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D-3.3.4 - TRAINING REQUIREMENTS FOR FDM ANALYSTS

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

Data stays at foundation of decision-making, accelerating the digital transformation across industry. Strong data systems and new technology have been embraced in aviation with significant changes to the traditional working processes, business models, standards and regulations. In this context, 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

This report belongs to task “T-3.3 - Training material” of the “Digital Transformation – Case Studies for Aviation Safety Standards” project (EASA.2022.HVP.01- Horizon Europe Project). The purpose of this deliverable is to provide dissemination material designed to detail some of the solutions identified within the project's context, particularly those that could represent potential quick wins. This material aims to offer initial and independent reflections from the consultant, serving as a foundational resource for future initiatives by the Agency and the industry. By outlining these actionable insights, the document seeks to stimulate further exploration and implementation of effective strategies, ultimately contributing to the advancement and innovation within the sector. Particularly, this document focuses on defining potential training requirements for FDM analysts aiming to ensure that they pose the necessary skills and knowledge, ultimately contributing to enhancing the efficiency and the functioning of the FDM programmes.

Results and Application

The report delves into one of the solutions proposed in the context of the project, providing further details and a series of recommendations that could be applied to achieve an effective implementation of the solution. All of this is collected and provided in the form of training materials. Such training materials are intended to be used at EASA's discretion, for instance by including it in dissemination documents or in guidance material to help in the potential implementation of the solutions by the stakeholders. Thus, the output of this document provides additional information to EASA to support their decision on the evolution of the solutions proposed in the context of this project. Regarding this specific document, it covers the definition of a set of preliminary training requirements for FDM analyst.

CONTENTS

ABBREVIATIONS

ACRONYM	DESCRIPTION
ACARS	Aircraft Communication Addressing and Reporting System
AMC	Acceptable Means of Compliance
AOC	Air Operator Certificate
ATO	Approved Training Organisations
AU	Airspace Users
CAT	Commercial Air Transport
CBTA	Competency-Based Training and Assessment
CS	Case Study
D4S	Data4Safety
EAFDM	European Authorities coordination group on Flight Data Monitoring
EASA	European Union Aviation Safety Agency
EBT	Evidence-Based Training
EOFDM	European Operators Flight Data Monitoring forum
FDAU	Flight Data Acquisition Unit
FDM	Flight Data Monitoring
GM	Guidance Material
KPI	Key Performance Indicator
OJT	On the Job Training
NAA	National Aviation Authority
SMS	Safety Management System
SPI	Safety Performance Indicators
SRM	Safety Risk Management
UC	Use Case

1. Introduction

This report represents one of the deliverables under the task "T-3.3 Training material" of "Digital Transformation – Case Studies for Aviation Safety Standards" project (EASA.2022.HVP.01- Horizon Europe Project). D-3.3 is complemented by 5 (five) individual deliverables covering the different case studies of the project, presented in Table 1-1 below.

Table 1-1 List of deliverables complementing D-3.3

Deliverable		Title	Case Study
D – 3.3	D-3.3.1	Standardised metrics and methods for instructor concordance assurance	CS3 - EBT
	D-3.3.2	Untapped benefit of fuel reduction schemes: Reviewing the NPA-2016-06(A) economic impact assessment	CS4 - Fuel
	D-3.3.3	Recommendations on assurance framework for analytical development and approval of fuel schemes	
	D-3.3.4	**Training requirements for FDM analyst**	**CS5 - FDM**
	D-3.3.5	Development of industry-agreed FDM algorithms and logics	

Within the context of the DATAPP project, the D-3.3.x deliverables are intended to provide dissemination material designed to concretise some of the solutions proposed during the project, particularly those that could represent potential quick-wins. Such materials are intended to be used at EASA's discretion, for instance by including it in dissemination documents or in guidance material.

This deliverable "D-3.3.4 Training requirements for FDM analysts" focuses on defining the approach for establishing training standards and requirements for FDM (Flight Data Monitoring) analysts. Its primary objective is to bolster the effective implementation of FDM programmes within a rapidly evolving digital ecosystem specific to FDM. By delineating the key limitations driven by the lack of training guidelines, this document aims to justify their need to ensure that FDM analysts possess the necessary skills and knowledge to navigate and leverage advancements in digital technologies. This deliverable addresses the primary challenges stemming from the lack of specific training standards, proposing potential approaches to mitigate these issues. It outlines a preliminary set of requirements aimed at establishing essential standards for FDM analysts.

The present document is structured as follows:

- Section 1 presenting the scope of the document and the structure of this report.
- Section 2.1 as an introduction covering the background, including the rationale and the objectives behind the document.
- Section 2.2 presents an overview of the proposed solution, including discussion on potential approaches to put in place training requirements for FDM team members.
- Section 2.3 provides a proposal of general provisions for competency-based training framework for FDM analysts.
- Section 2.4 provides a proposal of general provisions for designing relevant training programmes / curriculums as per the proposed competency-based training framework.

- Section 3 includes the conclusions where the results of this deliverable have been summarised.
- Section 4 lists the reference material that have been used as a reference for developing this document.

2. Training requirements for FDM analysts

2.1 Background

2.1.1 Why we need to act – Issue / rationale

The Air OPS Regulation establishes the technical requirements and administrative procedures applicable to air operations in the EU regulatory system, implementing the essential requirements for air operations established in Annex V to the Basic Regulation. Under this regulation, operators must have in place a Flight Data Monitoring (FDM) programme according to Part-ORO, ORO.AOC.130, which applies to operators of aeroplanes operated for commercial air transport with a Maximum Certificated Take-Off Mass (MCTOM) in excess of 27,000 kg.

AMC1 ORO.AOC.130 specifies that the safety manager should be responsible for the FDM programme, and GM1 ORO.AOC.130 (e)(3) provides recommendations on organising the FDM programme from a team perspective (FDM Team), indicating the role and main responsibilities of each profile. A new sentence was proposed in the recently issued NPA 2024-02 point (e)(3)(i) to recommend that the 'FDM team' is part of the team under the authority of the safety manager.

In its point (e)(3)(ii), it states that all FDM team members need appropriate training or experience for their respective area of data analysis and that each team member should be allocated a realistic amount of time to regularly spend on FDM tasks.

However, despite the recognition by both industry and Member States that FDM team members are a key piece within the overall FDM programme, the Air OPS Regulation does not include training requirements for them. This lack of requirements has resulted in several issues which are discussed below.

Lack of adequate training standards

As already stated, FDM team guidance in AMC1 ORO.AOC.130 and ICAO Doc 10000 provides information on organising the FDM programme from a team perspective (FDM Team), including the profiles and areas of expertise. Moreover, these documents specify that all FDM team members need appropriate training or experience for their respective areas of data analysis and should be allocated a realistic amount of time to regularly spend on FDM tasks. However, these did not fully cover the full range of roles and responsibilities of different profiles within current FDM programmes and provided specifications and recommendations on their minimum qualifications are insufficient to clearly define what training should be delivered or guaranteed. As a result, the consistency and effectiveness of FDM programmes are not uniformly maintained across Europe. In the recent NPA 2024-02, some of these inconsistencies are addressed, reformulating the description of roles and responsibilities, as well as qualifications for certain profiles, including the FDM analyst, which is one of the core profiles of the programme. However, further guidance may need to be provided to operators in defining minimum qualifications for members operating the FDM programme.

FDM analysts today face the challenge of assessing complex events in a multiparametrical context, managing overwhelming data parameters and whose analytical work have an actual impact on the overall safety management system, using advanced technology. Not all FDM events need to have a complex trigger logic, and some are quite straightforward (e.g., TCAS RA, TAWS warning, speed limit exceedance, stall protection triggered). However, as highlighted during the DATAPP research interviews and interactions with the industry, the software used by FDM analysts is becoming increasingly sophisticated to handle larger volumes and more variable data. While having more operational data can lead to better decision-making (e.g. better identification of root-causes for identified safety threats through safety precursors analysis), it also increases the risk of data overload, where both relevant and irrelevant information are present. Analytical support tools are increasingly developed to support FDM analysts at performing their job, even including tools such as predefined dashboards with pre-computed events for easing the root-cause analysis and the analysis and diagnosis related tasks.

However, without proper training this might lead as well to a lack of robustness, relevance and reliability over the analysis performed, and consequently on trust over the conclusions provided by the FDM system. This increases the potential for incorrect assessments based on irrelevant data, underscoring the need to filter and focus on the most pertinent information. As systems and technology advance and become more complex, it is crucial for FDM analysts to stay updated and adapt to these changes to build effective barriers against safety risks.

Moreover, besides the needed technological related capabilities, aircraft operation knowledge is as important as programming and IT skills for properly performing the job. In that regard, it should be ensured that the personnel involved in the FDM programme have the appropriate knowledge of the particular operation of the operator, since working with profiles that lack such important insights may be challenging.

Additionally, the science of training has evolved dramatically. Some years ago, it sufficed to teach someone how to use a basic tool and impart essential knowledge. Today, the demands are far more rigorous. Contemporary training programs strive to instill lifelong skills for tackling complex problems and adapting to new challenges and uncertainties. These innovative training methods emphasise developing competencies that enable individuals to manage both everyday issues and long-term changes. The focus is on capabilities rather than mere knowledge, encouraging people to adapt and apply their skills in diverse analytical situations. Trainees now learn to grasp the consequences of their actions within a complex context, rather than simply performing tasks without understanding their purpose or impact.

Most Member States have not defined particular minimum qualification and training standards of FDM team members. In some cases, Member States have promoted slight adaptations of recommendations captured in EASA GM1 ORO.AOC.130 (e)(3). This leads to different practical standards applicable in each Member State with regard to the approval and oversight of these training programmes, thus creating a potential scenario of insufficient assurance that the level of qualification of this personnel is adequate to the complexity of the tasks allocated to them. While many operators have robust FDM programmes, with highly skilled teams operating them, this is of particular concern for operators with small teams and/or some outsourcing of analytics services, jeopardising the customisation of analytics to the operator's specific operations and hence the effectiveness of the programme itself. This could constitute a potential safety concern.

Lack of level playing field

As previously mentioned, some Member States have national requirements or standards for training of FDM team, as a transposition of EASA GM1 ORO.AOC.130 (e)(3) standards. Some Member States refer to the EASA GM1 ORO.AOC.130 recommendations, others to ICAO Doc 10000, although both documents capture very similar guidance. However, as per such requirements, FDM analysts tasks are restricted to the “day-to-day running of the system, producing reports and analysis”.

Given the high-level guidance provided in the GM1, national FDM programmes are issued with different concepts of what FDM analysts should cover under an approved FDM programme. While this guidance provides flexibility for each operator to define his team as best suits his operation, as well as may be dependent on third parties, it does not fulfil the initial purpose of the GM, which is to provide guidance on the functions and roles that an FDM analyst should fulfil in the context of the programme. This leads to a total lack of harmonisation and recognition of minimum qualifications for FDM analysts at European level.

The NPA 2024-02 is much more explicit about the roles and responsibilities of the FDM analyst, including functions of definition and validation of algorithms, as well as analysis of their output. In addition, it proposes minimum competencies for this position, either assumed by the organisation or guaranteed by the third party providing the service.

Subsequently, we will detail a potential syllabus proposal that could supplement the capacities identified and competences inferred in the NPA.

Inefficiencies when subcontracted

Subcontracting Flight Data Monitoring (FDM) programmes to third-party service providers can offer several positive outcomes for operators. It allows them to leverage specialised expertise and technology that might not be available in-house, potentially reducing costs and improving the efficiency of data processing and analysis. Outsourcing can also provide operators with access to the latest industry practices and innovations, enhancing the overall quality of their FDM programmes.

However, despite these benefits, subcontracting often results in significant inefficiencies because the knowledge and expertise generated through FDM activities are not fully capitalised within the operator's organisation. When operators rely on external providers for data processing and FDM event validation, they risk losing critical insights and control over the implementation of their FDM programmes. This disconnect can lead to a fragmented understanding of flight data, reducing the overall effectiveness of safety-related actions and operational improvements.

Additionally, service providers do not always have sufficient knowledge of the operations and aircraft of the operator, and they are not always fully aware of the particular details relating to certain routes or airfields. In that regard, the FDM service providers could lack access to relevant contextual information such as flight crew reports, operator’s SOP or information on training and fatigue of flight crews, among others. For these reasons, although general statistical analyses prepared by the subcontractor may be acceptable, in-house analysts with the appropriate knowledge and familiarisation of the operations and that have access to such important information sources may be needed when performing deeper analyses. This is a fundamental aspect for the optimal functioning of the FDM programme, being an integrated part of the operator's Safety Management System, and can have an impact on the proactive management of operational risk. Otherwise, as previously mentioned for the analytical support tools for FDM analysts, without proper expertise and training this might lead to a lack of robustness, relevance and reliability over the analysis performed, and consequently on trust over the conclusions provided by the FDM system.

To address these inefficiencies, it is crucial to establish clear standards for the qualifications of FDM analysts, tailored to different modes of operation, whether fully in-house, partially subcontracted, or entirely outsourced. By defining these standards, operators can ensure that their FDM analysts possess the necessary skills to oversee and manage the work of third-party service providers effectively. This approach enables operators to maintain control over the FDM programme's implementation and ensure that safety and performance data are accurately analysed and utilised.

If data processing and FDM event validation are subcontracted, the FDM analyst must be capable of controlling and directing the service provider's work. Effective implementation of the FDM programme remains the operator's responsibility, necessitating that the FDM analyst has the required expertise to guide and evaluate the service provider's performance. Therefore, NPA 2024-02 in its point (e)(3)(i)(F) also recommends that the FDM analyst possesses the necessary skills to effectively control and direct the work performed by the FDM service provider. This might ensure that the operator retains a robust understanding of the flight data and leverages it for continuous safety and efficiency improvements.

Inefficiencies in other flight data uses

The use of flight data for purposes other than the FDM programme is allowed and common practice among more mature operators. Flight data is used, for example, to support fuel efficiency programmes or monitor aircraft performance. However, this use has not reached its full potential, in particular from an analytical standpoint, mainly due to the lack of standardised protocols (e.g., data governance rules) as well as specific qualifications for FDM analysts.

Flight data analysis related responsibilities have historically been centralised within FDM teams, which restricts the adaptability and learning opportunities for other teams within an organisation. This centralisation creates silos that hinder collaborative learning and knowledge sharing across the organisation, limiting the ability of the FDM team to support broader operational goals. Although regulatory mandates and increased service offerings have expanded access to FDM knowledge, the absence of uniform standards and qualification requirements results in inconsistent data analysis and interpretation across different operators, leading to varied levels of data utility and reliability, which limits utilisation of flight data beyond traditional FDM programmes.

Proposed amendments in NPA 2024-02 aim to address the utilisation of flight data beyond the traditional FDM programme. It acknowledges that using flight data for various purposes is common practice among operators but emphasised as well that the flight data designated for FDM should not be used indiscriminately in other programmes. Uncontrolled use of this data could compromise the safeguards intended to protect its source, as outlined in ORO.AOC.130. To effectively implement that and ensure the secure and efficient use of flight data, it is essential to establish standardised training protocols for FDM analysts and other FDM team members, covering the full flight data life-cycle, from its collection and storage, to the analysis and outputs, including governance and data protection.

Challenge on adapting to new advanced technological environments and sophisticated analytical techniques

On top of that, as has been observed during the DATAPP project and based on the research and the held discussions, the analytical potential of FDM programmes extends beyond the traditional monitoring that the early stages of implementation of an effective FDM programme entail. Among various aspects, these include the integration of various data sources to enrich the data and the related analysis and the introduction of more sophisticated analytical techniques that enable the identification of patterns of events and trends in multi-parametric and complex environments from a data point of view (e.g., outlier detection algorithms for anomaly safety trends identification, Principal-Component based analysis to evaluate importance of operational data sources / contributing factors into specific safety precursors / risk areas, unsupervised clustering techniques to group operational scenarios, such as airports and approaches, that exhibit similar safety exposures, enabling the identification of shared risk patterns and facilitating the derivation of lessons learned for safety improvements…). In addition, it also includes the progressive introduction of new technological frameworks for the storage and processing of data on scale as well as big data technology based on cloud solutions. Hence, this results in an environment of analytical tools, either developed in-house or acquired from third parties, which are adapting progressively and accordingly, and in turn, it also results in the need to introduce new competencies for the FDM analysts responsible for the programme. This is an additional challenge added to the lack of standards for the minimum competencies of the FDM analysts, which also affects the effectiveness of FDM programmes from an analytical perspective. In that regard, a similar reflection is captured in section I.2.d of the “Breaking the silos” document developed by the EOFDM Working Group C.

2.1.2 What we want to achieve – Objectives

The overall objectives of the EASA system are defined in Article 1 of the Basic Regulation. This proposed solution aims at contributing to achieving the overall objectives by addressing the issues described in the previous subchapter.

The specific objectives of this proposed solution are to:

- ensure that tasks and responsibilities of an AOC holder’s FDM programme personnel are clearly identified, in particular the FDM analyst;
- address the lack of EU training requirements for the AOC holder personnel involved in the FDM programme;
- improve the clarity of some of the provisions on FDM team qualifications to fully achieve the intention behind the proposals in the recent NPA 2024-02, including clear differentiation of analytical competencies that should be proven on the AOC side to ensure an effective implementation of FDM programme and/or control over functions subcontracted to third-parties

2.2 How we could achieve it – Overview of potential approaches

The definition of specific minimum competencies and training requirements could address these limitations by supporting the establishment of a baseline level of proficiency among FDM analysts, promoting collaboration across operators' different departments, and ensuring effective utilisation of flight data for safety purposes. In this way, the effectiveness of FDM programmes could be substantially improved through a higher quality and sophistication of the performed analyses, as well as through a wider and more efficient use of the data. All of this would contribute to improving safety, since it would potentially result in an improved detection of occurrences, events or incidents, and corrective measures could be derived to mitigate them.

However, in practical terms, the implementation of these minimum competencies can be translated into several approaches, to be evaluated in the future by the Agency and stakeholders. By way of example, the current approach could be followed, by deepening through Guidance Material and/or safety promotion material (e.g., EOFDM) to support operators and States in moving towards the harmonisation of competences for the experts involved in FDM programmes and their standardisation at European level. Alternatively, a certification approach could be considered, similar to the one adopted in other dimensions of the industry, although this would entail a significant burden on operators, taking away part of the flexibility guaranteed today for the implementation of FDM programmes, being key for their adaptation to the operational reality of the aircraft operator and the promotion of their effectiveness.

The following is a brief description of two potential avenues to be evaluated, to be considered in future studies and/or rule-making groups.

2.2.1 Approach #1 - Provision of guidance for the creation of a competency-based framework and trainings or courses

A first option would be to opt for a "soft" regulatory approach, in line with the current provisions in the US regulatory framework. Specifically, it would involve the development of guidelines and/or promotional material indicating the minimum competencies and/or qualifications for FDM analysts, which could be used as a reference for the creation of initial and recurrent trainings and/or courses. A reference example for this approach could be the one followed for 'airspace designers', whose trainings or courses do not follow a 'personnel licensing approach' but a more flexible competence-based approach, which could be fulfilled either by internal training capabilities of the organisations and/or covered by various aviation organisations and training institutions.

Regulation (EU) 2017/373 states that the airspace designers should have successfully completed a training course that provides competency in that field. Additionally, the organisation providing the services should ensure that they are suitably experienced to successfully apply the theoretical knowledge and that they successfully complete continuation training.

As a result, the capacitation process for airspace designers often involves completion of specialised training programmes or courses focused on airspace design principles, regulations, and procedures. Additionally, candidates may also be required to demonstrate proficiency in using airspace design software and tools. While such certification in airspace design is not mandated, it is valued within the aviation industry and may be preferred or required by employers seeking qualified airspace designers since it demonstrates proficiency in this specialised field.

While individual certification for airspace designers may not be a legal requirement, the company or organisation employing airspace designers needs to be certified or authorised by the relevant regulatory authority to operate within the aviation industry. In a similar vein, operators must have their FDM programmes approved and overseen by the authorities, but do not require specific certification for the FDM analysts. As previously stated, FDM analysts are required to demonstrate some experience and receive the necessary training, but the exact associated requirements are not clearly defined.

Also in the context of airspace design personnel, there are documents such as "ICAO Doc 9906 - Quality Assurance Manual for Flight Procedure Design" which are intended to serve as a reference and to provide guidance for organisations designing and delivering airspace design training, including potential contents to be included. Additionally, such document provides guidance to regulators who certify and approve training courses and programmes and for the organisations who provide the trainings through third parties to check the appropriateness of such trainings. For this particular case, a Competency-based Training and Assessment (CBTA) approach is used, similar to the one used in flight crew training, as a set of competencies necessary for the specific role is established. Moreover, the document provides guidance on how to derive or design a curriculum or syllabus based on this competency framework.

Similar to the approach assumed for airspace designers, guidance documentation could be developed to be used as a reference for the design of the trainings for FDM analysts. The present document proposes a potential non-exhaustive reference syllabus, as a list of required topics in which knowledge is needed to ensure that the different training programmes or courses serve to prepare FDM analysts and that the proper development of the necessary skills and competences for exercising the job is achieved.

2.2.2 Approach #2 - Personnel licensing or certification process

Another option would be to adopt a personnel licensing or certification process, which is the approach followed, for example, in the case of Air Traffic Safety Electronics Personnel (ATSEP).

In a personnel licensing approach, individuals must meet strict requirements and pass standardised examinations to obtain certification. This certification serves as a legal requirement to work in certain roles within the aviation industry. The enrolled candidates must demonstrate proficiency in technical skills, knowledge of safety regulations, and familiarity with specific systems. They need to successfully complete the established basic training, the qualification training and the system/equipment rating training. Once certified, ATSEP are legally authorised to perform their duties within the aviation industry. However, to maintain their certification, they may be required to undergo continuing education and recertification periodically to ensure that they stay updated with advancements in technology and changes in regulatory requirements.

Although this approach would ensure greater control and standardisation of the profiles involved in the FDM programme, as well as benefits in the professionalisation of these expert profiles, it would also burden all agents in the sector, with special impact on the operators responsible for its implementation and the certification authorities. In addition, the implementation of this solution would also be costly from a regulatory point of view, creating the need to define the certification framework of the profiles as well as the organisations responsible for issuing such certifications. Finally, the solution could compromise the flexibility given today to promote the effective implementation of the programmes.

2.3 Proposed general provisions for competency-based training for FDM analysts

This chapter outlines, in a general manner, the principles and procedures that could be followed in the design and implementation of a competency-based approach to training and assessment of FDM analysts. It outlines its key features and briefly describes how the competency-based approach is to be used by course developers. This chapter provides the requirements with which training providers and licensing authorities could comply to implement competency-based training and assessment.

2.3.1 Competency-based approach to training and assessment

The development of competency-based training and assessment must be based on a systematic approach whereby competencies and their standards are defined; training is based on the competencies identified and assessments are developed to determine whether these competencies have been achieved. Competency-based approaches include:

- **Mastery learning:** Ensuring that trainees achieve a high level of understanding or proficiency in each area before moving on to the next area, hence they need to demonstrate mastery in specific competencies.
- **Performance-based training:** Focuses on developing specific skills and knowledge that can be directly applied in real-world scenarios. For FDM analysts, the training should be focused on measurable outcomes such as the ability to interpret flight data, detect anomalies, and report findings, ensuring that the trainees' performance meets operational needs.
- **Criterion-referenced training:** Method in which trainees are assessed against defined criteria or standards of performance, rather than being compared to other trainees.
- **Instructional systems design:** Systematic approach to designing, developing and delivering training programmes for ensuring that the training is structured around clearly defined learning objectives, instructional methods and assessment tools, while being aligned with the defined competencies.

Following the criteria provided in ICAO Doc 9906, competency-based approaches to training and assessment should include the following features:

- the justification of a training need through a systematic analysis and the identification of indicators for evaluation;
- the use of a job and task analysis to determine performance standards and the inventory of skills, knowledge and attitudes;
- the identification of the characteristics of the trainee population;
- the derivation of training objectives from the task analysis and their formulation in an observable and measurable fashion;
- the development of criterion-referenced, valid, reliable and performance-oriented tests;
- the development of a curriculum based on learning principles, with a view to achieving an optimal path to the attainment of competencies;
- the development of material-dependent training; and
- the use of a continuous evaluation process to ensure the effectiveness of training.

The competency framework consists of competency units, competency elements, performance criteria, evidence and assessment guide. These components within the competency framework must be derived from job and task analyses of FDM analysts and describe observable outcomes. Definitions of the competency framework components are provided below:

- **Competency Unit:** A discrete function consisting of a number of competency elements.
- **Competency element:** An action that constitutes a task that has an observable outcome.
- **Performance criteria:** A simple, evaluative statement on a required outcome of the competency element. Several performance criteria can be associated to a competency element.

The FDM analysis process flow indicating workflow and items by the FDM analyst has been derived from general provisions included in GM1.ORO.AOC.130, as well as recommendations captured in the guidance material developed by EOFDM WGC "Flight Data monitoring analysis techniques and principles". In general, work items referred in the mentioned documentation correspond to some proposed competency elements in the competency framework. However, they are not identical. For instance, one single competency element might be applicable to multiple work steps. Based on that, the competency framework for FDM analysts is proposed to be based on the following competency units:

- Data acquisition & processing
- Definition, implementation & validation of FDM algorithms
- Analysis, visualisations and outputs of the FDM programme

Based on this competency units, an initial proposal of potential competency components for FDM analysts are provided in the next section, filling the following format.

Table 2-1 Illustrative example of competency framework template

X	Competency Unit	Standard / Regulation	Required for controlling the subcontracted tasks
X.X	Competency element		
X.X.X	Performance criteria		

On top of the competency components, the following additional fields are provided, further contextualising the proposed criteria:

- **Standard / Regulation:** For each proposed competence unit / performance criteria, non-exhaustive references to published regulation provisions and/or proposed amendments as per latest NPA are provided from which such competencies could be inferred for the position of FDM analysts. Although not specified, all proposed competency units and performance criteria can be mapped with criteria provided by "EOFDM WGC FLIGHT DATA MONITORING ANALYSIS TECHNIQUES AND PRINCIPLES" document.
- **Competencies to be retain by AOC FDM analyst (not subcontracted)?:** The 'team' necessary to run an FDM programme could vary in size from one person for a small fleet, to a dedicated section for large fleets. In some cases, some of the roles of the FDM programme are subcontracted to a service provider, including some responsibilities under the FDM analyst role. If data processing and FDM event validation are subcontracted to a service provider, the FDM analyst should be capable of controlling and directing the work of that service provider, as effective implementation of the FDM programme remains the responsibility of the operator. Therefore, this field aims at proposing those competencies that the FDM analyst within the operator should retain to effectively control and direct the work performed by the FDM service provider.

2.3.2 The competency framework

A preliminary competency framework for FDM analysts is provided below. The following table should be considered as a non-exhaustive set of competencies that may be necessary for the execution of the FDM analyst role, based on the consultant's experience, interviews with industry experts as well as available standard level material, proposals for amendments and/or guidance material.

Table 2-2 Proposed competency framework for FDM analysts

1	Data acquisition & processing	Standard / Regulation	Competencies to be retain by AOC FDM analyst (not subcontracted)?
1.1	Production of the DFL decoding file		
1.1.1.	Appropriately requests, collects & validates DFL documentation from manufacturers	NPA 2024-02- GM1 ORO.AOC.130 (d)(5) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	Yes
1.1.2.	Produces a decoding file that interprets raw flight data correctly	-	No
1.1.3.	Validates the decoding file through rigorous testing	-	No
1.2.	Decoding of flight data		
1.2.1.	Performs the selection and retrieval of stored binary data in an accurate manner	NPA 2024-02- GM1 ORO.AOC.130 (d)(5) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	Yes
1.2.2.	Correctly selects the appropriate DFL decoding file	NPA 2024-02- GM1 ORO.AOC.130 (d)(5) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	Yes
1.2.3.	Successfully performs the decoding of binary data	NPA 2024-02- GM1 ORO.AOC.130 (d)(5) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	Yes
1.2.4.	Properly validates the decoding	NPA 2024-02- GM1 ORO.AOC.130 (d)(5) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	Yes
1.3.	Data pre-processing		
1.3.1.	Assesses flight data collection reliability for effective FDM applications	NPA 2024-02- AMC1 ORO.AOC.130 (h) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	Yes
1.3.2.	Properly understands data frame layouts documentation	NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	Yes
1.3.3.	Evaluates flight data parameters availability	NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	Yes
1.3.4.	Accurately assesses & applies rules to ensure overall quality of flight data (completeness, uniqueness, accuracy, timeliness, validity)	-	Yes
1.3.5.	Adequately assesses & applies rules to ensure overall flight parameter quality (spikes, malfunction, standardisation, offset / bias correction)	-	Yes
1.3.6.	Correctly performs the definition & implementation of flight splitting & flight-phase splitting logic	-	Yes
	Adequately assesses & evaluates flight data parameters performance for effective FDM algorithms (sampling rate, accuracy, recording resolution, operational range…)	GM1 ORO.AOC.130 (a)(1)	Yes
2	**Definition, implementation and validation of FDM algorithms**	**Standard / Regulation**	**Competencies to be retain by AOC FDM analyst (not subcontracted)?**
2.1.	Identification & mapping of FDM algorithms and integration with SMS		

2.1.1.	Demonstrates proper understanding of FDM integration within overall safety performance monitoring & hazard identification system	GM1 ORO.AOC.130 (a)(1)	Yes
2.1.2.	Appropriately identifies safety risks and potential sources of risk	GM1 ORO.AOC.130 (a)(1)	Yes
2.1.3.	Demonstrates and adequate understanding over causal relationship between FDM algorithms & safety key risk areas.	GM1 ORO.AOC.130 (a)(1)	Yes
2.1.4.	Properly identifies 'broad' FDM event algorithms	GM1 ORO.AOC.130 (a)(1)	Yes
2.1.5.	Properly identifies specialised FDM algorithms (e.g., SOP deviation)	GM1 ORO.AOC.130 (a)(1)	Yes
2.2.	Definition of FDM algorithms		
2.2.1.	Performs the identification of necessary data for FDM algorithms (events or measurements)	GM1 ORO.AOC.130 (a)(1)	Yes
2.2.2.	Adequately performs the verification of flight parameters	GM1 ORO.AOC.130 (a)(1)	Yes
2.2.3.	Properly defines search windows	GM1 ORO.AOC.130 (a)(1)	Yes
2.2.4.	Appropriately performs the definition of trigger logic of FDM event algorithms	GM1 ORO.AOC.130 (a)(1)	Yes
2.2.5.	Appropriately defines severity levels of FDM algorithms	GM1 ORO.AOC.130 (a)(1)	Yes
2.2.6.	Performs the documentation process of FDM algorithms definition (e.g., pseudocodes & tech specs)	GM1 ORO.AOC.130 (a)(1)	Yes
2.3.	Implementation of FDM algorithms		
2.3.1.	Properly performs the pre-processing of required flight parameters / data sources	GM1 ORO.AOC.130 (a)(1)	Yes
2.3.2.	Properly performs the coding of FDM algorithms	GM1 ORO.AOC.130 (a)(1)	No
2.4.	Validation of FDM algorithms		
2.4.1.	Properly defines the testing plan for FDM algorithm	GM1 ORO.AOC.130 (a)(1) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	No
2.4.2.	Performs the testing of the FDM algorithms against recordings of flights with known events	GM1 ORO.AOC.130 (a)(1) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	Yes
2.4.3.	Performs the testing of the FDM algorithms over a sample flight dataset	GM1 ORO.AOC.130 (a)(1) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	No
2.4.4.	Performs the testing of the FDM algorithms under an incremental sampling approach	GM1 ORO.AOC.130 (a)(1) NPA 2024-02- GM1 ORO.AOC.130 (e)(2)	No
2.5.	Production & continuous improvement of FDM algorithms		
2.5.1	Continuous validation of FDM algorithms trigger logic / search window	GM1 ORO.AOC.130 (a)(1)	Yes
2.5.2	Continuous validation of FDM thresholds / severity levels	GM1 ORO.AOC.130 (a)(1)	Yes
2.5.3	Amendment to FDM algorithm documentation	GM1 ORO.AOC.130 (a)(1)	Yes
3	**Analysis, visualisations and outputs of the FDM programme**	**Standard / Regulation**	**Competencies to be retain by AOC FDM analyst (not subcontracted)?**
3.1.	FDM event analysis & investigation		

3.1.1.	Adequately performs the identification and categorisation of triggered FDM events	GM1 ORO.AOC.130 (a)(1)	Yes
3.1.2.	Properly conducts the detection and assessment of outliers	GM1 ORO.AOC.130 (a)(1)	Yes
3.1.3.	Performs the root-cause analysis of identified FDM events, including flight data enhanced with additional available data sources	GM1 ORO.AOC.130 (a)(4)	Yes
3.1.4.	Conducts analysis as required to support Safety Risk Assessments conducted within the SMS framework	GM1 ORO.AOC.130 (a)(1)	Yes
3.1.5.	Prepares relevant material, as required, to support Safety Promotion activities relevant for the mitigation of identified events (e.g., flight animation of events…)	GM1 ORO.AOC.130 (a)(1)	Yes
3.2.	Safety Performance Indicators & statistics over FDM events outputs		
3.2.1.	Adequately understands and defines the Safety Performance Indicators (SPIs) as per operators' SMS safety performance framework	GM1 ORO.AOC.130 (a)(2)	Yes
3.2.2.	Performs the calculation of relevant SPIs per FDM algorithm (event rate, event counts, event severity...)	GM1 ORO.AOC.130 (a)(2)	Yes
3.2.3.	Properly performs the definition & design of threshold levels supporting aggregated analysis (e.g., evaluation of temporal series deviations)	GM1 ORO.AOC.130 (a)(3)	Yes
3.2.4.	Adequately designs statistical methods to analyse aggregated trends (e.g., moving average…)	GM1 ORO.AOC.130 (a)(3)	Yes
3.2.5.	Correctly implements SPIs calculations & statistical methods within FDM analytical solution	GM1 ORO.AOC.130 (a)(3)	Yes
3.3.	Reporting & dashboarding		
3.3.1.	Adequately defines FDM programme target audience (internal & external customers)	GM1 ORO.AOC.130 (a)(1)	Yes
3.3.2.	Properly performs the identification of key data / outputs for each target audience (e.g., integration with SMS, reporting to collaborative safety teams…)	GM1 ORO.AOC.130 (a)(1)	Yes
3.3.3.	Appropriately performs the selection & design of visualisations for each key data / output for each target audience (e.g., use of bar / stacked bar charts, violin / box plots, event heat maps…)	GM1 ORO.AOC.130 (a)(1)	Yes
3.3.4.	Correctly understands & designs visualisations / outputs as per agreed Data Governance rules for each end user group (e.g., de-identification rules, confidentiality policies…)	GM1 ORO.AOC.130 (d)	Yes
3.3.5.	Accurately performs the design & development of static reports for end users (using selected FDM software and/or dedicated office productivity software)	NPA2024-02 - GM1 ORO.AOC.130 (b)(v)(F)	Yes
3.3.6.	Properly performs the design & development of interactive reports / dashboards for end users (using selected FDM software and/or dedicated dashboarding solutions)	NPA2024-02 -GM1 ORO.AOC.130 (b)(v)(F) NPA2024-02 -GM1 ORO.AOC.130 (e)(ii)(B)	Yes

2.4 From the competency framework to the training programme

The ultimate goal of training programmes would be to ensure FDM analysts meet the competency framework requirements. This goal could not be achieved through initial training alone; on-the-job training would be essential, including hands-on experience within the FDM programme processes. The interplay between initial and on-the-job training affects the designed training programme, as well as the course length, with the time needed for on-the-job training depending on the performance standards set during initial training.

The following paragraphs discuss various types of training for FDM analysts, considered as interdependent training modules which in their conjunction ensure the competency of the experts. To plan an effective and efficient training path, training providers and stakeholders should consider this interdependence, while each organisation would find its own way to achieve training effectiveness and efficiency.

The duration of a course should be based on a competency-based course plan rather than predetermined. While the course length affects cost-effectiveness for both training providers / instructors and trainees, balancing the duration is crucial. Longer courses can pose human resource planning challenges for operators, while shorter courses may compromise training quality.

Additionally, training needs differ across operators and States, influenced by the development or phasing out of technologies / software adopted by operators to support their FDM programmes as well as the proven experience of the FDM team. Thus, training providers might tailor parts of the training to meet specific needs, affecting course duration and prerequisites. For instance, some States might require Advanced Analytics competency elements in initial training, while others might include them in recurrent or advanced training.

2.4.1 Proposed training phases

The following training phases are proposed to compound FDM analysts' training programme, aligned with provisions for other competency-based training paths:

- **Ab initio training / Knowledge evaluation:** Before beginning initial training, the skills and knowledge of trainees should be evaluated. FDM analysts come from various backgrounds (such as engineering, statistics, mathematics, physics, technical fields, piloting, and aviation operations), leading to diverse skill sets and knowledge bases. Ideally, ab initio training is provided to bring all trainees to the required entry level for initial training across different domains. This phase focuses on basic skills and knowledge, not specific FDM analysis techniques. The goal is to standardise the trainees' foundational abilities before they start initial training. The curriculum for ab initio training should not be based on the competency framework. In practice, ab initio training may not be realistic to be applied for all the FDM analysts, since only few companies can afford to pay the studies of the trainees for several semesters. In some cases, this ab initio training could be structured through internship programs, allowing new entrants to develop the necessary skills to fully assume the responsibilities of an FDM analyst. Hence, in those cases in which the provision of ab initio training may not be possible, it should be ensured that the candidate has the minimum knowledge required as demonstrated by diplomas, training certificates and/or experience.
- **Initial training:** Initial training is the first phase where specific FDM analysis topics and criteria are introduced. It aims to provide new or transitioning FDM analysts with the basic skills and knowledge necessary for their role. Derived from the competency framework, this training includes an introduction to the FDM process, its integration within the overall Safety Management System (SMS) of the operator, and familiarisation with FDM software and analytical tools. Following initial training, on-the-job training is essential to consolidate the acquired skills and knowledge.
- **On-the-job-training:** Although not a formal course, on-the-job training is a crucial phase in the training programme. Its purpose is to reinforce formal training and help achieve competency standards. Like initial training, the curriculum for on-the-job training is derived from the competency framework and

focused on training objectives. On-the-job training phases can also follow advanced or refresher training if needed. When most FDM tasks are subcontracted to a service provider, on-the-job training for the operator's FDM analysts should also focus on the oversight and monitoring of the service provider's performance and on the effective collaboration and communication with such provider, mainly on those competences to be retain by the AOC personnel. This might be challenging for small teams and thus, it should be framed to be proportionate to the overall scope of work retain within the AOC, potentially relying on external services to support such trainings. As previously mentioned, although in some cases the service provider handles most of the FDM tasks, the operator is still ultimately responsible for the safety outcomes and regulatory compliance.

- **Advanced training:** Advanced training aims to enhance the skills and knowledge of active FDM analysts for more complex responsibilities. This may involve advanced analytical techniques, participation in enhanced FDM programmes, or large data exchange initiatives. The advanced training curriculum should be developed from the competency framework. [1]
- **Recurrent training:** Recurrent training addresses changes in criteria and regulations. It ensures that FDM analysts update their knowledge and skills to align with the latest standards,technologies, particular operational boundary conditions of the AOC, and benchmark their FDM analyses against best practices. Therefore, this training could focus on recent changes implemented by operational departments, such as new routes, updated SOPs, modifications to flight crew training programs, and emerging safety risks related to these changes. It would also cover new techniques and technologies, as well as regulatory updates and risks associated with changes in the operator's fleet or operational routes

2.4.2 Potential pre-requisite skills, knowledge and attitude

FDM analyst trainees intending to attend initial training would need to meet particular requirements. If training providers and/or operators offer ab initio training, it would help ensure that trainees meet these entry prerequisites. These prerequisites would be established mainly to assure that the training objectives can be met within the designated training duration. If a trainee does not comply with the prerequisites set by the training provider, it may not necessarily lead to their exclusion from the training, but it could impact their ability to meet the training objectives within the allotted time.

This subchapter emphasizes the potential pre-requisites for a specialized FDM training for safety analysts rather than focusing solely on the training of individuals who process and analyze FDM data. The traditional view of the "FDM analyst" can be quite limiting, as it suggests a narrow role focused only on FDM data. In reality, FDM analysts should be equipped to handle a variety of data types, such as flight crew reports, weather information, maintenance records, and training logs. Utilizing this diverse array of data is crucial for gaining a comprehensive understanding of events and trends and to communicate those findings to the experts responsible of the consequent tasks within the overall Safety Risk Management process of the operator.

When FDM findings are shared with other departments within an airline, it's essential that they include relevant contextual information. This highlights the need to integrate FDM insights with other data sources, moving beyond isolated data analysis and thus, the need for a certain set of skills and knowledge for FDM experts. The concept of breaking down these silos is further explored in the "EOFDM Breaking the Silos" document [5]. Additionally, many operators have small Safety Management System (SMS) teams, which often means there

[1] Some courses are beginning to explore the application of Advanced Analytics in safety-related or operational roles within airlines, but none are specifically dedicated to Flight Data Monitoring (FDM) analysis. Meanwhile, service providers often offer training or demo sessions to familiarize users with their platforms and software, but these don't go much further in advancing skills. This presents a potential opportunity for the European industry to advocate for more specialized courses in this area.

isn't a full-time dedicated FDM analyst. This reinforces the importance of fostering collaboration and integration between various data types and departments to enhance overall safety management practices.

In case of advanced, or recurrent training for experienced FDM analysts, they must establish entry prerequisites according to the training objectives and duration of the respective training. Such prerequisites could vary depending on whether these are conducted by training providers offering "open" courses, where participants come from diverse operators and backgrounds, or "tailored" courses, designed for a specific operator and/or airlines with similar expertise (e.g., similar FDM software vendor).

A potential list of pre-requisite skills, knowledge and attitude is provided below:

- **Mathematics and physics:** Trainees should possess a solid foundation in various mathematical disciplines as well as in physics to successfully engage with FDM analysis. The following areas are particularly important:
    - **Probability & statistics:** Trainees should have basic knowledge of statistical and probability mathematics, particularly an understanding of the Gaussian (normal) distribution, central limit theorem and analysis of variance.
    - **Algebra:** Trainees should be competent in algebra to at least the level of resolving equations with two unknowns and handling operations of the third level (exponentiation, radical, logarithms and angular functions).
    - **Geometry:** Trainees should be familiar with the classical Euclidian geometry (plane geometry, solid geometry) as well as Thales and Pythagoras constructions.
    - **Trigonometry:** Trainees should be competent in all trigonometry functions such as sine, cosine, tangent, cotangent, secant and cosecant. Furthermore, they should be familiar with trigonometry theorems such as the theorem of sines and the theorem of cosines.
    - **Physics Basics:** Trainees should have the basic knowledges in physics, including notions of the variables affecting flight performance (e.g., temperature, pressure, speed, forces, accelerations, kinetic energy…)
- **Aviation knowledge:** The job profile of a FDM analyst requires knowledge in various fields of activity in aviation. Operators / training providers could offer ab initio training covering the following prerequisites that should be met by the trainee so as to ensure that the length of the training can be optimised.
    - **Aircraft operations:** Trainees should demonstrate knowledge of the basics of flying and aerodynamics.
    - **Aircraft performance:** Trainees should demonstrate knowledge of aircraft performance to the level of any pilot's license with instrument rating (IR).
    - **Aircraft systems**: Trainees should be familiar with the key aircraft's systems (e.g., engines, electrical, pneumatic and hydraulic systems, fuel systems, pressurization system, structural system, navigation system…), as well as particular subsystems and sensors (e.g. transponder, TCAS, TAWS…). This includes understanding the key parameters collected from these systems and sensors, as well as the mechanisms behind them, such as the origin of the data (e.g., source system), the type of sensor used (e.g., pressure, temperature, or position sensors), and the method for computing the parameters (e.g., signal processing, data fusion algorithms). Furthermore, knowledge on the recurrent issues of the systems is also recommended.
    - **Air traffic management and navigation systems:** Trainees should demonstrate fundamental knowledge of air traffic management (ATM) as well as understanding the broad concept of ATM which consists of ATS including air traffic control, air traffic flow management, airspace

management and other fields related to ATM such as route spacing, ATC separation and aviation weather. Knowledge of navigation systems should also be required.

  - **Airport operations & safety:** Trainees must be familiar with the basic requirements for aerodrome operations, design & safety risk management (ICAO Annex 14…).
  - **Aviation meteorology:** Trainees should have basic knowledge of aviation meteorology, as weather conditions significantly impact flight operations and safety. This includes being familiar with meteorological phenomena (e.g., turbulence, wind shear, icing, thunderstorms and temperature variations) and having notions of weather patterns, atmospheric pressure and visibility conditions, thus being capable of appropriately assess weather-related data.
  - **Human performance / human factors in aviation:** Trainees should demonstrate basic knowledge regarding the human actions and decisions that play a critical role in flight safety, which includes understanding specific human factors (e.g., fatigue stress, workload, decision-making…), which should be considered for performing an appropriate interpretation of flight data and to identify potential patterns and anomalies.

- **Aviation safety & SMS:** It is essential that the trainees are familiar with key safety concepts, since the FDM is part of the operator's SMS per regulation, and the primary purpose of the FDM programme is to help manage flight safety.
  - **Safety Management System (SMS):** Trainees need a solid understanding of the components and functions of an SMS, including safety policies, risk management, safety assurance, and safety promotion. They should know how SMS integrates into daily operations and how it contributes to maintaining a high safety standard.
  - **Safety Risk Management (SRM):** Trainees should understand the principles and processes of SRM, including hazard identification, risk assessment, and risk mitigation. They should know how to evaluate safety risks, apply controls, and continuously monitor the effectiveness of such controls in preventing incidents.
  - **Safety Risk Assessment Methods:** Trainees should be familiar with the basic process and parameters of a Safety Risk Assessment (severity / probability and tolerability dimensions), as well as with various risk assessment techniques (e.g. bow-tie methodology or fault-tree analysis). They need to know how to apply these methods to evaluate potential safety risks, prioritise them, and propose mitigation measures.
  - **Just Culture:** Trainees should understand the principles of just culture. They need to understand the benefits of Just Culture and the required conditions to create Just Culture in the organisation, with particular emphasis into FDM data and its protection. Additionally, the trainee should understand the importance of open reporting, how just culture encourages transparent safety communication encouraging individuals to report safety concerns and incidents without fear of unfair punishment, and the distinction between acceptable errors and reckless behaviour.

- **Programming / coding:** Trainees should possess the following prerequisite skills in programming and coding to successfully undertake FDM analysis:
  - **Basic Programming Concepts:** Trainees should understand fundamental programming concepts such as variables, data types, loops, conditionals, and functions. This includes the ability to write and debug simple programs.
  - **Data Structures:** Trainees should be familiar with basic data structures such as arrays, lists, stacks, queues, and dictionaries, as well as their applications and operations.

- **Algorithms:** Trainees should have a foundational understanding of common algorithms, including sorting and searching algorithms, and should be able to implement them.
- **Scripting Languages:** Trainees should be proficient in at least one scripting language, such as Python, R, or MATLAB, commonly used for data analysis and manipulation.
- **Software Development Tools:** Trainees should be familiar with basic software development tools and environments, including version control systems (e.g., Git), integrated development environments (IDEs), and command-line interfaces (CLI).
- **Database Knowledge & understanding of APIs:** Trainees should understand basic database concepts and be able to write and execute simple SQL queries to retrieve and manipulate data. Trainees should have a basic understanding of how to use and interact with APIs (Application Programming Interfaces) for data retrieval and integration.
- **Error Handling and Debugging:** Trainees should have skills in identifying, diagnosing, and fixing errors in code, as well as using debugging tools effectively.

2.4.3 Example of Flight Data Analyst training programme

Below are examples of different module structures for an initial training course. The modules are sequenced differently depending on the terminal objectives the employing organisations expect the trainees to achieve.

Table 2-3 Example of Flight Data Analyst training programme

Syllabus or relevant topics	
Module	**Topic & Description**
Module 1: Foundations of Flight Data Monitoring	**Introduction to Flight Data Monitoring (FDM)**
	Overview of FDM's role in aviation safety, its historical context, and regulatory framework
	Aviation safety principles
	Fundamentals of safety management, safety culture, and human factors in aviation safety
	Airlines operations
	Minimum background regarding the operator's operations or operational scenarios, enabling a better understanding of the specific needs and characteristics of the airline
	Aircraft systems and sensors
	Knowledge of the aircraft's main systems and sensors, to understand where the different parameters come from
Module 2: Data Acquisition and Processing	**Data Frame Layout (DFL)**
	Background on the DFL, understanding what it is and the differences between aircraft, also considering that it may vary over time
	Binary encoding
	Basics of binary encoding to be able to understand potential errors or unusual values, as well as to be capable of identifying errors coming from the decoding. Additionally, minimum familiarity with ARINC717, ARINC767 and ARINC429. This is also useful when the airline outsources the decoding, to better understand the process and how to get the clean data.
	Data collection
	Knowledge on the data collection, decoding and quality assurance processes
	Flight phases and flight identification
	Insights on how the different phases of the flight are obtained and how the flight splitting is performed to identify the flights, which is relevant for a better understanding of the results
Module 3: Data Analysis and Interpretation	**Mathematics and plotting**
	Advanced concepts of mathematics, especially in the statistics field, as well as data analysis and plotting concepts and capabilities

Syllabus or relevant topics	
Module	**Topic & Description**
	Data quality
	Basics of how to interpret and correctly handle data spikes, gaps, excessive values, as well as detecting outliers
	Flight data analysis techniques
	Understanding aircraft data systems, flight data characteristics and limitations, principles of analysis and data visualisation tools
Module 4: Event Detection and Investigation	**FDM event detection and investigation**
	Techniques for identifying, categorising, and investigating safety events, including root cause analysis. Analysis of individual events and trends, including identification of causal factors.
	Pseudocode and programming skills
	Best-practices regarding pseudocode, algorithms and programming for the identification and validation of events. Data engineering and date formats handling skills.
Module 5: Reporting and Performance Monitoring	**Dashboarding**
	Basic skills on dashboarding tools, both for internal reporting and the reporting to the authorities
	Safety performance monitoring
	Key performance indicators (KPIs), trend analysis, and methods for monitoring safety performance
	Regulatory compliance and reporting
	EASA regulatory framework and reporting protocols for safety events
Module 6: Safety Management and Integration	**SMS integration and the SRM process**
	Best-practices to effectively incorporate safety management principles and risk assessment methodologies into the analysis, thereby enhancing safety performance and mitigating operational risks within the FDM programme
	Data management and security
	Principles of data management, integrity and security, including compliance with data protection regulations and promoting just culture. Confidentially policies and de-identification process and techniques for FDM data.
Module 7: Collaboration and Quality Assurance	**Collaboration between departments**
	Effective communication within safety teams and across different teams, and collaborative decision-making
	Quality Assurance
	Strategies for improving FDM programmes, quality assurance processes, and incorporating feedback

All of these topics should be considered and covered in the trainings provided to the FDM analysts, since they represent the different areas in which they would need to be proficient or, at least, have the basic knowledge on which to continue developing while performing their job. Additionally, this grouping should provide a logical flow for the participants, starting from foundational concepts and progressing towards more advanced topics related to analysis, reporting, and safety management within the FDM context.

3. Conclusions

The requirements for the FDM team, as outlined in AMC1 ORO.AOC.130 and ICAO Doc 10000, provide guidance on organising the FDM programme from a team perspective, including the necessary profiles and areas of expertise. These documents specify that all FDM team members should have appropriate training or experience in their respective areas of data analysis and should be allocated sufficient time to regularly perform FDM tasks. However, they do not fully cover the range of roles and responsibilities for different profiles within current FDM programmes, and the specified requirements for minimum qualifications are insufficient to clearly define the necessary training. Consequently, the consistency and effectiveness of FDM programmes are not uniformly maintained across the European Union. This is particularly identifiable in those operators with smaller fleets and smaller FDM programmes, with a streamlined team and much of the analytical role outsourced to FDM software vendors. The lack of such competencies could limit the capitalisation of the knowledge generated by the programme in the operator or the management of the work provided by third parties. This may limit the adaptability and evolution of the programme to the operator's specific operations and therefore its effectiveness.

In addition, different approaches to establishing minimum competencies and training requirements for the role of FDM analysts are discussed. From a regulatory point of view, two main approaches are considered: one through the creation of guidance material and recommendations for a competency-based framework or, alternatively, a more rigid approach through a licensing and certification framework.

Although it is not the purpose of this document to go into the assessment of advantages and disadvantages of each approach, based on the consultations carried out in the context of the project, the industry advocates the progressive and rationalised evolution of the expert profiles within the FDM programme, avoiding more rigid approaches that may detract from the flexibility of the programme. For this reason, the paper elaborates on proposals for the establishment of a competency-based framework for FDM analysts.

Based on the FDM process captured in the present European regulation, as well as on the guidance material developed in collaborative working groups (EOFDM WGC), the responsibilities of the FDM analyst and a first proposal for a competence framework for their effective execution have been derived. In addition, a framework for the design of a curriculum or training programme is proposed, describing how to transpose the proposed competences into training modules and different phases of training, from ab initio, through initial training, OJT and recurrent/refresher. An example of a training syllabus is also captured in the document.

In terms of next steps, defining the best approach to standardise the professionalisation of FDM analysts within the EU requires a methodical approach to meet regulatory standards and industry needs. This process involves several key steps, beginning with an initial assessment of the needs. It is recommended that EASA conducts a comprehensive assessment to identify the specific skills, knowledge, and competencies required for FDM analysts working in safety teams. This assessment would involve consultation with industry stakeholders, including airspace users, aviation safety experts, FDM software providers, and regulatory authorities. By engaging with these stakeholders, EASA could gain insights into the current practices and challenges faced by FDM analysts, helping to shape the best approach to FDM analysts training or course curriculum. For the time being, the material developed under the DATAPP research project could be considered and discussed in the context of EOFDM WG, to develop potential guidance material supporting the advancement of the effectiveness of FDM programmes.

4. Reference material

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