The European Organisation for Civil Aviation Equipment
L'Organisation Européenne pour l'Equipement de l'Aviation Civile

MINIMUM OPERATIONAL PERFORMANCE STANDARD FOR ELECTRONIC FLIGHT BAG (EFB) APPLICATION APPROVAL

ED-273

[December 2019]

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EXECUTIVE SUMMARY

The rapid development of Electronic Flight Bags (EFBs) and their widespread adoption over recent years has made them a very common and important tool for flight operation. Not only has EFB replaced paper in most cockpits, it has provided many functions that increase flight operational effectiveness and enhanced situation awareness for pilots.

The growth of EFB has helped airlines achieve important operational and safety goals, and has been a strong contributor to the global aviation initiative to leverage innovation for the next century of air travel. At the same time, the increased scope and usage of EFB makes it more difficult and complex for national aviation authorities to efficiently evaluate and approve for the use in operations of EFB applications.

This document is a EUROCAE industry standard that provides a modern and systematic means to address the design, development, evaluation and validation of EFB applications and functions, proportionally to the safety risk of their intended use in flight operations.

This standard is applicable to EFB application suppliers. It was initially developed to support the approval of EFB applications by the European Union Aviation Safety Agency (EASA).

This standard provides MOPS for the following aspects of EFB application:

- Determination of whether emerging functions are suitable for EFB,
- Operational Risk Assessment,
- Human Machine Interface,
- Development Assurance,
- Databases,
- Security,
- Operational and installation data.

The standard provides also additional MOPS applicable to specific EFB functions, existing at the time of development of this document.

This standard does not replace the requirements and/or conditions applicable to operators to obtain an operational approval or authorisation by their national aviation authorities for the usage of EFB applications. These requirements and/or conditions are provided by the operational regulations and/or policies established by the national aviation authorities.

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CHAPTER 1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This document is an industry standard applicable to EFB application suppliers. It provides MOPS for the design, development, evaluation and validation of EFB applications and functions.

The MOPS include requirements, recommended practices and guidelines.

The MOPS are proportionate to the safety risk of the intended use of the EFB functions in flight operations.

An Electronic Flight Bag (EFB) is an electronic information system, comprised of equipment and applications for flight crew, which allows for the storing, updating, displaying and processing of EFB functions to support flight operations or duties.

EFBs were initially introduced in the cockpits to supplement and/or replace conventional paper products traditionally carried in the pilot's flight bag, such as airport and navigation charts, aircraft performance and weight and balance charts or flight operational manuals.

The usage of EFBs also includes functions intended to increase the flight operational effectiveness and enhance the pilot situation awareness. Examples of those functions include electronic airport and en-route moving maps, in-flight weather function…

This continuous trend makes it more difficult for national aviation authorities to evaluate whether these new functions and applications, which are typically hosted on commercial-off-the-shelf (COTS) hardware and operating system, can be safely used in operation. This evaluation proved to be particularly complex for candidate EFB functions similar to functions hosted in the aircraft certified avionics (e.g. presentation of the aircraft position on a moving map) and that generate a safety risk if not properly used by the flight crew. National aviation authorities may not have the resources and the expertise needed for this assessment, which create delays and hurdles for the introduction of these innovative functions in flight operations.

To address this challenge, EUROCAE created the Work Group 106 and invited its members to develop an industry standard specifically applicable to EFB applications. The standard had to be structured and formatted in order to be used as a basis for the approval of EFB application software (and its associated installation and operating data) by an authority.

The scope of the work given to the WG-106 was to develop a standard adapted for EFB applications that unambiguously define the perimeter of EFB functions without preventing future innovation in that domain. The standard should also not contradict existing guidance such as that contained in the European regulation or in the ICAO EFB Manual Doc 10020 but could implement objectives to achieve completeness. The WG-106 verified also consistency of its work with other EFB policies such as the FAA AC 120-76.

The WG-106 was composed of EFB application suppliers, aircraft manufacturers, equipment suppliers, operators, regulators, authorities and association representatives. This panel of participants covered a large spectrum of the stakeholders involved in the EFB eco-system and ensured that the standard is adapted to the needs.

This industry standard address the following general EFB aspects:

<u>Determination of whether emerging functions are suitable for EFB:</u>

The standard provides a clear and systematic process for determining whether a given function is authorized on an EFB or not. This process is consistent with the definitions and principles of the EFB regulatory materials and relies on the conclusive completion of an operational risk assessment. This process is simple and streamlined for the EFB functions already authorized by the EFB regulatory materials at the time of writing this standard. This process could be applied onto any kind of emerging functions proposed to be hosted on an EFB.

Operational Risk Assessment:

The standard provides an operational risk assessment process developed on the model of the “bowtie” method. This process addresses an issue that has been existing since the onset of the EFB regulations. By the current regulatory definition, EFB includes functions with failure effect no greater than minor after considerations of the operational/procedural mitigation means (typically pilot procedures and training). Though, it is recognized that some EFB functions, such as the takeoff and landing performance calculations, may have a failure effect greater than minor, for instance in case of a misleading calculation error that is not detected by the flight crew by the operational/procedural mitigations. To resolve this issue, the process uses the concept of residual risk and defines it as the risk associated to hazard which may contribute after application of the operational/procedural mitigation to a severity effect more than minor. The existence of residual risk or not for a given function has been applied throughout the standard in order to ensure for the proportionality of the requirements to the criticality of the function. Application hosting function(s) without residual risk have to comply with the minimum set of requirements. Application hosting function(s) with residual risk have to apply additional requirements in order to provide assurance that the contributors to the hazard are prevented to an acceptable level.

Human Machine Interfaces:

The standard provides considerations for the design of the Human Machine Interface (HMI) of EFB applications. These considerations have been developed using the HMI provisions of the EFB regulatory materials as well as additional best industry practices. A human factors assessment of the HMI is required when HMI aspects are identified as a contributor to a residual risk. The standard specifies the characteristics of the protocol of a human factor’s assessment.

Development Assurance:

The standard provides development assurance considerations for the development of the EFB software application. These development assurance considerations have been defined using existing industry standard and best practices that have been fully reviewed and adapted for use in the context of EFB application software development. These considerations are applicable to the various software development methods (e.g. classic waterfall method, agile method). The applicant has to apply the adequate assurance level proportionate to the risk associated with the use of its EFB application. The terminology “Function Qualification Level” (FQL) is used to define the selected level of assurance. Two FQL levels are defined: Low and High. The FQL Low development process objectives are applied for all EFB application. The additional FQL High development process objectives are applied when EFB software application errors are identified as contributor to a residual risk by the risk assessment.

Databases:

The standard provides considerations for addressing databases used by EFB applications and stored on the EFB host platform. In addition to proposing two levels of considerations depending whether the database contributes to a residual risk or not, the standard also provides considerations adapted to whether the database is approved or not with the application. It will be up to the applicant to make this decision to approve database(s) with the application or not.

Security:

The standard provides considerations for addressing the security threats. A minimum set of security measures has been developed based on existing best industry practices. This minimum set is applicable to all EFB applications. A comprehensive security assessment process specifically defined for EFB applications is also provided and must be applied in case of residual risk identified for EFB function(s).

Operational and installation data:

The standard defines the operational and installation data to be provided by the EFB application supplier to the operators for the integration of the application into their operations. The objective is to ensure that the EFB application supplier provide the adequate set of data for ensuring the proper installation, administration, use and maintenance of the application by the operators.

Specific considerations:

The standard provides also additional considerations applicable to specific existing EFB functions. These additional considerations complements the general considerations. The EFB functions specifically addressed in this document are the aircraft performance and weight and balance calculation function, the airport moving maps (AMM) function, the weather function, the functions displaying the aircraft position on maps or charts, the electronic checklist function and the electronic signature function. The other existing EFB functions are considered as not deserving specific considerations i.e. that the general considerations are deemed sufficient.

Additional specific considerations may be needed for new, emerging functions that were not in-service at the time of the development of this standard. If this is the case, these additional specific considerations would be identified and discussed during the development, evaluation or approval of these new, emerging functions.

1.2 DOCUMENT STRUCTURE

The document structure is as follows:

- Chapter 1 introduces the standard and provides its intended use, the stakeholders, the definitions, acronyms and reference documents.
- Chapter 2 contains general considerations applicable to all EFB applications.
- Chapter 3 contains additional specific considerations applicable to specific EFB functions.
- Chapter 4 defines the relevant operational and installation data to be provided to the operator(s) for integration of the EFB application into their operations.
- Appendixes provide additional information to facilitate the use of this standard, such as guidance, templates, and examples.

1.3 USE OF THE STANDARD

This standard is applicable to EFB application suppliers. The standard has been developed to support the approval of EFB applications by the European Union Aviation Safety Agency (EASA) using the certification procedures and specification as established by EASA.

1.4 WORDING RULES OF THE STANDARD

The following convention is used to graduate the different level of requirements defined in the document.

1.4.1 Requirements

A requirement indicates a mandated criterion; i.e. compliance with the particular procedure or specification is mandatory and no alternative may be applied.

The following verbal forms are used to express requirement:

Intent	Basic Form	Equivalent expression
Requirement	Shall	is to… is required to… it is required that…

		has to… only … is allowed must
	Shall not	… is not allowed is required to be not… is required that … be not … is not to be … must not...

331

332 **1.4.2 Recommendations**

333 A recommendation indicates a means of compliance as the preferred option to comply with a
334 requirement, alternative means of compliance may be applied, provided that the applicant can provide
335 information or data to adequately support and justify the alternative.

336

337 The following verbal forms are used to express recommendation:

338

Intent	Basic Form	Equivalent expression
Recommendation	Should	it is recommended that … ought to…
	Should not	it is recommended that … not… ought not to…

339

340 **1.4.3 Guidance materials**

341 Requirements and recommendations may be completed by additional guidance to help the applicant to
342 comply with a requirement or a recommended means of compliance.

343

344 The following verbal forms are used to express guidance:

345

Intent	Basic Form	Equivalent expression
Guidance	May	is permitted… it is allowed……
	need not	it is not required that … no … is required
	Can	to be able to… to be in a position to… there is a possibility of… it is possible to…
	Cannot	to be unable to… to not be in a position to… there is no possibility of … it is impossible to…

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1.5 STAKEHOLDERS

The following stakeholders are referred in the document.

Applicant: The EFB application supplier applying to demonstrate compliance with this standard.

Operator: The organization that will integrate the EFB application in its operations.

Flight Crew: The pilot or any flight crew member that will use the EFB application.

Authority: Any agency verifying the compliance to the standard.

1.6 DEFINITIONS

Airport moving map display: A software application that displays an airport map on a display device and uses data from a navigation source to depict the aircraft current position on this map while the aircraft is on the ground.

Approval of an EFB application: The application has been recognized compliant by the competent authority to the requirements defined by this standard.

Authoritative source: A State authority or an organization formally recognized by the State authority to originate and/or publish data which meets the data quality requirements (DQRs) as specified by that State;

Checklist includes

- Checklist i.e. a means to ensure that some actions of a procedures have been completed ("read and check") and
- Procedure i.e. a means to ensure a logical progression of actions, decisions, or both in a sequence which is prescribed to achieve a specified objective ("read and do").

Coding Standards: Guidelines and recommendations to establish secure code best practices as well as stylistic preferences and conventions. Coding standards are specific to a programming language.

Code Review: A process by which someone reviews source code authored by someone else to ensure it conforms to the company's coding standards and all applicable specifications (e.g. functional, architecture, design). A code review differs from static analysis insofar as it relies on people instead of software tools. Because code reviews are intrinsic to collaborative software development methodologies -- e.g. Extreme Programming (XP) -- additional code reviews can be optional.

Configuration baseline: A defined and recorded configuration of one or more configuration items, that thereafter serves as the basis for further development, and that is changed only through change control procedures.

Configuration item: One or more development data treated as a unit item for the configuration management purposes.

Database: One or more files of data structured to enable data to be extracted from the files and for them to be updated. This primarily refers to data stored electronically and accessed by computer rather than in files of physical records.

Note: This definition does not include Data Base Managements Systems (DBMS) which are considered external services.

Data Quality Requirement: The specification of the characteristics of data (i.e. accuracy, resolution, integrity (or equivalent assurance level), traceability, timeliness, completeness, and format) to ensure that the data is compatible with its intended use.

Development data: All the data used for or produced during the EFB application development process.

Development environment: Encompasses all means used to develop the EFB application (framework, tools, compiler, etc.).

Distribution information: Includes guidelines and steps for the operator to ensure that the EFB application and associated databases are delivered in the EFB host platform.

EFB Application: A software application installed on an EFB host platform that contains at least one EFB function.

EFB function: A software function intended to be used by the flight crew to support their flight operations tasks and duties.

EFB host platform: The hardware equipment in which the computing capabilities and basic software reside, including the operating system and the input/output software.

EFB system: The hardware equipment (including any battery, connectivity provisions, input/output components) and software (including databases and the operating system) needed to support the intended EFB application(s).

Electronic checklist: An EFB application which displays checklists to the flight crew by means of a display.

Electronic flight bag: An electronic information system, comprised of equipment and applications for flight crew, which allows for the storing, updating, displaying and processing of EFB functions to support flight operations or duties.

Electronic signature: The electronic means used a primary means for acceptance or for confirmation of authority.

Hardening: Process of securing a system by reducing its surface vulnerability.

Human Factors: Is the disciple of studying how a system is compatible for a human to use.

Human Factor's Assessment: An evaluation of an application aimed at identifying shortcomings that may lead to human performance issues (such as errors or workload issues).

Human–machine interface: A component of certain devices that is capable of handling human–machine interactions. The interface consists of hardware and software that allow user inputs to be interpreted and processed by machines or systems that, in turn, provide the required results to the user.

Installation Guidelines: includes all information for the operator to ensure that EFB application is installed in the EFB host platform.

Minor safety effect: Conditions which would not significantly reduce aircraft safety, and which involve crew actions that are well within their capabilities. Minor safety effect may include, for example, a slight reduction in safety margins or functional capabilities, a slight increase in crew workload, such as routine flight plan changes, or some physical discomfort to passengers or cabin crew.

Miscellaneous (non-EFB) function: Functions that are part of the EFB application and that are not directly related to the tasks performed by the flight crew in the aircraft.

Mitigations means: Means that mitigate the severity of the consequences of a hazard.

Night mode: Night mode (or dark mode) is a software feature that makes the user interface darker. It generally changes light backgrounds to a dark color and changes text from dark to light color. Dark or night mode is not necessarily a simple color inversion of the light mode, but the palette can be adapted to retain the significance of some colors such as for example red, amber, blue.

No safety effect: A condition which would have no effect on safety: For example conditions which would not affect the operational capability of the airplane or increase crew workload.

Operational requirements: Requirements which define the EFB function and its intended use.

Parameter data items: A set of data that, when in the form of a Parameter Data Item File, influence the behavior of the software without modifying the Executable Object Code and that is managed as a separate configuration item.

Prevention means: Means that prevent the occurrence of a hazard or reduce its likelihood to an acceptable level.

Refutation: Acts as an independent set of assurance activities beyond analysis and requirements. As an alternative to exhaustive testing, refutation can be used to provide evidence that an unwanted behavior has been precluded to an acceptable level of confidence. Refutation is also known as Security Evaluation in some contexts.

Release: An official version of an EFB application delivered for operational use.

Residual risk: Risk associated to hazard which may contribute after operational/procedural mitigation to a severity effect more than minor.

Security Measure: Used to mitigate or prevent a threat condition. Security measures may be features, functions, or procedures, both on-board and off-board. Security measures can be technical, operational, or process oriented.

Software requirement: Part of the specification of an EFB function. These requirements are the ones used by the software developers to implement the function.

Software Security Asset: The logical and physical resources of the EFB application which contribute to the application operation, including but not limited to functions, software, interfaces, data flows and data.

Static Code Analysis: Tool-driven analysis of source or object code to detect possible security vulnerabilities and to ensure adherence to industry standards and general code quality.

Supported Operational Environment: The EFB Host Platform(s) and software environment where the function may be implemented and the additional resources which may be required for the use of the function. For instance, additional resources for the use of a function may be input devices, external or internal sensors such as: GNSS, interfaces to A/C systems, remote display, keyboard. The supported operational environment corresponds to the minimum configurations for which the performance and integrity of the function is guaranteed by the applicant.

Taxi Route: In the context of an airport moving map function, the term “taxi route” refers to any sequence of taxiway and/or runway fixes (e.g., “turn left at Echo”) that are interconnected and depict the desired taxi path.

Third Party Software: Software that would be used by an application provider as part of their application. Additionally, this would include commercial off the shelf (COTS) items.

Threat: A potential for violation of security, which exists when there is an entity, circumstance, capability, action, or event that could cause harm.

Validation: The determination that the requirements for a product are correct and complete. [Are we building the right function/data?]

Verification: The evaluation of an implementation of requirements to determine that they have been met. [Did we build the function/data right?]

Vulnerability: Weakness in an information system, system security procedures, internal controls, or implementation that could be exploited or triggered by a threat source.

1.7 ACRONYMS

AMMD: Airport Moving Map Display

AMDB: Airport Map Data Base

DQR: Data Quality Requirements

EASA: European union Aviation Safety Agency

ECL: Electronic Checklist

EFB: Electronic Flight Bag

FQL: Function Qualification Level

GNSS: Global Navigation Satellite System

HMI: Human Machine Interface

SSA: Software Security Asset

1.8 REFERENCES

ICAO Doc 10020 EFB Manual

FAA AC 120-76() Authorization for Use of Electronic Flight Bags

(EU) No 965/2012 Air operations regulation

EUROCAE ED-76() Standard for processing aeronautical data

491 ***EUROCAE ED-99()*** User Requirements for Aerodrome Mapping Information

492 ***RTCA DO-257()*** Minimum Operational Performance Standards for the Depiction of Navigational
493 Information on Electronic Maps

494

CHAPTER 2 GENERAL MINIMUM OPERATIONAL PERFORMANCE STANDARD

This chapter includes the requirements applicable to all EFB applications and functions.

2.1 EFB APPLICATIONS AND FUNCTIONS

This section addresses the determination of whether a function can be defined as an EFB function. This determination is exclusively process-based. If this determination is not conclusive, the function cannot be hosted on an EFB and should be considered to be hosted on an airworthiness approved platform.

All functions of the application intended to be approved shall be demonstrated as EFB functions in accordance with the process specified in §2.2

2.2 EFB FUNCTIONS ELIGIBILITY

The process presented in this chapter aims at determining whether the functions of the software application may be considered EFB functions. Until functions are demonstrated as such, they are termed "candidate EFB functions."

For a given EFB application, the process is successfully completed when all candidate EFB functions have successfully demonstrated the eligibility criteria.

Only the candidate EFB functions or sub-functions must be demonstrated as compliant with the standard.

2.2.1 Functional breakdown

A functional breakdown of the EFB application shall be performed.

The EFB application should be broken down in functions and sub-functions.

The functional breakdown of the EFB application shall clearly list the candidate EFB functions and the functions not intended for approval.

The scope of all functions shall cover the full scope of the EFB application.

The scope of all sub-functions shall cover the full scope of each function.

An EFB application may host EFB functions (intended for approval) as well other functions or sub-functions not intended for approval.

Note: Although an applicant may elect not to demonstrate compliance of all the application functions or sub-functions with this standard, the acceptability for use in flight of the functions or sub-functions not intended for approval will be left under operator responsibility and be governed by the applicable operational regulation.

The identification of the scope of EFB functions and of a function's sub-functions is left at the discretion of the applicant. It is recommended to consider the following:

- The level of detail used in defining an EFB function should ensure that the scope of each EFB function is large enough to, from a flight crew perspective, contribute to the same flight operations task or duty. An EFB function should be a logical subset of the application.

- The level of detail used in defining sub-functions should support the Risk Assessment process with sufficient details. Keeping the scope of the sub-functions small enough will improve the confidence that all significant risks can be assessed and then mitigated or prevented at the adequate level.

2.2.2 Intended use

The intended use of each candidate EFB function shall be defined and include the following information:

- Definition of the type of data and service provided by the function to the flight crew,
- The phases of flight and the types of operations during which the function is intended to be used (as applicable),
- Whether the function provides data needed to perform the flight,
- Whether the function is intended to be used as a primary means, and if not, proposal of a reference source of information,
- If applicable, definition of whether the function is intended to replace existing means,
- Whether the function is intended to address an operational regulatory requirement.

If certain considerations are left at the discretion of the operator, this shall appear in the intended function definition.

Primary means refers to information that can be directly used for operating the aircraft or for fulfilment of an operational regulatory requirement, without the need to verify or crosscheck its validity with an independent reference source of information.

Independent reference sources of information may include approved digital performance data, referenced paper documentation, avionics information certified for use as primary means. A second EFB running an identical application is not considered as a reference source of information.

Common examples of using EFB applications for primary means include calculating aircraft performance without crosschecking the AFM and access to documents and charts.

The intended use of each non-EFB function shall be defined

2.2.3 EFB functions eligibility

In order for a candidate EFB function to be considered eligible, the following shall be demonstrated:

- The function is intended to be used by flight crew to support flight operation tasks and duties, and
- The intended use is authorized, and
- The risk assessment process was performed.

2.2.3.1 Flight crew operation tasks and duties

Flight crew operations tasks and duties are assigned by the operators for the purpose of conducting the flight. They may include pre-flight, flight and post-flight tasks and duties.

A function not intended to be used by flight crew is not an EFB function. A function from an EFB application may also be accessible to non-pilots and interface or overlap with tasks or duties governed under other regulations than operational regulation (e.g. Maintenance regulations for Technical Logbook).

For the purpose of this exercise, the following categories of flight operations tasks and duties can be considered:

- "Aviate" or "Fly" refers to the flight crew's actions to monitor and control the aircraft flight parameters in order to achieve and maintain a desired flight path.
- "Navigate" refers to the flight crew's actions to determine where the aircraft is (present position), where it should be, and where the aircraft should go, in accordance with published procedures and with appropriate navigation performance where applicable.
- "Communicate" refers to the communication between flight crew members, the flight crew and the Air Traffic Control (ATC) as well as between the flight crew and the cabin crew, the flight crew and the company ground staff.
- "Manage systems" refers to the flight crew's actions to monitor and control the aircraft systems.
- "Build & maintain situational awareness" refers to the flight crew actions to build and maintain a mental picture of the aircraft and its situation with respect to its environment (e.g. weather, terrain and obstacles, traffic, FIR, Country boundaries, etc.).
- "Support Mission" refers to:
    - Flight crew's consultation of reference information (e.g. flight operational manuals, navigation charts, EOSID, etc.), the computation of "flight-related" information (e.g. aircraft performance, Mass & Balance (M&B), etc.) and any other information supporting the conduct of the flight.
    - The actions performed before the flight (e.g. flight planning, dispatch, etc.) or after the flight (e.g. post flight report, aeronautical administrative forms, etc.) in relation with the flight itself
- "Manage Logistics" refers to the tasks non-related to the conduct of the flight Authorized Intended Uses

2.2.3.2 Intended uses

The following intended uses are explicitly not authorized for an EFB function:

Category	Prohibited Intended uses
All	• Any use substituting or duplicating the intended use of instruments or equipment required by airworthiness regulations, airspace requirements, or operational rules. • Alerting uses i.e. uses that require immediate crew awareness and/or responses for safety of the flight.
Aviate or Fly	• All uses.
Navigate	• All uses.
Communicate	• Communication with ATC.
Manage systems	• Monitoring as a primary means of the real-time status of aircraft critical and essential systems. • Control of aircraft critical and essential systems. • Consultation of checklists taking inputs from aircraft to reflect the status as primary means of aircraft systems or switch positions

Table 1 Prohibited intended uses

The following list contains examples of possible intended uses for EFB functions. This list is non-exhaustive and is based on EFB applications in-service at the time of writing this standard.

Category	Intended uses

Communicate	• Communication with ground services (such as OCC or MCC), • Communication with service providers.
Manage systems	• Use of contextual augmentation of information provided by aircraft systems.
Situational awareness	• Improvement of Situational Awareness in flight via representation of ownship position on navigation charts, • Anticipation or management of flight events such as diversions (e.g. Nearest airport functions), • Consultation of graphical weather information in flight, • Video surveillance of Cabin and aircraft exterior.
Support Mission	• Consultation of aeronautical charts and maps, • Computation of aircraft performance and mass and balance, • Consultation of documents and manuals, • Electronic signature, • Consultation of checklists manually selected by the flight crew • Consultation of checklists automatically presented to the flight crew based on the aircraft context (flight phases, flight crew alert messages) • Aid to Flight Profile Optimization, • Management of flight time and duty time limitations, • Monitoring of en-route navigation integrity coverage, • Flight briefing and following (Electronic Flight Folder), • Reporting, • Log Book consultation and entries.
Manage Logistics	• Any non-safety related intended use.

Table 2 Possible intended uses

2.3 OPERATIONAL RISK ASSESSMENT

The process presented in this chapter aims at ensuring a systematic and step-by-step qualitative approach to the identification of the hazards introduced by a particular candidate EFB function, the identification of adequate mitigation and prevention means, and their validation.

It is recommended to perform this process as early as practicable during the development cycle.

The picture here below gives an overview of the process

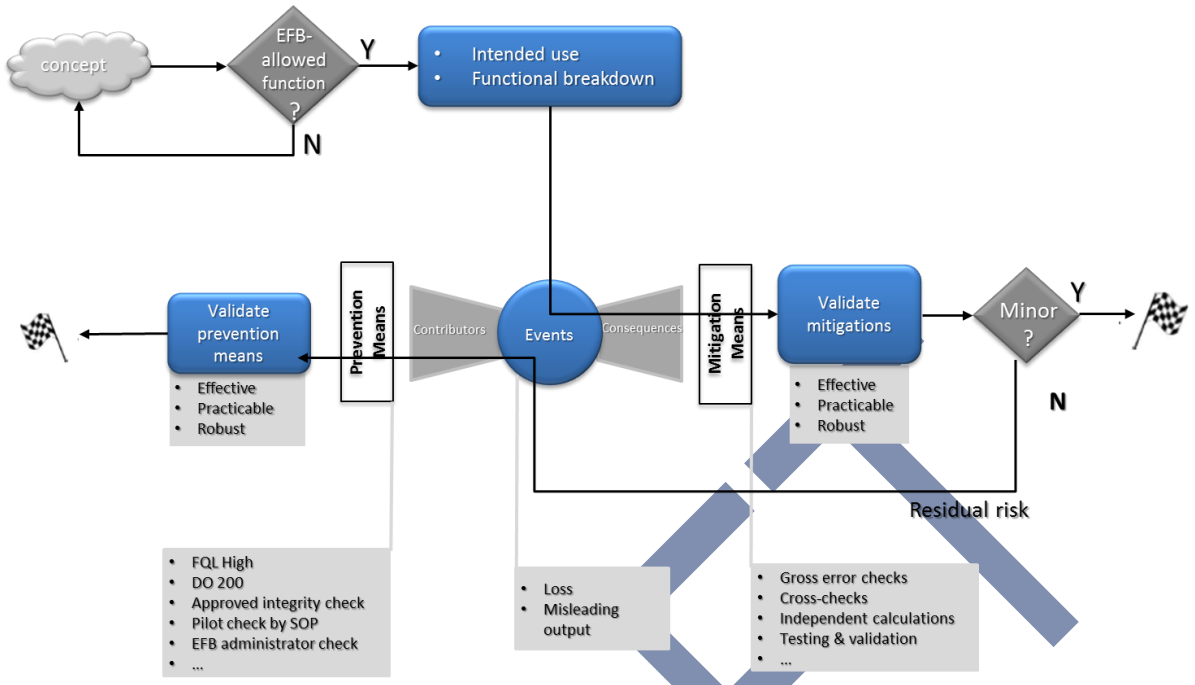

Figure 1 ORA overall process

The data needed to perform the risk assessment process shall be defined and include:

- Breakdown of the function into sub-functions (see §2.2.1),
- Inputs/Outputs of the function and its sub-functions, including as applicable:
  - Input: flight crew entries, databases, administrator settings, data provided from avionics or other sources;
  - Output: data displayed to the flight crew, data sent to avionics, data sent to other EFB functions or applications, data sent to the ground (connectivity);
- All operational assumptions supporting the risk assessment,

The operational assumptions may include:

- Access to backup means (i.e. independent from the EFB function),
- Type of operations,
- Phases of flight, etc.

For each sub-function, the following hazards shall be assessed and recorded:

- Loss of the sub-function,
- Display of erroneous output by the sub-function.

Loss of the sub-function: the complete loss of the sub-function is to be considered i.e. the sub-function is lost on all EFB host platforms simultaneously.

Erroneous output: Only the display of erroneous data to the flight crew by the sub-function is to be considered. The risk associated with the use of EFB output by other applications or systems (such as avionics, ground systems etc.) is to be assessed in the risk assessment of those other applications or systems.

Mitigation means may be proposed to mitigate the severity effect of each hazard.

If used in the risk assessment, a mitigation means shall be:

- Recorded, to ensure that it is communicated to the operator, and
- Validated.

Each mitigation means should be validated with respect to its:

- Effectiveness: When correctly applied, the mitigation mean will reduce or remove the consequences of the hazard.
- Practicability: The mitigation mean can be applied by the crew without requiring exceptional concentration or skills, and does not create unacceptable workload.
- Robustness: The mitigation mean will be effective over time for the considered operational assumptions.

Any mitigation validation activity allocated to the operator should be recorded in the operational information (see §4.3)

Mitigation means based on procedures and training should be validated with a flight crew involvement.

The effectiveness and robustness of the mitigation means should be validated from a security point of view when based on assets subject to security threats.

For functions with residual risk, this validation is performed through the security risk assessment process.

The objectives of the means of mitigations are:

- For loss of the sub-function: to reduce the operational impact by providing an alternative means to access equivalent data, such as paper, communication with operations centre or use a different EFB application/host platform;
- For display of erroneous output: to increase the likelihood to detect the error and/or minimize the severity effect of the hazard.

The severity effect at aircraft level of each hazard, with consideration of all mitigation means, shall be evaluated and classified according to the following criteria:

1. Severity effect is Minor at worst, or
2. Severity effect is greater than Minor, i.e. there is a residual risk.

The severity effect of the hazards should be assessed in accordance with the intended use and the operational assumptions (e.g. use with paper backup or not, use only during certain phases of flight, etc.).

Example of scenarios that could lead to residual risks:

- When the loss of a sub-function cannot be fully mitigated and has the potential for more than a minor safety effect,
- When the display of erroneous data by a sub-function could remain undetected by the flight crew (undetected erroneous data) despite the proposed mitigations and has the potential for more than a minor safety effect.

The contributors to each hazard with residual risk shall be identified and recorded.

- At least the following contributors should be analysed to determine if they will cause the hazard:
- Misbehaviour of the host platform,
- Misbehaviour of the software due to design errors,
- Erroneous database,

- Erroneous crew input,
- Security threats,
- Erroneous inputs coming from another system or EFB application,
- Erroneous configuration or customization settings.

Prevention means shall be identified and recorded for every contributor to hazards with residual risk, unless it can be demonstrated that all hazards stemming from this contributor are already satisfactorily mitigated (e.g. errors can be detected).

Acceptable prevention means for misbehaviour of the host platform include:

- Operational procedures for cross-checking results from two EFBs (acknowledging that misbehaviour events of the host platform are random in nature), or
- Other means that ensure detection of the misbehaviour of the host platform, or
- Development assurance on the host platform itself.

An acceptable prevention means for misbehaviour of the software caused by design errors is to reduce its likelihood by using the FQL high development assurance level.

An acceptable prevention means for erroneous databases is the use of the proper Database processes (see section §2.6).

An acceptable prevention means for erroneous crew input is the increase of Human Factors assessment scrutiny. (see section §2.4)

Acceptable prevention means for security threats are to be defined carrying a security risk assessment (see section §2.7)

Other prevention means not listed above shall be validated.

In order to validate a prevention means it should be ensured that it is:

- Effective: When correctly applied, the prevention mean will prevent the hazard or reduce its likelihood to an acceptable level.
- Practicable (When the prevention means is under flight crew responsibility) it can be applied without requiring exceptional concentration or skills, and does not create unacceptable workload.
- Robust: The prevention means will be effective over time for the considered operational assumptions.

Any prevention means validation activity allocated to the operator should be recorded in the operational information (see section §4.3)

2.4 HUMAN MACHINE INTERFACES

This section addresses the design of the Human Machine Interface of EFB applications. This section includes, but is not limited to, data entry methods, colour-coding philosophies and symbology. Considerations are given to the environment (aircraft type, host platform, integration in flight deck), operating system and other applications as specified below.

Graphic and text displayed on the EFB shall be legible to the flight crew in the intended operation environment.

- Considerations should be given to the hardware intended to host the EFB application, the intended viewing distance, the typical range of lighting conditions expected (including extreme illumination conditions such as direct sunlight or night.) and environmental conditions.

- The resulting hardware requirements and installation requirements should be the responsibility of the operator.

The EFB application shall be designed in such a manner to not distract the flight crew from their duties

- There should be a means to inhibit both EFB visual and aural messages
- Flashing text or symbols should be avoided
- Messages should be prioritized and the message prioritization scheme evaluated and documented
- During critical phases of the flight, information necessary to the pilot should be continuously presented without uncommanded overlays, pop-ups, or pre-emptive messages, except for those indicating the failure or degradation of the current EFB application

Red and amber shall be reserved for safety-related information.

- These colours should not be used for information (such as text, icons, figures and graphics) that is not safety-related.
- Red may be used for keep-out zones such as severe weather or taxiway construction.
- Amber may be used for zones or conditions where caution is required, such as marginal weather or failures that adversely affect performance of the EFB application.

The EFB application shall notify the flight crew if there is a detected failure in the EFB adversely affecting performances or usability of the EFB application.

The EFB application response time shall be predictable to the user

- System busy or process indicator should be displayed
- Immediate feedback to touch indicators should be given to the user

The response time of the system to user inputs shall be consistent with an application's intended function.

When the EFB application is busy it shall display a 'system busy' indicator (e.g. spinner, progress bar)

The application shall inform the user when a user input is mandatory or if a user input is not required.

- The pilot should be informed of the mandatory entries in order to ensure a good functioning of the system

If user-entered data is not in the correct format or type expected by the EFB application, the EFB application shall provide feedback to the user regarding which entry is erroneous or what type of data is expected.

If user-entered data is not in the correct format or type expected by the EFB application, the EFB application shall not accept the data.

The software version of the EFB application shall be accessible.

- A mechanism should allow the flight crew to check the validity of the software application

There shall be a means to check the validity of a database

- A mechanism should allow the flight crew to check the validity of the data base

The EFB application shall clearly distinguish pilot entries, default values and entries imported from other EFB applications and aircraft systems.

The use of the EFB application shall not result in unacceptable flight crew workload.

- When the user returns to an EFB application that was running in the background, it should appear in the same state as when the user left that EFB application with the exception of differences stemming from the progress of the flight or completion of processing performed in the background.
- A search function should be available if the EFB application can display a large amount of textual information (e.g. data, charts, documents)
- The EFB application should be designed to minimize the number of steps needed to navigate through information and/or functions.

If content is not visible in its entirety in its available display area, such as during “scroll”, “zoom” or “pan” operations, the existence of off-screen content shall be clearly indicated in a consistent way, unless the presence of that off-screen content is readily obvious.

- Off screen content should be shown through visual cues implemented in the application design. (e.g. scrollbars)
- If there is a cursor, it should be visible on the screen at all times while in use
- The EFB application should always display the names or symbols of the active EFB function.

All software controls shall be properly identified and sized for their intended function.

- Active areas should be sized appropriately for accessibility in the intended position and for use in turbulence
- Labels or icons may be used. It is recommended to utilize icons that are commonly recognized.

The EFB Application shall appear distinct from, but not conflict with, the installed avionics displays.

- Organize information in a manner that is consistent with other displays within flight deck yet should clearly showing a distinction from certified displays, e.g. this can be done using different fonts or colours
- Display of EFB applications on installed displays may require differentiation to enable the flightcrew member to distinguish between the installed avionics display and the supplemental or “secondary” EFB display.

Text Colours, Symbols shall be compatible with the flight deck environment

- An EFB application should not disturb the pilot’s night vision.
- The EFB application HMI may be configurable in order to ensure consistency with a specific flight deck environment
- The EFB application may have the ability to be customized by the operator to ensure commonality with their flight decks or any other operator’s policy.

Data entry methods, units of measure, colour-coding philosophies, and symbology shall be consistent throughout the EFB application user interface

- Consistency between applications or airplane systems may be achieved.

The pilot shall easily understand clearly what units are being used for numerical data

- Where applicable measurement units should be displayed to ensure accuracy of information
- Applicable units should be displayed next to each data field.

The EFB application provider shall perform a human factors' assessment when HMI aspects are identified as potential contributor to the residual risk by the risk assessment

This human factor's assessment should be carried out through a specific evaluation protocol.

This evaluation protocol and results should be validated by a human factor's specialist.

The definition of the evaluation protocol may include:

- The detailed objectives of the evaluation
- The description of the means and the operational environment
- The involvement of a flight crew panel representative to the foreseen end users
- The definition of detailed scenario to be executed or ad-hoc use case
- The way to record the observations and data collection

The evaluation report should record issues and the way to address or mitigate these issues

These mitigations for the recorded issues may contain but are not limited to:

- Design changes to EFB application as necessary
- Flight crew Training
- Flight crew procedure
- EFB Administrative recommendations

2.5 DEVELOPMENT ASSURANCE

This section defines development assurance considerations for the development of the EFB application. The applicant has to apply the adequate assurance level proportionate to the risk associated with the use of its EFB application. The terminology "Function Qualification Level" (FQL) will be used to define the selected level of assurance. Two FQL levels are defined: Low and high.

FQL Low objectives shall be applied for any EFB application.

FQL High objectives shall be applied when EFB application errors are identified as contributor to a residual risk by the operational risk assessment (see §2.3)

2.5.1 FQL objectives

The table below defines for each FQL level the applicable development process objectives as defined in section 2.5.2.

	Development process objective		FQL allocation	
	Section	Description	High	Low
Development plan	2.5.2.1.1	Minimum considerations	x	x
	2.5.2.1.2	Additional considerations	x	
Operational requirements	2.5.2.2.1	EFB Function operational requirements definition	x	x
	2.5.2.2.2	EFB application architecture definition	x	x
	2.5.2.2.3	EFB Function Operational Requirements validation	x	x
	2.5.2.2.4	EFB Function compliance with operational requirements	x	x
Software development	2.5.2.3.1	EFB Function software requirements definition	x	
	2.5.2.3.2	EFB function software requirements validation	x	

	2.5.2.3.3	EFB function compliance with software requirements	x	
Configuration Management	2.5.2.4.1	Configuration items are identified.	x	x
	2.5.2.4.2	Baselines and traceability establishment	x	
	2.5.2.4.3	Problem reporting, change control, and change review	x	
	2.5.2.4.4	Archive, retrieval, and release establishment	x	x
	2.5.2.4.5	EFB Application development environment control	x	
Application Release	2.5.2.5.1	EFB Application conformity review is conducted.	x	x
	2.5.2.5.2	Impact analysis of known issues	x	x
Quality Assurance Process	2.5.2.6	Quality assurance	x	x

Table 3 FQL objectives

2.5.2 Development process objectives

The following picture represents main processes of a typical EFB application development.

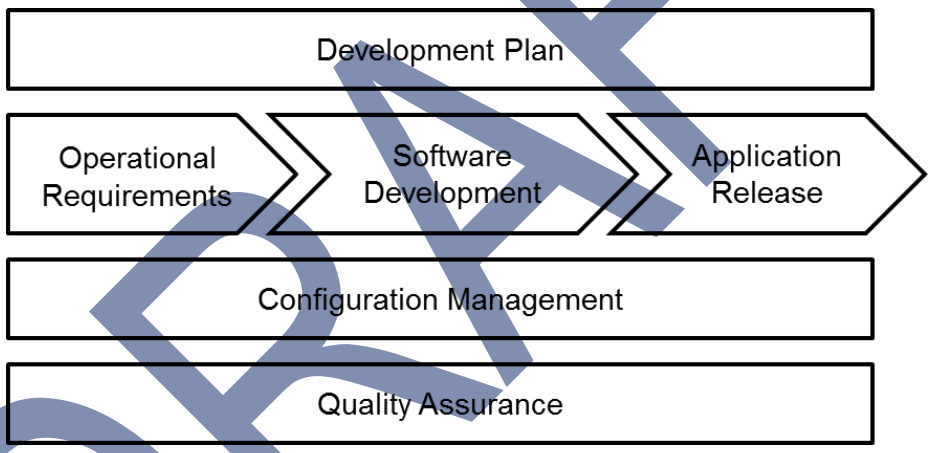

Figure 2 Processes of an EFB application development

2.5.2.1 EFB Application development plan

2.5.2.1.1 Minimum considerations

The EFB application development plan shall be defined

The EFB application development plan should describe:

- The software development methodology and processes,
- The configuration management processes,
- The quality management processes,
- The development environment including frameworks and tools,

A development plan may be defined in a set of documents or may be made available in a shared team workspace or can discuss what common tools are being used by the team.

Existing procedures or guidelines defined by the applicant may be part of the development plan

902

903 2.5.2.1.2 Additional considerations

904 If necessary, the development plan may address additional considerations, such as those defined below.

905

906 2.5.2.1.2.1 Multi-functions EFB applications

907 An EFB application may host several different functions and the EFB application may be configurable
908 by the applicant or the operator to enable or disable some functions.

909

910 The appropriate FQL is determined for each function during the risk assessment process.

911

912 Low FQL functions shall not adversely impact high FQL functions

913 It is recommended that the entire EFB application should be qualified to the highest FQL.

914 When different FQLs are applied, the applicant should ensure that FQL Low functions do not adversely
915 affect high FQL functions.

916 Absence of adverse effects from low to high FQL functions may be demonstrated by:

917 • Software architecture analysis,
918 • Data flow analysis,
919 • Verification.

920

921 2.5.2.1.2.2 Usage of third party software

922 An EFB application may include third party software.

923 Any third party software included in the EFB application shall be identified

924 Third party software should be managed under configuration.

925 Third party software identification may include the editor, the version and the licenses.

926 The use of third party software should be assessed to identify the activities that need to be performed
927 or re-performed to ensure that the EFB application including this third party software complies with the
928 operational requirements and application requirements.

929

930 2.5.2.1.2.3 Usage of service history

931 If an applicant seeks approval of an EFB application or a function that is already in service, service
932 history may be used to demonstrate compliance with some requirements in this standard.

933 In case service history is used to comply with some qualification requirements regarding this standard,
934 the applicant shall justify it with relevant evidence data.

935 The following aspects of an EFB application service history should be evaluated:

936 • Identify the service history data and its relevance to demonstrate compliance with qualification
937 requirements.
938 • Problem reporting is required to support service history.
939 • The similarity of the EFB application operational environment in which the service history data
940 was collected to the one used for establishing the service history credit.
941 • Relevancy of the operational context of the EFB application for which service history credit is
942 claimed.

943

944 2.5.2.1.2.4 Alternative methods for EFB application qualification

945 Applicants may decide to use an alternative method than the one defined in chapter 2.5 for EFB
946 application software qualification

Alternative methods for EFB application qualification shall be identified and described.

The applicant should specify and obtain agreement from the subject matter expert on:

- The impact on the qualification process
- The equivalence with the method being replaced

2.5.2.2 Operational Requirements

The first step to develop an EFB application is to define how it will help and support the flight crew to perform his duties; the objective is then to capture the operational requirements.

2.5.2.2.1 EFB Function operational requirements definition

The EFB function operational requirements shall be defined.

The EFB function operational requirements should describe, as applicable:

- The operational context and the intended use of the function
- The supported operational environment
- The inputs entered by the user or acquired from other sources.
- Behavior in normal operating conditions
- Behavior in degraded operating conditions (as required)
- Possible customization of the function by the applicant or the operator or the user (options, configurations, parameters values, etc.)
- Requirements stemming from the risk assessment if applicable
- Non-functional requirements

2.5.2.2.2 EFB application architecture definition

EFB application architecture shall be defined.

The definition of the EFB application architecture should include

- High level architecture description relevant to identify potential degraded conditions that should be addressed during the risk assessment process
- The functional links between the different software components
- EFB Function FQL Assignment

A FQL shall be assigned to each function of an EFB application.

The FQL assignment should be an outcome of the risk assessment process.

2.5.2.2.3 EFB Function Operational Requirements validation

The EFB Function Operational Requirements shall be validated.

Reviews and analyses should be performed on the EFB Function Operational Requirements to ensure completeness, accuracy, verifiability and consistency.

2.5.2.2.4 EFB Function compliance with its operational requirements

The EFB function shall comply with its operational requirements.

The verification of the compliance of the EFB function to the Operational Requirements should be addressed:

- Test cases and procedures should be developed and executed to ensure that the function fulfills the operational requirements

- Test results should be reviewed to ensure that they are correct and that discrepancies between actual and expected results are justified.

Test cases and procedures may define the acceptable tolerance on expected results.

2.5.2.3 Software development

It is up to the applicant to choose their development methodology.

Software development activities described in this section may be done in an iterative way, with functional increments at each iteration.

2.5.2.3.1 EFB Function software requirements definition

The EFB function software requirements shall be defined.

The EFB function software requirements shall include:

- Functional, non-functional and interface (i.e. interoperability) related requirements,
- Degraded conditions and responses to these conditions as applicable,
- Specification of user interface, error messages, and potential constraints for the user,
- Specification of algorithms and associated boundaries,

The EFB function software requirements should implement operational requirements.

The EFB function software requirements should be verifiable and consistent.

The EFB function software requirements should be developed following the processes described in the development plan.

Expected calculation accuracy of algorithm should be defined.

Coding rules may be used to insure adequate calculation accuracy.

EFB function software requirements may be developed in different forms depending on the selected methodology (e.g. users stories for Agile methodology, shall statement classic requirements, model based requirements, formal methods…).

Each EFB function software requirement should trace to one or more operational requirements, with the exception of derived requirements.

Derived requirements are those for which the rationale is not linked to the operational requirements.

The existence of derived requirements should be justified, and they should be evaluated to ensure that they do not negatively impact the expected functionality and outputs defined in the operational requirements.

The EFB function software requirements should be defined to a level of detail appropriate to ensure proper implementation.

2.5.2.3.2 EFB function software requirements validation

The EFB function software requirements shall be validated before implementation.

Reviews and analyses should be performed on the EFB function software requirements at least to ensure completeness with recommendations from chapter 2.5.2.3.1.

2.5.2.3.3 EFB function compliance with software requirements

Test cases and procedures shall be developed and executed to demonstrate that the function fulfills its software requirements.

Each test case should be developed from the software requirements and identifies the set of inputs, the conditions, the expected results, and the pass/fail criteria.

Test procedures should be defined from the test cases.

EFB function software requirements shall be fully covered by tests.

Input data including user entries should be exercised in representative ranges including boundaries values.

Expected accuracy and boundaries of algorithm calculation should be verified.

Robustness tests should be performed to address:

- The ability of the EFB application to respond to abnormal inputs or conditions.
- The prevention of invalid output.

Test coverage analysis should be performed to demonstrate that all requirements have been tested.

Software structural coverage assessment may be used for the test coverage analysis.

Test results shall be reviewed and acceptable discrepancies between actual and expected results shall be explained.

2.5.2.4 Configuration management

The configuration management process includes the activities of configuration identification, change control, application baseline establishment, and archiving of the EFB application product, including the related life-cycle data.

2.5.2.4.1 Configuration items are identified.

Each EFB application configuration item and its successive versions shall be identified unambiguously.

The objective is to establish the basis for the control and reference of the application configuration items.

Configuration identification should be established for each configuration item and for combinations of configuration items that constitute the EFB application.

Configuration management process should be established.

Change control process should be established.

Revision identification scheme for configuration items should be established.

Supported releases should be defined by the applicant and made available to the operators as required.

Supported releases are those releases for which the applicant may provide support to operators (e.g. assistance, bug fixing…)

2.5.2.4.2 Baselines establishment

A baseline shall be established for each EFB application release

A configuration index shall define for each EFB application release:

- The release configuration baseline
- All files required for the EFB application installation and use
- Each source component used to build the EFB application

2.5.2.4.3 Problem reporting, change control, and change review

Anomalous behavior of the EFB application shall be recorded as a problem report.

A method shall be defined for managing problem reports.

EFB application change control shall provide for recording, evaluation, resolution, and reviewing of changes throughout the EFB application development.

Change review shall ensure problems and changes are assessed and then approved or disapproved.

Each problem should be documented, along with its initial reported severity, characteristic, and effects and be managed into configuration.

Any changes to any baselined configuration item should be managed.

1082

1083 2.5.2.4.4 Archive, retrieval, and release establishment

1084 Development data and development environment of supported releases shall be archived and
1085 retrievable.

1086 Development data and development environment retention and retrieval procedures should be
1087 established.

1088 Data retention time should ensure that recorded data of supported releases are available.

1089

1090 2.5.2.4.5 EFB Application development environment control

1091 The various environments used to support the development process shall be defined and controlled.

1092 Any change of the development environment should be assessed before implementation.

1093

1094 2.5.2.5 Application Release

1095

1096 2.5.2.5.1 EFB Application conformity review is conducted.

1097 The purpose of the conformity review is to obtain assurances, for an EFB application release, that the
1098 development processes and data are complete.

1099 Conformity review of EFB Application releases shall be conducted.

1100 A conformity review should be conducted prior to the delivery of the EFB application release for
1101 operational use.

1102 A conformity review may determine that:

1103 • Planned development activities have been completed and records of their completion are
1104 available,
1105 • Evidence exists that development data have been produced in accordance with defined
1106 processes, and is controlled in accordance with the configuration management process,
1107 • Evidence exists that EFB application Problem Reports have been evaluated and have their
1108 status recorded,
1109 • Development plan deviations are recorded and approved,
1110 • Problem Reports deferred from a previous conformity review are re-evaluated to determine their
1111 status.

1112

1113 2.5.2.5.2 Impact analysis of known issues

1114 Known issues and potential mitigations shall be recorded, assessed and made available to operators.

1115 Known issues are problem reports and functional limitations which are relevant for the operator/flight
1116 crew and not fixed for the considered release.

1117 The severity and the impact of known issues should be analyzed from a functional and operational
1118 perspective. It should be ensured that such issue does not compromise the intended function or any
1119 mitigation means used in the risk assessment.

1120

1121 2.5.2.6 Quality Assurance

1122 Assurance shall be obtained that actual development processes, including those of suppliers, comply
1123 with the development plan and the required FQL.

1124 The quality process should:

1125 • Ensure that the development plan is defined and complies with the required FQL

- Ensure that the deviations from the defined development plan are identified, tracked and addressed
- Produce records including evidence of completion of the EFB Application conformity review
- Provide assurance that any supplier processes and outputs comply with the defined processes

Those performing the quality process can take an active role in the activities of the EFB application development processes, and have the authority, responsibility, and independence to ensure that the quality process objectives are satisfied.

Credit may be taken from already existing quality assurance processes.

2.6 DATABASES

Data addressed here are databases used by EFB applications that are stored and not acquired in real time from an interfaced system. Considerations for real time data are addressed through the risk assessment, development process and security chapters.

This data includes those supporting the operational use of an EFB application by the operator. They may be produced and managed either by the applicant, either by the operator or a third party organization.

A non-exhaustive list of operational databases used by EFB applications may include:

- Navigation databases
- Airport map databases
- Aircraft performances databases
- Obstacles databases
- Terrain databases
- Runway & airport databases
- Aircraft Weight and Balance calculation databases
- Electronic Checklist databases
- Electronic Charts databases
- Documentation databases

This section does not apply to parameters data items that may be used to enable/disable optional functions, or to customize the HMI of an EFB application, etc.…They may be produced and managed either by the applicant, or by the operator. The definition of these files is done during the integration phase of the EFB application in the operational environment of the operator. A revision or an update to the parameter data items is an administration task that may impact the behavior of the EFB application and thus then may be considered as a change of the EFB application from the operator point of view.

Each database used by EFB functions shall be identified

The following is not applicable to any EFB application database not used by an EFB function

Depending on the potential contribution to residual risk and if the database is approved with the EFB application or not, one of the following options shall apply

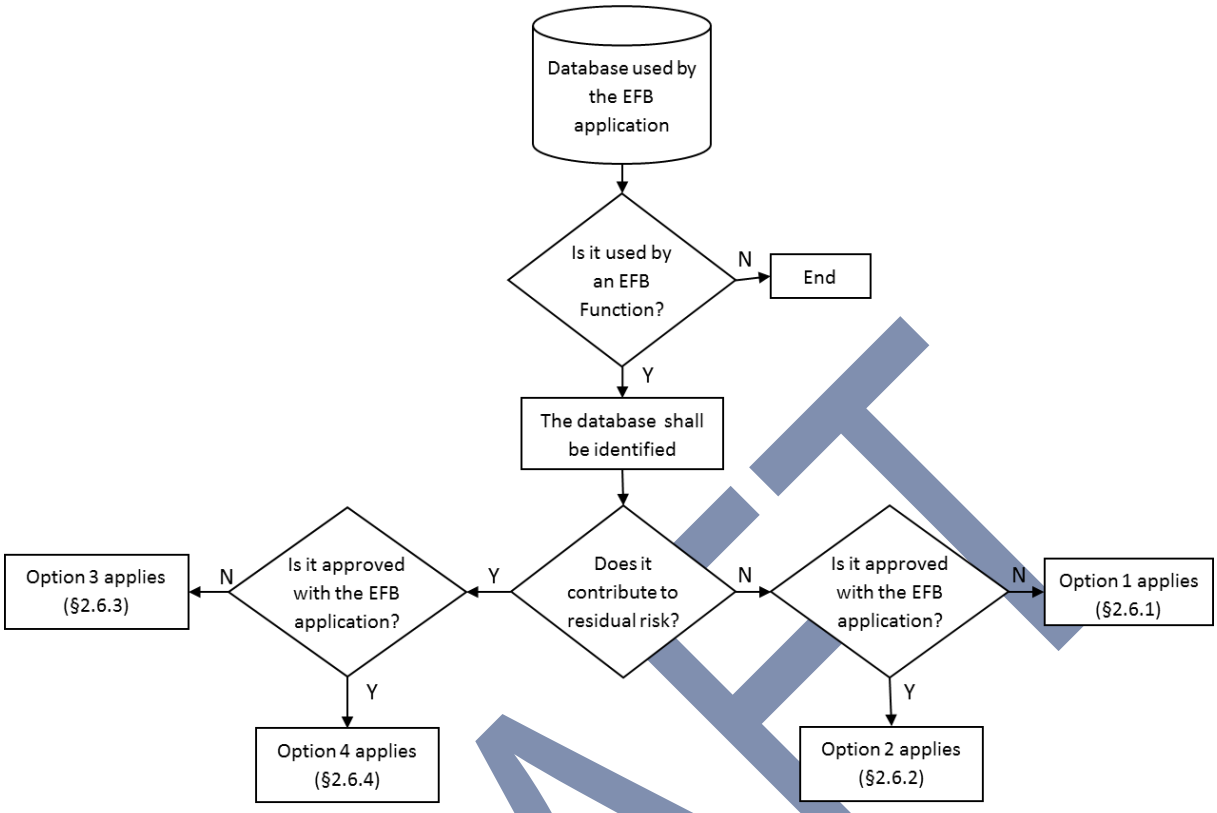

Figure 3 Databases consideration options

A database approved with the EFB application means that the database is an item of the application configuration (see section §2.5.2.4.1) and that the application has been verified using these data.

2.6.1 Option 1 - Database is not identified as a contributor to residual risk and is not approved with the EFB application

The applicant shall define and make available sufficient information regarding database for the data provider to ensure that the data is compatible with its intended use.

If the applicant is the data provider, sufficient information might not be formalized in a single document and may instead be described in documented internal processes.

2.6.2 Option 2 - Database is not identified as a contributor to residual risk and is approved with the EFB application

For a database approved with the EFB application, one of the three solutions should be considered:

- The database is a low complexity database; meaning that the amount of data is limited and the structure of the database is simple. The full database content has to be validated and verified by the applicant, or
- The database is developed with the function according to the Low FQL level, or
- Applying ED-76() process

2.6.3 Option 3 - Database is identified as a contributor to residual risk and is not approved with the EFB application

For aeronautical data, the applicant shall define and make available DQR for the data provider

The DQR should specify the characteristics of data to ensure that the data is compatible with its intended use:

- Accuracy,
- Resolution,
- Integrity (or equivalent assurance level),
- Traceability (ability to determine origin of the data),
- Timeliness,
- Completeness,
- Format.

For data other than aeronautical data (e.g. ECL database), the applicant shall define, as necessary in the documentation, specification of the database and/or the methods and mitigation mean (e.g. guidance on the use of a specific database processing tool to generate or modify the database)

DQR Compliance for data provider: The applicant may recommend to the data provider the use of ED-76(), in particular when the data provider is not the originator of the data and use “authoritative” sources (e.g. from AIP, OEM, etc.)

Maintaining DQR Compliance: Depending on the EFB application architecture, if data is transferred from a ground repository to the EFB host platform, it should be protected against corruption and alteration

If the applicant is the data provider, DQR might not be formalized in a single document and may instead be described in documented internal processes.

2.6.4 Option 4 - Database is identified as a contributor to residual risk and is approved with the EFB application

For database approved with the EFB application, one of the three alternatives shall be used to prevent the hazard identified as a contributor to a Residual risk

- The database is a low complexity database; meaning that the amount of data is limited, the structure of the database is simple, and the full database content is validated and verified by the applicant, or
- The database is developed with the function according to the High FQL level, or
- Applying ED-76() process.

2.7 SECURITY

By nature an EFB application may be exposed to various security threats. Security is a concern which requires attention during the whole software lifecycle:

- At the development level to ensure no vulnerabilities are introduced; part of this topic is already covered by development assurance.
- During distribution between the applicant and the customer, to ensure that the EFB application behaves as designed.
- After delivery of the EFB application to monitor any new vulnerabilities.

Addressing security concerns are done in two steps:

1. Apply the Minimum Requirements found in this chapter.
2. Apply the Security Process if residual risk exists.

See figure below

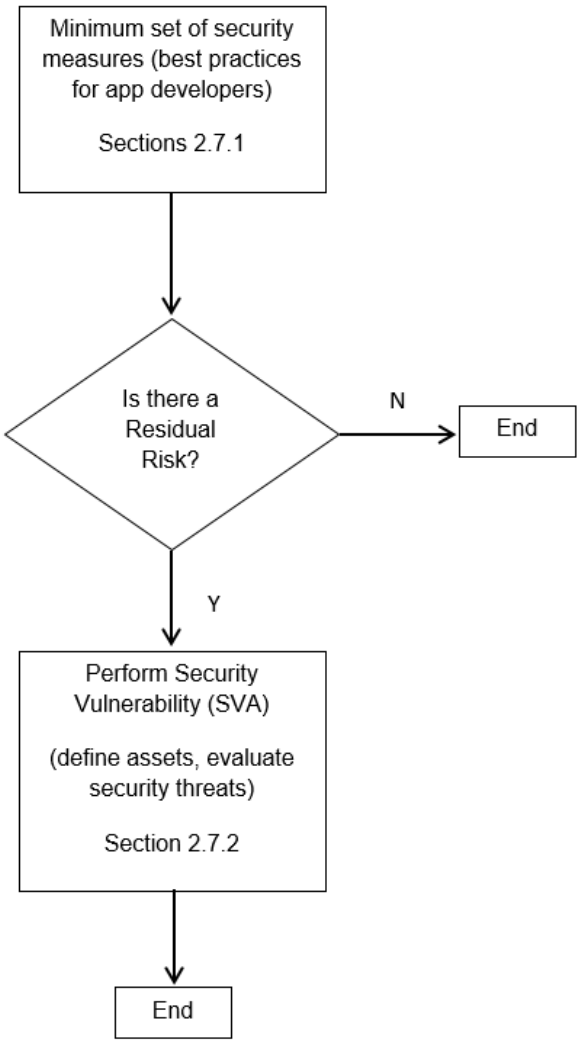

Figure 4 Security approach

2.7.1 Minimum set of security measures

The EFB application shall check the format and the range of all inputs.
Code reviews may be done to validate the format and range check before use of the input.
Detected erroneous input format or range may be recorded to ease further investigation.

Vulnerabilities published by third party software suppliers shall be assessed and cleared.
Vulnerability clearance means either mitigating the vulnerability or justifying there is no risk.

It is recommended that the applicant defines its strategy to regularly monitor vulnerabilities in the development plan and throughout the entire lifecycle of the EFB application.

The authenticity and integrity of configuration items of the EFB application shall be established.

Distribution of EFB application binary files, parameters data items and database files shall ensure both the integrity of the files and the authentication of the originator.

The use of the EFB application shall not require permanent deactivation of security measures on supporting assets.

2.7.2 Security Risk Assessment

In the event residual risks have been identified in the safety assessment, a Security Risk Assessment shall be carried out as per ”Figure 1 ORA overall process” to identify potential security vulnerabilities contributing to residual risks.

The following section defines the process that should be followed when performing a security risk assessment on an EFB application or function.

The security assets shall be defined.

The security assets of each EFB function should be defined, including but not limited to functions, software interfaces, network data flows and Third Party Software.

This is an example of data flows, assets and supporting assets:

- Data Flows:
  - Wired or Wi-Fi connectivity to AID/installed EFB or Onboard Server
  - Avionics Data retrieval
  - Writing data out to Avionics
  - Removable Media such as an USB stick
  - Data exchange with ground system or operator
  - HMI user entries
  - Data Integrity Check
- Primary Assets identification:
  - EFB application components (including Third Parties Software)
  - Avionics parameters
  - Messages exchange
  - Crew entries
- Supporting Assets:
  - Portable EFB hosting platform
  - Services provider (AID or installed EFB)
  - Wi-Fi
  - Configuration or Data Base, Load installation
  - Data from other EFB applications

Vulnerabilities in the EFB functions and assets shall be identified, evaluated and treated for their potential contribution on residual risk.

The applicant should define an Acceptable Means to prevent vulnerabilities contributing to residual risk, this means being embedded into the function(s) or being a procedure to be applied by the operator.

Vulnerabilities may be assessed on the basis of threats listed below (Table 4 Security threats).

Hardening may be used to reduce vulnerability of libraries used within the EFB application. Reducing available ways of attack typically includes the removal of unnecessary software, unnecessary usernames or logins, and the disabling or removal of unnecessary services.

A static code analysis scan may be used to prevent potential runtime errors.

Vulnerability identification should be initiated during development lifecycle phase.

A process should be established to evaluate vulnerabilities affecting the EFB functions (including Third Party Software) on an ongoing basis.

- Catalogue of Threats

The table below may be used by the applicant to determine which potential threats could affect assets used by the EFB functions.

Threat	Threat Description	Prevention means
ACCESS	An authorized user may gain unauthorized access to the EFB Application or to information controlled by the EFB Application via an attack for malicious purposes.	Implement Authentication and Credentials management
DEVELOP	Security failures may occur as the result of problems introduced during design, development, and implementation of the EFB Application.	Code review, coding rules, Static code analysis have to be done during the implementation life cycle
FAILURE	EFB Application system could be compromised or affected in the event of a system failure.	Identification of dummy data and restart with a functional context
INSTALL	The EFB Application may be delivered or installed in a manner that undermines security.	Check data at installation
MAINTAIN	The security of the EFB Application may be reduced or defeated due to errors or omissions in the administration and maintenance of the system.	Covered per installation (data load or configuration)
OBSERVE	Security events occur in EFB Application operation but the system, due to flaws in its specification, design, or implementation, may lead a competent user or technician to believe that the EFB Application is still secure.	Code and Design review, coding rules, Static code analysis
OPERATE	Security failures may occur because of improper operation of the EFB Application or systems interfacing with the EFB Application.	Code and Design review, coding rules, Static code analysis
PHYSICAL	Security-critical parts of the EFB Application may be subjected to a physical attack that may compromise security.	Refutation tests refutation activities
JAMMING	An attacker performs jamming on a communication physical medium.	Check on data EFB application input. Could be demonstrate by analysis or tests Refutation tests

FLOOD	An attacker performs flooding on a communication mean.	Check on data EFB application input. Could be demonstrate by analysis or tests Refutation tests
USURP	An attacker usurps the identity of an authorized external entity communicating with the EFB Application.	Implement Authentication and Credentials management
INJECTION-ALTER	An attacker injects or otherwise alters messages on a communication link in order to reduce the integrity of the EFB Application.	Check on data input Refutation tests
REPLAY	An attacker replays messages on a communication link in order to reduce the integrity of the system.	Check on data input
COMPROMISE	An attacker compromises EFB Application loadable components (FLS, DB, Digimaps etc.) in order to reduce the integrity, availability or confidentiality of the system.	Check data at installation
MALWARE	An attacker injects a malware within the EFB that aims at targeting the EFB Application, affecting the integrity, availability or confidentiality of this system.	

Table 4 Security threats

CHAPTER 3 SPECIFIC MINIMUM OPERATIONAL PERFORMANCE STANDARD

This chapter includes the additional requirements applicable to the following EFB functions:

- Aircraft performance and weight and balance calculation functions,
- Functions displaying the own-ship position,
- Airport moving maps (AMM) function,
- Weather function,
- Electronic checklist function,
- Electronic signature function,

3.1 AIRCRAFT PERFORMANCE AND WEIGHT & BALANCE FUNCTIONS

These functions include:

- Computation of take-off and landing performance limitations for specific aircrafts, runways and conditions.
- Computation of weight & balance for specific aircrafts, chosen aircraft and crew/catering configurations and passengers, bags and fuel load.

3.1.1 Human machine interfaces

Input and output data shall be clearly separated from each other.

Inputs designate the set of data that will be entered into the application by the user.

Inputs can also be prepopulated data that will be verified by the user as acceptable.

Outputs designate the set of data that are the results of the calculations.

All output data should be available in numbers except for commonly used terms in the environment, e.g. TOGA

For Take-Off and Landing performance calculation functions, at least the following input data shall remain visible on the screen after performing a calculation when applicable for the aircraft:

- Aircraft mass,
- Selected runway, runway entry / exit, and runway condition,
- Wind, Temperature and Pressure Altitude,
- Status (active/inactive) of MEL, CDL, or non-normal performance penalties,
- Status (active/inactive) of NOTAM or other runway / obstacle modification.

All other input data should remain accessible via a single user action (e.g. button press or swipe).

For En-Route, non-approved performance calculation functions, and mass & balance functions, flight crew inputs should remain accessible via a single user action after calculation.

If input data is displayed after calculation, it should be the data actually used by the calculation function.

The application should indicate if a set of entries results in an unachievable operation (for instance a negative stopping margin) with a specific message and/or colour scheme. The software application may include the ability for the operator to rearrange the graphical user interface in order to provide consistency with different flight deck configurations. If that is the case, the applicant has to ensure that the application remains compliant with the criteria of this MOPS throughout the envelope of possible interface modifications, or provide clear guidelines to the operator regarding how to ensure this.

The user should be able to modify calculations input parameters easily, especially when making last minute changes.

All the information necessary for a given calculation task shall be presented together or easily accessible.

The layout of any software application calculation outputs shall be consistent with the data entry interface of the aircraft system in which the calculation outputs are used (e.g. Flight Management Systems), or this instruction forwarded to the operator customizing the interface.

Airspeeds shall be provided in a form directly usable in the cockpit unless the unit clearly indicates otherwise (e.g. KCAS). Any difference in the type of airspeed provided by the EFB application and the type provided by the AFM or FCOM performance data shall be discussed in the flight crew guides and training material.

If the application offers different calculation modes (e.g. dispatch landing performance and operational landing performance), the active mode shall be unambiguously identifiable by the user.

Calculation results and any outdated input fields shall be deleted when inputs are modified.

Input and Output data shall be deleted when the EFB is shutdown or the EFB application closed.

The results of calculations and any outdated input fields should be deleted whenever the application has been in stand-by or 'background' mode or if data is no longer valid.

The deletion time may be configurable by the administrator.

Applications may use default input values where appropriate and when flight crew workload has not been negatively affected.

For Mass & Balance functions, the interface shall provide a diagram displaying the mass and its associated centre-of-gravity (CG) position.

3.1.2 Software considerations for Airplane Take-Off and Landing performance calculation functions

Except for:

- Airplane Take-Off and Landing performance calculation functions reusing computerized AFM software approved as per airworthiness requirements (CS2x.1581 or equivalent), and
- Airplane Take-Off and Landing performance calculation functions for which sufficient service history exists and whose extent and relevance can be substantiated by the applicant, demonstrating satisfactory operations,

the functions intended to be used as a sole means of airplane take-off or landing performance calculations shall be designed so as to ensure that a single software performance calculation error will not lead to performance results above the mass specified in the AFM for the same ambient conditions.

For this purpose, one of the following means developed at least to a FQL-Low level could be implemented:

- Independent reverse calculation flow with inputs cross-check:

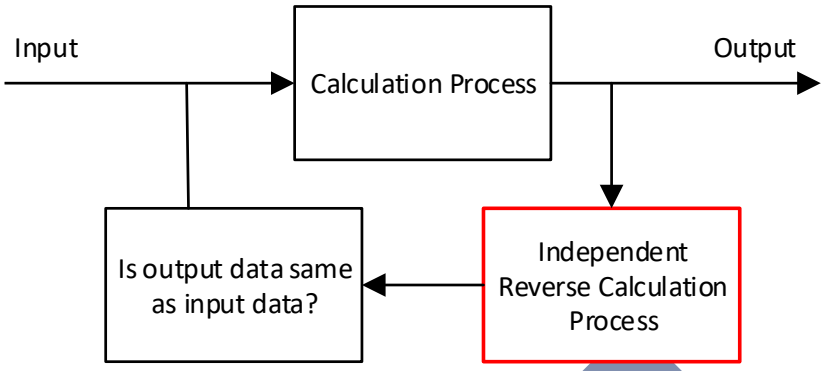

Figure 5 Perfo inputs cross-check

- Second independent calculation function with outputs cross-check:

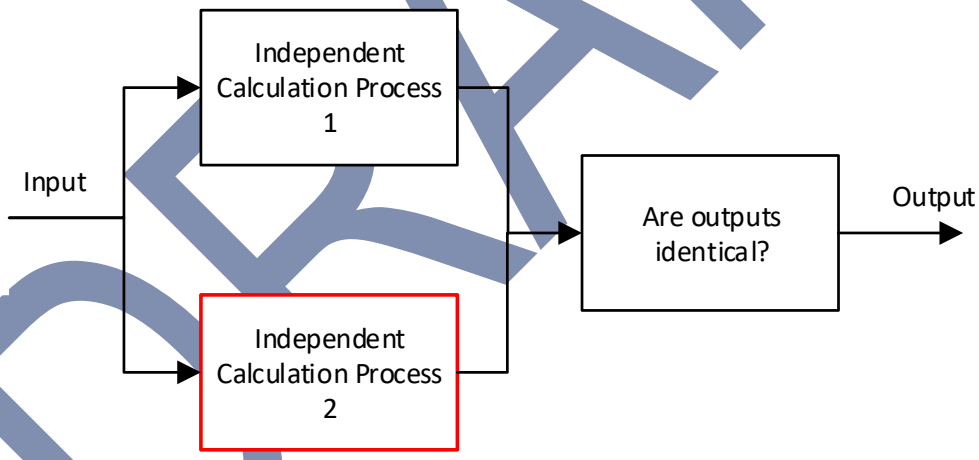

Figure 6 Perfo outputs cross-check

The functions not intended to be used a sole means of airplane take-off or landing performance calculations shall have an operational means independent from the application e.g. gross-error check based on pre-computed tables available on paper or electronically) specified and recorded, in order to ensure that a software performance calculation error from the application can be detected.

3.1.3 Recording of inputs and outputs

The performance and mass & balance functions shall record each computation performed (inputs and outputs).

3.1.4 Databases and calculations

Where it exists, performance and mass and balance functions should use existing approved data such as the Aircraft Flight Manual performance data. The functions should take into account for the applicable performance and mass and balance requirements from the Operational Regulations.

Performance and mass and balance functions should not extrapolate beyond information contained in approved data.

Performance and mass and balance functions may have the capability to interpolate within the information contained in approved data but they should not extrapolate beyond it.

3.2 FUNCTIONS DISPLAYING OWN-SHIP POSITION

This chapter specifies considerations for the depiction of own-ship position on an aeronautical maps or charts. It contains provisions that are generally applicable to all functions that display an own-ship position. Special provisions related to AMMD and to In-flight Weather are detailed in chapter 3.3 and 3.4 respectively.

3.2.1 Limitations

The display of own-ship position as an overlay on EFB functions shall not be intended for use as a primary source of information to fly or navigate the aircraft.

Except on VFR flights over routes navigated by reference to visual landmark, the limitations provided with the EFB application should allow display of the own-ship symbol only in aircraft having a certified navigation display (moving map).

In the specific case of IFW functions, the limitations provided with the EFB application should restrict the display of own-ship to aircraft equipped with a weather radar.

3.2.2 Position Source and Accuracy

The display of own-ship position should be based on a GNSS or GNSS-based (e.g. GPS/IRS) position from certified aircraft equipment or a suitable portable COTS position source.

Note: The selection of a position source in compliance with applicable operational regulations and the provisions in this section and is under operator responsibility.

The own-ship symbol should be removed and the flight crew notified if:

(1) The total system accuracy exceeds a certain threshold; or
(2) No or invalid position data is received for 5 seconds.

Note: The term "total system accuracy" is defined and explained in RTCA DO-257().

The total system accuracy threshold should be acceptable for the specific implementation of the function and should be selected such that erroneous misleading information is prevented. It may vary by chart type, phase of flight or selectable zoom scales.

For functions displaying own-ship position in flight, it may be sufficient to consider position source accuracy only.

Total system accuracy monitoring for the purpose of own-ship symbol removal may be unnecessary if the applicant can plausibly demonstrate for their implementation that the total system accuracy generally remains below the threshold because certain prerequisites are fulfilled (like certified aircraft equipment, a sufficiently accurate database or a sufficiently high total system accuracy threshold).

The zoom level of the application may be limited to prevent suggesting a level of accuracy that is unrealistically high, which could lead to users misusing the function as a primary source of information.

3.2.3 Charting Data Considerations

World Geodetic System (WGS-84) position reference system or an equivalent earth reference model shall be used for all displayed data.

If the map involves raster images that have been stitched together into a larger single map, it should be demonstrated that the stitching process does not introduce distortion or map errors that would not correlate properly with a GNSS-based own-ship symbol.

3.2.4 Human machine interface (HMI) Considerations

3.2.4.1 Interface

The flight crew shall be able to unambiguously differentiate the EFB function from avionics functions available in the cockpit, and in particular with the navigation display.

A sufficiently legible text label ‘AIRCRAFT POSITION NOT TO BE USED FOR NAVIGATION’ or equivalent should be continuously displayed by the application if the own-ship position depiction is visible in the current display area over a terminal chart (i.e. SID, STAR, or instrument approach) or a depiction of a terminal procedure.

The ‘not-to-be-used-for-navigation’ limitation may be also covered by training.

3.2.4.2 Display of own-ship symbol

The own-ship symbol shall be different from the ones used by certified aircraft systems intended for primary navigation.

The depiction of a circle around the EFB own-ship symbol may be used to differentiate it from the avionics one.

The pilot should be able to obtain information about the operational status of the own-ship function (e.g. active, deactivated, and degraded).

A means to disable the display of the own-ship position shall be provided to the flight crew.

If direction/track is not available, the own-ship symbol shall not imply directionality.

If directional/track data is available, the own-ship symbol should indicate directionality

If own-ship directionality information becomes unusable then this condition should be indicated.

If the own-ship symbol is directional, the front of the symbol that conveys directionality should correspond to the aircraft nose location.

If the own-ship symbol is non-directional, the aircraft location should correspond to the centre of the non-directional symbol.

3.2.4.3 Map orientation

The current map orientation shall be clearly, continuously and unambiguously indicated (e.g., Track-up vs North-up).

The display in track-up mode should not create usability or readability issues. In particular, labels should not be rotated in a manner that affects readability.

When the flight crew has selected a display orientation (e.g. Track-up), that display orientation should be maintained until a pilot action that requires an orientation change occurs.

If the North-up display is selected, the orientation of the map itself should be referenced to True North.

If direction information is referenced to True North, this should be indicated.

True bearings should be labelled with “ºT” to the right of the bearing value.

3.2.4.4 Map scale/range, panning

The function shall have the capability of manually changing the map range or scale

The function should provide an indication of the map range or scale.

The application zoom levels should be appropriate for the function and content being displayed and in the context of providing supplemental position awareness.

If a scale is depicted, it should be indicated permanently.

If the function is controlling the map range or scale automatically, the mode (e.g. auto map range) should be indicated.

It is recommended that the range/scale indication be depicted on at least one of the charts/maps (e.g. airport moving map or static airport/ground map).

If the function is controlling the map range or scale automatically, then the capability should exist to activate or deactivate the automatic map range.

If a panning and/or range selection function is available, the capability to return to an own-ship-oriented display should be provided.

When using the panning and/or range selection function, an indicator of own-ship current position should be provided within the overall displayed image. The indicator should be distinguishable from the own-ship symbol.

When the display is switched to a previously viewed page then the display should maintain the map range associated with that previously viewed page.

3.2.4.5 Data displayed

All overlayed data shall be presented in the same map orientation and scale as the base map.

The following parameters must not be displayed in a way that allows deduction of the airplane status or deduction of information that could be used to steer the airplane:

(i) Track/heading;
(ii) Estimated time of arrival (ETA);
(iii) Altitude;
(iv) Geographical coordinates of the current location of the aircraft; and
(v) Aircraft speed.

3.3 AIRPORT MOVING MAP (AMM) FUNCTION (INCLUDING OWN-SHIP POSITION)

An airport moving map shall include the following minimum information and control elements:

- Runways
- Runway Identifiers
- Taxiways
- Ramp Areas
- Indication of map/chart scale (should)
- Indication of map/chart orientation
- Ability to select map/chart orientation
- Ability to select map range/scale
- Ability to declutter the map/scale

The function should have a consistent prioritization scheme for layering map data.

To ensure the availability of appropriate information during surface operations, the order of display layer precedence (in case aerodrome features overlap) should be (higher priority layered on top):

a. Own-ship symbol (must be unobstructed)
b. Taxi route
c. Runway identifiers
d. Runways
e. Taxiway identifiers
f. Taxiways

The depiction of runways shall be distinctive from all other symbology.

With the exception of instances where two or more runways intersect, each runway should be depicted as a contiguous area (i.e., an unbroken rectangle).

Runways and taxiways should be depicted as filled areas, rather than outlined areas.

A capability should exist to depict runway identifiers on the display when the runway is within the selected map range/scale.

At reduced map ranges, if only a small portion of the runway is visible, developers may choose to only depict one runway identifier.

If runway markings (e.g., runway centerline) are provided they should be depicted in their correct relative position.

Runway identifiers should be distinguishable from the depiction of runway markings.

If taxiways are depicted then a capability should exist to depict taxiway identifiers on the display.

Additional data on the display (over and above the minimum required data) should be depicted in a consistent way and should not interfere with the usability of the minimum data.

The aerodrome designator (e.g., ICAO identifier) or name for the depicted aerodrome should be indicated on the display.

Taxi route information shall be distinguishable from all other AMM elements.

The way taxi routes are depicted in a preview or edit mode should be distinctive from the depiction of the active taxi route.

The depiction of taxi routes should not obscure runway or taxiway identifiers.

The function shall have the capability to present map information in at least one of the following orientations: North-up or Track/Heading-up (if direction/track is available).

All symbols shall be depicted in an upright orientation except for those designed to reflect a particular orientation.

If symbols or fonts cannot be rotated, the map orientation should be limited to North-up – except for runway identifiers.

Symbols used for one purpose on published paper charts should not be used for another purpose on the electronic function.

The spatial relationships between labels and the objects that they reference should be clear, logical, and, where possible, consistent.

The function shall have the capability for de-cluttering (e.g. manual or automatic) during operational use.

Movement of map information should be smooth throughout the range of aircraft manoeuvres.

The system may provide the option to automatically remove the own-ship position when the aircraft is in flight or exceeds a certain ground speed.

The function should provide a means to compensate for installation dependent GNSS antenna offset (i.e., along-track aircraft reference point bias associated with GNSS antenna position relative to the nose of the aircraft). (see chapter 3.2.2)

If the GNSS antenna offset cannot be compensated: operations with own-ship switched on may be limited to operations where the position source is in or near the flight deck.

The application shall provide an indication when the database is no longer valid

The application should require a pilot action acknowledging an expired database.

Database corruption shall be detected and annunciated to the flight crew clearly and in a timely manner

The AMM database accuracy and resolution should meet medium category data quality as defined in EUROCAE ED-99()/RTCA DO-272().

3.4 WEATHER FUNCTION

3.4.1 General Considerations

An in-flight weather (IFW) application is an EFB function or application enabling the flight crew to access meteorological information. It is designed to increase situational awareness and to support the flight crew when making strategic decisions.

IFW data shall not be intended to support tactical decisions and/or as a substitute for certified aircraft systems (e.g. weather radar).

The use of IFW applications should be non-safety-critical and not necessary for the performance of the flight.

Any current information from the meteorological documentation required to be carried on board or from aircraft primary systems should always prevail over the information from an IFW application.

An IFW function or application may be used to access both information required to be on board (e.g. World Area Forecast Centre (WAFC) data) and supplemental weather information.

The displayed meteorological information may be forecasted and/or observed, and may be updated on the ground and/or in flight. It should be based on data from certified meteorological service providers or other reliable sources evaluated by the operator.

The meteorological information provided to the flight crew should be, as far as possible, consistent with the information available to users of ground-based aviation meteorological information (e.g. operations

control centre (OCC) staff, flight dispatchers, etc.) in order to establish common situational awareness and to facilitate collaborative decision-making.

3.4.2 Display Considerations

Meteorological information should be presented to the flight crew in a format that is appropriate to the content of the information.

Coloured graphical depiction is encouraged whenever practicable.

The IFW display should enable the flight crew to:

(1) Distinguish between observed and forecasted weather data;
(2) Identify the currency or age and validity time of the weather data;
(3) Access the interpretation of the weather data (e.g. the legend);
(4) Obtain positive and clear indications of any missing information or data and determine areas of uncertainty when making decisions to avoid hazardous weather; and
(5) Be aware of the status of the data link that enables the necessary IFW data exchanges, as applicable.

Meteorological information in IFW applications may be displayed, for example, as an overlay over navigation charts, over geographical maps, or it may be a stand-alone weather depiction (e.g. radar plots, satellite images, etc.).

If meteorological information is overlaid on navigation charts, special consideration should be given to HMI issues in order to avoid adverse effects on the basic chart functions.

The meteorological information may require reformatting to accommodate for example the display size or the depiction technology. However, any reformatting of the meteorological information should preserve both the geo-location and intensity of the meteorological conditions regardless of projection, scaling, or any other types of processing.

3.4.3 Procedures and training

The operator shall establish procedures for the use of an Inflight Weather (IFW) application.

This training should address:

(1) Limitations of the use of an IFW application:
    a. Acceptable use (strategic planning only);
    b. Information required to be on board; and
    c. Latency of observed weather information and the hazards associated with utilisation of old information;
(2) Information on the display of weather data:
    a. Type of displayed information (forecasted, observed);
    b. Symbology (symbols, colours); and
    c. Interpretation of meteorological information;
(3) Identification of failures and malfunctions (e.g. incomplete uplinks, data-link failures, missing info);
(4) Human factors issues:
    a. Avoiding fixation; and
    b. Managing workload.

3.5 ELECTRONIC CHECKLIST FUNCTION

This section is applicable to electronic checklist (ECL) function. The initial part of this section will address the specific considerations for the risk assessment, for the Human Machine Interface (HMI) design and the various human factors aspects such as browsing in the application, connectivity of the application and accessibility to the ECL application from other applications. Finally, there will be a discussion on the presentation of checklist within an aircraft context.

3.5.1 Scope

This specific requirement provides the considerations applicable to the intended uses of electronic checklists as primary and sole means either when checklists are either manually selected by the flight crew or presented to the flight crew based on the aircraft context (flight phases, flight crew alert messages).

3.5.2 Risk assessment

The risk assessment shall evaluate the risks of the loss of the ECL function based on the intended uses as primary and only means and in the corresponding environmental conditions.

The ECL hardware may be compatible with the required temperature conditions required for fire and smoke checklists

The risk assessment shall evaluate the risks of undetected erroneous data

The ECL hardware may be compatible with the required acceleration conditions (g loads) required for emergency landing or evacuation checklists

The risk assessment shall evaluate the risks of accessibility to the response time of the checklists

3.5.3 ECL HMI design and human factors considerations

These HMI considerations are broken-down in two aspects: access to the ECL application and the browsing within the ECL application. The response time required to access the application depends on each specific checklist.

For example, some non-normal and emergency checklists are time critical and require quicker access in comparison to other checklists such as normal checklists.

3.5.3.1 Checklist

This section applies to the browsing within the ECL application.

3.5.3.1.1 Accessibility

The response time of the checklist within the ECL application shall be compatible with its time criticality aspects.

Within the ECL application, shortcuts to time critical checklists should be available.

Time criticality criteria may be defined by the type certificate holder or if not available then the evaluation will be done by the applicant.

It is recommended to organise the checklists in a specific order to improve the access time for the user. For example, Checklists may be organized by separating checklist and procedures, by flight phase or by criticality where the most critical items may appear first.

3.5.3.1.2 Display

The title of the checklist should be displayed and distinguished at all times when in use.

The end of each checklist should be clearly indicated.

The field of view of each checklist should be limited to the viewing window of the hardware used by the flight crew to display the checklist.

Having information displayed outside the flight crew immediate field of view may result in the loss of information when executing a checklist

3.5.3.1.3 ECL with interactivity

ECL with interactivity refers to the possibility offered by an ECL HMI to reflect the actions of the flight crew. It offers a better situational awareness of the progress inside the checklist as well as an improved display of the checklist. Examples of actions include the recording of the completion of checklist or checklist items, the display of conditional branching of a checklist, the restart of checklist, etc.

The ECL HMI shall reflect the actions and the progress of the flight crew in the checklists execution

ECL shall provide a checklist overview displaying which checklists are completed and which are not.

- ECL should display the completion status of action items within a checklist.
- ECL should provide means to restart a checklist with a verification step to confirm the restart.
- ECL should provide means to check or uncheck an action item in a checklist.
- ECL should provide means to prevent the flight crew from missing the applicable conditional branching(s) within a checklist.

3.5.3.2 Access to the ECL application

The access to ECL application depends upon the operational supporting environment. The operational supporting environment described in general section also applies to ECL applications and specific considerations are addressed through this section.

The ECL application shall be easily usable and quickly accessible to the flight crew in accordance with the intended use

Shortcut to directly access an ECL application, supporting the time critical checklists, should be available

The toggling between EFB applications on the same hardware may have an impact on the accessibility to the ECL application

3.5.3.3 Supporting environment

The support hardware shall minimize the effort of the flight crew to interact between ECL and cockpit equipment.

The hardware may be disconnected in order to achieve this capability.

3.5.3.4 ECL presented to the flight crew based on the aircraft context

The intended use of those ECL is the capability to display automatically the normal check-list based on the flight phase and/or the abnormal/emergency checklists based on the data or events provided by the aircraft

The normal checklists shall be displayed at the right moment in the sequence of the flight

The non-normal/emergency checklists shall be displayed according to the alert messages

3.6 ELECTRONIC SIGNATURE FUNCTION

This section provides considerations applicable to an electronic signature when used in EFB applications as sole and primary means.

3.6.1 Uniqueness

The electronic signature shall identify a specific individual and shall be unique to this individual

A valid electronic signature shall be under the sole control of the signatory.

It shall be difficult for another individual to duplicate or alter one's electronic signature

Electronic signature requiring the signatory to use a unique user name and password (or PIN code) with limited validity to access the system and affix the signature should be considered as appropriate.

Advanced electronic signatures, qualified certificates and secured signature-creation devices are typically not required for this requirement.

3.6.2 Association

The electronic signature shall be attached to or associated with the electronic record being signed.

The electronic signature should identify the scope of the information being affirmed with by the signature and it should be clear to the signatory and to the subsequent readers of the record, record entry, or document.

It should be clear to the signatory exactly what it is that they are signing. In an electronic environment, the signer should have an opportunity to review the record before signing it, and to clearly understand the parameters of the record they are signing. It is also critical that the signing process be established in a manner to ensure that the signatory's electronic signature is applied only to what they can review.

The electronic signature applied by the signer should be linked to the record being signed. Satisfying this requirement requires storing the data constituting the electronic signature and doing so in a way that permanently associates it with the electronic record that was signed.

3.6.3 Significance

The electronic signature shall show a deliberate and recognisable action for an individual to sign the electronic record to indicate a person's approval or affirmation of the information contained in the electronic record.

The signatory should be prompted before their signature is affixed. The electronic signature block should contain a word or statement of intent that definitively conveys the signatory's intent to affix his or her signature.

Acceptable deliberate actions for creating an electronic signature may include, but are not limited to, the following:

- Using a digital signature;
- Entering a user name and password;
- Swiping a badge; and/or
- Using an electronic stylus.

Examples of statements that do this may include, but are not limited to:

- “Signed by,”
- “Certified by,”
- “Instructor’s signature/certification,”
- “Signature,”
- “Authorized by,”
- “Signatory,”
- “Authentication,”
- “Acknowledged by,”
- “Acknowledgement,” and/or
- “Affirmed by.”

The EFB application may notify the signatory that the signature has been affixed.

3.6.4 Non-repudiation

The electronic signature shall prevent a signatory from denying (repudiating) that they affixed a signature to a specific record, record entry, or document

An electronic signature should allow to ensure the authenticity of the signature and that the signer cannot deny having affixed the signature to a specific record, document, or body of data.

The more difficult it is to duplicate a signature, the likelier it is that the signature was created by the signatory

3.6.5 Traceability

An electronic signature shall provide positive traceability to the individual who signed a record, record entry, or any other document.

The user shall be able to identify and retrieve the documents to which his or her electronic signature has been applied.

The electronic signature should have authentication capabilities that can identify a signature as belonging only to a particular signatory. An individual using an electronic signature should be required to use a method of authentication that positively identifies the individual within the electronic signature function.

3.6.5.1 Specific considerations for mass and balance records

For electronic signature affixed to mass and balance records, the following requirements should be considered:

The individual's name and professional capacity should be printed-out on the relevant record(s) in such a way that it is evident, to anyone having a need for that information, who has signed the document

The system should log information to indicate when and where the record has been signed.

The requirements for record keeping remain unchanged by the requirements related to electronic signature

3.6.6 Security

A valid electronic signature shall be a permanent part of the record or document to which it was affixed. The information to which the electronic signature is attached shall be unalterable without a new signature to validate the alteration.

There should be a means to preserve the integrity of the signed record.

An electronic signature process should be secure and should prevent unauthorized access to the system that affixes the signature to the intended documents or records. The process should ensure that only the intended signatory can affix his or her signature and should prevent unauthorized individuals from certifying required documents. The process should prevent modifications to information/data or additional entries to records or documents without requiring a new signature.

An electronic signature process should include a means to correct records or documents that were electronically signed in error, as well as those documents where a signature is properly affixed but the information or data is in error. An electronic signature should be invalidated any time a superseding entry is made to correct the record or document. The information or signature being corrected should be voided but remain in place. The new information and/or signature should be easily identifiable.

CHAPTER 4 OPERATIONAL AND INSTALLATION DATA

This chapter defines the operational and installation data to be provided to the operators for integration of the EFB application into their operations. The objective is to ensure for the proper installation, administration, use and maintenance of the application by the operators.

4.1 EFB APPLICATION DESCRIPTION AND CHARACTERISTICS.

Applicants shall provide a description and characteristics of the EFB application including those established as means of compliance with the standard.

This description and characteristics may include an overall view of the EFB application and the functions. These will support the airline in defining its own risk assessment. This is based on:

- The information used in determining the application's eligibility to be hosted on an EFB (§2.2)
- The information used to conduct the risk assessment (§2.3)

Applicants should provide an overall description of the EFB application including the version number.

Applicants should provide the functional breakdown of the EFB application and the identification of non-EFB functions.

Applicants should provide the intended use of each EFB function and sub-function.

Applicants should provide a description of the supported operational environment.

Applicants should provide all operational assumptions that support the risk assessment.

Applicants should provide the relevant information from the risk assessment that allows the operator to conduct its risk assessment. It should contain the following information for each EFB function and sub-function.

- Hazards identified during the Risk Assessment process.
- Mitigation means including responsibilities allocated to the operator.
- Prevention means including responsibilities allocated to the operator.

It is responsibility of the operator to complete, apply and validate mitigation and prevention means.

4.2 EFB APPLICATION ADMINISTRATION

Applicants shall provide administration instructions and limitations including instructions and limitations established as means of compliance with the standard.

The administration instructions and limitations are based on the development assurance set by the applicant (§2.5). It also includes the information necessary for the administrator to manage the EFB application on all the users platforms, i.e. the identification of the database used (§2.6), the security preventions (§2.7) and the configuration of the EFB application software.

Applicants should provide the minimum performance specifications required of any network connection for usage of the EFB application.

The network connections include, but are not limited to:

- Air/Ground Aircraft communication
- EFB Cellular or WiFi connectivity
- On-board networks

Applicants should provide all distribution information relevant to the operator.

If applicable, applicants should provide installation guidelines.

Applicants should provide a description of the known issues and suggested solutions to address them.

Applicants should provide the identification of the database used by the EFB application. This includes the identification of the databases that may be modified and administrated by the operator (i.e. configuration files). If the database is not approved with the EFB application, it should include the characteristics of the data.

When applicable, applicants should provide a description of the application configuration options including configuration management guidelines.

Applicants shall provide security preventions expected to be followed by the operator on an ongoing basis.

The provided security preventions may include:

- Security prevention means not implemented at function level, expected in the integrated environment of use of the EFB application
- Security procedures to maintain the protection of the function

4.3 EFB APPLICATION OPERATIONAL INFORMATION

Applicants shall provide operational information, instructions, limitations and any other means necessary to ensure that the EFB application is adequately and safely used by the flight crew. Any operational information, instructions, limitations or any other data established as means of compliance with the standard shall be included.

Operational information is provided to ensure the use of the EFB application in accordance with the intended use and the outcome of the risk assessment defined by the applicant.

Applicants should provide a user manual or other equivalent means describing the usage of the EFB application.

Applicants may propose equivalent means to user manual such as: application instructions, in-app help etc.

Intuitive user interfaces for basic functionalities may not require user manual descriptions.

Applicants should provide the operator with sufficient information to define flight crew procedures for the basic and safe use of the EFB application. Any flight crew procedures used as mitigation means for the Risk Assessment should be identified.

Flight crew procedures may cover application usage in normal and degraded conditions (e.g. degraded functionalities, loss of the EFB application in one platform, etc.)

Applicants should provide operators sufficient information to ensure appropriate flight crew training. Flight crew training items used as mitigation means for the Risk Assessment should be identified.

Applicants may provide training items for initial and recurrent training/checking.

Applicants may provide reference to recommended training means such as e-learning, on-site training, etc.

APPENDIX 1

EXAMPLES OF HOW TO APPLY THE SECURITY RISK ASSESSMENT TO AN EFB APPLICATION

THREAT	VULNERABILITY	
Name		Proposed mitigations
OBSERVE.LOG-OVERKILL	application sends too much logging data	• Specify and Implement a security log policy to be able to detect any cyber security incident on the application over EFB application. • Apply a good design practice on the application system in order to ○ Ensure the maintainability and the evolution of the application logging system (define and use a dedicated homogeneous application logging function to be used by all the application system components). ○ use as much as possible the logging capabilities of the EFB platform OS (this will centralize the application logs with all the EFB logs, the log processing and management will rely on the OS responsibility, the aircraft operator or maintenance personnel will be able to tune the log policy directly from the EFB system) ○ make event log messages as clear / as simple as possible ○ rationalize event log messages frequency (e.g., manage a counter of identical event logs after a 1st occurrence is logged, group log messages with counter information, ...) ○ Define a severity level for each of the application log messages and map this severity with the severity scale associated with the EFB OS log system.
OBSERVE.LOG-PROTECT	Unprotected Events from application	• Apply a good design practice on the application system in order to - use as much as possible the logging capabilities of the EFB platform OS (this will centralize the application logs with all the EFB logs, the log processing and management will rely on the OS responsibility, the aircraft operator or maintenance personnel will be able to tune the log policy directly from the EFB system • In the case the EFB logging system is not used, insure that the application log files access is protected against unauthorized access to prevent its deletion or alteration. This can be managed by EFB OS application and users access rights allocated on the application log files (MAC policy). With such protection mean, an attacker would have to acquire application or user access rights before to be

THREAT	VULNERABILITY	
Name		Proposed mitigations
		able to delete or directly alter the content of the application log files. EFB system available data encryption and authentication mechanisms can also be used to protect the application, application resources files and logs against unauthorized access. (e.g., recommend to activate the EFB cyphering, ask that the EFB user authenticates itself on the EFB before to be able to use the application).
OBSERVE.UNABLE	Lack of security event policy implementation	• Specify and Implement a security log policy to be able to detect any cyber security incident or corruption to the application. • Apply a good design practice on the application system in order to ○ Ensure the maintainability and the evolution of the application logging system (define and use a dedicated homogeneous application logging function to be used by all the application system components). ○ use as much as possible the logging capabilities of the EFB platform OS (this will centralize the application logs with all the EFB logs, the log processing and management will rely on the OS responsibility, the aircraft operator or maintenance personnel will be able to tune the log policy directly from the EFB system ○ make event log messages as clear / as simple as possible ○ rationalize event log messages frequency (e.g., manage a counter of identical event logs after a 1st occurrence is logged, group log messages with counter information, ...) ○ Define a severity level for each of the application log messages and map this severity with the severity scale associated with the EFB OS log system.
USURP	Weak of authentication in application dataflow exchanges	• Activate cyphering OS mechanism on the EFB + user login protection before unlock the access to the application binary and data. Or recommend the end user to • To implement a mechanism which increases the security (confidentiality, integrity and authenticity) of the dataflow exchanged between the involved legitimate application and application • *We could imagine establishing a secured communication tunnel (using TLS1.2 for instance) between each application and application which are involved in the application for EFB system before any application dataflow is exchanged.*

THREAT	VULNERABILITY	
Name		Proposed mitigations
INJECTION	No trusted path on application air-ground communication link	• Assess the absence of implementation vulnerabilities of the application for EFB software by following the security coding rules, perform code review to validate that there is no vulnerability, use tooling to detect eventual defects and patch the found vulnerabilities. • Perform regularly a COTS vulnerability assessment and provide patches or workaround procedures when relevant.

APPENDIX 2

WG-106 MEMBERSHIP

Name	Company or Organisation

IMPROVEMENT SUGGESTION FORM

Name: _____ Company: _____

Address: _____

City: _____ State, Province: _____

Postal Code, Country: _____ Date: _____

Phone: _____ Fax: _____

Email: _____

Document : ED- / DO- _____ Sec: _____ Page: _____ Line: _____

[ ] Documentation error (Format, punctuation, spelling)
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[ ] Enhancement or refinement

Rationale (Describe the error or justification for enhancement): _____

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