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D-3.2 PROPOSED ROADMAPS FOR CHANGES

Digital transformation - Case studies for aviation safety standards – Data Science Applications (DATAPP)

An Agency of the European Union

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SUMMARY

Problem area

Digitalisation is reshaping the aviation business at quick pace, bringing efficiency and wider opportunities to manage information. The deployment of digital solutions throughout the air transport industry is a fact and brings significant changes to the traditional working processes, business models, standards and regulations.

EASA faces new challenges on what the required changes in safety standards and regulations are needed in response to the introduction of innovative solutions and processes. Anticipating what is to come in the industry in the field of data science applications is key to make sure safety levels are maintained without slowing innovation down.

The objective of this project is to identify and assess relevant changes to the existing aviation safety standards to support the deployment of the digital solutions under three case studies:

- Case Study 3: Flight training data for EBT/CBTA (Evidence-Based Training / Competence-Based Training and Assessment)
- Case Study 4: Digital fuel management
- Case Study 5: Flight data models for safety

The project aims to provide a comprehensive evaluation of benefits, constraints, standardisation and deployment issues, including the recommendations for adjusting safety regulations and related standards, and how new digital technologies could contribute to addressing the identified issues.

Description of work

The present document is ‘D-3.2 Proposed roadmaps for changes” project (EASA.2022.HVP.01- Horizon Europe Project). It presents an overview of the roadmap to delivery of all the solutions proposed in ‘D-2.1 Development of the case study’ and the regulatory review presented in ‘D-3.1 Report of the main changes required to regulatory materials and standards’. The work does not define how the regulation should be updated but highlights the rationale, benefits and risks of doing so to support the decision-making process in determining which solutions to take forward.

Note for case study 3 Flight training data for EBT/CBTA, some of the changes will be covered in the development of training material presented in D-3.3.1 Standardised metrics and methods for instructor concordance assurance.

CONTENTS

ABBREVIATIONS

ACRONYM	DESCRIPTION
ASR	Aerodrome Surveillance Radar
CA	Competent Authority
CAAi	Civil Aviation Authority International
CBTA	Competency Based Training and Assessment
DFL	Data Frame Layout
EASA	European Union Aviation Safety Agency
EBT	Evidence Based Training
EU	European Union
FDM	Flight Data Monitoring / Management
IPR	Intellectual Property Rights
KPI	Key Performance Indicator
MCTOM	Maximum Commercial Take Off Mass
PS	Package Solution
SMS	Safety Management Systems
SPI	Safety Performance Indicator
UC	Use Case

1. Introduction

1.1 Background

Digitalisation is reshaping the aviation business at quick pace, bringing efficiency and wider opportunities to manage information. The deployment of digital solutions throughout the air transport industry is a fact and brings significant changes to the traditional working processes, business models, standards and regulations.

In its role of EU Aviation Safety Regulator, EASA faces new challenges on what the required changes in safety standards and regulations are needed in response to the introduction of innovative solutions and processes. Anticipating what is to come in the industry in the field of data science applications is key to make sure safety levels are maintained without slowing innovation down. For that, identifying the key main applications in that area in the form of case studies, allows to better picture us in what is to come and will allow translating that future into recommendations for standardisation and regulations.

This project aims at evaluating a series of changes applied to aviation products, processes and operations resulting from the deployment of new digital solutions with a focus on measuring the impact on safety standards and regulatory materials as well as to prepare their evolutions. The project is built upon three case studies allowing to develop a comprehensive investigation of the key changes at stake:

- Case Study 3: Flight training data for EBT/CBTA. The case study will encompass the development of comprehensive guidelines for moving towards the implementation of EBT and CBTA concepts.
- Case Study 4: Digital fuel management. The project will encompass the in-depth analysis of the benefits and constraints associated to state-of-the-art digital solutions for fuel management, considering the current safety issues reported, as well as the preparation of comprehensive documentation to support the proposed evolution of standards and regulatory requirements.
- Case Study 5: Flight data models for safety. The proposed case study will investigate the development of comprehensive data models 'bridging' between the flight data sources and their use for the operator's safety-relevant processes and for industry-wide data exchange programmes.

1.2 Scope of the report

This report represents deliverable 'D-3.2 Presentation materials for the case study, the lessons learned, the proposed roadmaps for changes of "Digital Transformation – Case Studies for Aviation Safety Standards" project (EASA.2022.HVP.01- Horizon Europe Project). It provides an overview of recommendations to help support the delivery of the solutions proposed in D2.1 Development of the case study. The work does not state how the solutions should be delivered or integrated into EASA regulations, requirements, Acceptable means of compliance, or guidance material, but focuses on identifying the rationale, benefits and risk of the areas associated with each case study.

This report does not define the sequence for the delivery of the solutions proposed or the timelines to implement them.

The present document is structured as follows:

- Section 1 as an introduction presenting the background of the project, the scope of the document and the methodology followed to develop the literature review.
- Section 2 to 4 Present the individual recommendation for each of the case studies

2. Flight training data for EBT/CBTA

The solutions proposed for Flight training data for EBT/CBTA have been separated into; Regulatory / AMC / GM updates required or Non regulatory work e.g. development of industry best practice, updates to training material, etc. These are presented in Table 2-1, Table 2-2 and Table 2-3.

Table 2-1 Use Case 3.1: Use of flight crew training and instructor data to drive EBT programmes

Use Case 3.1: Use of flight crew training and instructor data to drive EBT programmes	
Regulation / AMC / GM updates required	**Non-Regulatory work**
UC3.1-SOL.4 – Promoting learning initiatives where forced concordance is addressed	**UC3.1-SOL.1 -** Regulatory requirements / Guidance Material explicitly capturing the potential risks related to the use of software or services supporting EBT evaluations
UC3.1-SOL.7 - Definition and introduction of a metric for programme difficulty	**UC3.1-SOL.2 -** Publication and promotion of best-practices for additional metrics for the EBT programmes
	UC3.1-SOL.3 - Publication and promotion of best-practices for avoiding the appearance of forced concordance
	UC3.1-SOL.5 - Regulatory requirements / Guidance Material explicitly capturing desirable capabilities for EBT software or services supporting EBT evaluations
	UC3.1-SOL.6 - Regulatory requirements / Guidance Material for standard application of grading system and assessment method and techniques
	UC3.1-SOL.8 - Regulatory requirements / Guidance Material explicitly capturing desirable capabilities for data analysis supporting solutions to identify training needs and programme improvements
	UC3.1-SOL.9 – Development and use of a generic data analysis tool for EBT programme
	UC3.1-SOL.10 – Development of best-practices for the conduction of clustering analysis for training data
	UC3.1-SOL.11 – Development of best-practices for training needs identification
	UC3.1-SOL.12 - Publication and promotion of best-practices for standardised metrics and methods to assess agreement and alignment
	UC3.1-SOL.13 – Development and use of a generic tool for concordance analysis
	UC3.1-SOL.14 - Publication and promotion of best-practices for concordance-related data management
	UC3.1-SOL.15 – Implementation of a tool that allows the operators to manage the ICAP related data
	UC3.1-SOL.16 – Definition and introduction of a framework of indicators and data management considerations to assess the appearance of forced concordance
	UC3.1-SOL.17 – Development of guidance material for normalisation of instructors' data
	UC3.1-SOL.18 – Research on the efficient usage of simulator data within the safety department
	UC3.1-SOL.19 – Development of best-practices for sharing data from the training to the safety department
	UC3.1-SOL.20 - Regulatory requirements / Guidance Material explicitly highlighting the importance of the debriefing
	UC3.1-SOL.21 - Publication of best-practices for instructor training and learning materials provision

Use Case 3.1: Use of flight crew training and instructor data to drive EBT programmes	
Regulation / AMC / GM updates required	**Non-Regulatory work**
	UC3.1-SOL.22 - Publication of Guidance Material on how to satisfy the established Observable Behaviours
	UC3.1-SOL.23 - Publication of best-practices for sharing data with pilots
	UC3.1-SOL.24 - Publication of best-practices for preventing training data misuse
	UC3.1-SOL.25 - Publication and promotion of best-practices for implementation and continuous improvement of ICAP
	UC3.1-SOL.26 - Publication of best-practices for methods to assess instructors' alignment
	UC3.1-SOL.27 – Creation and provision of "Golden Standards" as reference videos to be used by any operator
	UC3.1-SOL.28 – Establishment of a governance framework of recurrent concordance meetings among operators to share best practices

Table 2-2 Use case 3.2: Syllabus customisation and scenario contextualisation using operation data

Use Case 3.2 Syllabus customisation and scenario contextualisation using operational data	
Regulation / AMC / GM updates required	Non-Regulatory work
UC3.2-SOL.1 - Development of best-practices to map FDM event definition and EBT competencies and training topics	**UC3.2-SOL.4 -** Development of best-practices that recommend a minimum number of audits or site visits
UC3.2-SOL.2 - Development of GM/AMC for avoiding operational data misuse	**UC3.2-SOL.13 –** Development of Guidance Material for the definition of the responsibilities for the staff involved in EBT programme
UC3.2-SOL.3 - Initiatives for promoting collaborative data sharing programmes	
UC3.2-SOL.5 - Regulatory requirements / Guidance Material explicitly capturing desirable capabilities for EBT software regarding programmes' customisation	
UC3.1-SOL.6 - Regulatory requirements / Guidance Material explicitly capturing desirable capabilities for EBT software regarding the contextualisation of scenarios	
UC3.2-SOL.7 – Development of best-practices on how to ease integration and governance of safety and training department cooperation	
UC3.2-SOL.8 - Development of guidelines and industry best-practices to integrate / fuse inner loop data (safety-relevant and training data) for customisation and contextualisation of scenario elements	
UC3.2-SOL.9 - Regulatory requirements / Guidance Material explicitly capturing the need for integration of the EBT programme with the operator's management system to be used together with other relevant data sources for supporting safety risk management (SRM) and evaluate effectiveness of mitigation actions	
UC3.2-SOL.10 - Regulatory requirements to explicitly cover integration between FDM and EBT, identifying requirements for transmission of information and scope of data to be shared, similar to the FDM-related conditions captured in AMC1 ORO.FC.A.245 for ATQP programmes	
UC3.2-SOL.11 – Development of procedures to foster the access to safety data for training managers ensuring a secure access	
UC3.2-SOL.12 – Promote the figure of the EBT Manager	
UC3.2-SOL.14 – Development of Guidance Material for a proper EBT programme adaptation including realistic training scenarios	
UC3.2-SOL.15 - Publication of additional or alternative tables for training topics and scenarios selection	

Table 2-3 Use case 3.3: Authorities support and role within EBT programmes

Use Case 3.3 Authorities support and role within EBT programmes	
Regulation / AMC / GM updates required	Non-Regulatory work
UC3.3-SOL.1 - Development of best-practices for sharing authority data with operators	**UC3.3-SOL.3 -** Incentivise the creation of collaborative data-driven mechanisms among Authorities and operators (e.g., Data4Safety) supporting the continuous customisation of EBT programmes through evidence gathered from external safety-relevant sources (i.e., outer loop)
UC3.3-SOL.2 – Development of initiatives to facilitate access to safety data by the authority	**UC3.3-SOL.4 –** Development of best-practices for sharing gradings' data among operators
UC3.3-SOL.8 - Regulatory requirements / Guidance Material defining a recommended framework of KPIs for oversight of EBT programmes by Authorities	**UC3.3-SOL.5 –** Development of best-practices to encourage the sharing of data from operators in other countries
UC3.3-SOL.11 – Definition of safety management process to identify risks from operators' training data	**UC3.3-SOL.6 –** Development of best-practices for the establishment of collaborative data-driven mechanisms among Authorities and operators (e.g., Data4Safety) supporting the different areas of EBT programmes
UC3.3-SOL.12 - Regulatory requirements / Guidance Material defining the requirements for the reporting of simulator hours	**UC3.3-SOL.7 -** Regulatory requirements / Guidance Material for the sharing of gradings distribution data with authorities
	UC3.3-SOL.9 - Support the definition of specific trainings for the enhancement of the authorities' IT capabilities
	UC3.3-SOL.10 – Development of best-practices for enhancing authorities' visibility on EBT programmes
	UC3.3-SOL.13 - Development of Industry best-practices for standardised metrics to monitor the consistency of EBT programmes
	UC3.3-SOL.14 - Development of best-practices for the research on alternative means to verify the accuracy of the grading system

2.1 Detail rationale for EBT/CBTA roadmap

2.1.1 Use of relevant safety data such as FDM, SMS within EBT programmes

To establish the mapping of FDM event definitions SMS's and collaborative data programmes to support the development of appropriate EBT programmes. Additionally, established the desirable capabilities for EBT software for both programme customisation and contextualisation of scenarios.

- **Rationale:** By utilisation and integration of FDM and SMS data in training, and by encouraging and supporting data sharing, the development of EBT programmes will evolve to ensure best practice is always embedded as well as continually improving safety through lessons learnt. By adopting and embracing digital tools to support EBT will add to the usability and uptake of EBT programmes.

- **Benefits:** By ensuring there is continuous loop of data feeding back into EBT programmes it will ensure ongoing improvements for safety and performance are enabled, additional it supports the ongoing assurance that staff are competent to current practices,

- **Risks:** If strong links between departments responsible for SMS / FDM are not established, the feedback of knowledge to enhance training and development will not happen.

This recommendation is an answer to solutions:

- UC3.1-SOL.6 - Regulatory requirements / Guidance Material explicitly capturing desirable capabilities for EBT software regarding the contextualisation of scenarios
- UC3.2-SOL.1 - Development of best-practices to map FDM event definition and EBT competencies and training topics
- UC3.2-SOL.2 - Development of GM/AMC for avoiding operational data misuse
- UC3.2-SOL.3 - Initiatives for promoting collaborative data sharing programmes
- UC3.2-SOL.4 - Development of best-practices that recommend a minimum number of audits or site visits
- UC3.2-SOL.5 - Regulatory requirements / Guidance Material explicitly capturing desirable capabilities for EBT software regarding programmes' customisation
- UC3.2-SOL.7 – Development of best-practices on how to ease integration and governance of safety and training department cooperation
- UC3.2-SOL.8 - Development of guidelines and industry best-practices to integrate / fuse inner loop data (safety-relevant and training data) for customisation and contextualisation of scenario elements
- UC3.2-SOL.9 - Regulatory requirements / Guidance Material explicitly capturing the need for integration of the EBT programme with the operator's management system to be used together with other relevant data sources for supporting safety risk management (SRM) and evaluate effectiveness of mitigation actions
- UC3.2-SOL.10 - Regulatory requirements to explicitly cover integration between FDM and EBT, identifying requirements for transmission of information and scope of data to be shared, similar to the FDM-related conditions captured in AMC1 ORO.FC.A.245 for ATQP programmes
- UC3.2-SOL.11 – Development of procedures to foster the access to safety data for training managers ensuring a secure access

2.1.2 Development of best practices

To support the consistency of training and assessment the development of best practice guidance is recommended.

- **Rationale:** To ensure consistence in training and assessment the development of best practice guidance and information will support both eh students and the assessor

- **Benefits:** The development of best practice will support the consistency across operators and Cas in the delivery and evaluation of training, ensure all staff are appropriately trained and developed. This in turn will enhance safety practices and performance.

- **Risks:** The development of best practice requires agreement between multiple bodies and the adoption of it across industry. Without this agreement it may still require regulatory change to implement, rather than through guidance.

This recommendation is an answer to solutions:

- UC3.1-SOL.2 - Publication and promotion of best-practices for additional metrics for the EBT programmes
- UC3.1-SOL.3 - Publication and promotion of best-practices for avoiding the appearance of forced concordance
- UC3.1-SOL.4 – Promoting learning initiatives where forced concordance is addressed
- UC3.1-SOL.7 - Definition and introduction of a metric for programme difficulty
- UC3.1-SOL.11 – Development of best-practices for training needs identification
- UC3.1-SOL.12 - Publication and promotion of best-practices for standardised metrics and methods to assess agreement and alignment
- UC3.1-SOL.14 - Publication and promotion of best-practices for concordance-related data management
- UC3.1-SOL.16 – Definition and introduction of a framework of indicators and data management considerations to assess the appearance of forced concordance
- UC3.1-SOL.18 – Research on the efficient usage of simulator data within the safety department
- UC3.1-SOL.19 – Development of best-practices for sharing data from the training to the safety department
- UC3.1-SOL.21 - Publication of best-practices for instructor training and learning materials provision
- UC3.1-SOL.23 - Publication of best-practices for sharing data with pilots
- UC3.1-SOL.24 - Publication of best-practices for preventing training data misuse
- UC3.1-SOL.25 - Publication and promotion of best-practices for implementation and continuous improvement of ICAP
- UC3.1-SOL.26 - Publication of best-practices for methods to assess instructors’ alignment
- UC3.3-SOL.1 - Development of best-practices for sharing authority data with operators
- UC3.3-SOL.2 – Development of initiatives to facilitate access to safety data by the authority

- UC3.3-SOL.5 – Development of best-practices to encourage the sharing of data from operators in other countries
- UC3.3-SOL.10 – Development of best-practices for enhancing authorities' visibility on EBT programmes

2.1.3 Development of digital tools to support assessment and training

Establishment of guidance on the use of digital tools to enable training and assessment to be captured easy and improve efficiency.

- **Rationale:** The introduction of digital tools to support the assessor and trainees in both grading and evidence collation will support a more consistence approach

- **Benefit:** The use of digital tools not only supports improvements in training, but it asl enables a greater capability to conduct data capture in an anonymised manner to support CA in utilising evidence to understand benefits, progress and potential areas of risk within training

- **Risks:** There is a risk that the use of software distracts the assessor by drawing focus away from the person under test.

This recommendation is an answer to solutions:

- UC3.1-SOL.1 - Regulatory requirements / Guidance Material explicitly capturing the potential risks related to the use of software or services supporting EBT evaluations
- UC3.1-SOL.5 - Regulatory requirements / Guidance Material explicitly capturing desirable capabilities for EBT software or services supporting EBT evaluations
- UC3.1-SOL.6 - Regulatory requirements / Guidance Material for standard application of grading system and assessment method and techniques
- UC3.1-SOL.8 - Regulatory requirements / Guidance Material explicitly capturing desirable capabilities for data analysis supporting solutions to identify training needs and programme improvements
- UC3.1-SOL.9 – Development and use of a generic data analysis tool for EBT programme
- UC3.1-SOL.10 – Development of best-practices for the conduction of clustering analysis for training data
- UC3.1-SOL.13 – Development and use of a generic tool for concordance analysis
- UC3.1-SOL.15 – Implementation of a tool that allows the operators to manage the ICAP related data
- UC3.1-SOL.20 - Regulatory requirements / Guidance Material explicitly highlighting the importance of the debriefing
- UC3.1-SOL.22 - Publication of Guidance Material on how to satisfy the established Observable Behaviours

2.1.4 Define the responsibilities of staff in a EBT

Ensure that individual roles and responsibilities are clear within a EBT programme

- **Rationale:** By having clear role definitions, the flow and process in a EBT programme will more agile.

- **Benefits:** Clear role description/responsibilities will aid both the students and the assessor in ensuring all actions are completed in a good EBT programme

- **Risk:** Careful consideration of role demarcation will be required to ensure that overlaps or gaps do not exist.

This recommendation is an answer to solutions:

- UC3.2-SOL.12 – Promote the figure of the EBT Manager
- UC3.2-SOL.13 – Development of Guidance Material for the definition of the responsibilities for the staff involved in EBT programme

2.1.5 Defining KPIs for oversite

Establish the KPIs to enable authorities to have oversite of EBT programmes.

- **Rationale:** By establishing a set of KPIs, all training bodies are aware of the level of performance that must be reached and maintained

- **Benefits:** All trainers will be able to operate at the same minimum level and oversite by authorities will be consistent across borders

- **Risk:** The KPIs established may not be appropriate requiring repeat of the process to optimise them and support their establishment for all authorities.

This recommendation is an answer to solutions:

- UC3.3-SOL.7 - Regulatory requirements / Guidance Material for the sharing of gradings distribution data with authorities
- UC3.3-SOL.8 - Regulatory requirements / Guidance Material defining a recommended framework of KPIs for oversight of EBT programmes by Authorities
- UC3.3-SOL.12 - Regulatory requirements / Guidance Material defining the requirements for the reporting of simulator hours

3. Digital Fuel management roadmap

The most critical action centres on establishing clear definitions and frameworks for fuel performance metrics, safety event parameters, and SPI categorisation. regulation changes will be required to implement this step. The establishment of a dedicated working group tasked with defining and refining SPIs is another high-priority action. This group will determine SPI categories, establish impact levels, and recommend target levels.

The solutions proposed for digital fuel management have been separated into; Regulatory / AMC / GM updates required or non-regulatory work e.g. development of industry best practice, updates to training material, etc. These are presented in Table 3-1, Table 3-2, Table 3-3 below.

Following the establishment of standardised parameters, a series of medium-priority actions target data management challenges. Developing guidelines for data source integration and data compatibility will streamline information flow. Regulations may require some adaptation, but existing frameworks might be adaptable. Similarly, establishing clear guidelines for safe data de-identification is crucial for fostering data sharing while ensuring confidentiality and privacy. Regulation changes might be needed to define acceptable de-identification methods and data security protocols. Implementing standardised data formats and protocols for operating conditions data is essential for seamless data exchange. Regulation changes might be required to mandate the use of standardised formats.

Facilitating the creation of data-sharing programs and establishing systems for consolidating operating conditions data is another medium-priority action. These initiatives will leverage collective knowledge and expertise across the industry. Regulation changes might be needed to incentivise data sharing and define data governance frameworks. The development of a centralised platform for operating conditions data is presented as an optional addition. This initiative could be implemented as a later phase or through industry-led efforts, requiring minimal regulation changes.

Outlining best practices for establishing tailored safety monitoring systems aligned with fuel reduction initiatives is a medium-priority action. Regulations might be necessary to establish safety monitoring requirements. Furthermore, defining a framework for collaboration between fuel and safety departments for evaluating the safety aspects of fuel initiatives is crucial. Regulation changes might be needed to mandate collaboration protocols.

Refining reporting requirements for fuel scheme safety performance, regulatory compliance, and operating conditions data is a final medium-priority action. These revisions will ensure that reported data is most relevant for effective oversight while minimising burdens on airlines. Regulation changes may be necessary to update reporting requirements.

Table 3-1 Use case 4.1: Leveraging aircraft-specific fuel data for fuel performance-based schemes

Use Case 4.1 Leveraging aircraft-specific fuel data for fuel performance-based schemes	
Regulation / AMC / GM updates required	Non-Regulatory work
UC4.1-SOL.6 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards	**UC4.1-SOL.1 -** Development of guidelines for minimum conditions and selection criteria of fuel-related data sources
UC4.1-SOL.8 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards	**UC4.1-SOL.2 -** Development of guidelines for FDM data governance frameworks to allow for fuel-related developments
UC4.1-SOL.9 - Development of GM/AMC for minimum requirements and selection criteria of fuel-related data sources	**UC4.1-SOL.3 -** Development of industry best-practices for uniform data formatting and standards
UC4.1-SOL.11 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards	**UC4.1-SOL.4 -** Development of industry best-practices for selection criteria of duplicated fuel-related data parameters
UC4.1-SOL.12 - Development of GM/AMC that establish a standardised framework for generalising statistical models	**UC4.1-SOL.5 -** Development of industry best-practices for data validation guidelines for duplicated parameters
UC4.1-SOL.13- Development of GM/AMC specifying what constitutes statistically relevant data	**UC4.1-SOL.7 -** Development of industry best-practices for generic data validation guidelines
UC4.1-SOL.14 - Development of GM/AMC specifying criteria for assessing the adequacy of data for statistical analysis	**UC4.1-SOL.10 -** Development of industry best-practices for data compatibility and integration guidelines
UC4.1-SOL.17 - Development of GM/AMC capturing the need for transparency in algorithm details provided by vendors	**UC4.1-SOL.15 -** Development of industry best-practices for data sharing and collaboration among operators
UC4.1-SOL.18 - Development of GM/AMC that allow for more flexibility regarding fuel consumption monitoring systems	**UC4.1-SOL.16 -** Development of industry best-practices for the generalisation of statistical models
UC4.1-SOL.20 - Development of GM/AMC for minimum requirements regarding fuel-related parameters that are manually collected	**UC4.1-SOL.19 -** Development of industry best-practices for the definition of a comprehensive fuel data framework
UC4.1-SOL.22 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards	**UC4.1-SOL.21 -** Development of industry best-practices for validation guidelines of manually collected data
UC4.1-SOL.25 - Development of GM/AMC for FDM data governance agreements	**UC4.1-SOL.23 -** Support the adoption and integration of IoT devices into aircraft systems
UC4.1-SOL.27 - Development of GM/AMC that enhance the modification of the Operation Manual to provide pilots with insights on models	**UC4.1-SOL.26 -** Development of industry best-practices for standardised statistical and advanced fuel-reduction models
	UC4.1-SOL.28 - Development of industry best-practices for fuel-related model validation frameworks
	UC4.1-SOL.29 - Development of industry best-practices for the deployment of fuel-related models
	UC4.1-SOL.30 - Support the definition of specific trainings for the enhancement of analytical capabilities
	UC4.1-SOL.31 - Development of industry best-practices for collaboration and coordination between Authorities regarding the harmonization of fuel-related data processes
	UC4.1-SOL.32 - Support the definition of specific trainings for the enhancement of IT capabilities regarding statistical and advanced models
	UC4.1-SOL.33 - Development of industry best-practices for collaboration and coordination between Authorities regarding the harmonization of fuel consumption estimation models

➡ **Table 3-2** Use case 4.2: Characterising the safety performance indicators for fuel schemes

Use Case 4.2 Characterising the safety performance indicators for fuel schemes	
Regulation / AMC / GM updates required	Non-Regulatory work
UC4.2-SOL.2 - Development of GM/AMC for standardised lists of SPIs	**UC4.2-SOL.1 -** Development of industry best-practices for the definition and differentiation of safety indicators and events
UC4.2-SOL.8 - Development of GM/AMC for the alignment of fuel initiatives with Safety Management System (SMS)	**UC4.2-SOL.3 -** Development of industry best-practices for the definition of safety frameworks to specific fuel reductions
UC4.2-SOL.9 - Development of GM/AMC for the de-identification of fuel-related data	**UC4.2-SOL.4 -** Creation and promotion of collaborative data programmes for the definition of SPIs
UC4.2-SOL.10 - Development of GM/AMC for the continuous reporting of fuel-related safety performance	**UC4.2-SOL.5 -** Development of industry best-practices for the definition of expanded lists of SPIs
	UC4.2-SOL.6 - Development of industry best-practices for the monitoring of fuel-related safety trends
	UC4.2-SOL.7 - Creation and promotion of collaborative data programmes for safety monitoring
	UC4.2-SOL.11 - Development of industry best-practices for the monitoring of fuel-related safety events
	UC4.1-SOL.12 - Development of industry best-practices for collaboration and coordination between Authorities regarding the monitoring and reassessment of safety performance

➡ **Table 3-3** Use case 4.3: Using operating conditions data to support performance-based fuel schemes

Use Case 4.3 Using operating conditions data to support performance-based fuel schemes	
Regulation / AMC / GM updates required	Non-Regulatory work
UC4.3-SOL.1 - Development of GM/AMC for the definition of minimum set of operating conditions data sources	**UC4.3-SOL.2 -** Promote the implementation of systems that consolidate operating conditions data from various sources into a centralized platform
	UC4.3-SOL.2 - Development of industry best-practices for the integration of operating conditions data sources
UC4.3-SOL.3 - Development of GM/AMC for the definition of minimum requirements for operating conditions data sources	**UC4.3-SOL.6 -** Development of industry best-practices for operating conditions data analysis and validation for fuel estimation models
UC4.3-SOL.4 - Development of GM/AMC accounting for specificities in regard with validation of operating conditions data	**UC4.3-SOL.7 -** Development of GM/AMC for the definition of communication channels / OCCs to share operating conditions data seamlessly
UC4.3-SOL.5 - Development of GM/AMC for the integration of operating conditions data	**UC4.3-SOL.8 -** Development of industry best-practices for the coordination between dispatchers, fuel team and crew members
	UC4.1-SOL.9 - Support the definition of specific trainings for the enhancement of analytical capabilities
	UC4.1-SOL.10 - Development of industry best-practices for collaboration and coordination between Authorities regarding the harmonization of operating conditions data processes
	UC4.3-SOL.11 - Development of industry best-practices for monitoring operating conditions data

3.1 Detail rationale for DFM roadmap

3.1.1 Standardised lists of fuel and safety parameters

Develop a clear distinction between fuel performance metrics and safety event monitoring. Define a framework for categorising SPIs (performance & event indicators).

- **Rationale:** The aviation industry currently lacks standardised definitions and methodologies for fuel and safety data, leading to inconsistencies and hindering effective analysis. Categorisation helps identify and focus on the most relevant SPIs that significantly impact fuel efficiency and safety, ensuring resources are directed towards the most impactful areas.

- **Benefits:** Clear definitions and distinctions between fuel performance metrics and safety event monitoring parameters prevent confusion and ensure consistent data collection and analysis across airlines. Standardised fuel performance metrics and safety parameter lists enable airlines to benchmark their performance against industry averages and identify areas for improvement. Common terminology and definitions promote seamless data exchange and collaboration among airlines, airports, and regulatory bodies. Clear definitions prevent confusion and misinterpretation of data, leading to more reliable and actionable insights.

- **Risks:** An overly complex categorisation system can be cumbersome and hinder practical implementation. Implementing new standards may require changes to existing data collection and reporting practices, potentially leading to initial resistance from some stakeholders.

  The framework should be regularly reviewed and updated to reflect changes in the industry and evolving data collection practices.

This recommendation is an answer to solutions:

- UC4.2-SOL.1 - Development of industry best-practices for the definition and differentiation of safety indicators and events
- UC4.2-SOL.2 - Development of GM/AMC for standardised lists of SPIs
- UC4.2-SOL.3 - Development of industry best-practices for the definition of safety frameworks to specific fuel reductions
- UC4.2-SOL.5 - Development of industry best-practices for the definition of expanded lists of SPIs
- UC4.2-SOL.6 - Development of industry best-practices for the monitoring of fuel-related safety trends
- UC4.2-SOL.8 - Development of GM/AMC for the alignment of fuel initiatives with Safety Management System (SMS)
- UC4.2-SOL.9 - Development of GM/AMC for the de-identification of fuel-related data
- UC4.2-SOL.10 - Development of GM/AMC for the continuous reporting of fuel-related safety performance
- UC4.2-SOL.11 - Development of industry best-practices for the monitoring of fuel-related safety events
- UC4.2-SOL.12 - Development of industry best-practices for collaboration and coordination between Authorities regarding the monitoring and re-assessment of safety performance

3.1.2 Fuel-related SPIs

Establish a working group to define SPIs, including:

- Categorising SPIs based on their function and impact. This framework should consider factors like the type of fuel efficiency improvement they measure, the potential safety implications, and the operational context.
- Recommended thresholds and target levels for SPIs based on precursor events, safety margins, operating conditions data, and ASR data.
- Defining clear criteria for each category. Specify the data elements and calculations used to determine each SPI. Ensure consistency and comparability across airlines and aircraft types.
- Establishing a dedicated working group to define and refine fuel-related SPIs. This group can leverage existing industry standards and best practices, as well as data from historical fuel efficiency initiatives and safety reports.

- **Rationale:** SPIs provide more granular and actionable insights than simply relying on average fuel consumption figures. SPIs can be tailored to specific aircraft types, routes, and operating conditions, enabling a more customised approach to fuel efficiency improvements.
- **Benefits:** Categorisation allows for more focused and efficient data analysis, enabling the identification of key trends and areas for improvement within specific fuel efficiency initiatives**.** By prioritising SPIs based on their potential impact, airlines can allocate resources more effectively towards the most impactful fuel-saving strategies. A standardised framework facilitates communication and knowledge sharing among stakeholders regarding the interpretation and utilisation of SPIs.

  By focusing on SPIs with the highest potential impact, airlines can prioritise their efforts and achieve more significant fuel savings. Utilising SPIs provides airlines with data-driven insights to inform fuel management strategies and optimise fuel consumption. Standardised SPIs and target levels enable airlines to benchmark their performance against industry averages and identify areas for improvement.

- **Risks:** The effectiveness of SPIs depends heavily on the quality and accuracy of the underlying data. Robust data collection and validation procedures are crucial.

  An overly complex categorisation system can be cumbersome and hinder practical implementation. Tracking and analysing a large number of SPIs can be resource-intensive for airlines. It's important to prioritize the most impactful SPIs based on their potential for improvement.

  The framework should be regularly reviewed and updated to reflect changes in the industry and evolving data collection practices.

This recommendation is an answer to solutions:

- UC4.2-SOL.1 - Development of industry best-practices for the definition and differentiation of safety indicators and events
- UC4.2-SOL.3 - Development of industry best-practices for the definition of safety frameworks to specific fuel reductions
- UC4.2-SOL.5 - Development of industry best-practices for the definition of expanded lists of SPIs
- UC4.2-SOL.6 - Development of industry best-practices for the monitoring of fuel-related safety trends
- UC4.2-SOL.11 - Development of industry best-practices for the monitoring of fuel-related safety events

- UC4.2-SOL.12 - Development of industry best-practices for collaboration and coordination between Authorities regarding the monitoring and re-assessment of safety performance

3.1.3 Data integration and compatibility

Establish guidelines for data source integration to mitigate compatibility issues and ensure data accuracy and completeness for fuel planning and management. Develop guidelines for data source integration to address potential compatibility issues between different systems and data formats Develop guidelines that specify the minimum set of operating conditions data sources required for specific fuel reduction applications and fuel schemes.

This may involve:

- Standardising data dictionaries and definitions.
- Implementing data transformation and mapping procedures.
- Utilising open-source data standards and protocols.

Establish best practices for ensuring data accuracy and completeness throughout the data collection, storage, and analysis process. This includes data validation procedures, quality checks, and regular data audits.

- **Rationale:** Data incompatibility is a significant barrier to effective data management and analysis in the aviation industry. Standardised data formats and integration protocols are essential for the widespread adoption of data-driven fuel efficiency and safety initiatives across the industry.

- **Benefits:** Addressing compatibility issues ensures seamless data integration from various sources, leading to a more comprehensive and accurate data set for analysis. Streamlined data integration eliminates the need for manual data manipulation and reconciliation, improving efficiency and reducing administrative burdens. Standardised data formats and protocols promote seamless data exchange and collaboration among stakeholders, enabling a more unified approach to fuel efficiency and safety.

- **Risks:** Implementing new data standards and protocols may require changes to existing systems and processes, potentially leading to initial resistance from some stakeholders.

  As data formats and technologies evolve, it's crucial to maintain and update integration protocols to ensure continued compatibility and data integrity.

This recommendation is an answer to solutions:

- UC4.1-SOL.1 - Development of guidelines for minimum conditions and selection criteria of fuel-related data sources
- UC4.1-SOL.2 - Development of guidelines for FDM data governance frameworks to allow for fuel-related developments
- UC4.1-SOL.3 - Development of industry best-practices for uniform data formatting and standards
- UC4.1-SOL.4 - Development of industry best-practices for selection criteria of duplicated fuel-related data parameters

- UC4.1-SOL.5 - Development of industry best-practices for data validation guidelines for duplicated parameters
- UC4.1-SOL.6 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.7 - Development of industry best-practices for generic data validation guidelines
- UC4.1-SOL.8 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.9 - Development of GM/AMC for minimum requirements and selection criteria of fuel-related data sources
- UC4.1-SOL.10 - Development of industry best-practices for data compatibility and integration guidelines
- UC4.1-SOL.11 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.19 - Development of industry best-practices for the definition of a comprehensive fuel data framework
- UC4.1-SOL.20 - Development of GM/AMC for minimum requirements regarding fuel-related parameters that are manually collected
- UC4.1-SOL.21 - Development of industry best-practices for validation guidelines of manually collected data
- UC4.1-SOL.22 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.24 - Alignment of FDM and fuel schemes guidelines regarding relevant parameters to be collected under performance
- UC4.1-SOL.25 - Development of GM/AMC for FDM data governance agreements

3.1.4 De-identification of fuel-related data

Develop guidelines for safe data sharing while ensuring confidentiality and privacy. These guidelines should:

- Specify the types of identifiable data to be removed.
- Recommend appropriate de-identification methods, such as:
  - Aggregation - combining data points to reduce the level of details.
  - Generalisation - replacing specific values with broader categories.
  - Differential privacy - adding noise to data while preserving its statistical properties.
- Emphasise the importance of data security measures to protect the de-identified data.

- **Rationale:** Sharing raw data can expose airlines to competition and privacy concerns.

- **Benefits:** De-identification techniques ensure that sensitive information about airlines, aircraft, and flight operations remains confidential and protects individual privacy. By removing identifiable information, data can be shared more freely among stakeholders for collaborative analysis and fuel efficiency improvements. De-identification mitigates the risk of data misuse or unauthorised access to sensitive information.

- **Risks:** De-identification techniques may lead to some loss of granularity or context in the data, which could impact the accuracy of analysis. Implementing effective de-identification methods can be technically challenging and require careful consideration.

This recommendation is an answer to solutions:

- UC4.1-SOL.1 - Development of guidelines for minimum conditions and selection criteria of fuel-related data sources
- UC4.1-SOL.2 - Development of guidelines for FDM data governance frameworks to allow for fuel-related developments
- UC4.1-SOL.3 - Development of industry best-practices for uniform data formatting and standards
- UC4.1-SOL.4 - Development of industry best-practices for selection criteria of duplicated fuel-related data parameters
- UC4.1-SOL.5 - Development of industry best-practices for data validation guidelines for duplicated parameters
- UC4.1-SOL.6 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.7 - Development of industry best-practices for generic data validation guidelines
- UC4.1-SOL.8 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.9 - Development of GM/AMC for minimum requirements and selection criteria of fuel-related data sources
- UC4.1-SOL.10 - Development of industry best-practices for data compatibility and integration guidelines
- UC4.1-SOL.11 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.15 - Development of industry best-practices for data sharing and collaboration among operators
- UC4.1-SOL.16 - Development of industry best-practices for the generalization of statistical models
- UC4.1-SOL.19 - Development of industry best-practices for the definition of a comprehensive fuel data framework
- UC4.1-SOL.20 - Development of GM/AMC for minimum requirements regarding fuel-related parameters that are manually collected
- UC4.1-SOL.21 - Development of industry best-practices for validation guidelines of manually collected data
- UC4.1-SOL.22 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.23 - Support the adoption and integration of IoT devices into aircraft systems
- UC4.1-SOL.24 - Alignment of FDM and fuel schemes guidelines regarding relevant parameters to be collected under performance

- UC4.1-SOL.25 - Development of GM/AMC for FDM data governance agreements
- UC4.1-SOL.26 - Development of industry best-practices for standardised statistical methods and advanced fuel-reduction models
- UC4.1-SOL.28 - Development of industry best-practices for fuel-related model validation frameworks
- UC4.1-SOL.29 - Development of industry best-practices for the deployment of fuel-related models
- UC4.1-SOL.30 - Support the definition of specific trainings for the enhancement of analytical capabilities
- UC4.1-SOL.31 - Definition and publication of industry best-practices for collaboration and coordination between Authorities regarding the harmonization of fuel-related data processes
- UC4.1-SOL.32 - Support the definition of specific trainings for the enhancement of IT capabilities regarding statistical and advanced models
- UC4.1-SOL.33 - Definition and publication of industry best-practices for collaboration and coordination between Authorities regarding the harmonization of fuel consumption estimation models

3.1.5 Fuel performance modelling

Promote best practices for seamless data integration, ensuring operators can utilise comprehensive operating conditions data effectively in fuel performance models. Address data source variations and validation strategies. Implement standardised data formats and protocols for operating conditions data across different sources. This ensures compatibility and simplifies data exchange. Standardise data dictionaries and terminology to ensure consistent understanding of data elements. Establish robust data quality assessment procedures to identify and address data inconsistencies, missing values, and outliers before using it in models. Implement data cleansing and pre-processing techniques to prepare data for analysis. Utilise data integration platforms and tools that can efficiently combine data from various sources and formats. Consider cloud-based data management solutions for scalability and accessibility. Normalise data based on specific factors like aircraft type, weather conditions, and route characteristics to account for inherent variations. Develop normalisation techniques and algorithms tailored to fuel performance modelling needs. Employ advanced statistical methods to handle non-linear relationships and outliers in the data. Utilise machine learning algorithms that can learn from complex data patterns and adapt to variations. Conduct sensitivity analysis to assess the impact of different input variables on the model's outputs. Regularly update and refine models as new data becomes available and operating conditions evolve. Encourage collaboration between airlines, research institutions, and technology providers to share best practices and insights in fuel performance modelling. Develop open-source tools and resources to facilitate knowledge sharing and accelerate innovation in this field.

- **Rationale:** Fuel performance modelling offers airlines a powerful tool to optimise fuel efficiency and reduce operating costs.

- **Benefits:** Accurate fuel performance models allow airlines to optimise their fuel consumption and identify areas for further improvement**.** By optimising fuel efficiency, airlines can significantly reduce their operating costs. Fuel performance models provide airlines with valuable insights to inform fuel management strategies and operational decisions.

- **Risks:** Seamless data integration from various sources with different formats and quality levels can be challenging. Operating conditions data can vary significantly depending on factors like aircraft type, weather, and flight path. Reliable models require a complete picture of factors influencing fuel consumption. Fragmented or inconsistent data leads to inaccurate models.

Ensuring the accuracy and reliability of fuel performance models requires robust validation strategies.

This recommendation is an answer to solutions:

- UC4.1-SOL.1 - Development of guidelines for minimum conditions and selection criteria of fuel-related data sources
- UC4.1-SOL.2 - Development of guidelines for FDM data governance frameworks to allow for fuel-related developments
- UC4.1-SOL.6 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.8 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.9 - Development of GM/AMC for minimum requirements and selection criteria of fuel-related data sources
- UC4.1-SOL.11 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.15 - Development of industry best-practices for data sharing and collaboration among operators
- UC4.1-SOL.16 - Development of industry best-practices for the generalization of statistical models
- UC4.1-SOL.20 - Development of GM/AMC for minimum requirements regarding fuel-related parameters that are manually collected
- UC4.1-SOL.22 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.24 - Alignment of FDM and fuel schemes guidelines regarding relevant parameters to be collected under performance
- UC4.1-SOL.25 - Development of GM/AMC for FDM data governance agreements
- UC4.1-SOL.26 - Development of industry best-practices for standardised statistical methods and advanced fuel-reduction models
- UC4.1-SOL.28 - Development of industry best-practices for fuel-related model validation frameworks
- UC4.1-SOL.29 - Development of industry best-practices for the deployment of fuel-related models

3.1.6 Data sharing and collaboration

Encourage the creation of data-sharing programs (e.g., Data4Safety) for defining SPIs, monitoring safety trends, and utilising operating conditions data. Provide guidance for promoting the implementation of systems that consolidate operating conditions data from various sources into a centralised platform.

- **Rationale:** Data sharing breaks down information silos and allows for a more comprehensive understanding of safety trends and fuel efficiency opportunities. Collaboration enables the aviation industry to leverage the collective knowledge and expertise of various stakeholders. By working together, airlines and authorities can achieve faster progress in improving safety and fuel efficiency.

- **Benefits:** By sharing safety data and trends, airlines and authorities can identify potential safety risks more effectively and implement targeted mitigation strategies. Collaborative analysis of operating conditions data allows for the identification of fuel-saving opportunities across the industry. Sharing best practices and insights derived from data analysis can help airlines optimise their operations and reduce costs. Collaborative data programs can foster innovation and development of new fuel efficiency and safety technologies and practices.

- **Risks**: Airlines may be hesitant to share data that could give competitors an advantage.

  Ensuring data quality and consistency across different organisations is crucial for reliable analysis and collaboration. Robust data security measures and clear data privacy protocols are essential to protect sensitive information.

This recommendation is an answer to solutions:

- UC4.1-SOL.23 - Support the adoption and integration of IoT devices into aircraft systems
- UC4.1-SOL.30 - Support the definition of specific trainings for the enhancement of analytical capabilities
- UC4.1-SOL.31 - Definition and publication of industry best-practices for collaboration and coordination between Authorities regarding the harmonization of fuel-related data processes
- UC4.1-SOL.32 - Support the definition of specific trainings for the enhancement of IT capabilities regarding statistical and advanced models
- UC4.1-SOL.33 - Definition and publication of industry best-practices for collaboration and coordination between Authorities regarding the harmonization of fuel consumption estimation models

3.1.7 Operating conditions data source

Develop guidelines that establish minimum set of operating conditions data sources required for specific fuel reduction applications and fuel schemes. These guidelines should consider factors like the type of aircraft, the fuel scheme being used, and the specific fuel efficiency initiative being implemented. Airlines and airports can collaborate to ensure the availability and accessibility of required data sources.

- **Rationale:** Traditional fuel efficiency calculations often rely solely on fuel uplift and flight time data. However, various other factors significantly influence fuel consumption. Understanding the impact of weather, flight path, and other operational factors allows for a more nuanced understanding of fuel consumption patterns and targeted interventions.

- **Benefits:** Access to a wider range of operating conditions data allows for more accurate and comprehensive fuel efficiency modelling, leading to more effective fuel-saving strategies.

- **Risks:** Developing and maintaining a robust and scalable data platform requires significant technical expertise and financial investment.

  Clear data governance and ownership protocols are essential to ensure data security, privacy, and responsible data utilization within the platform.

This recommendation is an answer to solutions:

- UC4.1-SOL.10 - Development of industry best-practices for collaboration and coordination between Authorities regarding the harmonization of operating conditions data processes
- UC4.2-SOL.5 - Development of GM/AMC for the integration of operating conditions data
- UC4.3-SOL.1 - Development of GM/AMC for the definition of minimum set of operating conditions data sources
- UC4.3-SOL.3 - Development of GM/AMC for the definition of minimum requirements for operating conditions data sources
- UC4.3-SOL.4 - Development of GM/AMC accounting for specificities in regard with validation of operating conditions data
- UC4.3-SOL.6 - Development of industry best-practices for operating conditions data analysis and validation for fuel estimation models
- UC4.3-SOL.7 - Development of GM/AMC for the definition of communication channels / OCCs to share operating conditions data seamlessly
- UC4.3-SOL.8 - Development of industry best-practices for the coordination between dispatchers, fuel team and crew members
- UC4.3-SOL.11 - Development of industry best-practices for monitoring operating conditions data

3.1.8 Operating conditions data platform (optional)

Develop guidance for promoting the implementation of systems that consolidate operating conditions data from various sources into a centralised platform accessible to airports, airlines, and relevant authorities. Define standardised data formats and reporting procedures for consistency and real-time updates. Establish clear and standardised reporting procedures for real-time updates and data sharing on the platform.

- **Rationale:** Currently, operating conditions data often resides in separate systems across different organisations, hindering collaboration and hindering comprehensive analysis. A centralised platform facilitates the development and implementation of data-driven fuel efficiency and safety initiatives across the aviation ecosystem.

- **Benefits:** This will facilitate seamless data exchange and integration for fuel efficiency analysis. Consolidating data from various sources in one platform allows for more comprehensive data analysis and the identification of previously unseen trends and correlations. Access to real-time data updates enables airlines and other stakeholders to make informed decisions based on the latest operational conditions and fuel efficiency insights.

- **Risks**: Developing and maintaining a robust and scalable data platform requires significant technical expertise and financial investment.

  Implementing robust data security measures and clear data governance protocols is crucial to protect sensitive information. Clear data governance and ownership protocols are essential to ensure data security, privacy, and responsible data utilisation within the platform.

This recommendation is an answer to solutions:

- UC4.1-SOL.9 - Support the definition of specific trainings for the enhancement of analytical

- UC4.1-SOL.10 - Development of industry best-practices for collaboration and coordination between Authorities regarding the harmonization of operating conditions data processes
- UC4.2-SOL.5 - Development of GM/AMC for the integration of operating conditions data capabilities
- UC4.3-SOL.1 - Development of GM/AMC for the definition of minimum set of operating conditions data sources
- UC4.3-SOL.2 - Promote the implementation of systems that consolidate operating conditions data from various sources into a centralized platform
- UC4.3-SOL.3 - Development of GM/AMC for the definition of minimum requirements for operating conditions data sources
- UC4.3-SOL.4 - Development of GM/AMC accounting for specificities in regard with validation of operating conditions data
- UC4.3-SOL.6 - Development of industry best-practices for operating conditions data analysis and validation for fuel estimation models
- UC4.3-SOL.7 - Development of GM/AMC for the definition of communication channels / OCCs to share operating conditions data seamlessly
- UC4.3-SOL.8 - Development of industry best-practices for the coordination between dispatchers, fuel team and crew members
- UC4.3-SOL.11 - Development of industry best-practices for monitoring operating conditions data

3.1.9 Safety Monitoring Systems

Outline best practices for operators to establish tailored safety monitoring systems aligned with their fuel reduction initiatives. Consider factors like aircraft types, routes, and fuel schemes. This integration of fuel performance data can involve developing specific data analysis tools and procedures to identify potential safety risks associated with fuel-saving practices.

- **Rationale:** It's crucial to ensure that fuel-saving practices do not compromise safety standards. Integrating safety monitoring systems helps maintain a balanced approach. Utilising data analysis and safety monitoring systems allows for a more data-driven approach to safety management, enabling targeted interventions and resource allocation.

- **Benefits:** By identifying potential safety risks early, airlines can take preventative measures and mitigate potential hazards before they occur. A focus on data-driven safety analysis fosters a proactive safety culture within airlines, encouraging continuous improvement and risk mitigation strategies. Regulatory bodies can leverage safety monitoring systems to gain a comprehensive understanding of safety trends and risks associated with fuel efficiency initiatives.

- **Risks:** Integrating large volumes of fuel and safety data can be challenging to analyse effectively. Robust data management and analytical tools are essential. It's important to interpret safety data carefully and avoid drawing inaccurate conclusions that could lead to unnecessary restrictions or hinder fuel efficiency improvements.

  Regular reviews and updates of the safety monitoring system are crucial to ensure its effectiveness and adaptability to evolving fuel efficiency strategies.

This recommendation is an answer to solutions:

- UC4.1-SOL.1 - Development of guidelines for minimum conditions and selection criteria of fuel-related data sources
- UC4.1-SOL.2 - Development of guidelines for FDM data governance frameworks to allow for fuel-related developments
- UC4.1-SOL.6 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.8 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.9 - Development of GM/AMC for minimum requirements and selection criteria of fuel-related data sources
- UC4.1-SOL.11 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.12 - Development of GM/AMC that establish a standardised framework for generalizing statistical models
- UC4.1-SOL.13- Development of GM/AMC specifying what constitutes statistically relevant data
- UC4.1-SOL.14 - Development of GM/AMC specifying criteria for assessing the adequacy of data for statistical analysis
- UC4.1-SOL.15 - Development of industry best-practices for data sharing and collaboration among operators
- UC4.1-SOL.16 - Development of industry best-practices for the generalization of statistical models
- UC4.1-SOL.17 - Development of GM/AMC capturing the need for transparency in algorithm details provided by vendors
- UC4.1-SOL.18 - Development of GM/AMC that allow for more flexibility regarding fuel consumption monitoring systems
- UC4.1-SOL.20 - Development of GM/AMC for minimum requirements regarding fuel-related parameters that are manually collected
- UC4.1-SOL.22 - Development of GM/AMC accounting for specificities in regard with validation of fuel data through the adoption of standards
- UC4.1-SOL.24 - Alignment of FDM and fuel schemes guidelines regarding relevant parameters to be collected under performance
- UC4.1-SOL.25 - Development of GM/AMC for FDM data governance agreements
- UC4.1-SOL.26 - Development of industry best-practices for standardised statistical methods and advanced fuel-reduction models
- UC4.1-SOL.27 - Development of GM/AMC that enhance the modification of the Operation Manual to provide pilots with insights on models
- UC4.1-SOL.28 - Development of industry best-practices for fuel-related model validation frameworks
- UC4.1-SOL.29 - Development of industry best-practices for the deployment of fuel-related models

3.1.10 Unified approach to monitor SPIs

Define a framework for collaboration between fuel and safety departments in evaluating safety aspects of fuel initiatives while utilising operating conditions data. Establish regular meetings and communication channels for joint assessment of SPIs and operating conditions data. Align fuel efficiency initiatives with clearly defined safety objectives and risk tolerances. Implement secure and standardised data sharing procedures to facilitate seamless information exchange between departments. Provide training and awareness programs for both fuel and safety personnel to foster a collaborative culture and understanding of each other's domains.

- **Rationale:** Fuel efficiency initiatives can sometimes have unintended safety consequences. A unified approach ensures proactive risk management and mitigation strategies. By integrating safety considerations into fuel efficiency analysis, airlines can maximise fuel savings without compromising safety. A unified approach helps airlines comply with evolving safety regulations and demonstrate their commitment to safe and sustainable operations.

- **Benefits:** A unified approach ensures that safety considerations are integrated throughout the fuel efficiency improvement process, minimising potential risks associated with new initiatives. Collaborative evaluation of SPIs and operating conditions data allows for informed decision-making that balances fuel savings with safety priorities. Proactive identification and mitigation of potential safety issues can prevent disruptions and accidents. A clear framework fosters transparency and accountability within airlines and across the industry regarding safety and fuel efficiency efforts.

- **Risks:** Overcoming existing departmental silos and fostering a truly collaborative approach requires dedicated effort and cultural change. Integrating safety data with fuel performance data and operating conditions data can be technically challenging and require robust data management processes. Implementing a unified approach effectively requires dedicated personnel with expertise in both fuel efficiency and safety domains.

This recommendation is an answer to solutions:

- UC4.1-SOL.12 - Development of industry best-practices for collaboration and coordination between Authorities regarding the monitoring and re-assessment of safety performance
- UC4.2-SOL.1 - Development of industry best-practices for the definition and differentiation of safety indicators and events
- UC4.2-SOL.2 - Development of GM/AMC for standardised lists of SPIs
- UC4.2-SOL.3 - Development of industry best-practices for the definition of safety frameworks to specific fuel reductions
- UC4.2-SOL.5 - Development of industry best-practices for the definition of expanded lists of SPIs
- UC4.2-SOL.6 - Development of industry best-practices for the monitoring of fuel-related safety trends
- UC4.2-SOL.8 - Development of GM/AMC for the alignment of fuel initiatives with Safety Management System (SMS)
- UC4.2-SOL.9 - Development of GM/AMC for the de-identification of fuel-related data
- UC4.2-SOL.10 - Development of GM/AMC for the continuous reporting of fuel-related safety performance

- UC4.2-SOL.11 - Development of industry best-practices for the monitoring of fuel-related safety events

3.1.11 Reporting to competent authority

Refine reporting requirements for fuel scheme safety performance, regulatory compliance, and operating conditions data. Define specific safety indicators and metrics to be reported, such as:

- Occurrence of safety events potentially linked to fuel-saving practices.
- Trends in safety indicators before, during, and after implementation of fuel schemes.
- Effectiveness of safety mitigation measures associated with fuel schemes.
- Standardise reporting formats and frequency to ensure consistency and comparability across airlines.
- Establish clear procedures for investigating and reporting potential safety concerns related to fuel schemes.

Streamline reporting requirements to avoid duplication and unnecessary burden on airlines. Utilise standardised data formats and protocols to ensure compatibility with existing regulatory systems. Implement automated reporting mechanisms where feasible to improve efficiency and accuracy. Provide clear guidance and support to airlines on regulatory compliance requirements. Define minimum data sets to be reported based on specific fuel schemes and aircraft types. Specify the format and frequency of data reporting to ensure timely and accurate information. Establish clear data quality standards and validation procedures. Develop secure and reliable data submission channels for airlines. Collaborate with airlines, industry stakeholders, and relevant authorities to review and refine existing reporting requirements. Develop clear guidelines and templates for fuel scheme safety performance, regulatory compliance, and operating conditions data reporting.

Promote the use of standardised data formats and protocols to ensure compatibility and data exchange. Implement secure and reliable data submission channels for airlines. Provide training and support to airlines on the revised reporting requirements.

- **Rationale**: The current reporting system may not be providing optimal support for both effective safety oversight and minimising the burden on airlines.

- **Benefits:** Enhanced reporting enables competent authorities to effectively monitor safety trends and identify potential risks associated with fuel-saving initiatives. Comprehensive reporting provides valuable data for authorities to inform regulatory development and safety improvement strategies. Standardised reporting fosters transparency within the industry and promotes accountability of airlines for their fuel efficiency and safety performance. Streamlined reporting procedures and automation can minimise administrative burden on airlines.

- **Risks:** Finding the right balance between collecting sufficient data for effective oversight and minimising the reporting burden on airlines. Ensuring the accuracy, completeness, and consistency of reported data across airlines and different fuel schemes. Implementing robust data security measures and protocols to protect sensitive information.

This recommendation is an answer to solutions:

- UC4.1-SOL.12 - Development of industry best-practices for collaboration and coordination between Authorities regarding the monitoring and re-assessment of safety performance

- UC4.2-SOL.1 - Development of industry best-practices for the definition and differentiation of safety indicators and events
- UC4.2-SOL.2 - Development of GM/AMC for standardised lists of SPIs
- UC4.2-SOL.3 - Development of industry best-practices for the definition of safety frameworks to specific fuel reductions
- UC4.2-SOL.5 - Development of industry best-practices for the definition of expanded lists of SPIs
- UC4.2-SOL.6 - Development of industry best-practices for the monitoring of fuel-related safety trends
- UC4.2-SOL.8 - Development of GM/AMC for the alignment of fuel initiatives with Safety Management System (SMS)
- UC4.2-SOL.9 - Development of GM/AMC for the de-identification of fuel-related data
- UC4.2-SOL.10 - Development of GM/AMC for the continuous reporting of fuel-related safety performance
- UC4.2-SOL.11 - Development of industry best-practices for the monitoring of fuel-related safety events

4. Flight data models for safety

The most critical action required for the implementation of the solutions for flight data models for safety is the establishment of the range of aircraft that are to be included within a FDM programme. Currently, only aircraft with a MCTOM of greater than 27000kg are included, if smaller passenger aircraft are to be included, the MCTOM will need to be reduced.

Secondary to this is the definition of the FDM data that is required as a minimum. This will be impacted by the size and date of manufacture of aircraft, as not all data may be available for all aircraft. It should be noted that this is only a minimum FDM data set, and operators or manufacturers may decide to record a larger data set to help advance their operations and aircraft.

The ability to record greater amounts of data and move to the recording of flight parameter values in engineering units and explicit values (for discrete parameters), so that they do not have to be decoded (using conversion equations or value tables). This will be a significant driver in delivering a better FDM programme. That aligned with the development of easy methods to capture and transfer the data for analysis will also be critical, especially for smaller operators with lower capacity to take on additional cost and work.

The solutions proposed for flight data models for safety have been separated into; Regulatory / AMC / GM updates required or non-regulatory work e.g. development of industry best practice, updates to training material, etc. These are presented in Table 4-1 and Table 4-2.

Table 4-1 Use case 5.1 Identification, decoding and processing of flight data for a FDM programme

Use Case 5.1 Identification, decoding and processing of flight data for an FDM programme	
Regulation / AMC / GM updates required	Non-Regulatory work
UC5.1-SOL.2 - Set an objective for minimum data recovery	**UC5.1-SOL.1 -** Recording of flight data in non-binary formats for safety use
UC5.1-SOL.3 - Develop a Flight Parameter Reference document for FDM	**UC5.1-SOL.10 -** Establishment of open contextual data repository
UC5.1-SOL.4 - Definition by manufacturers of DFLs with a wide selection of parameters	**UC5.1-SOL.11 -** Industry best-practices on contextual data fusion
UC5.1-SOL.5 - Install WQAR equipment on newly manufactured smaller aircraft	**UC5.1-SOL.15 -** Integration of manufacturers of smaller aircraft into the EOFDM forum
UC5.1-SOL.6 - Create the conditions for open access to DFL electronic documentation	
UC5.1-SOL.7 - Conditions for minimum data analysis capabilities	
UC5.1-SOL.8 - Minimum list of risk areas to be monitored through FDM	
UC5.1-SOL.9 - Development of industry-agreed FDM algorithms and logics	
UC5.1-SOL.12 - Addressing Intellectual Property Rights in FDM	
UC5.1-SOL.13 - Maintaining knowledge and documentation on flight data and DFLs	
UC5.1-SOL.14 - Maintaining knowledge and documentation on FDM events and algorithms	

Table 4-2 Use case 5.2 Usage of flight datafor FDM and other safety relevant activities

Use Case 5.2 Usage of flight data for FDM and other safety-relevant activities

Regulation / AMC / GM updates required	Non-Regulatory work
UC5.2-SOL.1 - Define minimum FDM software capabilities	**UC5.2-SOL.3 -** Industry best-practices on FDM-SMS integration
UC5.2-SOL.2 - Technical standards for FDM-SMS integration	**UC5.2-SOL.4 -** Industry best-practices on data access policies for FDM
UC5.2-SOL.5 - Define cross-domain data formatting standards	**UC5.2-SOL.6 -** Explore flight data governance and concept mapping across flight data-based programmes
UC5.2-SOL.7 - Certification of FDM analyst competency	**UC5.2-SOL.8 -** Address data access policies for other uses of flight data
	UC5.2-SOL.9 - Industry best-practices for sharing flight data in collaborative frameworks
	UC5.2-SOL.10 - Industry best-practices on FDM causal factor analysis

4.1 Detail rationale for FDM roadmap

4.1.1 Definition of MCTOM of aircraft to be included in FDM programme

Widen the scope of aircraft that need to be included in a FDM programme by establishing a new minimum MCTOM.

- **Rationale:** Currently only aircraft with a MCTOM of greater than 27000kg are included within the requirements for a FDM programme. This currently excludes a large proportion of smaller aircraft that are utilised by operators. Certain aircraft are already required to have flight data recorders so gather certain data already.

- **Benefits:** Inclusion of a lighter aircraft into a FDM programme will support advancements in safety and optimal performance of these aircraft and support the SMS of their operators.

- **Risks:** The additional cost and technology required to implement a FDM programme on a larger range of aircraft could have undue financial penalties on smaller operators.

This recommendation is an answer to solutions:

- UC5.1-SOL.5 - Install WQAR equipment on newly-manufactured smaller aircraft
- UC5.1-SOL.15 - Integration of manufacturers of smaller aircraft into the EOFDM forum

4.1.2 Definition of minimum set of FDM events to be recorded

Establish a working group to establish the minimum list of risk areas to be monitored through a FDM programme.

- **Rationale:** By establishing a baseline of factors to be recorded for an FDM programme, operators and aircraft manufacturers will be able to develop solutions that meet the minimum requirements. This in turn will enable operators to establish a single consistent FDM programme across their fleets, reducing cost and improving comparative analysis between aircraft within a fleet and across aviation. Although this is a minimum required data set it does not preclude operators or aircraft manufacturers recording additional data

- **Benefits:** The sharing and cross operator, cross fleet comparison of data will be simplified due to the same minimum data being recorded by all operators in a FDM programme.

- **Risks:** If this minimum data set is too large, smaller aircraft or operators may struggle to establish and maintain this data. Consideration should be given to what the data captured will be used for and how this supports and improves safety and aircraft optimisation.

This recommendation is an answer to solutions:

- UC5.1-SOL.8 - Minimum list of risk areas to be monitored through FDM
- UC5.1-SOL.9 - Development of industry-agreed FDM algorithms and logics

4.1.3 Recording of flight parameter values in engineering units and explicit values (for discrete parameters), so that they do not have to be decoded (using conversion equations or value tables

Explore the feasibility of recording of flight parameter values in engineering units and explicit values (for discrete parameters), so that they do not have to be decoded (using conversion equations or value tables to optimise the use of increase storage and memory capabilities and cloud-based storage to increase the frequency and data that can be captured during a flight.

- **Rationale:** By enabling the use of digital flight data recording, a greater data set can be capture and the post analysis is simplified due to not require DFL to store data and for later decoding.

- **Benefits:** This simplifies the data capture process and the post analysis for operators by removing the need for specialist software to interpret DFL. It also increases the potential range of data that can be recorded and potentially enable real time data analysis either on board the aircraft or via remote link/cloud-based storage options. Additionally, the fusion of data with other sources is simplified enabling a greater insight in the data to be obtained**.**

- **Risks:** The establishment of new data recording formats may result in operators' with blended fleets having data captured in multiple formats reducing the benefits of a standardised approach, requiring multiple different data analysis and extraction capabilities. This may also lead to discrepancies between data depending on frequency and resolution of the data recorded.

This recommendation is an answer to solutions:

- UC5.1-SOL.1 - Recording of flight data in non-binary formats for safety use
- UC5.1-SOL.4 - Definition by manufacturers of DFLs with a wide selection of parameters

4.1.4 Definition of standardised DFL for FDM recording

Establish a standardised format for the recording for flight data in binary format to reduce the variation between suppliers and/or aircraft. This in turn will enable operators to use a single FDM software solution to download and decodify the FDM data from the DFL. This would be applicable to aircraft who cannot be retrofitted to use alternative means of data capture as describe in 4.1.3.

- **Rationale:** By having no standard DFL, operators are required to have multiple different decoders to download FDM data from aircraft. This also leads to variation in how the data is recorded, the sampling rates, and the lack of ability to compare data on a like for like basis.

- **Benefits:** A standardised DFL for all FDM solutions would enable operators of blended fleets to have only a single software solution to download and interpret FDM data, reducing costs and complications in the management of a FDM programme. It would also support regulatory analysis of FDM data by ensuring consistency of data and formats enable in-depth data analysis.

- **Risks:** Establishing industry agreement on DFL will be challenging due to aircraft manufactures not wishing to share proprietary information or fear of breach of IPR. The cost and complication of establishing and upgrading multiple FDM solutions on blended fleets may be prohibitive for smaller operators.

This recommendation is an answer to solutions:

- UC5.1-SOL.3 - Develop a Flight Parameter Reference document for FDM
- UC5.1-SOL.6 - Create the conditions for open access to DFL electronic documentation
- UC5.1-SOL.12 - Addressing Intellectual Property Rights in FDM

4.1.5 Fusion of contextual data with FDM data

Establishing a standard format for the recording of aerodrome data to supplement FDM data in developing understanding of factors that affect aircraft performance and safety.

- **Rationale:** By understanding external factors to the aircraft, such as localised weather conditions, and fusion of this data with the FDM, a clearer understanding of all factors affecting, and aircraft can be gained.

- **Benefits:** By understanding external factors affecting aircraft operations, operators will be able to have a greater understand of the factors that affect an aircraft performances leading to an optimisation in the performance of their fleet, improving efficiency and safety.

- **Risk:** Understanding the relevant data required may entail initially capturing excessive amounts of data. It would also require the investment in suitable technology and data collection devices by aerodromes to comply with any requirements, which may pose a financial burden on smaller aerodromes. As with FDM, a standardise format for recording and sharing would also have to be established.

This recommendation is an answer to solutions:

- UC5.1-SOL.11 - Industry best-practices on contextual data fusion
- UC5.1-SOL.10 - Establishment of open contextual data repository

4.1.6 Secure and rapid data recovery solutions.

The technology to enable rapid and secure data recovery utilising WQAR is already in existence which will support the increase range of operators able to comply with FDM requirements. The requirement for data analysis is already achievable once the data has been recovered.

- **Rationale:** The use of WQAR solutions on aircraft and the ability to rapidly and securely download the data wirelessly will support all operators in being able to implement a FDM programme. This is of relevance to smaller operators who may be constrained by resources limitations. Once data has been recovered understanding how to analyse the data is key to ensure the outcomes of a FDM programme can be used to enhance operations and safety in the future.

- **Benefits:** The use of technological solutions will reduce the complexity and cost of data recovery of FDM data, enabling smaller operators to comply with the requirements of a FDM programme. It will also reduce the risk of data corruption and loss of data through more manual process of data recovery. The development of strategies and best practice for data analysis, will support smaller operators in establishing their own FDM programmes by removing the need to spend time and cost to develop their own strategies.

- **Risks:** The use of new technologies may create a cyber or software risk to the aircraft, particularly if the data recovery is done while the plane is in flight. Solutions would have to reach the required levels of software assurance and cyber security requirements to implement which will have cost implications. Manufacturers and operators may also start to collate to much data with the simplification of data recovery. This may generate a situation where data analysis because over complicated and the outputs decrease in quality.

This recommendation is an answer to solutions:

- UC5.1-SOL.2 - Set an objective for minimum data recovery

4.1.7 Open access DFL

Establishment of DFL electronic documentation in open format to support operators in the establishment of FDM programmes.

- **Rationale:** With manufacturers providing the DFL electronic documentation to operators, and software vendors using it, the production of DFL decoding files is simplified and the cost can be significantly reduced.

- **Benefits:** By creating the environment for open format DFL, operators can move to non-propriety providers of FDM solutions, helping to reduce cost, supporting the role out of FDM programmes across a greater range of aircraft currently not included in FDM programmes.

- **Risk:** Assurance of the non-proprietary providers of FDM solutions may result in errors in data decoding and analysis. Aircraft manufacturers may also reduce investment in advancing FDM capabilities due to increased competition within the marketplace.

This recommendation is an answer to solutions:

- UC5.1-SOL.3 - Develop a Flight Parameter Reference document for FDM
- UC5.1-SOL.6 - Create the conditions for open access to DFL electronic documentation
- UC5.1-SOL.12 - Addressing Intellectual Property Rights in FDM

4.1.8 Data Sharing and Cross domain data format

Ensuring cross-interoperability of data in software solutions for different safety-relevant activities through standardised data formats, encompassing data structure, attributes and naming conventions. Map reference concepts across domains and processes within the operator to facilitate alignment across its multiple teams using flight data.

- **Rationale:** By increasing the accessibility and commonality in terminology used with regards to FDM within an organisation and across different airline operators, the usage of data to improve activities such as training will be enhanced.

- **Benefits:** By enabling standardisation of terminology, it ensures that as data is shared or utilised, such as for training, there is confidence in the validity in the outcomes and enhancement for all areas within an organisation. **Risk:** With the wider use of data, unless the users of it understand the details, it could be misinterpreted and misused leading to incorrect decisions being made or misleading training being provided.

This recommendation is an answer to solutions:

- UC5.2-SOL.3 - Industry best-practices on FDM-SMS integration
- UC5.2-SOL.5 - Define cross-domain data formatting standards
- UC5.2-SOL.6 - Explore flight data governance and concept mapping across flight data-based programmes
- UC5.2-SOL.9 - Industry best-practices for sharing flight data in collaborative frameworks
- UC5.2-SOL.4 - industry best-practices on data access policies for FDM
- UC5.2-SOL.8 - Address data access policies for other uses of flight data

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