS operating systems, such as Windows XP, Mac OS X, Linux, Solaris, etc, are generally considered Level D software in accordance with FAA CAST 14 *Use of a Level D Commercial Off-the-Shelf Operating System in Systems with Other Software of Levels C and/or D*. CAST 14 identifies that COTS operating systems, such as Windows XP, could be used in a Level C or D system provided that the issues listed in CAST 14 are addressed. These issues include assuring that the system architecture prevents the COTS operating system negatively affecting the operation of critical functions. Note that the list of issues in CAST 14 is not all-inclusive, and that DGTA should be engaged to ensure any unique circumstances are also considered. Addressing these issues is not a trivial undertaking and requires extensive analysis, and knowledge of the system and software.

29. CAST 14 requirements are applicable to Portable EFBs hosting Type C applications, and Integrated EFBs where the worst case functional failure of the EFB applications is assessed as no worse than Major, requiring Level C. The applications should be primarily Level D (Minor failure condition or better), with only one or two functions requiring Level C. It should be demonstrated that the software that could produce a major failure condition is protected from the software that could produce a minor failure condition. Furthermore, any failure of the COTS operating system should be shown to only result in a minor failure condition for the system. CAST 14 requirements are also advised for Portable EFBs that do not host Type C applications.

30. **Aeronautical Information Databases.** There are two aspects to the integrity of aeronautical information databases: the data stored in the database and the format/design of the database. Database data should be provided by accredited suppliers and should be approved and authorised in accordance with the relevant MILAVREGs. The data integrity should support the integrity requirements of the associated application. FEG or Wing authorisation and configuration control of database data is required to ensure that only authorised database data versions provided by accredited suppliers are used with EFB systems. The database format/design should be assessed and verified in conjunction with the associated application approval. Modification (e.g. a change to the format/design of the database) or installation of any new database should not be permitted until the database has been evaluated as part of the design approval and acceptance process to ensure that the data format and data integrity supports the integrity requirements of the application. Databases should also be protected from unauthorised change (both data and format/design) when resident on the EFB.

- 31. Source Documents.** Source documents such as manuals, references, publications, procedures, forms and logs, should be protected from unauthorised changes when resident on the EFB. This may be achieved through providing some 'read only' protection for the documents, or by ensuring the application is a 'reader' only and not an 'editor'.
- 32. Security.** The EFB should incorporate security measures to prevent introduction of unauthorised modifications to the EFB's operating system, its hosted applications, and any of the databases, or data links used to enable hosted applications. EFBs should be protected from external contamination from viruses and other malicious programs. As COTS operating systems and applications are frequently subject to security updates and patches, the relevant SPO should develop a process for ongoing assessment, and updating this software under the rigour of the design control system.
- 33. Additional System Safety Considerations.** The EFB safety assessment should take into account the relationship between cockpit procedures and references, and implicit safety assumptions made throughout the extant aircraft system safety program. Cockpit procedures, references, emergency checklists, etc. are typically developed during the initial development and certification of an aircraft, and in support of subsequent modifications. Embedded in these procedures and references are many implicit relationships to assumptions (e.g. availability, accuracy, and completeness of information) made in the system safety program accompanying aircraft development and/or modification. It is vital in any introduction of EFBs or further efforts to transition to a paperless cockpit, that these assumptions are adequately identified and maintained during the engineering development and approval process.
- 34. EFB Configuration Control.** The EFB equipment should be subject to configuration control and configuration status accounting by the relevant SPO including:
- a. operating system version control;
  - b. application program version control;
  - c. database format/design version control; and
  - d. make and model of EFB hardware, including a tracking process for major internal subcomponents whose replacement/upgrade may necessitate additional non-interference testing.
- 35. Instructions for Continued Airworthiness.** On-going maintenance and support of EFB equipment is an essential contributor to system integrity. A maintenance or inspection program should be defined to identify inspection items, and establish inspection and maintenance time-in-service intervals, methods and procedures. COTS operating systems and software applications should be managed using a problem reporting and management system as described in Section 2 Chapter 17.

### OPERATIONAL CONSIDERATIONS

- 36.** The introduction of EFBs into service requires explicit consideration of operational factors to complement technical activities, and to mitigate design shortfalls. Cockpit procedures, references, emergency checklists, etc. are typically developed during the initial development and certification of an aircraft, and in support of subsequent modifications. Embedded in these procedures and references are many implicit relationships to assumptions (e.g. availability, accuracy, and completeness of information) made in the system safety program accompanying aircraft development and/or modification. It is vital in any introduction of EFBs or further efforts to transition to a paperless cockpit, that these assumptions and other operational considerations are adequately captured. This section provides suggestions for operational approvals of EFBs.
- 37.** The following operational issues are fundamental to the successful introduction of an EFB:
- a. Training development should reflect the level of functionality and complexity of using the EFB. Training should include theory of operation and identify dependencies associated with the sources and limitations of the information presented by the EFB.
  - b. Training should ensure operators have a clear understanding of what the EFB is, its capabilities and limitations, and the applications for which the operator will use the EFB system and its components and peripherals.
  - c. Human factors (HMI and workload) should be assessed prior to and throughout the operational evaluation to ensure use of the EFB is at least as safe as the paper based system. While there are likely to be many benefits and productivity improvements associated with EFBs, particular attention should be paid to those scenarios or activities where the EFB displays required or time-critical information for that phase of flight.

- d. Procedures should be developed and approved for the employment and management of EFBs prior to their use. These are described in further detail in the following paragraph.
- e. A scheme for assessing and tracking operator currency with EFBs should be developed.

**38. Procedures.** Like any cockpit system, appropriate operational procedures are cornerstone to safe operation. It is recommended that procedures be developed for:

- a. use of the EFB during all phases of flight for single and multi-crew aircraft arrangements;
- b. defining all special flight manoeuvres, operations and procedures that the operator is authorised to conduct when using an EFB including:
  - (1) any special procedures when using EFB-based information,
  - (2) geographical or operational areas authorised for specific EFB operations, and
  - (3) authorised methods for managing inoperative EFB equipment, both prior to departure and during flight.
- c. using EFBs in coordination with other flight deck systems to ensure that the aircrew know what aircraft system to use for a given purpose, especially when both the aircraft and EFB system provide similar information;
- d. EFB failure scenarios, including reversion to backup EFBs or paper copies;
- e. ensuring database accuracy and currency, and the completeness of data loaded and maintained in each unit;
- f. confirmation of the revision numbers and/or dates of EFB flight databases and software installed on EFBs prior to flight;
- g. control and mitigation of additional workload potentially created by the EFB;
- h. any roles that aircrew may have in creating, reviewing and using performance calculations supported by EFBs;
- i. the use and modification of electronic checklists;
- j. installation, removal, and re-installation of any Portable EFB system from the aircraft, including any necessary maintenance entries;
- k. EFB shutdown to ensure that the EFB operating system and hosted applications remain “stable” after multiple start-ups and shutdowns;
- l. managing EFB battery use and replacement;
- m. ensuring that the EFBs are only connected to approved equipment (e.g. mission planning system, data transfer station, aircraft interface etc);
- n. enforcing security measures to prevent introduction of unauthorised modifications or viruses to the EFB’s operating system, its hosted applications, and any of the databases, or data links used to enable hosted applications; and
- o. initial operational test and evaluation, leading to full service release.

### Transitioning to a Paperless Cockpit

**39.** As previously stated, cockpit procedures, references, emergency checklists, etc. are typically developed during the initial development and certification of an aircraft, and in support of subsequent modifications. Embedded in these procedures and references are many implicit relationships to assumptions (e.g. availability, accuracy, and completeness of information) made in the system safety program accompanying aircraft development and/or modification. Therefore it is vital in any efforts to transition to a paperless cockpit that these assumptions and other

operational considerations are explicitly addressed, even if the EFB system has been operated in the cockpit for many years. The operation of EFB systems in a paperless cockpit carries numerous additional challenges that are typically not addressed during the acceptance of EFB systems into cockpits where paper products are used.

**40. Operational Evaluation.** A minimum 6 month operational evaluation period is recommended by the FAA when transitioning to a paperless cockpit before final approval to allow the reduction or elimination of paper copies in the cockpit or flightdeck. During this period, an EFB system must demonstrate that the information it displays or produces is as available, accurate, accessible and complete as that provided by the paper information system. A problem reporting system should be introduced to record all problems and issues the EFB presents, as this will provide a sound basis for review throughout the operational evaluation period. Mitigations should be provided against complete loss of functions provided by EFB systems. For example a complete set of sealed paper backups could be stored in the cockpit, or carried by selected crew members. Procedures should also be developed to cover the event of loss of functions provided by EFB systems in all failure scenarios and phases of flight.

**41. SPO Obligations in Transitioning to a Paperless Cockpit.** The design approval and acceptance of an EFB system is dependant upon the intended use of the EFB. If the incorporation of an EFB is in support of transition to a paperless cockpit, then the SPO should ensure that the EFB system design addresses the following considerations:

- a. all system safety assumptions (availability, accuracy, completeness) associated with all paper-based procedures and references used in the cockpit are identified and addressed by their EFB replacement;
- b. the design supports the required availability, accuracy and completeness of information;
- c. separate and backup power sources as necessary are provided to meet safety objectives;
- d. multiple redundant and/or diverse EFBs are provided to mitigate sources of common mode failures;
- e. factors relating to employment in single versus multi-crew aircraft, associated workload and availability of information have been assessed; and
- f. if required as a mitigation for potential design related failure conditions, that paper products are carried by selected aircrew members, or a complete set of sealed paper backups stored within reach of the cockpit.

#### **MANAGING DEFICIENCIES AGAINST EFB DESIGN REQUIREMENTS**

**42.** There may be circumstances where design requirements recommended by this chapter cannot be met. In such cases, an Issue Paper (IP) is the preferred means of managing the deficiencies to closure. An IP should be raised when:

- a. an ADF application does not neatly fall into the defined application types (refer to Annex A);
- b. an ADF application does not meet the relevant software safety and assurance requirements for its type, but the OAA considers the improvement in operational safety or capability to be worth retaining the residual risk; or
- c. any other circumstances where technical shortcomings of the EFB system against the criteria of this chapter require operational mitigations (usually procedures) to retain an acceptable level of safety.

**43.** The previous paragraph acknowledges that the ADF may elect to employ an EFB application that would not be approved by civilian Airworthiness Authorities. However, the TAA's firm expectation is that ADF engineers will strive to achieve the benchmark level of safety widely accepted in the civilian domain. Only where significant technical issues or an urgent operational imperative prevent full compliance with the requirements of this chapter, will the TAA propose to the OAA that a lesser level of safety be accepted. Factors such as rapid acquisition and cost, would not normally be considered adequate justification for short cuts in engineering rigour.

#### **Annex:**

- A. Examples of Type A, B and C Applications