EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION

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EAD Safety Case Guidance

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Abstract

This document presents the European Aeronautical Information System (AIS) Database (EAD) Safety Case Guidance material and is intended to aid and support migrated EAD Data Providers and Data Users in understanding how to interpret the EAD Safety Case with regards what they can claim in terms of safety integrity from EAD along with how the supporting safety analyses can be used in developing their own local safety assessments for AIS provision.

This document should be read in conjunction with the EAD Safety Case.

Keywords

EAD	AIS	European Commission (EC)
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Aeronautical Data	SES	ISO

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1. INTRODUCTION

1.1 Background

The Central Flow Management Unit (CFMU) is a part of the EUROCONTROL Agency; it provides air traffic flow management services over the states of western and central Europe who are members of ECAC and makes available the EAD. Within the CFMU Directorate Organisation, the EAD and Aeronautical Information Bureau (EAB) is responsible for the EUROCONTROL EAD service and overall coherence of aeronautical information aspects within the CFMU.

On 30 September 2010, 200 clients were participating in the EAD comprising 62 Data Providers and 140 Data Users, including EUROCONTROL Units.

The concept of the European Aeronautical Information Service (AIS) Database (EAD) was developed by EUROCONTROL and its Member States following a study carried out in the early 1990's which revealed that the AIS operational structure suffered from several limitations and drawbacks when seen from a European perspective, including:

- incoherence of cross-border aeronautical information
- inconsistent quality of data throughout the European Civil Aviation Convention (ECAC) area
- lack of interoperability between systems due to different data models and exchange formats
- shortcomings in ensuring timely distribution of aeronautical information updates to all stakeholders.

These issues compromised the safety and efficiency of air navigation and the duplicated processes and investments of the operational structure caused high maintenance costs for all involved.

EAD came into service in June 2003 with a limited set of pilot users with plans to migrate other Data Users and Data Providers to EAD over a number of years. As part of the introduction of EAD into operational service, EUROCONTROL required the production of a Safety Case to demonstrate that the EAD can be operated in an acceptably safe manner.

EAD supports the aeronautical community by providing a variety of services to data providers and a central source of aeronautical information for data users. The EAD Safety Case provides the arguments and supporting evidence that demonstrates EAD *contributes to the achievement of an acceptable level of safety*[1] *for Aeronautical Information Service provision.* Data Users and Data Providers alike can thus refer to the evidence in the EAD Safety Case to support their own safety cases subject to compliance with the EAD service level specifications.

1.2 Purpose

The purpose of this document is to present the EAD Safety Case Guidance Material for use by EAD migrated Data Providers and connected Data Users. It provides a

[1] An acceptable level of safety is defined as; AIS related risk shall be no higher when using EAD than exists when not using EAD (non-EAD); EAD satisfies all applicable regulatory requirements and risk is reduced As Far As Reasonably Practicable (AFARP)

summary of the EAD Safety Case and is intended to aid and support migrated Data Providers and connected Data Users in understanding how to interpret the EAD Safety Case along with how the supporting safety analyses can be used in developing local safety assessments for AIS provision.

This guidance material is intended to address the following general questions EAD Users may have with regards EAD Safety Assurance.

For EAD Data Providers:

- the use and contribution of the EAD Safety Case in quantifying AIS processes in local safety assessments
- alignment of Service Level Agreements with Formal Arrangements.

For EAD Data Users:

- guidance for EAD Data Users when using EAD e.g. what they can claim, in terms of data quality and safety integrity when using EAD as a source of Aeronautical Information
- alignment of Service Level Agreements with Formal Arrangements.

1.3 Scope

The EAD Safety Case Guidance Material presents the EAD safety assessment activities up to the EAD baseline (Release 5) of the ongoing EAD IT Provider (ITP) and Data Operations (DOP) Services.

1.4 Structure

This Safety Case Report is structured as follows:

Section 1 Introduction – presents an overview of the EAD Safety Case Guidance Material itself, including background, aim, purpose and scope.

Section 2 EAD Safety – presents the operational context for EAD along with an overview of the EAD Safety Case.

Section 3 Aeronautical Information Service Provision– provides a brief overview of the main applicable regulatory documents.

Section 4 Overview of EAD – presents a brief overview of the main functions of EAD.

Section 5 EAD Safety Assurance – presents a brief summary of the safety assessment activities and documentation produced for EAD.

Section 6 EAD User Requirements – presents the EAD User requirements and how they should be used by Data Providers and Data Users.

Section 7 Understanding the EAD Safety Case Conclusions – presents the overall conclusions of the report along with an overview of how Data Users and Data Providers should interpret the EAD Safety case conclusions.

Appendix A provides an overview of the EAD Change Process.

Appendix B repeats the EAD hazard probability predictions from the EAD Safety Case [3].

Appendix C presents a list of referenced documents and abbreviations used within this report.

2. EAD SAFETY

2.1 Operational Safety Context

Many ground and air based aeronautical applications and functions rely on accurate data to describe relevant features or states of the Air Traffic Management (ATM) operational environment. For example, pilots require accurate charts to navigate the terrain, identify airways and danger areas, etc. Automated flight management systems require accurate approach/departure procedures, which need accurate data e.g. obstacle locations, types, and heights to ensure safe landing and takeoff routes are defined. A large amount of data is created and maintained to cover much of the globe. Each State is responsible for publishing all aeronautical data for their airspace, although they may not necessarily be aware of all of the applications for which the data can be used.

Errors in certain aeronautical data can affect the continued safe flight, landing or manoeuvring of aircraft and in the worse case have the potential to lead to catastrophe. End-users of aeronautical data are obligated, under the European Safety and Regulatory Requirements (ESARR), Federal Aviation Regulations (FAR) or Joint Aviation Regulations (JAR), etc. as applicable, to demonstrate that an acceptable level of safety is achieved for their service provision or application. Since Aeronautical Information Service Providers (AISP) do not know all of the potential uses of data, end users must define the properties they require of the published data but AISPs must show that these requirements are met. ICAO Annexes [1], [4], [5] and [6] and associated Standards and Recommended Practices (SARP), etc. are the primary means by which end-users define their data quality requirements.

2.2 Safety Argument

The Safety Case for EAD [3] demonstrates that the EAD *contributes to the achievement of an acceptable level of safety*[2] *for Aeronautical Information Service provision*. The evidence presented within the safety case and the safety arguments are made subject to the following constraints:

- EAD Migrated Data Providers and Data Users must use the EAD in accordance with the agreed Service Level Agreements and in particular taking note of the specific hazard probability predictions for EAD presented within the EAD Safety Case [3].

- EAD Migrated Data Providers and Data Users must not place greater reliance on the integrity of any committed data item than as defined in ICAO Annex 15 [1] or amended or otherwise notified by the State Aeronautical Information Service provider responsible for the data.

- EAD Migrated Data Providers retain responsibility in accordance with ICAO Annex 15 [1] for the completeness and correctness of data committed to EAD. In particular, migrated Data Providers must not rely on EAD to check the following:

    - accuracy of aeronautical data

    - contents of IAIP scanned to PAMS

[2] An acceptable level of safety is defined as; AIS related risk shall be no higher when using EAD than exists when not using EAD (non-EAD); EAD satisfies all applicable regulatory requirements and risk is reduced As Far As Reasonably Practicable (AFARP)

- content of AIP or Charts created using the EAD AIP and Charts support tools.

The EAD Safety Case [3] provides assurance in the form of arguments and evidence to support the claim that the EAD contributes to the achievement of an acceptable level of safety for Aeronautical Information Service (AIS) provision (**Arg 0**) as outlined in Figure 1 below.

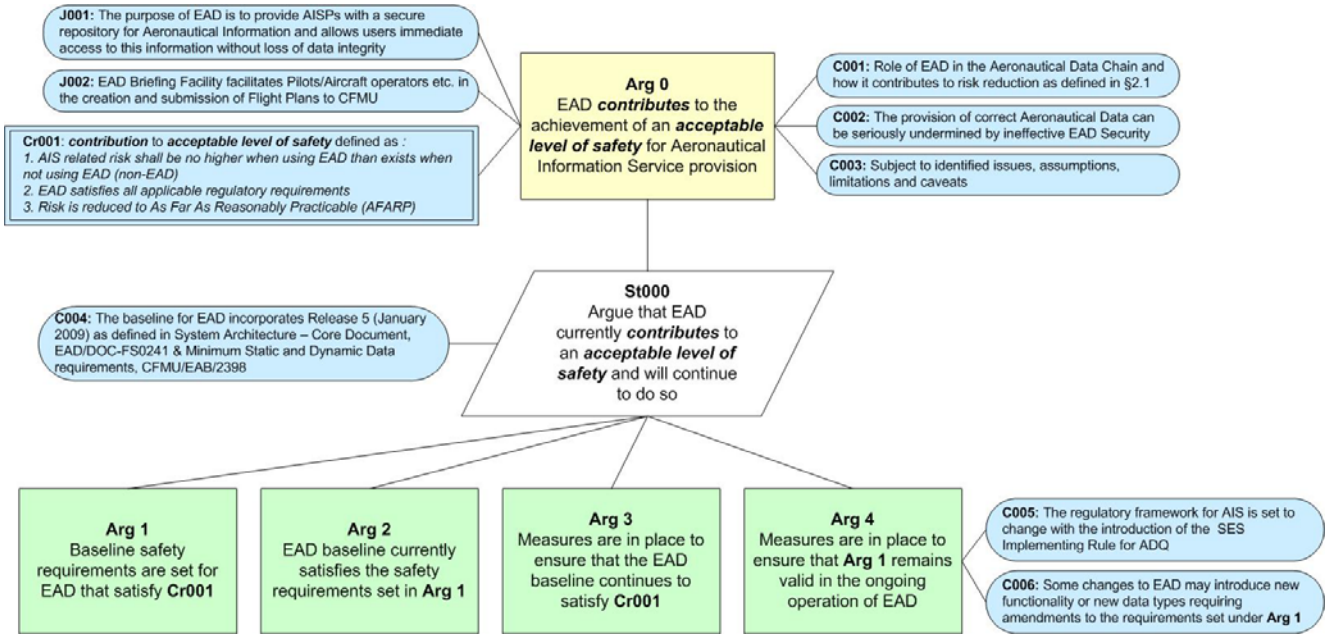

Figure 1: EAD Top Level Safety Argument

ICAO Annex 15 [1] sets out the requirements for the provision of Aeronautical Information Services by individual States. The responsibility for complying with ICAO Annex 15 rests with individual States. EAD provides a support function to AIS publication and European wide distribution. EAD can thus provide the basis for a positive contribution towards reducing the risk of errors in the published Aeronautical Data, but only as part of a coherent and robust AIS publication process. The EAD Safety Case thus provides the argument and evidence to support the claim that EAD contributes towards the provision of acceptably safe AIS (**Arg 0**). Thus the safety criteria for the EAD define an acceptable level of safety (**Cr001**) as:

- AIS related risk shall be no higher when using the EAD than exists when not using the EAD (non-EAD)
- The EAD satisfies all applicable regulatory requirements
- Risk is reduced As Far As Reasonably Practicable (AFARP).

3. AERONAUTICAL INFORMATION SERVICE PROVISION

The aim of this section is to summarise the requirements on ECAC States with regards Aeronautical Information Services (AIS) Provision along with identifying the key applicable regulation and recent European Commission and EUROCONTROL initiatives in addressing AIS related issues.

3.1 Overview

Within the European Civil Aviation Conference (ECAC) there are some 44 Contracting States each of whom, in accordance with Article 28 of the Convention on International Civil Aviation Organisation (ICAO) (Chicago Convention) and Annex 15 to this Convention, have the responsibility for providing an Aeronautical Information Service (AIS). The formal provision of these services is performed by civil and military, state owned or privatised Aeronautical Information Service Provider (AISP) organisations. Independent of the nature of these organisations, each State remains responsible for the information or data published for and on its behalf.

3.2 ICAO Annex 15

The International Civil Aviation Organisation (ICAO) Annex 15 [1] chapter one states: "*The object of the aeronautical information service is to ensure the flow of information/data necessary for the safety, regularity and efficiency of international air navigation*." The provision of Aeronautical Information of sufficient quality, integrity and timeliness is recognised as a key enabler for present and future ATM systems, particularly in support of the Single European Sky ATM Research Programme (SESAR).

The safety related quality properties of data required by users, including accuracy, resolution, data integrity level etc. for data items are defined in ICAO Annex 15 [1] , collectively known as the Data Quality Requirements (DQRs). The data integrity levels define numerical targets for the assurance that data is not corrupted during the data preparation, publication and distribution of aeronautical information.

ICAO Annex 15 [1] also lays down the Specification and Recommended Practices (SARPs) for the provision of AIS by a State, including the need for provision of the Integrated Aeronautical Information Package (IAIP) and pre-flight briefing.

3.3 General Issues

3.3.1 Context for the EAD

The EAD can only assure the integrity of aeronautical information/data once it is committed to the database; it remains the responsibility of Data Providers to assure the integrity of data entered into the EAD. The EAD provides a support function to Data Providers and Data Users; whilst the EAD can detect certain types of errors in entered data other errors that the EAD is not able to detect will remain (e.g. accuracy errors). Note that whilst the EAD Data Quality Reviews may pick up errors that the EAD cannot automatically detect they are only sample reviews and therefore cannot be relied upon to detect all potential erors.

The general quality of Aeronautical Data has been the subject of extensive study and safety assessment as part of the EUROCONTROL CHAIN programme [7] and the Aeronautical Data Quality (ADQ) initiative as part of the European Commission Interoperability Mandates [2]; these initiatives are summarised below.

3.3.2 EUROCONTROL Data Chain Study

A number of EUROCONTROL studies e.g. [7] have concluded that aeronautical information does not currently achieve the integrity levels required to meet specific applications such as Area Navigation (RNAV); the integrity of aeronautical information is considered to be one of the cornerstones of the implementation of RNAV in terminal airspace and for final approach. Moreover, surveys of States to obtain a detailed understanding of the processes involved from data origination to publication have shown that a variety of data processes and procedures are currently used. This lack of harmonisation has created a wide gulf between States in terms of simple regulation of the process and the level of Data Integrity achieved.

Other studies [12] based on extensive data comparisons between various sources of aeronautical information provide clear evidence to question both the accuracy and integrity of published aeronautical information. In the worst cases, the data integrity requirements are not only failing to be met but it can be demonstrated that some data does not even achieve the $1x10^{-3}$ error rate needed for *routine* data. One key weakness identified is in the provision of flight critical data mainly through manual processes (processing and transfer).

The above research provides strong evidence to suggest that current regulatory requirements are not being fully complied with by States. This is particularly true of, but not limited to, the ICAO Annex 15 standards and recommended procedures (SARPs). Furthermore, it was assessed that a major reason for the loss of data integrity was the way in which aeronautical information was originated, transmitted, processed and delivered from the point of origination to application in an end-user system. The processing of aeronautical information remains a mainly paper-based, manual activity and there is a significant opportunity for the introduction of errors and the degradation of data quality through manual interaction.

The introduction of the Aeronautical Data Quality (ADQ) Implementing Rule will ensure compliance with the data quality requirements of ICAO Annex 15. It is anticipated that an improvement in the quality of data will be achieved and proven to be achieved (observed). Consequently, safety cases for new navigation techniques that rely more heavily on accurate data with *critical* integrity will be able to be supported in the future.

3.4 Aeronautical Data Quality Implementing Rule (ADQ IR)

The Aeronautical Data Quality Implementing Rule [2] was developed under the Interoperability Regulation with the intent of improving and standardising the quality of aeronautical data made available within Europe. A mandate issued to EUROCONTROL in 2005, resulted in Commission Regulation (EU) No 73/2010 (ADQ) of 26 January 2010, laying down requirements on the quality of aeronautical data and aeronautical information for the single European sky. The IR is to be supported by relevant Community Specifications (CS) and appropriate guidance material.
The IR introduces provisions to assure data quality and interoperability to meet ICAO and SES requirements. Significantly, the IR extends the scope of the data quality and interoperability requirements to encompass the data originators (i.e. surveyors, procedure designers, aerodromes, heliports and electronic terrain data providers) to ensure that quality is captured at the point of origination. The IR applicability extends only to the publication by the Aeronautical Information Service (AIS) to the next intended user; however, it is recognised that to achieve end-to-end data quality, the activities downstream of AIS should also be addressed in the frame of ADQ-2. ADQ-2 will be developed, in response to the European Commission's mandate for the development of a draft implementing rule on aeronautical data and

aeronautical information quality addressed to the post-publication phase (ADQ-2). This will complement Commission Regulation (EU) No 73/2010 of 26 January 2010.

The IR addresses aeronautical data and information within the Integrated Aeronautical Information Package (IAIP), airport mapping data, electronic obstacle data and electronic terrain data. Aeronautical Information Circulars are excluded from the IAIP as they are purely informative.

In particular, the IR addresses:

- the need to achieve interoperability by the implementation of a common dataset throughout the data chain, and of digital data exchange performance requirements. At the ANSP level, a common format is required, the means of compliance for which already exists in the form of the Aeronautical Information Exchange Model (AIXM). For non-ANSP data originators, higher level exchange format requirements are provided. Interoperability cannot be achieved within this context without the use of a common set of definitions, items and values. The addition of metadata is also needed to ensure that source, performance and traceability of data items can be assured.

- the need for data quality requirements to be properly defined by the users such that the data providers are able to provide data of sufficient quality. This relies on the ICAO baseline, which can be complemented by States where ICAO does not define requirements or these requirements are insufficient. To avoid a series of non-harmonised data quality requirements being published within Europe, the development of a specification, developed in full consultation with Stakeholders, would be required.

- the need for data assurance level definitions to be provided so that data providers can demonstrate achievement of the data quality requirements. This will involve the implementation of processes within the overall quality management system, to implement formal arrangements between the parties, error feedback and rectification mechanisms, timeliness performance requirements, software and tool validation processes, process automation specifications, and training, qualification and competence requirements.
- the need for specific technical requirements to be placed on data originators to ensure that data quality is achieved and captured at the start of the process. Recovering data integrity once it is lost is almost impossible after this point in the process.
- the need to protect data from unauthorised interference and to guarantee that it has come from an authorised source in the first place.
- the need for all parties within the data chain to have suitable Quality Management Systems (QMS) that cover data provision activities and that include the requirements of the draft IR as well as other applicable requirements, standards and procedures.
- the need for a minimum level of safety and security management to be exercised throughout the data chain, in organisations large and small. These requirements are addressed by some of the provisions of the draft IR but a minimum number of objectives are included to ensure that QMS include the necessary procedures.

The implementation of the IR follows two basic phases as follows:

- for the provisions concerned with achievement of data quality requirements and that are not directly associated with meeting the common dataset and digital exchange format provisions, 30 June 2017.

- for the provisions that concern the implementation of the common dataset and digital exchange format (without digital NOTAM), 30 June 2014.

3.5 Safety and Security

All Air Navigation Service Providers (ANSPs) including Aeronautical Information Services within any State under the Single European Sky (SES) framework must meet SES requirements in order to achieve certification. Commission Regulation (EC) No 2096/2005 [13] identifies common requirements for the provision of Air Navigation Services. This gives details on the security requirements for all Air Navigation Service Providers. These security requirements cover security management systems and the security of personnel, facilities and data.

The EAD Safety Case [3] provides the evidence for the demonstration that adequate and procedural preventative measures are in place in accordance with the SES Regulation outlined above.

The safety of the EAD relies on adequate security arrangements being in place for EAD including the prevention of accidental or deliberate changes to the EAD data primarily through unauthorised access. Note that only one security specific issue was identified as part of the EAD safety assessment with respect to the confidentiality of legal reporting. This is not assessed further as it does not directly impact the ability of the EAD to provide aeronautical information.

4. OVERVIEW OF EAD

4.1 Operational Context

The prime beneficiaries of the EAD are ANSP organisations and the airspace user community. The EAD can also be used by airlines that are based outside the ECAC area and by commercial organisations that use the aeronautical information to provide value added services and products. Migration to EAD introduces automation and centralisation in the provision, storage, processing and distribution of aeronautical information for ANSPs and access to electronic data for data users. An overview of the prime functions of the Data Chain including the EAD is provided in Figure 1 below.

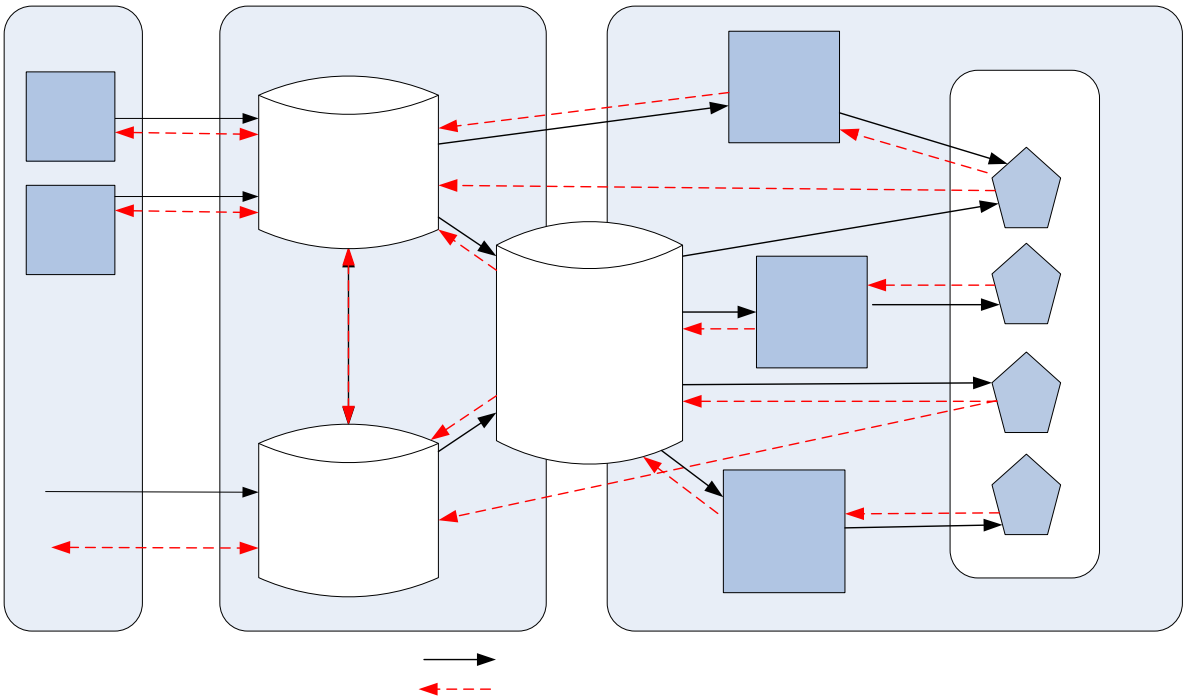

Figure 2: Overview of the Data Chain with EAD

4.2 EAD Functionality

4.2.1 EAD IT Services

The EAD is intended to support the data publication and distribution component of the Aeronautical Data Chain. It also provides functionality to compile, handle and submit flight plans (FPL) to CFMU and makes available the Route Availability Document and the Electronic Route Availability Document (eRAD) on behalf of CFMU. Fundamentally, the EAD provides the following basic functions to Data Providers and Data Users:

- supporting Migrated Data Providers with the creation of static and dynamic aeronautical data publications, including:
  - provision of data preparation tools such as Chart and AIP production
  - validation of static data against pre-defined rules or dynamic data against static data

Data Origination

Data F

- data entry for Non-migrated Data Providers (which is also subject to validation)
- storing and distributing static and dynamic aeronautical data
- providing facilities for Flight Plan construction, initial validation and submission to CFMU Initial Flight Planning System (IFPS)
- making available to CFMU customers the Route Availability Document (RAD) and Electronic Route Availability Document (eRAD)

EAD provides this functionality through a number of services as illustrated in Figure 3 below.

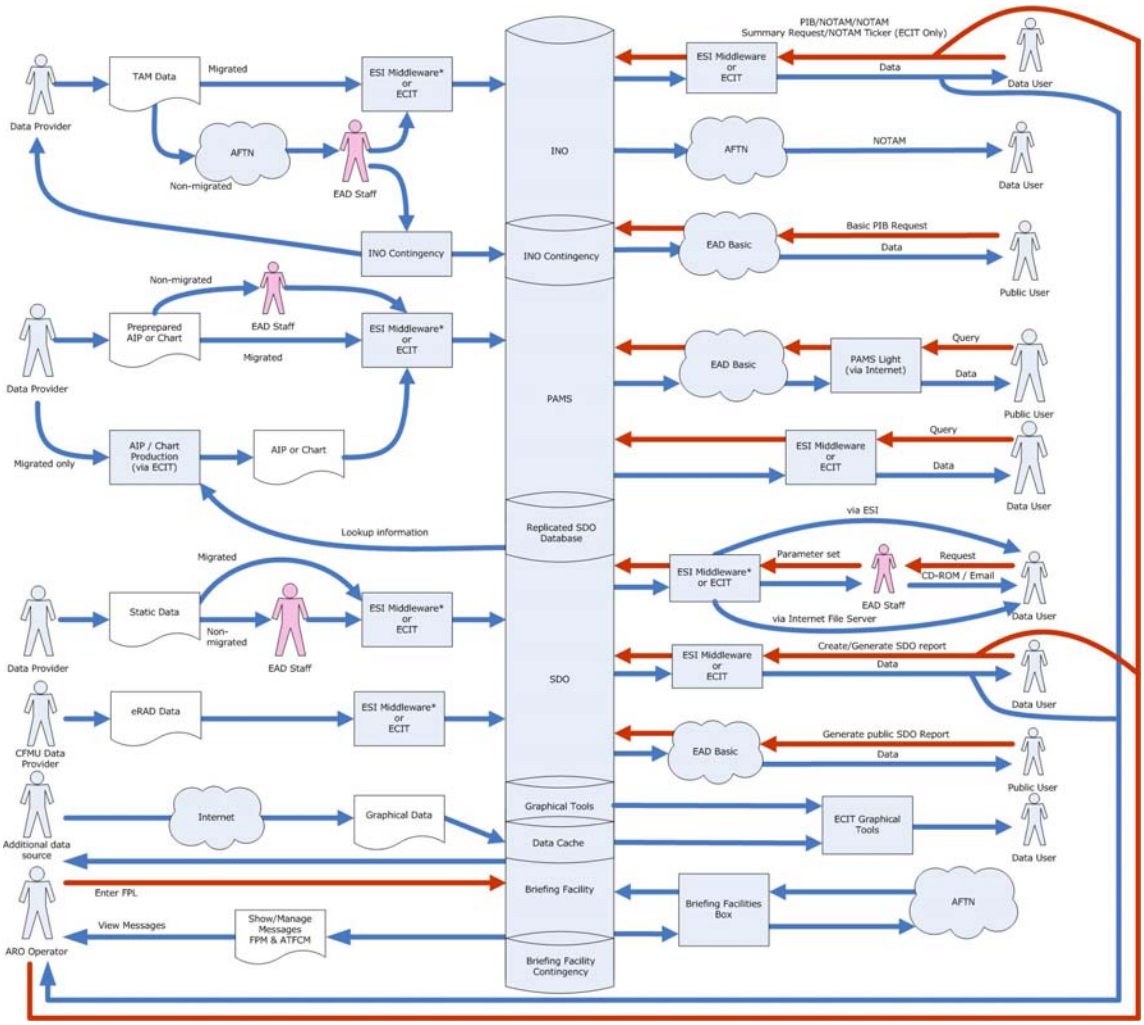

Figure 3: High Level logical model for EAD

The logical elements represented are described in the EAD Safety Case [3] and include:

- **Static Data Operations (SDO)** – provides facilities for the input and checking of static aeronautical data required for the safe and timely execution of flight operations, for the efficient operation of the INO, and for additional data that is of common interest to EAD Clients.

- **International NOTAM Operation (INO)** – provides facilities for processing, checking and creating international NOTAM and other relevant message data to be handled by the EAD. The INO data is checked against the SDO data and all other INO data in order to ensure coherence and prevent double publications.

- **Published AIP Management System (PAMS)** – responsible for storing the published documents, viewing services through read only access and printing the documents. This includes maps and charts that are part of any of the above types of documents. The PAMS can also manage single charts in PDF format. The PAMS subsystem uses the flash-DMS COTS product.

- **Aeronautical Information Publications (AIP)** – a Data Provider support tool responsible for the production, maintenance and storage of the AIPs, AIP Amendments, AIP Supplements and AICs. The (e)AIP subsystem is based on the FrameMaker/FrameAPS COTS product.

- **Chart Production (CHART)** – used to generate and maintain aeronautical charts from the SDO database. Charting parameters like chart specifications, graticule definitions, ellipsoid definitions and symbolisation can be used and maintained. Chart Production also offers specific charting functionality, such as geographical calculations and map projections. The Chart Production subsystem is based on the MicroStation/SmartGlobe COTS product.

- Message Handling System and other support functions.

4.2.2 EAD Data Operations

The EAD provides the following Data Operations services:

- **EAD Aeronautical Data Entry** –undertakes aeronautical data entry on behalf of non-migrated clients; this includes the minimum static data set, NOTAM processing and scanning/input of AIP documentation into PAMS.

- **EAD Training** – provides essential training on all EAD functions, although there is no obligation on users to use the training.

4.2.3 Support Functions

The following support functions are also provided:

- **Surveillance** – provides Advanced Helpdesk, Network Management and System Management services and is based on the COTS product Jira. The product includes functionality that covers the requirements for System Management, Network Management, and Service Desk.

- **Security** – security management is based on COTS products. The security management provides facilities to secure EAD.

5. EAD SAFETY ASSURANCE

5.1 Overview

The safety assessment approach for the EAD is based on the EUROCONTROL Safety Assessment Methodology (SAM) [9] and is consistent with the general (qualitative) requirements of ESARR 4 [10]. Specifically, the approach used considers the EAD as an ongoing operation and thus follows a Unit Safety Case template from the EUROCONTROL Safety Case Development Manual [11].

The approach considers separately the safety of the EAD baseline plus any changes made. The EAD baseline today is represented in the current set of safety documentation, which is maintained to ensure the continued satisfaction of existing safety requirements and is updated at each new release of the EAD. The EAD has an ongoing change management plan which assesses any temporary or permanent modification to or addition of any, respectively, existing or new element of the EAD.

5.2 EAD Safety Assurance Documentation

Figure 4 below provides a diagrammatic representation of the EAD safety assurance documentation including identification of the key inputs and outputs to/from each.

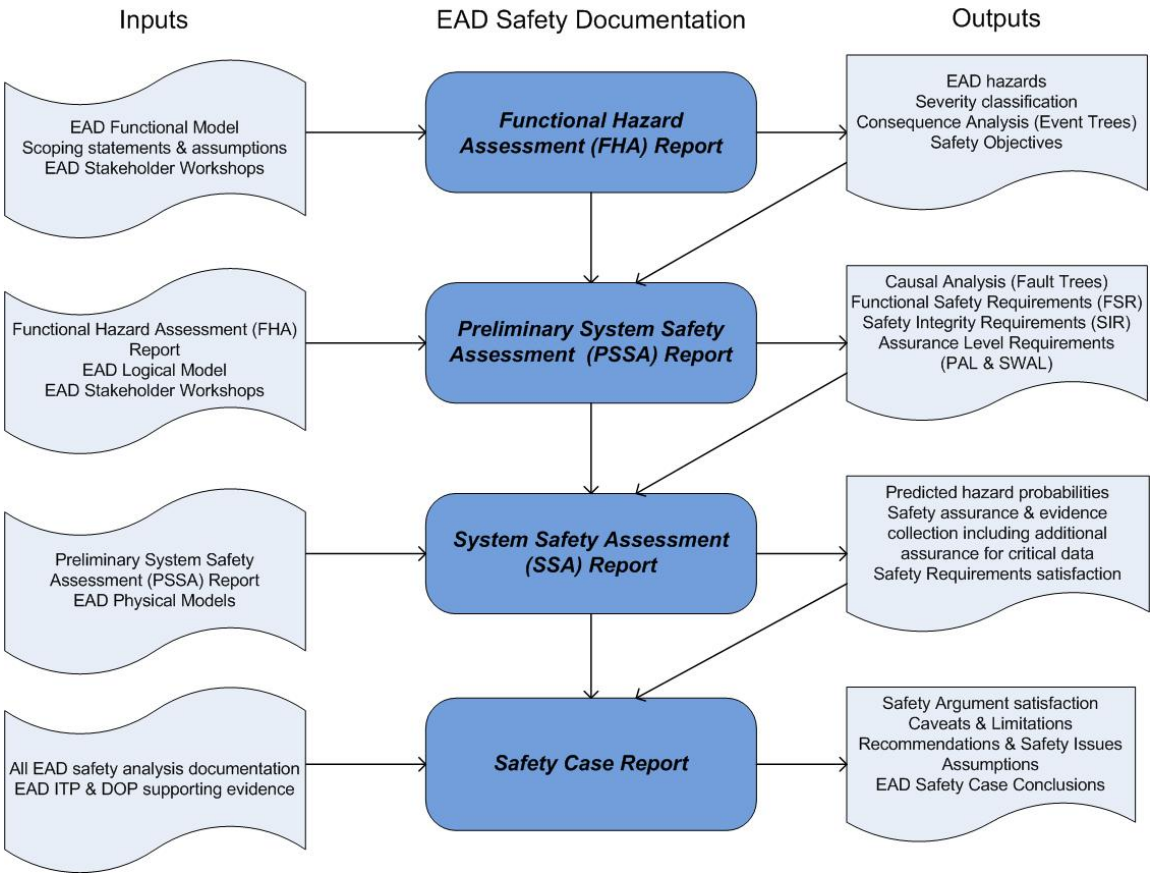

Figure 4: Key EAD Safety Documentation

5.2.1 Functional Hazard Assessment (FHA)

The EAD Functional Hazard Assessment (FHA) Report [16] provides an independent assessment of the hazards and potential consequences of those

hazards in relation to the EAD in support of the overall EAD Safety Case. The FHA Report identifies the scope and boundary of the EAD safety assessment as:

> "*EAD provides a support function to Aeronautical Data Providers and a centralised storage and distribution function to Aeronautical Data Users. EAD supports Data Providers in fulfilling their obligations under ICAO Annex 15 [1] for the publication and distribution of AIP, Charts, AIP Supplements, NOTAM, etc. It provides a basic World Wide Data Maintenance function to support the processing of NOTAM from non-migrated Data Providers. EAD also provides the functionality to compile, handle, validate and submit flight plans (FPL) to CFMU via the Briefing Facility. It also, as part of Release 5, makes available the Electronic Route Availability Document (eRAD) on behalf of CFMU*."

The FHA activity identified six hazards that fall within the defined scope of the EAD. The hazards were identified at the boundary of the EAD and reflect the EAD functional failure scenarios and generic data property anomalies that have the potential to lead to the causes of Air Traffic Service provision hazards.

For the EAD to contribute towards the provision of an acceptable level of safety in the provision of AIS, the risks associated with the identified hazards must be reduced to an acceptable level. As such the risks for with-EAD should be no worse than for the non-EAD situation and nonetheless compliant with relevant regulation and further reduced as far as reasonably practicable. In order to assure this the following risk objectives are set for each of the EAD hazards.

Hazard	Description	Risk Objectives
HAZ001	Distributed Integrated Aeronautical Information Package (IAIP) contains valid but corrupt aeronautical data.	Based on the data integrity requirements of ICAO Annex 15 for critical data, AIS must assure[3] that data is not plausibly corrupted more often than 10^{-8} Given that EAD is one of several links in the Data Chain then it is necessary to apportion EAD a more stringent target of 10^{-9} to ensure it does not undermine the integrity of the data chain as a whole.
HAZ002	Distributed IAIP is missing specific change(s) in Aeronautical Information.	As above.
HAZ003	Total or substantial loss of Aeronautical Information.	For static data then a loss of AIPs for more than 24 hours would result in a Severity 4 scenario in accordance with the ESARR 4 Severity Classification Scheme and as such is set a safety objective of 5 x 10^{-6} based on a TLS (Target Level of Safety) for Severity 4 events of 10^{-3} apportioned to 200 hazards[4]. For dynamic data, a loss of NOTAMS for more than 1 hour could result in a Severity 2 scenario (worse case) which for an individual ANSP should not occur more often than 5 x 10^{-8} per flight hour. This is based on an apportioned TLS for Severity 2 events of 10^{-6} between 20 hazards.

[3] Note that the requirement in ICAO Annex 15 has no units so it has been assumed that the target should be interpreted per flight hour for the purposes of apportionment.

[4] It is necessarily the responsibility of ANSPs to determine the safety objectives for this hazard. However, these indicative targets are based on TLS (Target Level of Safety) apportionment for EUROCONTROL Upper Airspace Control Centre at Maastricht and are used in the absence of any specific user requirements.

Hazard	Description	Risk Objectives
HAZ004	Discrepancy between adjacent State boundary aeronautical data.	No Safety Objectives are set for these hazards as an acceptable level of safety is judged using a relative safety criteria i.e. the risk must be no greater than exists in the non-EAD situation but nonetheless reduced as far as reasonably practicable.
HAZ005	Inconsistent Aeronautical Information between actors of Downstream Data Chain.	
HAZ006	Discrepancy between FPL held by pilot and FPL held by other parties.	

Table 1: EAD Hazards and Risk Objectives

5.2.2 Preliminary System Safety Assessment (PSSA)

The EAD Preliminary System Safety Assessment (PSSA) [14] Report documents the derivation of EAD safety requirements that need to be addressed by the EAD and by the users of the EAD (in relation to the use of the EAD). These requirements include:

- Internal Safety and Security Requirements that are to be satisfied by the EAD (**IFSR**).
- External Safety and Security Requirements (**EFSR**) that should be complied with by EAD Users, commensurate with the agreed Service Level Agreements.

The distinction between internal and external requirements is based on determination of the extent of EAD managerial control, i.e. all requirements are internal unless satisfaction of the requirement is the responsibility of external actors, e.g. Data Providers and Data Users.

The PSSA Report [14] identified 70 Internal Safety Requirements (IFSRs), 23 External Safety Requirements (EFSRs) and 4 Assurance Level Requirements (ALRs).

5.2.3 System Safety Assessment (SSA)

The EAD System Safety Assessment (SSA) Report [15] provides an independent assessment in support of the overall safety case that shows that the EAD satisfies its safety objectives and safety requirements as specified in the EAD FHA Report [16] and EAD PSSA Report [14] and consequently contributes to the achievement of an acceptable level of safety for Aeronautical Information Service.

The EAD SSA Report demonstrates that the EAD satisfies its internal safety and security requirements (**IFSR**) and addressed Critical data (as defined in ICAO Annex 15 [1]) and associated numerical targets. The SSA Report presents safety issues, constraints and recommendations associated with the operation of the EAD, see section 7.2.

5.2.4 EAD Safety Case

The EAD Safety Case Report [3] presents the detailed safety arguments and supporting evidence to show how the EAD contributes to the reduction of risks to safety posed by the publication and distribution of aeronautical information. Its shows that risks are identified, mitigated and managed with respect to the increasing utilisation and ongoing operation of the EAD.

The EAD Safety Case Report [3] concludes that overall, the EAD provides for a potential reduction in the overall risk to safety posed by failures in the aeronautical Data Chain. The EAD Safety Case shows that the EAD can reduce the likelihood of hazards related to aeronautical data publication preparation and distribution through:

- For migrated Data Providers:
    - improved data validation and reinforcement of Data Provider verification.
- For Data users:
    - centralised checking and distribution of AIPs, NOTAMs and other publications.
    - reduced likelihood of discrepancies between publications.
- In the longer term:
    - potential reduction in the amount of redundant manual and electronic transfer.
    - improvements to data error reporting.
    - reduced likelihood in discrepancies between Data users.

5.3 EAD Change Management

The change management process for the EAD is defined in the Change Management Plan [21]. This implicitly covers changes that require a period of transitional operation, with explicit reference to the consideration of safety. Each change is assessed via a Preliminary Safety and Security Assessment for System Changes (preSSA) which identifies which components within the EAD need to be changed along with the identification of all dependant components. The assessment considers the criticality of the function changed, whether the change can be tested whether the change affects user operations and the safety impact of the change including if any EAD safety documentation updates are required. A diagrammatic representation of the EAD Change Process is provided in Appendix A.

All changes to the EAD must be approved by the Change Control Board (CCB) before initialisation and implementation of the change for operational use. An assessment verification report is compiled for each new release of the EAD, documenting any changes that have been implemented since the previous release. This report demonstrates that the EAD remains compliant with the safety requirements after implementation of the changes.

6. EAD USER REQUIREMENTS

As outlined in section 5.2.2, the EAD safety assessment activities have derived a series of safety requirements; internal safety and security requirements (IFSR) which have been demonstrated as being met within the EAD Safety Case [3] and external safety and security requirements (EFSR) which must be satisfied by Data Users and Data Providers as applicable. EFSR satisfaction is normally verified during (and is a precondition of) the migration process, but EAD Users should also demonstrate compliance as part of their own safety case activities.

The following sections outline the requirements on each EAD migrated provider or user in terms of safety that should be demonstrated as being satisfied within their local safety assessments. It also outlines any caveats and limitations on the use of the EAD that need to be observed and understood to ensure the ongoing safety of AIS provision.

6.1 EAD Data Users

Data Users cannot connect to the EAD without completion of all the relevant steps (including safety and security) to the satisfaction of EAD Data Operations and EUROCONTROL Oversight Management. The connection process assesses each new EAD User and derives an individual migration plan.

Data Users must also sign a Data User Agreement [17], which governs the way EAD should be used, maintained or relied on including a definition of the responsibilities of each party.

EFSR Reference	EAD Data User Safety Requirement	Traceability to Data User Agreement
EFSR-15	Data Users shall ensure that the Client Hardware systems do not corrupt or remove items of aeronautical meta data or associated meta data during input/processing	**No explicit trace within the Data User Agreement [17]**
EFSR-17	Data Users shall make contingency arrangements for temporary access to static and dynamic data in the event that such data is not available via EAD	Data User Agreement [17], Attachment A, para 1.1.2 For example Data Users could keep their own database copy of Aeronautical Information or a paper archive
EFSR-19	Data Users should maintain procedures for non-EAD levels of checking aeronautical data with EAD	Data User Agreement [17], Attachment A For example although EAD can provide data with the appropriate integrity this is dependent on the Data Provider. Data Users should not alter their data related procedures (such as FMS data production) from those used prior to EAD
EFSR-20	Data Users should not place greater reliance on the data provided by EAD than the hazard probabilities as specified in Table 4 of the EAD Safety Case	Data User Agreement [17], Attachment A, para 1.2.1 Discussed further in Section 7 below
EFSR-21	Data Users should use EAD in accordance with any procedures defined within the Service Level Agreement	Data User Agreement [17]All Migrated Data Users are required to sign a Client Agreement to ensure they accept and understand the terms of the agreement
EFSR-22	Data Users shall verify data items against associated CRCs where provided	**No explicit trace within the Data User Agreement [17]**

Table 2: EAD Data User External Functional Safety Requirements

6.2 EAD Data Providers

Data Providers cannot migrate to EAD operational status without completion of all the relevant migration steps (including safety and security) to the satisfaction of EAD Data Operations and EUROCONTROL Oversight Management. The migration process assesses each new EAD Provider and derives an individual migration plan.

Data Providers must sign a Data Provider Agreement [18], which governs the way EAD should be used, maintained or relied on and defines the responsibilities of each party.

EFSR Reference	EAD Data Provider Safety Requirement Text	Traceability to Data Provider Agreement
EFSR-01	Data Providers shall ensure that aeronautical data or associated meta data entered into SDO is complete and correct	Data Provider Agreement [18], Article 4, paras 4.3, 4.6 & Attachment A, para 2.1.2
EFSR-02	Data Providers shall ensure that aeronautical data or associated meta data entered into INO is complete and correct	Data Provider Agreement [18], Article 4, paras 4.3, 4.6 & Attachment A, para 2.1.3
EFSR-03	Data Providers shall ensure that aeronautical data or associated meta data entered into PAMS is complete and correct	Data Provider Agreement [18], Article 4, paras 4.3, 4.6 & Attachment A, para 2.1.4
EFSR-04	Data Providers shall provide independent checking of data committed to EAD	Data Provider Agreement [18], Attachment A, para 2.3.1
EFSR-05	Data Providers shall ensure the completeness and correctness of aeronautical data entered into EAD	Data Provider Agreement [18], Article 4, paras 4.3 & 4.6
EFSR-06	Migrated Data Providers shall update dynamic aeronautical data in accordance with the timescales set out within the Service Level Agreements	Data Provider Agreement [18], Article 4, paras 4.3 & 4.6
EFSR-07	Data Providers shall only allow suitable trained operators to update aeronautical data stored by EAD	Data Provider Agreement [18], Article 4, para 4.8
EFSR-08	Data Providers shall only allow authorised operators to update aeronautical data stored by EAD	Data Provider Agreement [18], Article 4, paras 4.3, 4.8 & 18.2
EFSR-09	Data Providers shall check SDO data in full the first time the database is populated following successful migration to EAD Operation	Data Provider Agreement [18], Article 4, para 4.3
EFSR-10	Data Providers shall resolve any potential errors in their data identified by EAD in so far as is practicable	Data Provider Agreement [18], Article 4, para 4.5
EFSR-11	Data Providers shall verify the consistency of SDO, INO and PAMS data and notify EAD of any known unresolved deficiencies	Data Provider Agreement [18], Article 4, para 4.5
EFSR-12	Data Providers shall ensure that any effective dates associated with aeronautical data are entered correctly	Data Provider Agreement [18], Article 4, paras 4.3, 4.6 & Attachment A, para 2.1.3
EFSR-13	Migrated Data Providers shall update static aeronautical data in accordance with the timescales set out within the Service Level Agreements	Data Provider Agreement [18], Article 4, paras 4.3, 4.6 & Attachment A, para 2.1.2
EFSR-14	Data Providers shall ensure that aeronautical data or associated meta data entered into or used from EAD into AIP is complete and correct	Data Provider Agreement [18], Article 4, paras 4.3, 4.6 & Attachment A, para 2.1.4
EFSR-15	Data Providers shall ensure that the Client Hardware systems do not corrupt or remove items of aeronautical meta data or associated meta data during input/processing	**No explicit trace within the Data Provider Agreement [18]**
EFSR-16	Data Providers shall ensure that aeronautical data or associated meta data entered into Charts is complete and correct	Data Provider Agreement [18], Article 4, paras 4.3, 4.6 & Attachment A, para 2.1.4

EFSR Reference	EAD Data Provider Safety Requirement Text	Traceability to Data Provider Agreement
EFSR-18	Migrated Data Providers shall keep aeronautical data stored in EAD up to date	Data Provider Agreement [18], Attachment A, para 2.1.5
EFSR-20	Data Providers should not place greater reliance on the data provided by EAD than the hazard probabilities as specified in Table 4 of the EAD Safety Case	Data Provider Agreement [18], Attachment A, para 2.2.1 Discussed further in Section 7 below
EFSR-21	Data Providers should use EAD in accordance with any procedures defined within the Service Level Agreement	Data Provider Agreement [18] All Migrated Data Providers are required to sign a Client Agreement to ensure they accept and understand the terms of the agreement
EFSR-23	Data Providers shall enter CRCs for all survey data items where and as provided by the data originator	**No explicit trace within the Data Provider Agreement [18]**

Table 3: EAD Data Provider External Functional Safety Requirements

7. UNDERSTANDING THE EAD SAFETY CASE CONCLUSIONS

7.1 Summary

The EAD Safety Case [3] demonstrates that EAD is acceptable safe subject to a number of different types of caveat as follows:

- Safety Issues – identified concerns or problems that impact the fundamental arguments for safety of EAD; Safety Issues require resolution as soon as possible.
- Operational Limitations and Constraints – are restrictions on the use of the EAD that need to be taken into account by Data Users and Data Providers.
- Assumptions – statements that have been assumed to be true in the construction of the EAD safety arguments and support analyses.
- Recommendations – suggestions or proposals for additional work required to strengthen the case for safety.

The following sub-sections provide an overview of each of the caveats above contained within the EAD Safety Case [3], the following sections also outline the implications for EAD Data Providers and Data Users.

7.1.1 Safety Issues

The EAD Safety Case [3] identifies two specific safety issues as outlined and discussed further below:

SI001 *The ADQ Mandate and supporting Community Specifications will define assurance objectives for demonstrating data integrity for AIS. Until such time as the Community Specifications are made available it is difficult to assure that independent Data Provider checking can achieve the level of integrity required i.e. 1 x 10^{-6}*

As discussed in Section 3.4 until such time as the ADQ IR and associated Community Specifications are available, external safety requirements on migrated Data Provider checking cannot be defined. This safety issue is being closely monitored and reviewed in-line with the ADQ work being carried out by the EUROCONTROL Safety Regulatory Unit (SRU).

SI002 *Given the previously assessed threat level security arrangements for EAD are considered adequate for Critical data; however, urgent action is required to complete the security assessment including a review of the security controls in place at the EAD offshore contingency site in Canada. This issue must be resolved within the next 6 months to avoid becoming a safety concern*

This safety issue needs to be addressed by EUROCONTROL EAB prior to the next release of EAD Safety Case.

7.1.2 Operational Limitations & Constraints

The following limitations have been identified as applicable to both Data Providers and Data Users. Each of the limitations needs to be considered when integrating the EAD into local AIS provision/use.

L001 *The loss of NOTAM data should be detected by sequence number checks, but for loss of PAMS no additional assurance for Critical data is provided*

Data Users should continue to check NOTAM sequence numbers to ensure that NOTAMS are not missed. An equivalent system is not provided for PAMS data, so Data Users should check to make sure they are using the latest information.

L002 *Until training needs for the Data Quality Reviews of SDO approach and departure procedures has been finalised and all EAD DOP staff have received the appropriate training; Data Quality Reviews of SDO data shall only be performed by suitably qualified and competent personnel*

This limitation has been placed on the EAD Data Operations (DOP) and requires no action by EAD Data Providers or Users.

L003 *Aeronautical Data delivered via EAD Basic over the internet is not guaranteed to satisfy the associated integrity required by ICAO Annex 15*

EAD Data Providers and Users should not rely on aeronautical data made available via the public EAD internet portal as it is not guaranteed to satisfy the associated integrity required by ICAO Annex 15 [1].

L004 *ARINC data available via the EAD is only assured to Essential*

EAD Data Users should check the correctness of critical data items within ARINC data available via EAD specifically items as identified in ICAO Annex 15 [1] before use in critical data applications.

In addition to the limitations stated above, the EAD Safety Case [3] also identifies the following specific constraints on the use of EAD.

Data Users must:

- use the EAD in accordance with the agreed Service Level Agreements (see **EFSR-21**) taking particular note of the specific caveats presented in Appendix B
- not place greater reliance on the integrity of any committed data item than as defined in ICAO Annex 15 [1] or amended or otherwise notified by the State Aeronautical Information Service provider responsible for the data (see **EFSR-20**)

Data Providers must:

- use the EAD in accordance with the agreed Service Level Agreements (see **EFSR-06** & **EFSR-13**) taking particular note of the specific caveats presented in Appendix B
- **not** place greater reliance on the integrity of any committed data item than as defined in ICAO Annex 15 [1] or amended or otherwise notified by the State Aeronautical Information Service provider responsible for the data (see **EFSR-20**).
- retain responsibility in accordance with ICAO Annex 15 [1] for the completeness and correctness of data committed to EAD. In particular, migrated Data Providers must not rely on EAD to check the following:

- o accuracy of aeronautical data
- o contents of AIP scanned to PAMS
- o content of AIP or Charts created using the EAD AIP and Charts support tools.

7.1.3 Assumptions

Assumptions made during the construction of the EAD safety arguments and completion of the safety analyses need to be validated by each migrated Data Provider and Data User of the EAD.

Table 4 below lists the EAD Safety Case assumptions those which require validation by Data Providers and Data Users are highlighted below.

Ref	Assumption	Validation
A001	Flight plan filing organisations using the EAD Briefing Facilities comply with the IFP European Commission Mandate in accordance with the associated Community Specification or suitable alternative	The IFPL Implementing Rule [23] was adopted on 04 July 2006 compliance against which is assessed as part of Data User migration to the EAD Briefing Facility
A002	CFMU IFPS will send amendments to FPL originators when changes to the conditions of a FPL are required	This assumption is a requirement of the IFPL Implementing Rule [23] and the responsibility of EUROCONTROL CFMU. Validation of this assumption is documented within the EAD Safety Case
A003	Data Providers and Data Users are responsible for assuring their overall processes in which EAD is used achieve an acceptable level of safety	EAD Users are responsible for developing and documenting local safety assessments/cases in support of overall AIS processes in accordance with the requirements of the EUROCONTROL Safety Assessment Methodology (SAM) [9] and ESARR 4 [10].
A004	Data Providers and Data Users comply with identified EAD external safety requirements	EAD Users must demonstrate compliance with the External Functional Safety Requirements (EFSRs) Satisfaction of **EFSR-13** by Migrated Data Providers and of **EFSR-21** by Data Users
A005	The potential end consequences for aeronautical data errors are the same in the ***non-EAD*** and ***with-EAD*** scenarios.	Assumption validated via the EAD FHA and PSSA Workshops (see Functional Hazard Assessment [16] and Preliminary System Safety Assessment [14] reports)

Ref	Assumption	Validation
A006	The worst case consequence for data error would be **2. Large reduction in safety margins** which is commensurate with the following definition of critical data given in ICAO Annex 15 [1]: *The [critical] data, if erroneous, would prevent continued safe flight and landing or would reduce the ability to cope with adverse operating conditions to the extent that there is a large reduction in safety margins or functional capabilities. There is a high probability when trying to use corrupted critical data that an aircraft would be placed in a life threatening situation.*	Based on the domain specification for AIS, ICAO Annex 15.

Table 4: Assumptions

7.1.4 Recommendations

The EAD Safety Case [3] contains a series of recommendations all of which require resolution by EUROCONTROL via the EAD infrastructure. The aim of the recommendations is to ensure a complete and correct set of referable evidence is available to support the ongoing safety and security of EAD.

APPENDIX A EAD CHANGE PROCESS

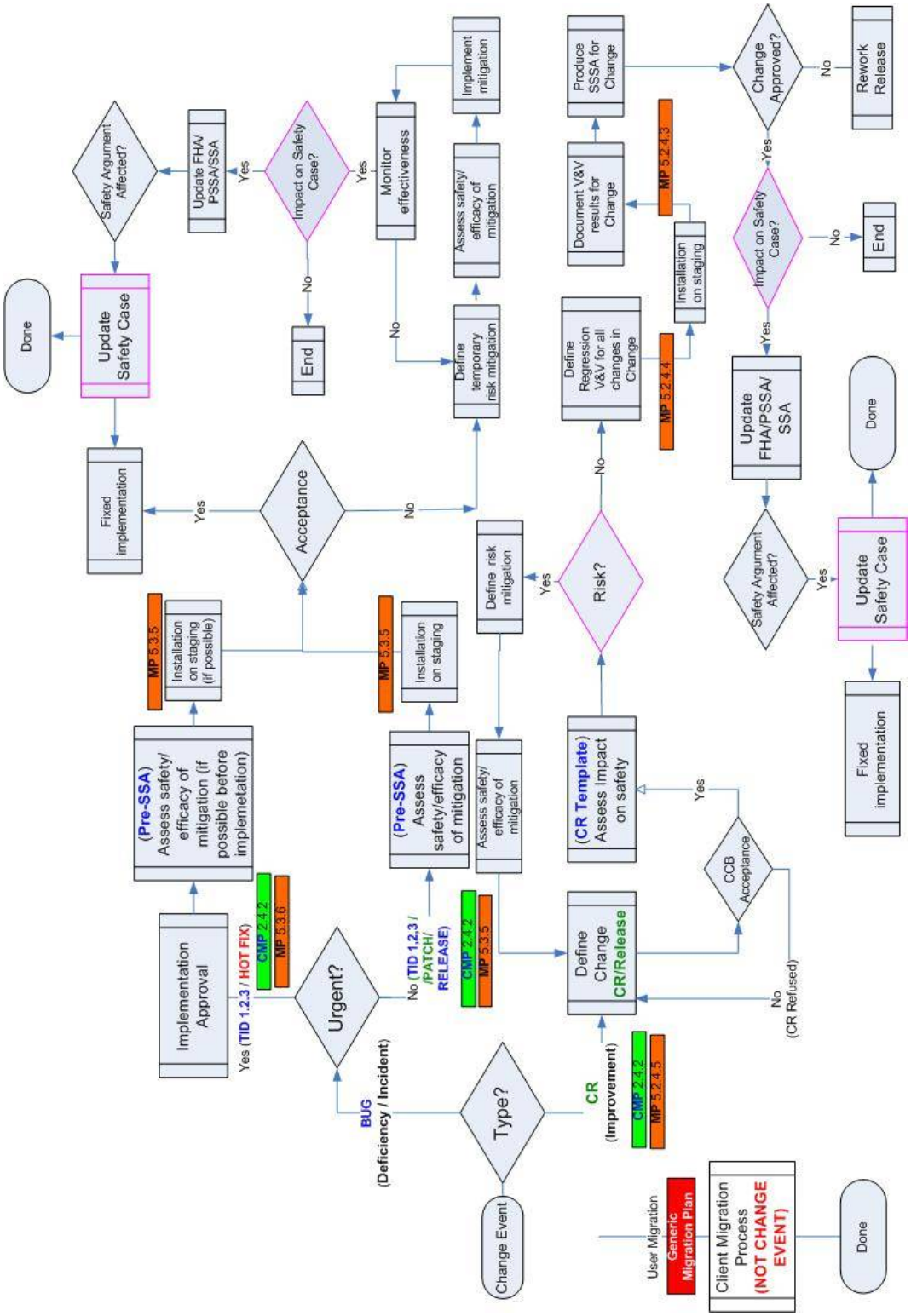

Figure 5: EAD Change Process

APPENDIX B EAD HAZARD PROBABILITY PREDICTIONS

Hazard	Risk Objectives[5]	SDO	INO	PAMS	Specific Caveats
HAZ001	Critical Data < 1×10^{-8} Essential Data < 1×10^{-5} Routine Data < 1×10^{-3}	3.0×10^{-9}	3.1×10^{-9}	4.8×10^{-9}	Data Users check the CRC for each data item used (**EFSR-22**). Where no CRC is present the hazard frequency for all services is limited to 2.0×10^{-6}
HAZ002	As above	3.1×10^{-9}	4.3×10^{-9}	2.0×10^{-6}	Data Providers verify changes are committed to SDO, INO, or PAMS (**EFSR-05**) Data Users verify sequence numbers for NOTAMS (**EFSR-19**)
HAZ003	Static data (loss of AIPs for more than 24 hours) <= 5×10^{-6} Dynamic data (loss of NOTAMS for more than 1 hour) <= 5×10^{-8}	5.2×10^{-9}	5.2×10^{-9}	5.2×10^{-9}	Data Users maintain alternative source e.g. local SDO backup, AFTN, etc. (Note that a backup failure probability of <1×10^{-3} is taken into account in calculating these failure frequencies)
HAZ004	No Safety Objectives set an acceptable level of safety is judged using a relative safety criteria i.e. risk must be no greater than exists in the ***non-EAD*** situation but nonetheless reduced AFARP	The introduction of boundary data checking between each State AIS for consistency, self evidently provides a reduction in the probability of this hazard			
HAZ005		Data Users can use a common validated source of data thus significantly reducing the likelihood of an error or discrepancy as a result of: • manual transfer of data • electronic transfer using non-standard or partially compatible formats • de-centralised information available on multiple paths within the Data Chain (each new source or path for data adds to the potential for discrepancy)			
HAZ006		See EAD FHA [16], PSSA [14] and SSA [15] Reports			

Table 5: EAD Hazard Probability Predictions

[5] All figures are per EAD operational hour assuming a 1:1 relationship with per flight hours as any error will in the worse case affect all aircraft.

APPENDIX C REFERENCES AND ABBREVIATIONS

C.1 References

It should be noted that the CMDB from which a number of references within the following table are derived is a living configuration management database; updated documents are added to the CMDB on a daily basis. The latest version at the time of issue of this report has thus been used.

[1] Aeronautical Information Services, Annex 15 to the Convention on International Civil Aviation, Twelfth Edition – July 2004

[2] COMMISSION REGULATION (EC) No 73/2010.laying down requirements on the quality of aeronautical data and information for the single European sky, 26 January 2010.

[3] EAD Safety Case Report EAD/DOC-ECN6FT

[4] Aeronautical Charts, Annex 4 to the Convention on International Civil Aviation

[5] Air Traffic Services, Annex 11 to the Convention on International Civil Aviation

[6] Aeronautical Telecommunications, Annex 14 to the Convention on International Civil Aviation

[7] CHAIN Preliminary Safety Case, DAP/NET/CHAIN/ , Issue 0.1, Working Draft, 24 October 2005

[8] ADI Mandate Justification Material, SES-IOP-JMA v1.0, 12 March 2007

[9] Air Navigation System Safety Assessment Methodology, SAF.ET1.ST03.1000-MAN-01, Edition 2.1, 03 October 2003

[10] ESARR 4, Risk Assessment and Mitigation in ATM, edition 1.0, 05 April 2001

[11] Safety Case Development Manual, DAP/SAF/091, v2.2, 13 November 2006

[12] Navigation Data Integrity Assurance (NADIA) Final Report, Davidson Limited, Edition 1 January 2006

[13] Commission Regulation (EC) No 2096/2005 of 20th December 2005 laying down common requirements for the provision of air navigation services, 20th December 2005.

[14] EAD Preliminary System Safety Assessment (PSSA) Report, EAD/DOC-ECR3Y9

[15] EAD System Safety Assessment (SSA) Report, EAD/DOC-FRR2HC

[16] EAD Functional Hazard Assessment (FHA) Report, EAD/DOC-ECR17J

[17] Client Agreement – Data User, EAD Service Provision, EAD/DOC-3992, latest edition.

[18] Client Agreement – Data Providers, EAD Service Provision, EAD/DOC-3989, latest edition.

[19] EAD System Safety Assessment (SSA) Report Annex C: EAD Requirements Tracing, EAD/DOC-FRR2HC-3

[20] EAD System Safety Assessment (SSA) Report for EAD Release 4, EAD/DOC-FRN5UI

[21] EAD Service, ITP Change Management Plan, EAD/DOC-FRKEA8

[22] EAD Programme: System Architecture – Core Document, EAD/DOC-FS0241

[23] Commission Regulation (EC) No 1033/2006 of 4 July 2006 laying down the requirements on procedures for flight plans in the pre-flight phase for the single European sky

C.2 Abbreviations

Abbreviation	Definition
AFARP	As Far As Reasonably Practicable
AFTN	Aeronautical Fixed Telecommunication Network
AIC	Aeronautical Information Circular
AIP	Aeronautical Information Publications
AIS	Aeronautical Information Services
ANSP	Air Navigation Service Provider
ATM	Air Traffic Management
ATSU	Air Traffic Service Unit
CFMU	Central Flow Management Unit
CIDIN	Common ICAO Data Interchange Network
CMDB	Configuration Management Database
CMP	Change Management Plan
COTS	Commercial Off-The-Shelf
CTS	Contract Technical Specification
EAD	European Aeronautical Information Service Database
EATM	European Air Traffic Management
ECAC	European Civil Aviation Conference
EFSR	External Functional Safety Requirements
ESARR	EUROCONTROL Safety Regulatory Requirements
FHA	Functional Hazard Assessment
ICAO	International Civil Aviation Organisation
IFSR	Internal Functional Safety Requirements
INO	International NOTAM Operation
ISDN	Integrated Services (switched) Digital Network
ISR	Inferred Safety Requirements
KPI	Key Performance Indicators
LAN	Local Area Network
MAN	Metropolitan Area Network
NOTAM	Notice to Airmen
PAMS	Published AIP Management System
PIB	Pre-flight Information Bulletins
PSSA	Preliminary System Safety Assessment
SDO	Static Data Operations
SIR	Safety Integrity Requirements
SLA	Service Level Agreements
SLS	Service Level Specifications
SSA	System Safety Assessment

Abbreviation	Definition
SSAR	System Safety/Security Assessment Report
SWU	Software Unit
TLS	Target Level of Safety
WAN	Wide Area Network

Table 6: Table of Abbreviations