EASA
European Aviation Safety Agency

EUROPEAN OPERATORS FLIGHT DATA MONITORING
WORKING GROUP C

BEST PRACTICE DOCUMENT: KEY PERFORMANCE INDICATORS FOR A FLIGHT DATA MONITORING PROGRAMME

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Foreword

This document was produced by the working group C of the European Operators Flight Data Monitoring forum Working Group C (EOFDM WG-C).

The EOFDM is a voluntary partnership between European[1] aeroplane operators[2] and the European Aviation Safety Agency (EASA). EOFDM is an action owner of the European Plan for Aviation Safety (EPAS).

This document should be considered as complementary and not alternative to any applicable regulatory requirement, and it should not be considered as official guidance from EASA.

If you would like to give your comments or a feedback on this document, please write to fdm@easa.europa.eu.

Information on the EOFDM forum can be consulted at
https://www.easa.europa.eu/easa-and-you/safety-management.

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1   The term Europe is used here to designate EASA Member States i.e. the 28 States of the European Union + Iceland, Lichtenstein, Norway and Switzerland.

2   Aeroplane operators having their principal place of business in an EASA Member State.

Introduction

Effective safety management within the aviation industry depends on the creation and combination of various technical, operational and human conditions. The underlying factor, however, is risk management, which is driven by safety intelligence a component of which is FDM data.

Within an operator there will be various sources of data which can feed in to the safety management system. However, one of the most accurate and reliable sources of data, is flight data recorded by aircraft on-board systems. This data can be used reactively, for example, by investigating incidents and accidents or proactively for monitoring of operational trends and behaviors, as part of a Flight Data Monitoring (FDM) programme.

Even though FDM programmes are mandatory for all commercial air transport operators having their principal place of business in an EASA Member State and operating aeroplanes with a maximum certificated take-off mass in excess of 27 000 kg[3], increasingly there is recognition within the aviation community of the real benefits which FDM has on safety, and the operation as a whole.

However, in order to take full benefit, an operator must ensure that its FDM programme is performing at an optimal level, and address any issues which can cause, for example, data corruption or loss, or result in delayed or degraded event detection capability.

It is with this purpose in mind that EOFDM Working Group C has produced this best practice document which presents four key performance indicators (KPI), designed to monitor the performance of an operator's FDM programme.

Note:

From a KPI perspective there is no need to track corrective actions taken: this falls under the heading of SMS or maintenance review. Recommendations on corrective actions are out of scope of this document.

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3   Refer to Annex III to Commission Regulation (EU) No 965/2012 (Part-ORO), paragraph ORO.AOC.130.

KPI No 1 - Flight collection rate

Scope of the KPI

To have an indication of the number of valid flights available in the FDM software compared to those flown. The quantitative rate (KPI) should reflect the efficiency of the data collection chain from the aircraft to the FDM office.

In the case of low recovery rates, the operator should take adequate actions to improve the rate.

How to apply the KPI

Flight collection rate = Number of valid flights / Number of flown flights of aircraft in the FDM programme

- Flown flights: those are flights of aircraft included in the FDM programme. There are benefits for the operator to consider all the flights done by the aircraft including commercial, training, ferry, positioning, etc.

  However, the operator should consider to carefully analyse non-commercial flights (training, maintenance, test, etc.) as separated from commercial flight statistics because they can be polluted by events uncommon during normal operations (go-around, thrust asymmetry, high bank, etc.). *E.g. a training flight will generate many events like "Go-around" or "engine failure" which are not relevant to aggregate with those generated during normal flights. Resources could be wasted at finding solutions to issues that are not existing.*

- Valid flights: flights available in the FDM software after the cleaning and the validation of the flights. Those flights should be exploitable and completely analysable.

The number of valid flights may be affected in many different ways.

The following is presenting some of them, but this is not an exhaustive list.

Note:

Some flights can be missing because of:

- *A recorder failure (e.g. no recording on the card);*
- *A card or disk failure (e.g. card unusable);*
- *Card or disk data corruption making the data processing impossible;*
- *A card or disk loss;*
- *A wireless transmission failure (for aircraft equipped with wireless ground link (WGL));*
- *FDAU Electrical power interrupted or loss, caused invalid recording;*
- *A sensor failure. In case where parameters relevant for detecting flight phases are missing or corrupt, some flights could remain undetected.*

Some flight can also be invalid: refer to Appendix 1.

How to present the KPI

This KPI can be used in the SMS processes and meetings.

Data can be presented:

- over time: e.g. for the Safety Review Board, and for a safety action group
- by fleet
- by aircraft tail (for maintenance).

This KPI should be well documented to highlight the reasons of the flight loss, in order to find the right solutions to increase the flight collection rate e.g.:

- Recorder
- Media
- Process
- Parameter
- Sensor
- Etc.

Example of the flight collection rate presentation

Rate Target: 90 %

Current rate (month 5): 75 %

On the 25 % of non-retrieved flights:

- *X % are linked with a recorder failure on the XX-YYY.*
  The FDM software provider support has been contacted.
  A new recorder has just been installed.
  Test will be done with the FDM department on the next flight.

- *Y % are linked with the loss of a PCMCIA card.*
  The maintenance process has been re-enforced.

- *Z% are linked with a failure of the PCMICIA card.*
  The data was unreadable. The card has been replaced.

KPI No 2 - Time between actual occurrence and first detection by the FDM software

Scope of the KPI

The scope of this KPI is to measure the time to retrieve and process the data in the FDM software.

This KPI depends on:

- Technology used (e.g. wireless transmission, hardware media);
- Interval of data retrievals (many operators with a small fleet and low aircraft utilisation may download the data on a monthly basis);
- Proximity to operations base or maintenance facility (whether the data retrieval procedure is an operational or maintenance task);
- Resources available (FDM software, staff number, etc.)

For example, following an unreported hard landing, the FDM should trigger the event in a reasonable short time.

Notes:

- *Assess the backlog based on the number of FDM events waiting to be analysed;*
- *See also Appendix 2.*

How to apply the KPI

Time between actual occurrence and detection of the event
    = Date of detection of the event by the software
    - Date of the actual occurrence of the event

Detection date as processed by the FDM software.

There are benefits for the operator to consider all the flights done by the aircraft including commercial, training, ferry and positioning, especially in business aviation operations where positioning flights (i.e. empty legs) are frequent.

In case various technologies to transfer the flight data to the ground are used (e.g. hardware media for one part of the fleet and wireless transmission for another part), it is advised to monitor the technologies separately.

How to present the KPI

Data can be presented using bar charts or scatter plots.

If several types of raw data capturing technologies are installed on the fleet (e.g. wireless versus physical media), a KPI by technology may be appropriate.

KPI No 3 - FDM coverage of safety issues identified in the SMS risk register

Scope of the KPI

This KPI measures FDM coverage (events or measurements) of the safety issues identified in the operator's SMS.

For this KPI to be applied,

- a list (risk register) of safety issues should have already been defined by the SMS, and
- for each safety issue, the most common unsafe situations (precursors) which can be monitored by FDM should have been identified and described.

How to apply the KPI

For each unsafe situation related to a safety issue on the SMS risk register and which can be monitored with FDM: is it fully covered by FDM events, have these FDM events been validated (run against a large sample of FDM data)?

Example:

- *if the unsafe situation is not covered by any FDM event, u(i)=0;*
- *if the unsafe situation is partially covered by FDM events or the FDM events are not yet all validated, u(i)=0.5;*
- *if the unsafe situation is fully covered by FDM events which are all validated, u(i)=1.*

$$Coverage = \frac{7{\times}1 + 2{\times}0.5 + 1{\times}0}{10} = 80\%$$

Coverage of safety issues is equal to the weighted sum of indicators of unsafe situations' coverage by FDM divided by the total number of unsafe situations which can be monitored by FDM.

Example:

Operator X has 5 safety issues identified on its risk register. Among these 5 safety issues, 2 do not generate any unsafe situation that can be monitored by FDM (e.g. ground-handling related risk or fatigue related risk). For the 3 remaining safety issues, 10 unsafe situations (precursors) could be monitored by FDM.

7 of these unsafe situations are fully covered by FDM events which are all validated (u(i)=1), 2 are partially covered by FDM events or the FDM events are not yet all validated (u(i)=0.5), 1 is not covered by any FDM event (u(i)=0).

How to present the KPI

This KPI should be recomputed each time the risk register or the set of FDM events are updated and reviewed annually. A record of KPI values should be retained to monitor if coverage of risk register safety issues by the FDM programme remains good.

KPI No 4 - Rate of undesired event detections

Scope of the KPI

This KPI measures the rate of undesired detections for a given FDM event. An event detection can be undesired for several reasons, such as:

- Corrupt data or faulty data due to an on-board sensor(s) failure (see note 1);

- A shortcoming in the measurement algorithm, detection logic or other FDM software configuration;

- It's the result of a necessary, intentional and expected action from the crew – meaning it's detection is correct, but the event is not applicable in the context of the flight (see note 2).

Undesired event detections have the potential to bias FDM statistics, hence monitoring their ratio is important.

Note 1: *This KPI is meant for the process which programs, detects and validates FDM events. If this process is subcontracted, then this KPI is primarily of interest for the subcontractor and it does not need to be implemented by the operator.*

Note 2: *If the vertical acceleration parameter gives a spurious value stuck at 0 for a flight while in cruise (while it should be close to 1 g in level flight), an event "Abnormal vertical acceleration in cruise" will be triggered and this is inconsistent with the reality.*

Note 3: Examples of necessary, intentional and expected actions:

- *Full-scale localiser and/or glideslope deviation while circling from an ILS approach;*

- *ILS selections producing erroneous deviations when required for non-precision approach ops, deviation from normal flight profiles resulting from wind shear escape manoeuvre;*

- *High speed taxi turn event triggered by the aircraft entering the runway for a rolling take-off;*

- *High-speed taxi event triggered by the aircraft back-tracking the runway;*

- *Some actions performed during training flights and functional check flights;*

- *Actions performed at particular airfields, as the departure and arrival procedures may require special manoeuvres.*

How to apply the KPI

For a given FDM event, count the number of undesired event detections and divide by the total number of event detections: this gives the ratio of undesired detections.

$$Rate= \frac{\text{number of undesired event detections for Event X}}{\text{total number of event detections for Event X}}$$

Note 1: *Manually validating event detections is a labour-intensive task. Implementing this KPI does not require validating all event detections systematically: it is sufficient to measure the rate of undesired event detections upon the creation of a new event and to review this rate on a periodic basis.*

Note 2: *Care must be taken when calculating rates based on a subset of the observations. The sample group must be large enough and the selection must be truly random, to ensure the conclusions may be extrapolated for the whole set.*

How to present the KPI

The total number of undesired event detection should be presented as a percentage of the total event detections.

In addition, producing results aggregated by flight phase, equipment or fleet, or per type of issue (from those listed above) will help in identifying the cause of undesired event detections and aid in the assessment a possible solution.

Appendix 1 - Invalid flights

Some flights can be present in the database but should not be taken into account for the calculation of the number of valid flights (see KPI No 1).

These are:

➥ **Incomplete flights**

Most of the time when a flight is incomplete this is either the beginning or the end of the flight which is missing while it is well known that most of the events are generated during taxi-out/take-off/climb and approach/landing/taxi-in phases.

These flights may pollute the statistics by giving a better image of the operations during the missing part because no event can be triggered.

Therefore, such flights should not enter into the count of the FDM flights.

E.g. If the final part of a flight is not recorded from the beginning of the descent. There will be no event during the approach, landing and taxiing parts giving a better picture of the operations than it could have really been. It doesn't prevent from analyzing the beginning of the flight but definitely when statistics will be launched the results affected by such a flight.

➥ **Flights with an unknown flight phase**

Most of the events are using the recognition of the flight phases in order to be triggered.

E.g. to generate a "high speed on approach" event the aircraft must be recognized by the software to be on approach. So if the approach phase is not recognized no "high speed on approach" event will be generated even if the speed is recorded with a high value.

If the unknown phases are related to the critical phases as the take-off, the climb, the approach or the landing, where most of the events are generated, keeping those flights in the database would, as previously, pollute the statistics by giving a better picture than it could have really been.

Therefore, such flights should not be counted.

➥ **Flights where a sensor failure is obviously affecting the global read-outs**

E.g. a flight where one of the landing gear switches keeps on toggling from 0 to 1 will have many spurious events related with VLE and/or VLO exceedance.

Erasing or putting aside spurious events should be done but if this sensor failure makes the flight not understandable and/or unreliable and hinders the analysis, this flight should not enter into the count of the FDM flights.

➥ **Flights where a parameter offset is obviously affecting the global read-outs**

E.g. an offset on the recorded flaps angle will have consequences on the configuration computation and may induce many spurious events related with VFE exceedance.

Erasing or putting aside spurious events should be done but if this parameter offset makes the flight not understandable and/or unreliable and prejudices the analysis, this flight should not enter into the count of the FDM flights.

➥ **Flights where the decoding/processing of the raw data provides incoherent read-outs**

E.g. incoherent FMA (Airbus Flight Mode Annunciator).

If the issue makes the flight not understandable and/or unreliable and hinders the analysis of the flight, this flight should not enter into the count of the FDM flights.

Appendix 2 – Time between actual occurrence and FDM programme response

Two times need to be distinguished:

1. The time it takes to detect the FDM event (data collection and scanning by the software), already addressed in KPI N°2;

2. The time it takes to analyse the FDM event once detected by the software.

Note:

The time it takes to address the findings made based on FDM gives an indication of the responsiveness of the operator's SMS. It is not specific to the FDM programme.

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