AC AOC16(0)

23 July 2010

Advisory Circular

ELECTRONIC FLIGHT BAG (EFB)

1   **GENERAL.** Advisory Circulars (ACs) are issued by the Civil Aviation Authority of Singapore (CAAS) and contain information about standards, practices and procedures acceptable to the Authority. The revision number of the AC is indicated in parenthesis in the suffix of the AC number.

2   **PURPOSE.** This Advisory Circular (AC) provides guidance to the operator applying for operational approval for Electronic Flight Bag (EFB) operations.

3   **APPLICABILITY.** This AC applies to all Singapore AOC holders.

4   **CANCELLATION.** This is the first AC issued on this subject.

5   **EFFECTIVE DATE.** This AC is effective from 23 July 2010.

6   **REFERENCES.** The following materials were referred to for the development of this AC:

(a)   EASA/JAA TGL 36; and

(b)   FAA AC 120-76A

7   **INTRODUCTION.**

7.1   An electronic flight bag (EFB) is an information management and display system by electronic means, intended primarily for flight crew or cabin crew functions that were traditionally accomplished using paper references (e.g. navigation charts, operating manuals, performance calculations).

7.2   The EFB may also support other functions that have no paper equivalent, e.g. a video surveillance display or flight dispatch function such as flight performance calculations based on data provided to the airline's flight crew. The EFB may also be used to host other secondary functions on the same display system.

7.3 An EFB system has essentially two components, viz. a host platform or hardware to run the software programmes and software programmes or applications to provide the required functionality.

7.4 Under EASA/JAA TGL 36 and FAA AC 120-76A the host platform or hardware is categorised into Class 1, Class 2 and Class 3 EFB systems while the software programmes or applications are identified as Type A and Type B.

7.5 An EFB may be portable or installed either as an independent system or as part of an integrated onboard information system.

7.6 The operator is hereby reminded that it is the sole the responsibility of the operator to ensure the accuracy and integrity of the information used and all data derived from are from verifiable sources.

8   HARDWARE OR HOST PLATFORMS.

8.1   Class 1 EFB systems

8.1.1 Considered as controlled personal electronic devices (PEDs), Class 1 EFBs are essentially commercially-off-the-shelf (COTS) portable computer system for use on an aircraft. It is not attached to any aircraft mounting device and must be secured during critical phases of flight.

8.1.2 Aircraft power may be connected to the EFB through a certified power source only. Except under specified conditions, EFB to aircraft data connectivity is not authorised.

8.1.3 Class 1 EFBs do not normally require airworthiness approval for the system.

8.2   Class 2 EFB systems

8.2.1 Though still considered as controlled PEDs, Class 2 EFBs are generally COTS-based computer systems connected to aircraft mounting devices during normal operations.

8.2.2 Aircraft power connection to Class 2 EFBs is through a certified power source and connectivity to aircraft avionics is possible.

8.2.3 A Class 2 EFB requires an airworthiness approval.

8.3   Class 3 EFB Systems

8.3.1 Class 3 EFB systems are installed equipment requiring an airworthiness approval. This approval should cover the integrity of the EFB hardware installation (e.g. server, display, keyboard, power, switching) and include hardware and software qualifications. Such aspects as the human machine interface should also be addressed.

9   SOFTWARE PROGRAMMES OR APPLICATIONS.

9.1   Type A Programmes

9.1.1 Type A programmes typically comprise applications including pre composed, fixed data which may be hosted by any of the 3 EFB hardware classes. Though requiring processing for operational approval by the Authority, there is no necessity to obtain an airworthiness approval for these programmes.

9.2   Type B Programmes

9.2.1 Type B programmes are applications which are capable of dynamic and interactive activities that can manipulate data and presentation. The data may be hosted by any of the 3 EFB hardware classes. Type B programmes do not require airworthiness approval but are subject to operational approval process by the Authority.

10   AIRWORTHINESS CONSIDERATIONS.

10.1   **Hardware or Host Platform**

10.1.1 Class 1 EFBs

(a)   A Class 1 EFB does not require airworthiness approval for use during non-critical phases of a flight so long as the provisions of AOCR Chapter 7 paragraph 2.8 and CAAS AC-7(0) are complied with.

(b)   The following items should be assessed in relation to the physical use of the device in the flight deck, its safe stowage, crashworthiness, security and the use of it under normal environmental conditions including turbulence:

   (1) **EMI Emission:** If the EFB is to be used during critical phases of flight such as take-off and landing, the EFBs should be tested for compliance with RTCA DO-160(F)/EUROCAE ED-4(F) for emission of radio frequency energy.

   (2) **Lithium Batteries:** As a minimum, lithium batteries should be tested to UL1642 standards for risk of leakage, hazards of overheating and short circuiting.

   (3) **Power Source:** The design of the power source should be such that it's easy for the crew to deactivate, remove or un-plug from the EFB, failing which a clearly labelled and conspicuous means such   as an on/off switch be provided.

   (4) **Data Connectivity:** Data connectivity to other aircraft systems is not authorised except if the EFB system is connected to a system which is completely isolated from the avionics/aircraft systems (e.g., EFB system connected to a transmission medium that receives and transmits data for Aircraft Administrative Communications (AAC) purposes on the ground only). Any other type of data connectivity requires an airworthiness approval.

10.1.2 Class 2 EFBs

(a)   A Class 2 EFB requires an airworthiness approval for the mounting device, crashworthiness, data connectivity and EFB power connection.

(b)   Evaluation of the EFB mounting device and flight deck location should be conducted as follows:

   (1) Design and placement of Mounting Device: The mounting device should not obstruct visual or physical access to aircraft controls and/or displays, flight crew ingress or egress, or external vision. It should allow easy access to the EFB controls and afford a clear view of the EFB display while in use. The following are considerations for the design of an EFB mounting device:

       (i)   Impedance to flight crew performing the task of operating the aircraft or aircraft system;

       (ii)   Location of mount to afford optimum visual scope and physical accessibility of the EFB to the flight crew in his normal seated position;

       (iii) The mount should be easily locked in place and secured out of the way when not in use;

       (iv)   The OEM data should be used when dealing with issues pertaining to mechanical interference adversely affecting control column forces or aircraft handling qualities;

       (v)   Cable to mate aircraft systems or other EFBs should be of optimal length and can easily and safely be secured to avoid becoming operational or safety hazard.

(2)   EMI emission, Lithium Batteries, Power Source: In respect of EMI emission, Lithium batteries and Power source guidelines provided for Class 1 EFB in paragraphs 10.1.1.2(a), 10.1.1.2(b) and 10.1.1.2(c) are also valid for Class 2 EFB.

(3)   Data Connectivity: EFB data connectivity should be validated and verified to ensure non-interference and isolation from aircraft systems during transmission and reception.

10.1.3 Class 3 EFBs

(a)   A Class 3 EFB is considered an installed equipment and is subject to assessment of compliance with airworthiness requirements as well as approval. The airworthiness requirements are typically concerned with:

(1)   the intended function and safety (e,g. security and integrity) of interfaces between EFB and avionics data sources including failure modes under normal and fault conditions. Software applications do not require airworthiness approval but are subject to operational approval process.

(2)   Hardware and software qualification should be conducted in accordance with an agreed Design Assurance Level (DAL) for the system and its interfaces. The DAL may take into consideration provisions for future needs.

(b)   Human factor assessment relating to display, keyboard, switches, annunciators, etc, should be conducted in accordance with criteria of the aircraft type design or basis of aircraft certification if it is a modification.

Note: For details refer EASA/JAA TGL 36 Appendix D.

10.2   **EFB Software Applications (Type A and Type B)**

10.2.1 Type A and Type B EFB software applications do not require airworthiness approval, but should be approved through the operational approval process.

10.2.2 EFB software applications not classified Type A or Type B under EASA/JAA TGL 36 or classified Type C under FAA AC 120-76A should undergo full airworthiness approval.

Note: For details on 10.2.1 and 10.2.2 above refer to Appendix A, B and C of EASA/JAA TGL 36

10.3   **Specific Considerations for Performance and Electronic Checklist Applications**

10.3.1 The operator must ensure that all EFB derived performance calculations are consistent with those derived from the approved Airplane Flight Manual (AFM).

10.3.2 The operator shall consult the Authority on any changes to the electronic checklist which differs from the approved procedures contained in the AFM.

11   OPERATIONAL APPROVAL.

11.1   The Authority grants EFB operational approval on a case-by-case basic taking into consideration the robustness of the EFB system and the reliability and integrity of information the EFB provides to the crew. A quality assurance system must also be established to approve the integrity of the software data prior to installation on the EFB.

11.2   **Modes of EFB operations:**

11.2.1 The operator may opt for EFB operations with no paper back-up in which case the operator will have to demonstrate to the Authority a full Operational Risk Assessment with suitable means of mitigation against failure or malfunction conditions.

11.2.2 Alternatively the operator may opt for EFB operations with paper back-up for cross-checking and mitigation against system failure or malfunction in which case the Authority may accept a safety review consistent with the operator's Safety Management System.

11.2.3 The third option is a combination of paragraphs 11.2.1 and 11.2.2 with limited paper back-up for which the operator has to satisfy the Authority of its merits and comply with specific conditions stipulated by the Authority. Approval of this mode of EFB operation is at the absolute discretion of the Authority.

11.3 **Operational Risk Analysis**

11.3.1 The Authority must be satisfied that the operator has taken into consideration for the analysis failure of the complete EFB system as well as individual applications including corruption or loss of data and erroneously displayed information.

11.3.2 The scope of analysis is operator-specific but should include:

(a)   How to minimise undetected erroneous application output;

(b)   Effective detection of erroneous outputs from software applications by

(i)   Description of corruption scenario;

(ii)   Description of mitigation means (crew monitoring).

(c)   Upstream development quality process

(i)   Root data reliability (qualified/verified input data)

(ii)   Software partitioning predicated on safety effect.

(d)   Mitigation means to the above.

11.4 **Human Machine Interface Assessment for Type A and B Software Application**

11.4.1 Assessment of Human Machine interface and Cockpit of Resource Management (CRM) to include at least the review of:

(a)   Human/machine interface

(b)   Legibility of text

(c)   Approach/departure and navigation chart display

(d)   Responsiveness of application

(e)   Off-screen text and content

(f)   Active regions

(g)   Managing multiple open applications and documents

(h)   Messages and the use of colours

(i)   System error messages

(j)   Data entry screening and error messages
       Note: For further details refer to Appendix D of EASA/JAA TGL 36.

11.5 **Flight Crew Operating Procedures**

11.5.1 The procedures for using EFB systems with other Flight Deck System should be designed such as to ensure the flight crew are able to:

(a)   Determine the correct use of the appropriate system for a given purpose;

(b)   Determine the appropriate course of action to deal with any information mismatch;

        (c)   Distinguish primary from backup information and decide upon the appropriate use of the backup information.

11.5.2 As far as possible the EFB/user interfaces should be consistent with the flight deck design philosophy.

11.5.3 A procedure should be in place to enable flight crew to determine at pre-flight the validity of the database, its version, revision number and the effective date. The verification should cover data that could adversely affect flight operations and the procedure should specify actions to deal with out-of-date application software or databases.

11.5.4 To mitigate and/or control additional workload arising from the use of EFB system, procedures should be developed to:

        (a)   Preclude both flight crewmembers become preoccupied with the EFB system at the same time; and

        (b)   Clearly define crew functions so to ease workload and enhance monitoring of operations of EFB and other aircraft systems.

11.5.5 The procedures should be strictly applied in flight and should include specific time periods during which the flight crew may not use the EFB system.

11.5.6 The operator should develop procedures to define the roles of the flight crew and dispatch office in creating, reviewing, and using performance calculations supported by the EFB systems.

11.6 **Quality Assurance**

11.6.1 The operator should document procedures for the quality control of the EFB system. This should detail an overall in-charge of the EFB system, i.e. the EFB Administrator who will have authority to authorise and activate amendments to the hardware and software.

11.6.2 Maintenance procedures should be established for the EFB system to deal with unserviceabilities and failures to assure the integrity of the EFB system. The maintenance procedures will include the handling of updated information, the acceptance and timely promulgation to all users and aircraft platforms.

11.6.3 A fault or failure of the system should be brought to the immediate attention of the flight crew and the faulty or failed system isolated until rectification action is taken. In addition to back-up procedures to deal with system failures, a reporting system needs to be in place so that necessary actions are to prevent the erroneous information being used by the flight crew.

11.6.4 The EFB hardware should be secured physically and protected against unauthorized access by the use of password protected system updates. Such measures should also include the control of laptop software installations to prevent unauthorised use of data.

11.7 EFB Administrator (Administrator)

11.7.1 An Administrator is essential in the running the EFB system. The Administrator needs to be trained in his role and should have a good working knowledge of the proposed system hardware and operating system.

11.7.2 The Administrator should seek guidance from the EFB system supplier to identify clearly which parts of the EFB system that can be accessed and modified by the Administrator and the parts that are only to be accessed by the supplier.

11.7.3 Certain specified roles of the Administrator involving changes and modifications to the EFB may be procedurally delegated by the Administrator to maintenance and support staff. The Administrator must ensure these procedural guidelines are strictly adhered to and that no unauthorised changes can take place.

11.7.4 The Administrator shall also be responsible for conducting audits and to ensure compliance with company procedures by all personnel and the audits should include systematic audits/checks against the procedures as well as random checks of reports for followed-up actions.

11.8 **Flight Crew Training**

11.8.1 Specific training should be give to flight crew on the use of the EFB system and the training should include at least the following:

(a)   An overview of the system architecture

(b)   Pre-flight checks of the system

(c)   Limitations of the system

(d)   Specific use of each application and the conditions specifying EFB usability.

(e)   Restrictions on system usage including system is non-availability

(f)   Procedures for cross-checking data entry and computed information

(g)   Phases of flight when the EFB system may and may not be used

(h)   CRM and human factor considerations on the use of the EFB

(i)   Training for new applications or changes to the hardware configuration

11.8.2 The EFB system may be used to play a role in the operator's Proficiency Checks as part of Recurrent training and checking.

11.9 Operational Evaluation Test (OET) The purpose of the OET is to verify satisfactory compliance with the above elements prior to final approval of the EFB to replace paper documentation.

11.9.1 Where the operator opts for initial retention of paper back-up, a two-stage operational evaluation will be conducted and the first stage should:

(a)   run in parallel with the equivalent paper format verification of correctness and reliability of the system;

(b)   run for 6 month or as determined by the Authority; and

(c)   include an evaluation and audits of the procedures used as well as checks on the accuracy of any computed data.

11.9.2 A report of satisfactory completion of the first stage should be submitted to the Authority for acceptance and issue of approval for the use of the system in place of the paper format.

11.9.3 The second stage will still involve with carriage of paper documentation as precaution against any event cause by EFB system non-availability or fault.

11.9.4 The Authority may ultimately grant approval to allow removal of paper documentation when it is satisfied that the back-up procedures are sufficiently robust.

11.9.5 Where the operator opts to start operations without paper back-up the OET will comprise of the followings:

(a)   A detailed review of the operational risk analysis;

(b)   A simulator LOFT session to validate the use of the EFB in normal, abnormal and emergency operating conditions. Such items as a late runway change and diversion to an alternate should also be included. The LOFT should precede any actual line flights,

as the LOFT outcome may result in changes to flight crew training and/or administrative procedures.

    (c)   Observation by the authority of the initial line flights.

11.9.6 The Authority must be satisfied that the operator is able to maintain the EFB to the required standard by the EFB Administrator and the quality assurance system.

11.10 **Final Operational Report (Operational Compliance Summary)**

11.10.1 As final operational report to the Authority, the operator shall submit an Operational Compliance Summary (OCS) summarising all activities conducted or demonstrated as means of compliance with the requirements for the issue of an operational approval for the EFB system. The report should include, but not be limited to, the following:

    (a)   EFB platform/hardware description;

    (b)   Description of each software application to be included in the approval;

    (c)   Risk analysis summary for each application and mitigation means put in place;

    (d)   Human factor assessment for the complete EFB system, human machine interface and all software applications;

    (e)   Pilot workload in both single-pilot and multi-crew flown aircraft;

    (f)   Size, resolution, and legibility of symbols and text;

    (g)   Navigation chart display: 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;

    (h)   Training; and

    (i)   EFB Administrator qualification.

11.10.2 An operational approval based on the submission above will depend upon satisfactory evaluation by the Authority that the EFB is suitable for use as replacement or as an alternative to paper based information.

12   WITHDRAWAL OF OPERATIONAL APPROVAL.

12.1   The operator shall develop its maintenance programme for EFB system including conduct of regular evaluation and audit.

12.2   Any defect or operational anomaly must be investigated and rectified promptly. Failure to comply with the terms of approval may result in the Authority withdrawing the operational approval.