Corporate Aviation Safety Executive

Business Aviation Flight Data Monitoring

Participating Operators Information Pack

www.case-aviation.com

Contents

About this Document

This document is designed to compile existing Flight Data Monitoring guidance material and to provide information on the CASE project. It may also be used as a step-by-step guide for operators considering or currently implementing Flight Data Monitoring within their organisation.

Additional reference material, guidance and resources from ICAO, EASA and CAA are detailed within this document.

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June 2015

Glossary of Terms

Term	Abbreviation	Definition / Description
Aviation Risk Management Solutions	ARMS	An industry working group, ARMS, developed an improved methodology for Operational Risk Assessment (ORA).
Corporate Aviation Safety Executive	CASE	The Corporate Aviation Safety Executive was formed in 2008 by a group of Safety Managers to collate data and monitor trends over the whole business aviation community with the express purpose of improving aviation safety.
Civil Aviation Authority	CAA	The CAA is the statutory corporation which oversees and regulates all aspects of civil aviation in the United Kingdom. The CAA is a public corporation of the Department for Transport.
Department for Transport	DFT	The Department for Transport is the government department responsible for the English transport network and a limited number of transport matters in Scotland, Wales and Northern Ireland that have not been devolved. The department is run by the Secretary of State for Transport.
Digital Flight Data Recorder	DFDR	A Digital Flight Data Recorder is a device used to record specific aircraft performance parameters. The purpose of a DFDR is to collect and record data from a variety of aircraft sensors onto a medium designed to survive an accident.
European Aviation Safety Agency	EASA	EASA is a European Union agency with regulatory and executive tasks in the field of civilian aviation safety. The main activities include: strategy & safety management, certification of aviation products & the oversight of approved organisation & member states.
Event Risk Classification	ERC	Individual safety events may reflect a high level of risk and consequently require urgent action. Therefore all incoming events need to be risk assessed. This step is called Event Risk Classification.
Flight Data Acquisition Unit	FDAU	A Flight-Data Acquisition Unit is a unit that receives various discrete, analog and digital parameters from a number of sensors and avionic systems and then routes them to a Flight Data Recorder (FDR) and, if installed, to a Quick Access Recorder (QAR).

Flight Data Monitoring	FDM	Flight Data Monitoring is the proactive and non-punitive use of digital flight information from routine operations to improve aviation safety.
International Civil Aviation Organisation	ICAO	ICAO is a United Nations specialised agency, working with its 191 member states & global organisations to develop international standards and recommended practices which states reference when developing their legally-enforced national civil aviation regulations.
Operational Risk Assessment	ORA	Operational Risk Assessment is the assessment of operational risks in a systematic, robust and intellectually cohesive manner
Quick Access Recorder	QAR	A Quick Access Recorder is an airborne Digital Flight Data Recorder designed to provide quick and easy access to raw flight data, through means such as USB or cellular network connections and/or the use of standard flash memory cards.
Safety Management System	SMS	Safety Management System is a term used to refer to a comprehensive business management system designed to manage safety elements in the workplace. SMS provides a systematic way to identify hazards and control risks while maintaining assurance that these risk controls are effective.
Standard Operating Procedures	SOPs	Standard Operating Procedures are detailed written instructions to achieve uniformity of the performance of a specific function.
Safety Performance Indicator	SPI	Safety Performance Indicators are linked to the safety performance targets. They enable the organisation to measure and demonstrate the achievement of the set target levels.
Safety Issue Risk Assessment	SIRA	The Hazard Identification process may lead to the identification of Safety Issues, which need to be risk assessed to determine what actions, if any are needed. This step is called Safety Issue Risk Assessment
Supplemental Type Certificate	STC	A STC is a National Aviation Authority approved major modification or repair to an existing type certified aircraft, engine or propeller. As it adds to the existing type certificate, it is deemed “supplemental”

Executive Summary

Although significant efforts have been made to mitigate risks, they still exist in everyday operations particularly where operators are interacting with complex systems. However, the traditional risk identification strategy of addressing problems after occurrences is limited. There is a need to constantly track risks of current concern in an organisation's routine daily operations to ensure safety in this rapidly growing industry.

Since **Flight Data Monitoring (FDM)** provides comprehensive and reliable information of daily routine flight performance, it creates a solution for many of the problems and challenges facing Business Aviation operators today. Long considered a best practice of air carriers around the world, **Quick Access Recorder (QAR)** technology now makes FDM practical in smaller aircraft. Benefits include:

Safety – Identifying and intercepting accident pre-cursors.

Operational – Producing aggregate data to support anecdotal flight operations feedback and to change operating environment or procedures.

Maintenance –Through the application of aggregate and individual airplane data to engine and airframe maintenance cost.

Air Carrier category FDM programs took 45 years to develop from the first experiments to today's mature programs. Business Aviation has the opportunity to accomplish its own FDM maturity development, with systematic and experimental initiatives such as the CASE FDM Project. We hope you will therefore join us as a Participating Operator.

FDM is a quality assurance process that also offers a vital safety management dimension. It involves the downloading, replaying and analysing of aircraft flight data on a regular and routine basis. Applying the information learned from this analysis helps to find new ways to improve flight safety and increase overall operational efficiency.

The objective of FDM is to inform and facilitate corrective actions in a range of operational areas by offering the ability to track and evaluate flight operation trends, identify risk pre-cursors and take the appropriate remedial action.

CAA: "the systematic, pro-active and non-punitive use of digital flight data from routine" operations to improve aviation safety"

EASA: "Pro-active use of digital flight data from routine operations to improve aviation safety"

"The absence of a FDM program could be construed by society as a failure to implement industry best practices." Flight Safety Foundation

The Corporate Aviation Safety Executive (CASE) aims to encourage other members to adopt FDM and to encourage the voluntary implementation of FDM by the Business Aviation community.

Aircraft and operators should benefit from this oversight. Additionally, it is anticipated that FDM will assist in developing enhanced **Standard Operating Procedures (SOPs)** and ultimately lead to increased safety in the Business Aviation sector. This mirrors the approach of the large air carriers and operators with FDM.

The main aim of the CASE FDM project is to set industry *'best practice'* by encouraging other CASE members to adopt FDM, including by offering smaller operators the opportunity to discover the benefits of FDM at a minimal cost. The effectiveness and efficiency of a small fleet or operation may be helped by pooling analysis within a group of similar operations, while retaining responsibility for risk assessment and action.

The Business Aviation community is extremely diverse, from large multi-based multi-national, to small national operators. One day can be very different to the next, making daily operations both diverse and challenging.

Dealing with the unfamiliarity of routes and airports that are scarcely, or may have never, previously been flown or visited, is a common challenge for flight operations and safety teams. Building a safety picture is a vital component to ensuring a successful and safe future operation.

A fully implemented and supported FDM program should assist and benefit any operation, helping it with its future growth. Customers and service providers, e.g. insurance agencies, are becoming more aware of such safety initiatives and it is vital that the Business Aviation community should endeavour to remain at the forefront.

Project partners

The Corporate Aviation Safety Executive (CASE) was formed by a like-minded group of Safety Managers in an effort to collate data and monitor trends over the whole Business Aviation community, with the express purpose of improving aviation safety.

This entirely voluntary international group meets regularly to share safety lessons learned and build upon experience from peers. It was through CASE that an initial step was completed to create a shared Safety Management System platform known as Air Safety Central:
www.airsafetycentral.com

CASE operates with a 'flat' hierarchy which hopes to promote a free and open exchange of information; no one member has any more influence than another. CASE is an inclusive group which welcomes anyone with an interest in safety who is willing to promote the group's objectives and act in confidence.

CASE Objectives:

- Pursue the highest standards of aviation safety with particular emphasis on Business Aviation.
- Facilitate the free exchange of aviation safety data in an open forum.
- Maintain an appropriate liaison with other bodies concerned with aviation safety.
- Provide assistance to operators establishing and maintaining a flight safety organisation.

www.case-aviation.com

Aerobytes has been supplying FDM software and services for 14 years. The company serves a range of customers from single aircraft operators to national airlines with large and varied fleets in all corners of the globe. Accurate results and easy to use, stable software, combined with excellent support means Aerobytes is able to supply useful and valuable information about eroded safety margins in a timely manner.

Aerobytes are a member of:

FLIGHT SAFETY FOUNDATION

www.aerobytes.co.uk

The Civil Aviation Authority (CAA) is the UK's specialist aviation regulator. Its activities include: making sure that the aviation industry meets the highest technical and operational safety standards; preventing holidaymakers from being stranded abroad or losing money because of tour operator insolvency; planning and regulating all UK airspace; and regulating airports, air traffic services and airlines and providing advice on aviation policy from an economic standpoint.

The CAA has supported the development of CASE since its inception and fully endorses the work undertaken as part of the CASE umbrella. The FDM project is a CAA led safety improvement project, and is fully funded by the Department for Transport (DfT).

David Wright, MBE CMILT has been involved with Flight Data Monitoring for over 35 years; working closely with British Airways, he helped develop the first generation of FDM programs. He managed the CAA's work from 1987, advising and training staff until his retirement in 2013. With this detailed, hands on knowledge of the benefits of FDM he proactively encouraged UK operators to establish practical FDM programs and supported ICAO's application of FDM standards. David's contributions were recognised in 2014 by the award of a MBE "for services to aviation safety".

Since "retirement" David has continued sharing his FDM experience with Cranfield University's FDM for Airlines courses, which he was a joint founder of. He has also provided EASA with similar training.

David voluntarily assisted with CASE Phase 1 and has now been engaged to provide advice and training during Phase 2.

Welcome

By incorporating FDM and working together as one community sharing safety data in a secure and confidential manner, the Business Aviation sector can not only benefit from a safer future, but also prosper commercially.

The fitting of Quick Access Recorders on aircraft below the legal weight limit for FDM means that we can monitor an area of the industry which up to now has not been monitored. This offers the Business Aviation community the opportunity to benefit from enhanced aircraft oversight, leading to the development of Standard Operating Procedures and greater compliance.

Phase 1 of the FDM project demonstrated that there are unequivocal benefits for Business Aviation and, as a result of this success we are now able to offer the opportunity for smaller operators to participate in Phase 2. Participating Operators will be assigned a Quick Access Recorder at no cost to the operator, and provided with full support and training as they implement FDM within their organisation. Data analysis will be undertaken by Aerobytes, again at no cost to the operator, and participants will be fully supported as they utilise the resultant safety event data and integrate it into their Safety Management System.

Hand-in-hand with this project, Air Safety Central has been developed to inform members of safety incidents as quickly as possible. The sharing of data through this platform not only gives us the opportunity to develop larger safety projects, such as stabilised approach and industry trending, it also offers us the chance to develop more radical projects in the future.

Just as importantly, the FDM project gives us the opportunity to offer smaller organisations with a proportionately lower number of flights compared to those of larger organisations, the chance to benefit equally from FDM. Thus, by working together and expanding the scope, we can all benefit in the long term.

Malcolm Rusby

European Safety Director - Tag Aviation

Chairman - Corporate Aviation Safety Executive

An introduction to the CASE FDM Project

Some operators within CASE with previous experience of FDM recognised the value and potential for this safety tool to be applied to smaller operators. Furthermore, they understood that, for this to be really effective, it had to be tied in with a data sharing mechanism to gain a greater depth of understanding and insight into the safety issues.

Background

The CASE FDM Project aims to incorporate FDM technology across the UK Business Aviation fleet by installing **Quick Access Recorders (QAR)** into aircraft for which FDM is not mandated.

The long term objective of the project is to encourage the Business Aviation community to voluntarily sign up to FDM and to integrate this into their SMS such that they can then develop their own **Safety Performance Indicators (SPIs)**.

Diagram 1:
(Continual Improvement through FDM)

Phase 1 Overview

Phase 1 was a pathfinder trial, funded and led by the CAA in partnership with CASE. The purpose was to demonstrate the feasibility of fitting FDM equipment on smaller corporate aircraft (below the 27,000 kg weight limit). Three operators took part, with each providing one of their aircraft for the trial. These aircraft were of differing types and were each fitted with a QAR. Data from 400 flights was then collected, proving that the aircraft could be modified to accept QARs.

The trial concluded that introducing FDM to Business Aviation aircraft is not technically difficult, and that data capture and analysis was a practical proposition for this class of aircraft and operation.

The lessons learned and best practices identified in Phase 1 have informed and directed the strategy and deliverables of Phase 2.

Phase 2 Overview

The primary objective of Phase 2 is to provide a much larger information base which can be used to further prove the benefit of FDM to the Business Aviation community.

The purpose is to build on the success of Phase 1 and to demonstrate the benefits of FDM data aggregation, both safety and economic, to Business Aviation operators, e.g. benchmarking and identifying trends to feed into individual operators' SMS. This is a critical component of the data sharing strategy.

The long term objective is to encourage the Business Aviation community to voluntarily sign up to FDM and to integrate this into their SMS such that they can then develop their own SPIs.

A secondary objective is to continue the collaborative partnership between the CAA/DfT and the Business Aviation community, thus encouraging voluntary uptake of FDM and achieving mutual benefit.

Individual stakeholder objectives are detailed below:

Participating Operators: To receive information from aircraft that they could not previously monitor and to incorporate this information, in a meaningful manner, into their SOPs and SMS.

CASE: To provide those CASE members who have access to the Air Safety Central system, data from a wide pool of sources that these members can incorporate into their SOPs and SMS.

CAA/DfT: To provide the CAA with access to de-identified, statistical safety event data that can be utilised to increase awareness of issues affecting and/or specific to Business Aviation.

Participation criteria

Operators participating in Phase 2 will be required to adhere to stipulated criteria as set down by CASE, in return for the provision of a QAR and the support of the Project Coordination Team as they implement FDM within their organisation, free of charge.

A Memorandum of Understanding detailing expectations and responsibilities for each of the stakeholders will be issued. It is a requirement that all parties fully understand the criteria before the Memorandum is signed.

Having signed the Memorandum, all Participating Operators will work with Aerobytes to have their aircraft surveyed, wiring diagrams produced, the modification approved and the QAR fitted. Training will be provided to assist Participating Operators to implement a FDM program that links to their SMS and adheres to *Just Culture* principles. Training will also cover the practical aspects of data upload and utilisation.

The following are key points expected of Participating Operators:

Prior to the installation of QARs

Participating Operators will:

- Become a member of CASE.
- Provide the Project Coordination Team with the data frame layout details for their aircraft.
- Agree to Standardised Operating Procedures pertinent to the FDM analysis.
- Ensure that their standard systems for change management are applied.
- Participate fully in the Participating Operator FDM and SMS training.
- Provide all necessary data and information to enable QAR installation.
- Provide access to their aircraft to enable the installation of the QAR.

Following the installation of QARs

Participating Operators will:

- Integrate the safety event data within their SMS.
- Utilise the FDM data collected to produce and maintain an internal Risk Register and provide the CAA with access (as per the requirements of their oversight).
- Provide access to aircraft weight information to enable the monitoring of airspeed related issues.
- Be responsible for the download of FDM data from their aircraft and upload to Aerobytes.

- Own all FDM data collected in respect of their individual fleet aircraft.
- Provide a summary of "Achieved Flight Records", i.e. the number of flights flown, so that the statistical frequency of safety events can be recorded and monitored.
- Use FDM data collected only for flight safety or other purposes related to their business and in accordance with *Just Culture* practices.
- Ensure that appropriate corrective action, commensurate with risk, is taken on any safety issues identified as per the safety risk management processes stipulated in their SMS.
- Ensure that any remedial training or advisory briefing of individuals required as a result of safety issues highlighted takes place in a constructive and fair manner.
- Encourage their aircrew to provide contextual information associated with FDM events detected, and will ensure that aircrew are protected as part of the normal air safety reporting process.

At the conclusion of the project

Participating Operators will:

- Provide a minimum 60 days' notice of their intention to withdraw from the project or discontinue FDM at the end of the project.
- Provide all necessary data and information to Aerobytes and the Project Coordination Team for the purposes of producing the necessary de-modification specifications.
- Provide access to their aircraft in order to enable the removal of the QAR.
- Return the QAR, associated installation bracket and QAR card reader in serviceable condition, together with Form 1 documentation.

All information/data belongs to the operator. Any information/data used for trended statistics will be de-identified.

An overview of FDM

What is FDM?

As an operator, FDM allows you to compare actual achieved data from everyday line flights against SOPs and, additionally, standards within industry.

This process sits well within a pro-active SMS where it can provide assurance that safety levels are being met or improved and, where significant deviations from standards are found, it allows timely corrective action to be taken.

The FDM feedback loop details the FDM process:

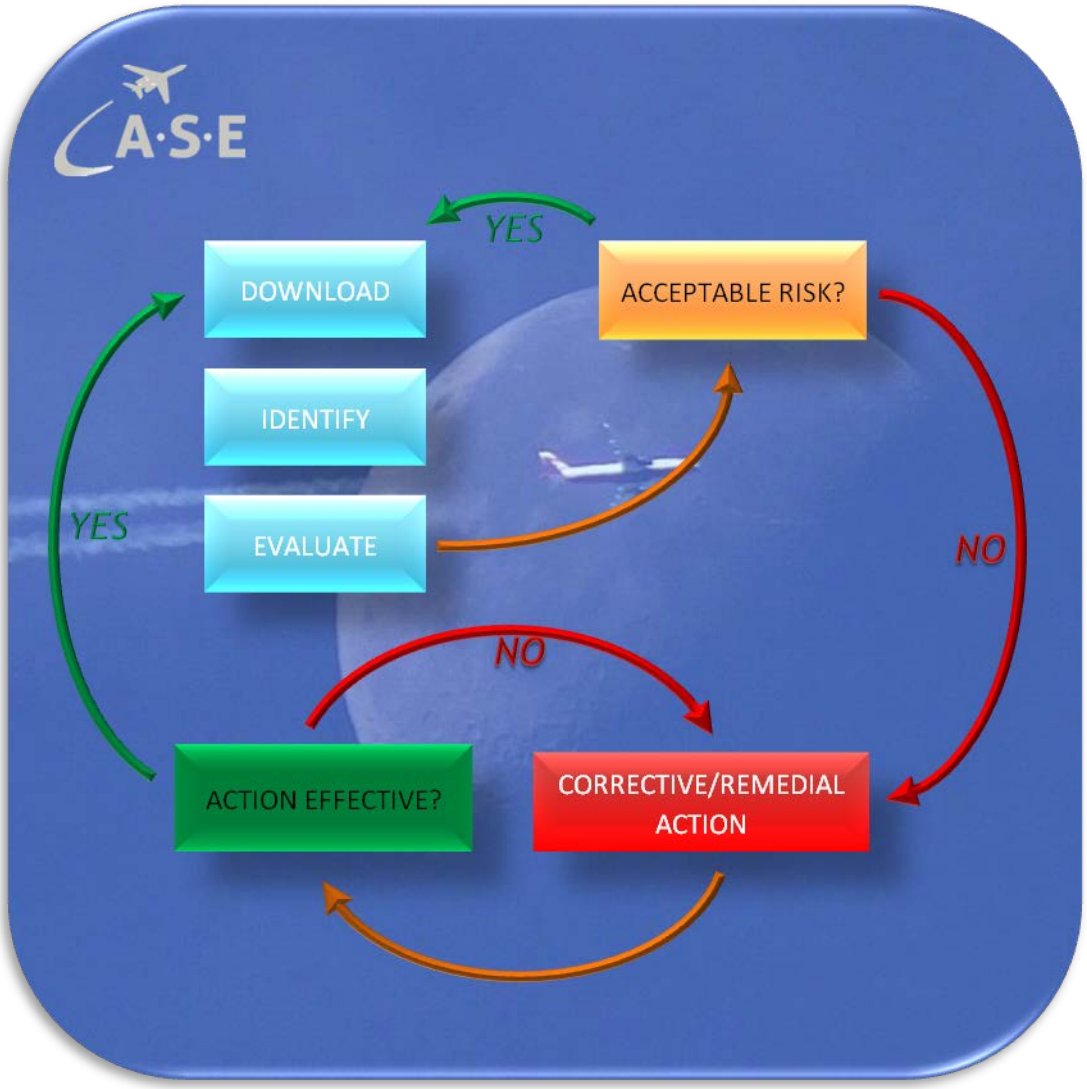


Diagram 2:
(FDM feedback loop)

A history of FDM

British Airways and its predecessors pioneered forms of FDM programs in the 1960's, and formal FDM programs have been in operation with most large air carriers in Europe, the US and some Asian countries since the late 1990's as an operational best practice.

Air Carriers that currently have FDM programs agree that the insights derived have helped to prevent serious incidents and accidents, and have led to improved operating efficiencies.

Effectively using FDM information over long periods has provided airlines with clear evidence that information obtained in a FDM program represents a source of valuable information that can contribute greatly to aviation safety when used appropriately.

The objective of FDM

The objective of a FDM program is to identify areas of potential risk in an entity's day-to-day operation by analysing the associated flight data generated.

This analysed information provides a greater insight into the flight operations environment through its day-to-day line operations. Using the entity's SMS, data collection uses the factual inputs from the flight data to provide a diagnostic of the entity's strengths as well as providing it with factual data to improve on any weaknesses.

This process provides the entity with information-driven solutions to enhance the overall company operation safety, allowing it to mitigate the risks to an acceptable level.

FDM may be used for, but is not limited to, evaluating the following areas:

- Aircraft performance
- Aircraft systems performance
- Aircraft design
- Airport operational issues
- ATC system operation
- Company procedures
- Meteorological issues
- Training programmes
- Training effectiveness
- Crew performance

The benefits of FDM

Safety benefits:

- Proactive, accurate identification & prevention of risks and hazards including the ability to develop leading indicators to potential safety events.
- Evidence-based decision making.
- With an improved operational insight, provision of the means by which to identify potential risks and to modify pilot training programmes accordingly.
- Digital data provides the opportunity for objective dialogue between pilots and management to improve operations and safety.
- The ability to analyse and trend data across the sector such that information and best practice can be shared, and to benefit a risk-based oversight approach.

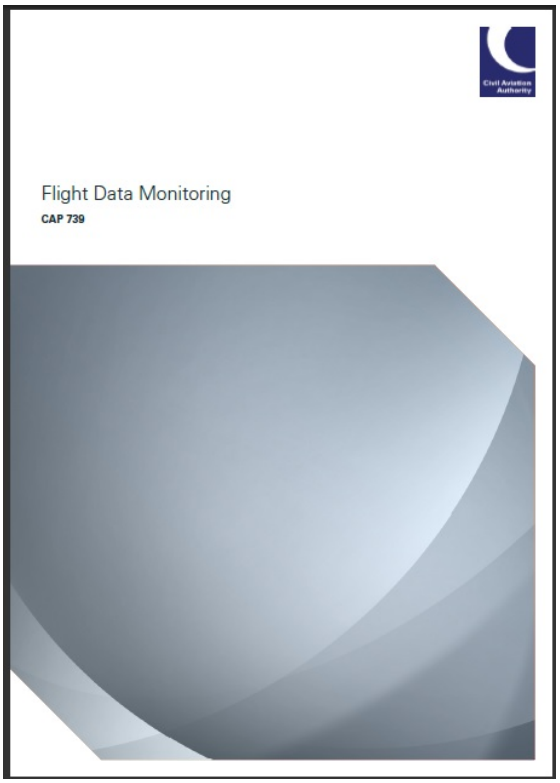
Commercial benefits

- The ability to identify and make improved adjustments to operating procedures or aircraft with unusually high fuel consumption rates. (Example: implement stabilised approach for increased fuel efficiency).
- Reduction in unnecessary maintenance and repairs, quicker diagnosis resulting in lower maintenance costs and higher aircraft availability.
- The provision of empirical data with which to verify and demonstrate adherence to noise abatement restrictions.
- Possible insurance benefits based on long term safety improvements through FDM.
- Reputational and therefore commercial benefits derived from an established and demonstrable safety culture.

Other benefits

- Managed correctly utilising *Just Culture,* an improvement in stakeholder trust and respect is possible with a resultant improvement in communication.
- Increased communications lead to improvements not only in safety, but also the efficiency of operations and customer satisfaction.

CAP 739



For over ten years the CAA's CAP 739 has been acknowledged as the best, most practical FDM guidance material available. The first drafts were "test run" by several UK operators who had established FDM programs.

The latest edition of CAP 739 outlines good practice relating to first establishing and then obtaining worthwhile safety benefits from a FDM program. This document replaces the first issue of CAP 739 published in 2003.

Chapter 10, "FDM in Small Fleets and Business Aviation" will be of particular interest to operators considering joining the CASE FDM Project. It deals with the use of FDM in small operators with fleets of say less than ten aircraft and also Business Aviation operators who generally have a small fleet, although some do have large and varied fleets. Subjects discussed include:

FDM in a Small Fleet:

- Obtaining sufficient technical expertise to implement a FDM data system.
- Dealing with a mixed fleet of "one-off" aircraft rather than a standardised fleet.
- Getting the most from a limited number of flights.
- Contracting out the routine acquisition and initial analysis of FDM data.
- Ensuring the confidentiality/protection of crew related data from a small, often non-unionised workforce.

FDM in Business Aviation:

- Challenges of Business Aviation
- Many "one off" sectors/airfields including positioning flights.
- More operations into non-ILS equipped, remote, secondary airfields.
- Distributed small bases encouraging "local practices".
- Lack of standardisation of SOPs across types.
- Extended tours away from the normal base of operations.

Below is a full list of the CAP739 chapters:

1. Introduction - What is Flight Data Monitoring?
2. Objectives of an Operator's FDM System.
3. Description of a Typical FDM System.
4. FDM within a Safety Management System.
5. FDM Technologies.
6. Planning and Introduction of FDM.
7. Organisation & Control of FDM Information.
8. Interpretation & Use of FDM Information.
9. Statistics in FDM.
10. FDM in Small Fleets and Business Aviation.
11. Helicopter Flight Data Monitoring (HFDM).
12. National FDM Forum.
13. FDM in Alternative Training & Qualification Programmes (ATQP).
14. Legislation & Requirements Related to FDM.
15. Legislation Related to FDM Information.
16. Mandatory Occurrences and FDM.
17. Maintaining Aircraft FDM Systems.
18. Regulatory Oversight of FDM.

CAA - CAP 739

QAR based Flight Data Monitoring

The main components of a QAR based FDM system

Digital Flight Data Recorder (DFDR)

A DFDR is a device used to record specific aircraft performance parameters. The purpose of a DFDR is to collect and record data from a variety of aircraft sensors onto a medium designed to survive an accident.

Current Survivability Standards:

- **Fire (High Intensity)** - 1100°C flame covering 100% of recorder for 30 minutes. (60 minutes if ED56 test protocol is used)
- **Fire (Low Intensity)** - 260°C oven test for 10 hours
- **Impact Shock** - 3,400 Gs for 6.5 ms
- **Static Crush** - 5,000 pounds for 5 minutes on each axis
- **Fluid Immersion** - Immersion in aircraft fluids (fuel, oil etc.) for 24 hours
- **Water Immersion** - Immersion in sea water for 30 days
- **Penetration Resistance** - 500 lb. dropped from 10 ft. with a ¼-inch-diameter contact point
- **Hydrostatic Pressure** - Pressure equivalent to depth of 20,000 ft.

Flight Data Acquisition Unit (FDAU)

The FDAU is an electronic device that collects, samples, conditions, and digitizes analog, discrete, and digital signals representing aircraft functions. It supplies a serial digital bit stream to the DFDR and QAR.

Quick Access Recorder (QAR)

QAR is an airborne DFDR designed to provide quick and easy access to raw flight data, through means such as USB or cellular network connections and/or the use of standard flash memory cards. Unlike the DFDR, the QAR provides easy access and removability (hence the name Quick Access Recorder).

A QAR receives its inputs from the FDAU, recording flight parameters. The QAR has a much higher capacity than the DFDR.

Project CASE utilises the L-3 Micro QAR, which is designed for use in commercial and military aircraft operating with solid-state flight recording systems. The Micro QAR has a

very light structure with a fixed or removable Compact Flash memory card. It is a solid state recorder that can work side by side with a tape Flight Data Recorder.

The Micro QAR records a copy of the data provided to the DFDR for easy retrieval. The data stored in the Compact Flash card can then be transferred into a third-party Flight Data Monitoring system for analysis.

Compact Flash Memory Card

The memory card is a removable data storage device capable of recording and storing digital information. It is normally replaced at the end of each operational day or after a period of elapsed time, depending on your data recovery strategy.

Data replay and analysis

Once the memory card has been removed from the QAR, it is immediately inserted into a card reader which is attached to a computer. The data can then be sent to the FDM provider, where the raw data is converted and processed using specialised computer software. The converted data is then replayed and analysed for events, quality checks, and for trending purposes.

Diagram: 3:
(Data Replay & Analysis)

Aerobytes have streamlined this traditionally time consuming process, providing a heavily automated system that allows for:

- Manual or automatic replay of flight-data for specific aircraft-types.
- Scheduling of tasks that can include uploading and matching of crew roster and schedule information.
- Support for all QARs in common use, including wireless.
- Ad hoc creation of values for special engineering or operational investigation.
- Standard deviation and other more advanced statistical functions.
- Script and wizard based configuration for values and events.
- Support for engine-health monitoring.
- Fully user-configurable event definitions, detection thresholds and severity thresholds.
- Re-analysis of historical data for new values or events without effecting previous analysis.

Diagram 4:
(FDM System Flow Diagram)

Safety Event information that FDM can provide

Exceedance or event detection is the standard FDM algorithmic methodology that searches the data for deviations from flight manual limits, SOPs and good airmanship.

There is normally a set of core events that cover the main areas of interest that are fairly standard across operators.

Example Events

- High Speed Descent;
- Flap limit speed exceedance;
- High take-off rotation rate;
- Stall warning;
- GPWS warning;
- High/low on glide slope;
- Hard landing.

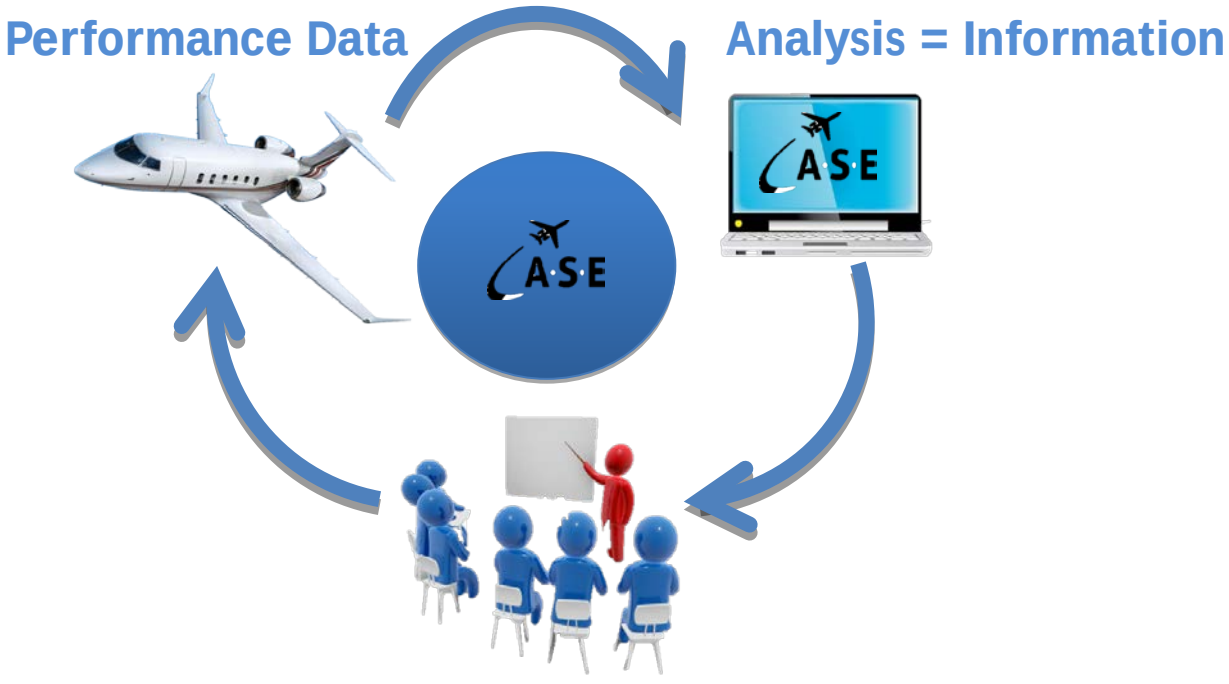


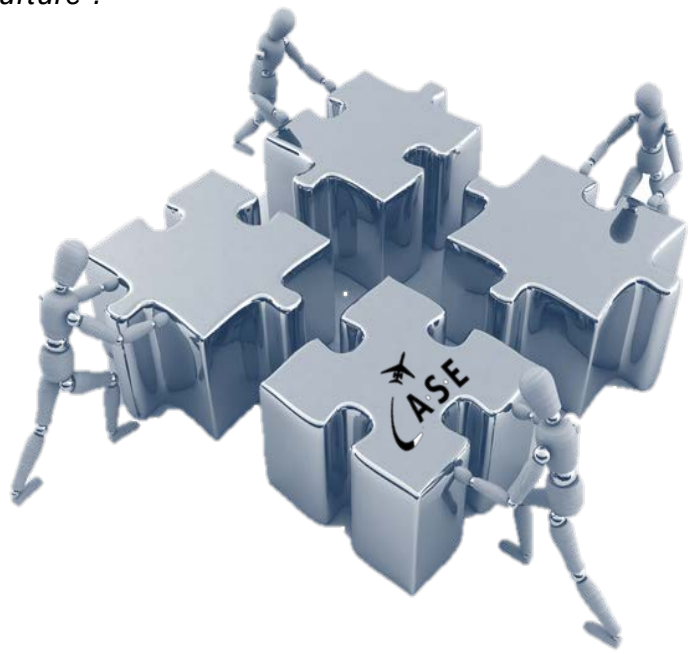
Diagram 5:
(Information = Knowledge)

FDM within a Safety Management System

A FDM program held remotely from all other safety systems will produce lower benefits when compared with one that is linked with other safety monitoring systems.

SMS and FDM share much the same principles. SMS allows FDM to function far more effectively and gives context to the FDM data which will, in return, provide quantitative information to support investigations that otherwise would be based on less reliable subjective reports.

FDM data tells us what **has** happened, but it needs the situational background to understand **why** it happened. Contributory factors can be far easier to establish with a *'positive safety culture'.*



Safety Culture

Integration of information from varied data sources is essential for an effective safety culture. All of the following must be linked together to produce a best estimate of operational risks:

- Flight Data Monitoring
- Internal Safety Reporting
- Human Error Reporting
- Technical Reporting
- Continued Airworthiness Reporting
- Ground Incidents Reporting

A restriction of data identification may in some cases be required whilst ensuring that useful information is passed on.

The benefits of FDM within SMS

To be an effective safety tool, SMS requires knowledge of actual operations; using assumed safety performance will not achieve this.

Given the percentage of actual flights performed compared with the number of assessed check flights, it is not possible to know with certainty that all flights conducted measure up to stipulated standards. FDM can significantly reduce that uncertainty and fill in this missing information, additionally assisting in the definition of what is normal practice.

Definitive risk data is provided by FDM which helps to verify that the SMS is managing the actual safety issues as opposed to assuming them.

The benefits of incorporating FDM into a SMS:

- FDM identifies precursors to events that may cause incidents and accidents, enhancing the SMS.
- FDM provides evidentiary basis for safety improvements and a measure of success following implementation, enhancing the SMS and providing evidence of cost-benefit.
- FDM gives knowledge of actual operations rather than assumed, validating the SMS.
- FDM helps to define the buffer between normal and unacceptable operations and can enable trending, improving the SMS risk assessment activity.
- FDM indicates potential as well as actual hazards, enhancing the SMS.
- FDM provides risk-modelling information to enable tailoring of the SMS.
- FDM provides a continuous and independent audit of safety standards.
- FDM can help identify area where flight crew training can be further improved.

Diagram 6:
(Training Benefits)

Diagram 7:
(Information process)

Operational Risk Assessment Methodology

Risk assessment methods are still developing and a number have moved beyond what was originally covered by ICAO some time ago. An example of such developments is the **Aviation Risk Management Solutions (ARMS**) method.

ARMS developed an improved methodology for **Operational Risk Assessment (ORA).** This is described in detail in a report that also provides guidance and examples for safety professionals on how to apply the method. In addition to the method itself, the report reviews the difficulties in using the older methods and describes the ARMS working group.
http://www.skybrary.aero/index.php/ARMS_Methodology_for_Risk_Assessment

The executive summary describes the approach as follows:

The methodology defines an overall process for ORA and describes each step. The assessment process starts with:

1. **Event Risk Classification (ERC**), which is the first review of events in terms of urgency and the need for further investigation. This step also attaches a risk value to each event - which is necessary for creating safety statistics reflecting risk.
2. The next step is data analysis in order to identify current Safety Issues.
3. These Safety Issues are then risk assessed in detail through the **Safety Issue Risk Assessment (SIRA)**.

The whole process ensures that any necessary safety actions identified are used to create a register for following up risks and actions. Additionally, it provides a safety performance monitoring function. SIRA can also be used to make Safety Assessment, which is a requirement of the "Management of Change" element of the SMS.

Barrier Modelling

FDM data can also potentially assist in risk modelling. An increasingly popular method of modelling risk is the Bow-Tie Safety Risk Model.

This is a visual tool to assist with:

1) Identifying and communicating risk controls.
2) Highlighting their effectiveness.
3) Identifying measures to monitor their performance.
4) Driving safety improvement actions which should feed into an organisation's SMS.

Bow-Tie models identify the dependencies on risk controls, and whether these controls are robust enough to prevent events. The risk controls within the model also identify pre-cursor and leading indicator data.

FDM data can inform this model by providing quantitative evidence to rationalise the acceptability of particular aspects of an operation as effective risk controls or barriers. Likewise, FDM data can be used to monitor continued effectiveness of the risk controls.

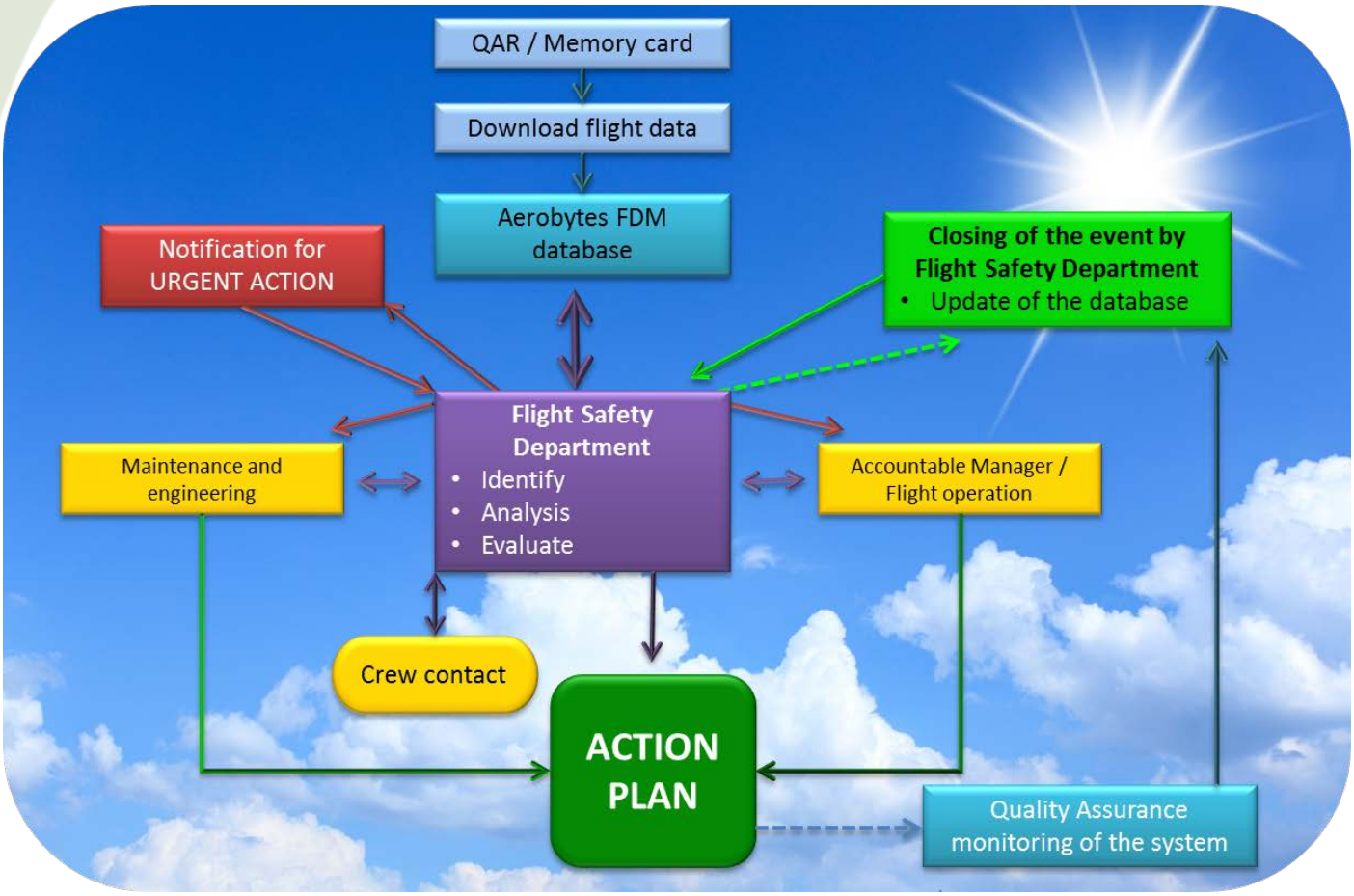


Diagram 8:
(FDM Safety Process Flow Diagram)

Prerequisites for a FDM program

FDM is an effective safety tool with additional commercial benefits but, as with any safety system, there are prerequisites which are imperative for the system to function at its optimum potential:

The existence of a Just Culture

The CAA espouses a *'Just Culture'* in the interests of the ongoing development of flight safety. This means that the CAA supports the development, within all areas of the aviation community, of a culture in which:

> Individuals are not punished for actions, omissions or decisions taken by them that are commensurate with their experience and training but which result in a reportable event;
>
> *But,*
>
> where gross negligence, willful violations and destructive acts are not tolerated.

More information can be found on Just Culture using the following links:

http://www.caa.co.uk/default.aspx?catid=1831&pagetype=90&pageid=15271

http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=5806

Upper management support

Upper management support for FDM is absolutely vital for its success and effectiveness. Upper management personnel must make their support for the FDM program known to stakeholders, and clear communication of expectations to each person who has a role to play in the program is vital.

Talking safety without actively supporting it is unlikely to see any safety programme succeed.

Targets: both short and long term

Setting targets from the beginning will help your organisation through its early stages of FDM implementation. As analysis becomes routine, you are likely to find your FDM/SMS system will naturally evolve.

Short term target examples:

- Establish data download procedure.
- Validate and investigate exceedance data.

Medium term target examples:

- Produce annual report – include key performance indicators.
- Add other modules to analysis (e.g. Continued Airworthiness).
- Plan for additional aircraft to be added to the program.

Longer term target examples:

- Network information across company information systems.
- Ensure FDM provision for any proposed "Advanced Qualification Program" style training.
- Share data across the sector via Air Safety Central and the CAA Flight Operations Inspectorate in order to understand sector trends and to inform the risk picture.

Focusing on a few known areas of interest is more prudent in the early stages to help prove the system's effectiveness. Early success is more likely with this method rather than a "scatter-gun" approach. For example, analysis of known problem airports may generate monitoring methods for all locations.

Be careful not to over-sell its initial phase. Everyone has to understand the objectives of the program. If expectations are too high the project could fail.

Keep a record of successes and failures. Having set project objectives, all successes and failures should be recorded. This will form the basis of a review of the project and the foundation of future work.

The FDM Team

The size and resources of your organisation will determine the size of your FDM team. Experience has shown that the "team" required for a FDM program can vary in size, from one person in a small organisation to a small department looking after scores of aircraft.

The description below briefly outlines the various roles within a larger FDM operation. Most of the aspects covered will still be required in a smaller operation but can be handled by one individual in a "multi-role" function and/or provided by part time support from other departments of an organisation.

In addition to their existing subject area expertise, all staff should be given at least basic training in the specific area of Flight Data Recorder data analysis. It is essential that a regular, realistic amount of time is allocated to FDM tasks.

FDM Team Leader: The Team Leader will be trusted by and given the full support of both management and crews. They may have direct crew contact in situations that require diplomatic skills. They will be able to act independently of other line management to make recommendations that will be seen by all to have a high level of integrity and impartiality. The individual will have good analytical, presentation and management skills.

Flight Operations Interpreter: This person will normally be a practising or very recent pilot, possibly a senior Captain or trainer, who knows the company's normal route network and aircraft. Their in-depth knowledge of SOPs, aircraft handling characteristics, airfields and routes will be used to place the FDM data in context.

Crew Liaison Officer: This person will be the link between the fleet or training managers and aircrew involved in circumstances highlighted by FDM. It is essential that the post-holder has the trust of both crew and managers for their integrity and good judgment.

Engineering Technical Support: This will be an individual who is knowledgeable about the FDM and associated systems needed to run the program. An avionics specialist is normally also involved in the supervision of mandatory FDR system serviceability.

Air Safety Co-ordinator: This person will be involved with the follow-up of Air Safety Reports and will be able to put the FDR data into context.

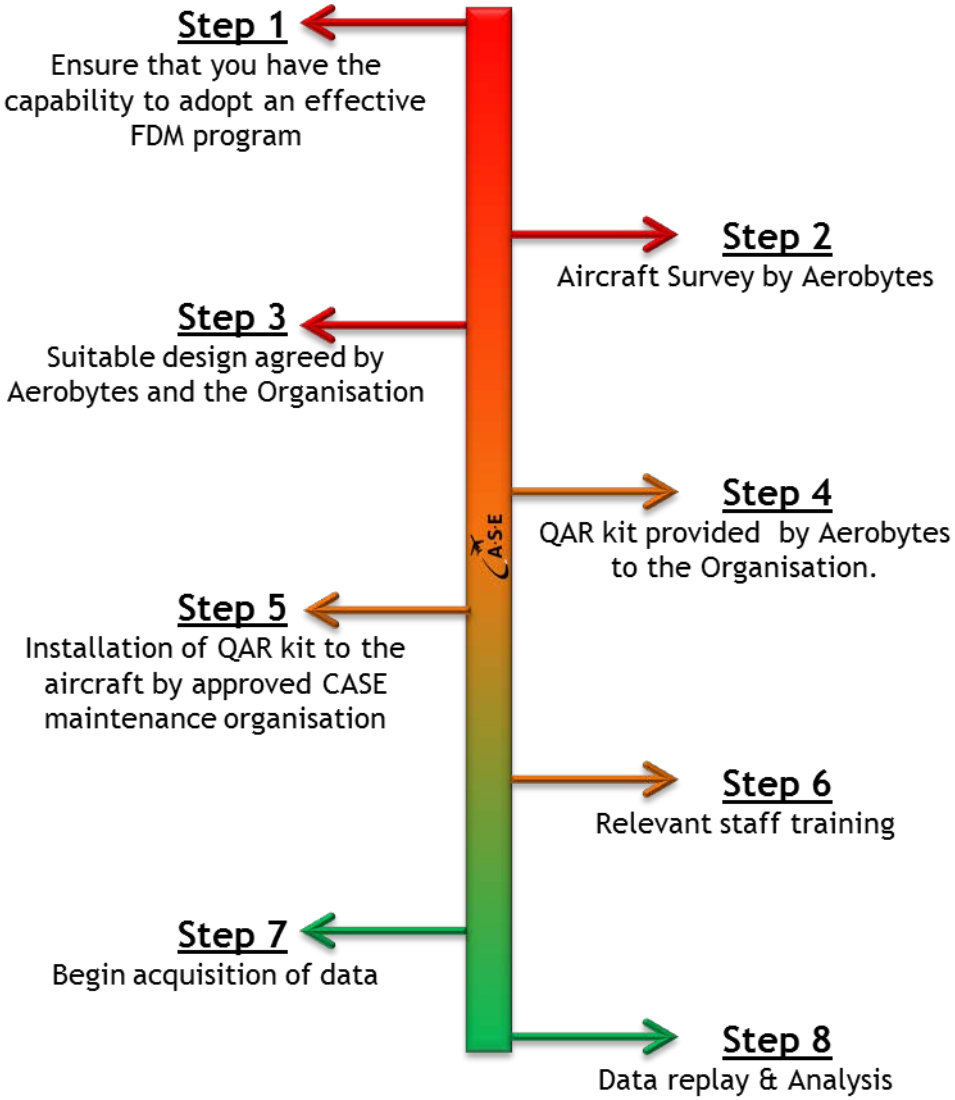
In summary, the following planning list is key to the smooth and successful implementation of FDM:

1) Confirm CEO approval and support for FDM implementation.
2) Identify key team members.
3) Agree aims and objectives.
4) Develop crew agreements and involvement.
5) Survey key areas in the operation for targets of opportunity.
6) Put in place operating procedures.

How Participating Operators will proceed

In this section we aim to take you through the Phase 2 process. Once you have decided that participating in the CASE FDM project is right for your organisation, whether you are a larger multi-national organisation or a smaller UK-based operation, the help and support you require will be there for you.

The CASE FDM project is fully managed and supported. Once the kit is installed and your FDM system is active, as long as your organisation downloads your data, Aerobytes will provide you with a regular monthly report.



Step 1) **Planning and introduction:**

The first step to conducting effective flight data monitoring is to ensure you have the capability within your organisation and can easily download flight data on a regular basis. You will receive training and support from the Project Coordination Team to enable this capability.

Step 2) **Aircraft survey:**

Aerobytes will survey your aircraft at a suitably agreed location, date and time.

Step 3) **Design production:**

Once your aircraft has been surveyed the next step is for Aerobytes to produce a suitable design, which is then agreed with you before drawings and documentation are provided.

Aerobytes QAR designs are minor modifications and do NOT require a Supplemental type Certificate (STC).

Step 4) **Distribution of QAR kit:**

Aerobytes will then provide your organisation with a QAR kit for each aircraft placed on the CASE FDM program. The kits provided include:

- Mounting plates or brackets.
- Wiring, connectors.
- QAR.
- Memory cards.
- Card readers.
- Card reading software.

Step 5) **QAR Installation process:**

The QAR installation is dependent on the equipment already fitted to the aircraft but typically takes the following format: The data wires from the FDAU to the DFDR are spliced into, and provide a feed directly to the QAR. The QAR is mounted on a connector which itself is attached to a mounting bracket of some kind. The QAR also requires a fused power supply. The QAR mounting point is dependent on space and ease of location.

The QAR installation will be conducted by a CASE approved maintenance organisation at an agreed location, date and time.

Step 6) **FDM staff training:**

Training will be provided by the CASE FDM Expert. This will include a presentation outlining the ways in which to get the best out of your FDM program. Instructions for downloading and use of safety event data will also be provided by Aerobytes.

Additionally, Cranfield University offers a discounted rate for CASE members for their FDM course: Cranfield FDM Training Courses

Step 7) **Begin data retrieval and transfer:**

Each QAR comes with a compact flash memory card and an additional spare memory card. To record flight data, the card must be in place in the QAR while the aircraft is flying. To download the flight data the memory card is removed (usually a replacement is inserted immediately) and inserted into a card reader attached to a computer. Using special software the data is then transferred to the computer and the card is prepared for re-use.

Once the data is downloaded it can then be placed on a secure FTP site for Aerobytes to download, replay and analyse. There are no rules to say how frequently the data must be downloaded, however we would recommend an interval of a few days to a few weeks depending on the frequency of flying. The download frequency for operators participating in Phase 2 will be determined following discussion with Aerobytes, and will be tailored to your particular operation and requirements.

Step 8) Data replay and analysis:

The Aerobytes FDM software is highly automated and easy to use. Data replay and analysis can be automated. Aerobytes has developed over 300 measures, not including many more for engine and fuel use monitoring. These values can be put into context for the purpose of creating events. Events and values can be trended and can be used to find underlying problems that may otherwise not be recognised.

Aerobytes will furnish your organisation with regular reports on safety events for inclusion in your SMS procedures; additionally you will receive trended statistical data on industry events.

For the FDM project, CASE will provide Participating Operators with the following, free of charge:

- Training and support to put in place the necessary capabilities;
- Undertake the necessary aircraft survey (the operator will be required to provide access to their aircraft during this time);
- Supply and install the QAR kits;
- Provide instructions for data download;
- Analyse and report on the results.

Confidentiality

The effectiveness of CASE depends upon trust to enable matters relating to aviation safety to be discussed openly and freely. Therefore, the confidentiality and de-identification of information exchanged must be observed by all Members and Advisers. For this reason the "Confidential Warning", which is based on the Chatham House Rule, is read out at each CASE meeting and is to be included on the meeting register which Members sign as accepting the Rule of Confidentiality. Chatham House Rule states:

'when a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.'

The full text of the CASE Confidential Warning is as follows:

Details of accidents, serious incidents and incidents which may be discussed at this meeting are to be regarded as confidential. You are entitled to make use of the information within your own organisation but it must be used with discretion. Members are not to be quoted by name or organisation without their prior authority."

Circulation of information to non-CASE Members is forbidden, either in whole or part. However, wider distribution of the de-identified information is allowed.

Frequently Asked Questions

Can Flight Data monitoring be used in evidence to prosecute me?
It is extremely rare for FDM information to be used in this manner. Should any event warrant such actions, FDM would not be the precursor to prosecution. It is not the objective of FDM to be 'big brother'.

If a flight generates an event that is deemed reportable to the CAA, do I still have to have to fill in a Mandatory Occurrence Report, or will this be taken care of for me?
It is still your responsibility to ensure all events are reported, as per your company SOPs.

If a flight generates an event that is deemed reportable to the CAA, but I do not recognise this fact at the time, how will this be handled?
You will be provided with all of the FDM information obtained and requested to complete a retrospective Mandatory Occurrence Report, without prejudice.

Where is the data stored?
All data is stored securely with Aerobytes.

Who can access the data?
The data is held securely with Aerobytes and is released in its raw form only to the operator it relates to. Data used for statistical trending will always be fully de-identified.

How often do I need to download the data?
There are currently no specific rules to say how frequently the data must be downloaded. This will be agreed with Aerobytes and tailored to your specific operation.

My aircraft are regularly away from base for long durations. Can I access the FDM data during those periods?
You require a card reader and download software to be able action this. It is possible for you to download your data away from base provided that you have the necessary equipment with you.

How quickly is the analysed data available to me?
You will normally receive a monthly report, provided you have uploaded your FDM data in a timely manner.

Do I need to buy software and equipment?
No, all equipment is supplied to you care of Aerobytes.

What sort of information will we receive?
Aerobytes will furnish your organisation with regular reports on safety events for inclusion in your SMS procedures. Additionally, you will receive trended statistical data on industry events.

Reference Material

The following have been utilised in the production of this document, and may provide useful additional information:

Author	Title / Reference	Subject	Address
ARMS		Risk Assessment	http://www.skybrary.aero/index.php/ARMS_Methodology_for_Risk_Assessment
CAA	Bow Tie	Risk Assessment tool	www.caa.co.uk/default.aspx?catid=2786&pagetype=90
CAA	CAP 739	Flight Data Monitoring	http://www.caa.co.uk/docs/33/CAP739.pdf
CAA		Safety Management Systems	http://www.caa.co.uk/docs/33/CAP795_SMS_guidance_to_organisations.pdf
CAA	CAP 731	Approval, Operational Serviceability & Readout of Flight Data Recorder Systems	http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=1311
CAA	CAP 382	Mandatory Occurrence Reporting	http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=214
CAA	Report 2012/01	Flight Data Monitoring Based Precursors project	www.caa.co.uk/docs/33/Report201201.pdf
CAA	FDM for Business Jet Operator Conference – Nov 2012		www.caa.co.uk/default.aspx?catid=100&pagetype=90&pageid=14179
EASA	(EU) 965/2012	Commission Regulation	http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:296:0001:0148:EN:PDF
EASA	Part -ORO		https://easa.europa.eu/acceptable-means-compliance-and-guidance-materials-group/part-oro
EASA	Part – ORO (AOC.130)	Flight Data Monitoring - Aeroplanes	http://easa.europa.eu/system/files/dfu/Annex%20to%20ED%20Decision%202012-017-R.pdf
EASA	Part – ORO (AMC1) (ORO.AOC130)	Flight Data Monitoring - Aeroplanes	http://easa.europa.eu/system/files/dfu/Consolidated%20(unofficial)%20version%20of%20AMC%26GM_Annex%20III%20(Part-ORO).pdf
EASA	Part – ORO (GM1) (ORO.AOC130)	Flight Data Monitoring - Aeroplanes	http://easa.europa.eu/system/files/dfu/Consolidated%20(unofficial)%20version%20of%20AMC%26GM_Annex%20III%20(Part-ORO).pdf

EASA	Part – ORO (AMC1) (ORO.FC.A.245)	Alternative Training & Qualification Program	http://easa.europa.eu/system/files/dfu/Annex%20to%20ED%20Decision%202012-017-R.pdf
EASA	Part – ORO (AMC1) (ORO.GEN.200)	Management Systems	http://easa.europa.eu/system/files/dfu/Consolidated%20(unofficial)%20version%20of%20AMC%26GM_Annex%20III%20(Part-ORO).pdf
EASA	Good Practice on the oversight of Flight Data Monitoring Programs		www.easa.eu/system/files/dfu/EAFDM_Goodprctice_FDMOversight_v1.pdf
ICAO	Annex 6 (Part I)	Operation of Aircraft Part 1 (Flight Data Analysis)	
ICAO	Doc 9859	Safety Management Manuals	http://www.icao.int/safety/SafetyManagement/Documents/Doc.9859.3rd%20Edition.alltext.en.pdf

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John Thomson:	CAA Business Aviation Safety Performance Analyst
Matthew Reynolds:	Flight Operations Specialist (Document Editor)
Civil Aviation Authority:	Safety & Airspace Regulation Group (SARG)
Department for Transport:	State Safety Programme