

getting to grips with
FOM

Flight Operations Monitoring handbook

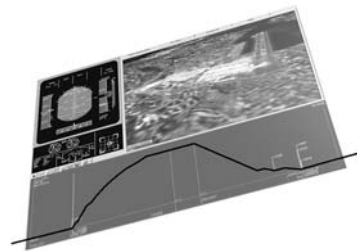


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FOM

flight operations monitoring handbook

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1 ADMINISTRATION AND RESPONSIBILITIES

1.1 Purpose

- 1.1.1 This Flight Operations Monitoring handbook is produced by the Flight Operations Support Department of AIRBUS, in partnership with AIR FRANCE Flight Safety Department, with CATHAY PACIFIC Corporate Safety Department and with AEROCONSEIL Company.

It is intended to serve as a guide to commercial Airline operators to establish and manage their own Flight Operations Monitoring and Safety program.

It is not a regulatory approved document and its contents do not supersede any requirements mandated by the State of Registry of the operator's aircraft, nor does it supersede nor amend AIRBUS' type specific AFM, FCOM, MMEL documentation nor any other approved documentation.

- 1.1.2 The contents and guidelines contained in this handbook may be updated without prior notice as and when new in-service recommendations and experiences are relayed to AIRBUS. Enquiries related to this handbook should be addressed to:

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- 1.1.3 This handbook should be read, where appropriate, in conjunction with:

- The AIRBUS Operations Policy Manual, chapters 2.03 (Accident Prevention) and JAR-OPS 1 (European Joint Aviation Regulations – Commercial Air Transport (Aeroplanes)).
- US FARs (United States Federal Aviation Regulations) in all parts applicable to the type of operation.
- The ICAO Convention, Annex 13 and associated annexes.
- The Operator's own Operations Policy Manual.
- The AIRBUS Flight Safety Manager's handbook.

1.2 Scope

The methods and procedures described in this handbook have been compiled from experience gained in the successful development and management of Flight Operations Monitoring programs in commercial airlines.

The aim is to give basic rules enabling an operator to implement a cost effective Flight Operations Monitoring system.

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2 FLIGHT OPERATIONS MONITORING CONCEPT

2.1 Background to Airbus Flight Operations Monitoring

As shown in later chapters, the benefits of a Flight Operations Monitoring program can stretch right across an airline, beyond just operations and engineering into the commercial and financial departments.

However, the primary purpose of a Flight Operations Monitoring program is to reduce the risk of flight operations incidents or accidents.

Accidents are not normally the result of a single failure or error. In a complex activity such as airline operations there are many processes which can go wrong, whether caused by system failure or human mistakes, leading to minor errors which by themselves are not dangerous.

Accidents normally occur when a series of these errors continue unchecked and coincide to cause a catastrophe. If any one of the errors had been corrected, then the “error chain” would have been broken and the accident avoided, using the words of the error-chain-accident concept created by Professor James Reason.

These “latent causes” lurk beneath the surface in all operations. It is essential for all airline management to be aware that these potential dangers exist, make positive efforts to detect any possible “precursors” that might lead to future accidents, and deal with them effectively.

This is best achieved through a Flight Operations Monitoring Program, which should be designed to:

- Detect precursors, latent causes or threats.
- Identify the reasons behind them.
- Implement preventative measures.
- Confirm the measures to be effective.

The three main complementary systems recommended by AIRBUS to achieve such a comprehensive Flight Operations Monitoring System are AIRFASE, LOAS and AIRS:

2.1.1 Flight Data Monitoring (FDM) - AIRBUS/TELEDYNE AIRFASE

Flight Data Monitoring systems act directly on the data recorded in the aircraft. Modern FDM systems can record practically every sensor in the aircraft, and retrieval rates of 95% are normally achieved using Optical Recorders/OQARs and PCMCIA/PC cards as recording media.

FDM is thus currently the most powerful monitoring tool, providing complete, accurate and objective flight safety data that can cover all flights within an airline, with risk events being detected automatically.

Otherwise airlines have to rely on the initiative of individuals to report events, and management may well be ignorant of serious “latent causes” until there is damage to an aircraft or some other significant incident.

The information generated by FDM systems can be used in many ways:

Detailed studies on individual events, statistics showing risk trends and quantitative data, unstable approaches, highlighting problems with ATC, specific airports, individual aircraft performance, GPWS TCAS and other warnings, unsuitable procedures for aircraft structural life or the airport noise environment, extreme weather conditions which may be outside the aircraft’s design criteria, etc.

As so much of FDM impacts directly upon the crews, it is absolutely essential that any Flight Data Monitoring system is set up in complete agreement with the whole flight crew community.

The FDM system recommended by AIRBUS is the AIRFASE which is described more fully in Section 2.4.1.

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However, FDM systems have their limitations – notably that although they give an accurate display of *what* happened they cannot necessarily indicate *why* it happened. Each significant event must also be verified by an aircraft type qualified crew member who also knows the route environment. Only such a person can confirm whether the event was part of a normal procedure like a circling approach, or that there was really a potential risk of a serious incident requiring action. Even then the event cannot be properly assessed without a discussion with the crew.

FDM systems cannot detect certain events like navigational errors and air proximity incidents, which must rely on human reports. Nor can it indicate the various problems and threats that the crew have to face on most flights like weather, ATC and communication difficulties and frustrations, perhaps even passenger disruptions, etc.

More importantly, FDM cannot assess the crews' capability in dealing with these threats and the Human Factors skills displayed on the flight deck. These can only be assessed by crew observation from within the cockpit in flight.

2.1.2 Analysis of In Flight Observations of Crew and System Performance – AIRBUS LOAS

An automatic Flight Data Monitoring system, such as AIRFASE, reproduces exactly *what* happened throughout every flight, but in flight observations can tell *why*.

Ideally, a Flight Operations Monitoring system includes a system which can always establish *why*, by monitoring crew behavior on the flight deck, highlighting the problems or threats they encounter and how they deal with them, ATC performance, relationship with cabin crew, capability of ground support, etc. The results can be analyzed to help establish why events occur, what weaknesses exist in the whole operational system, and the necessary improvements made.

Such a system is not normally achievable on many flights at present, and certainly not with anything approaching the 95% monitoring coverage of an FDM system. However LOAS has been created to allow In Flight Crew Reports made by observers to be recorded on worksheets using suitable Keywords and stored in a database.

These Observations should be taken from as wide a source as possible, preferably made by an observer additional to the crew and whose presence does not influence their operational behavior. (Regulations require that all crew members must be Line Checked, normally annually by being observed by a qualified Check Captain. The flights can be part of LOAS, however not only is this a small sample, but crews might behave differently to normal because they are under check.)

Airline resources would not normally allow extra flight crews as observers on many routine flights. However on routes where difficulties are known to exist, for example if significant AIRFASE events had been triggered, LOAS observer flights should be scheduled to establish the cause of the problems.

LOAS Keywords may also be used with training reports both on the simulator and in line operation.

In this way a worthwhile database can be built up to include items such as possible confusion over aircraft systems and instrumentation, crew CRM issues, etc.

LOAS is similar in concept to the surveys carried out under LOSA © – Line Operational Safety Audit – developed by the University of Texas, and supported by ICAO. To give airlines the benefit of compatibility of both projects, the relevant items in the LOAS worksheets are printed in the format used by LOSA, Copyright © The University of Texas at Austin 2001.

See Section 2.4.2 for further details of LOAS and LOSA ©.

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2.1.3 Analysis of Reports submitted by Flight Crews – AIRS (Aircrew Incident Report System)

Accurate and comprehensive Flight Crew Reports are a fundamental part of any flight safety program, which need to be stored and analyzed to establish any risks that may exist, and for remedial action to be taken as necessary. This can be illustrated by the following incident:

A four-engine airliner was cruising at Flight Level 350, in light turbulence. Suddenly, engine 2 was shut down by the fuel switch being put to cutoff.

The crew Air Safety Report, explained that the sun visor from the captain's side fell off and struck the No2 fuel control switch, moving it to cutoff. Instant relight was unsuccessful. Later the manufacturer confirmed that several similar cases had been reported by other operators.

The AIRS (Aircraft Incident Reporting System, part of the British Airways Safety Information System - BASIS) software stores such reports in a suitable form to enable the essential safety analysis to be made.

In addition to handling the mandatory Air Safety Reports, that are legally required to be filed for an incident such as the one above, AIRS also includes a module for Human Factors Reports. Crews are encouraged to submit HFRs, which are voluntary and confidential, whenever they encounter Human Factors problems in any part of the operation.

An example of a Human Factors item discovered during simulator training:

During a Go Around, the pilot did not rotate the aircraft to a high enough pitch attitude. The airspeed increased rapidly into the flap over-speed warning strip on the airspeed indicator, shown by a red and black "barbers pole", and the visual and aural master warnings were triggered.

Instead of pitching up to decrease speed, the pilot pitched down which further increased the speed. The other pilot had to intervene to pitch the aircraft up, to reduce the speed below the flap limit and cancel the warnings.

In discussion after the session, the pilot explained that he was confused by the master warning sounds and flashing lights. As the indicated airspeed was running up into the prominent red and black flap over-speed tape coming down from the top of the instrument, he instinctively pushed down to get away from the warning tape, forgetting his basic airmanship that this would simply increase speed.

A HFR report entered in the AIRS database will alert the industry to this possible confusion.

2.1.4 Threats Covered by Flight Operations Monitoring, and those left Uncovered

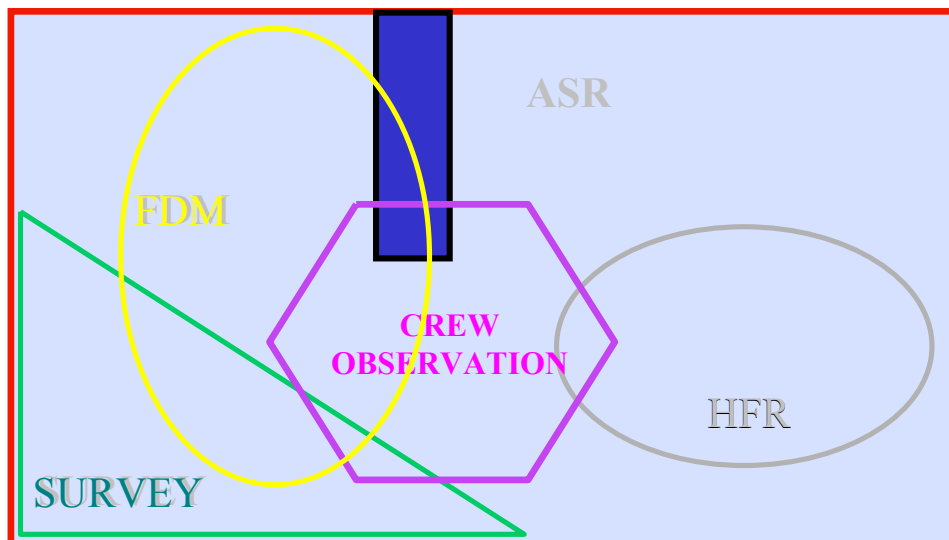
As has been mentioned, a multitude of safety threats constantly lurk in all areas of airline operations, involving factors such as aircraft design, mechanical failure and human behavior which should be capable of management, through to weather conditions which may be outside any form of control at present.

It is therefore essential to have several complementary tools in a Flight Operations Monitoring System to try to cover as many of these threats as possible, but even then some threats will remain uncovered.

This can be seen in the following graphic:

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The outer rectangle represents all threats, with various shapes showing the coverage of individual systems. Note that some areas of the rectangle remain uncovered, illustrating that some threats or latent causes may remain undetected even using all the current tools.



Partial Coverage of the Total Threat Rectangle by Current Safety Systems

Surveys, Flight Data Monitoring, Crew Observation, Air Safety Reports, Human Factors Reporting

2.1.5 European Experience in Flight Data Monitoring

The AIRBUS FOM package consists of three modules, but as the Flight Data Monitoring element – AIRFASE – is at its core, it is appropriate to give some history of how FDM has reached its present state in Europe.

(An FDM program is called FOQA (Flight Operational Quality Assurance) in the United States. In order to differentiate between Quality Assurance/Quality System in JAR OPS and the acronym FOQA used by the FAA, the term Flight Data Monitoring will be used in this document.)

Flight-Data Recorders (FDRs) can be traced back to wartime use in the early 1940s, and were legally required on civil airliners as crash recorders for accident investigation in the 1960s.

Early FDRs recorded the basic parameters required by the mandatory crash recorder:

Airspeed, Pressure Altitude, Magnetic Heading, Vertical Acceleration and Pitch Attitude.

These parameters were recorded at between .2 and 1 second intervals on a metal wire which was stored around a drum.

However the information gained by accident investigations using just this basic information, such as for a UK aircraft accident at LHR in 1965, showed the great value of flight recorded data. As a result, in 1966 it was suggested by the publication Flight International that more use should be made of FDRs in normal service to “monitor pilot approach performance” and that airline managements should be persuaded that “flight recorders aren’t just crash recorders”.....“they are pilot training aids”.

In the late 1960s the UK CAA sponsored the Civil Airworthiness Air Data Recording Programme (CAADRP), where special recorders were fitted to Comet, B707 and VC10 aircraft. This was to obtain data on autopilot performance, and investigate the possible values of disturbances in extreme weather conditions. Special events were triggered when specific parameters were exceeded in turbulence, and the information was shared with NASA.

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During this period, autoland was being developed, notably on the Caravelle and the Trident, which required new FDRs, separate from the crash recorders, to record the large amounts of data needed for certification of the autoland system in low visibility. The Trident FDR, for example, had data stored in a Quick Access Recorder on the flight deck, which crews would remove after landing to be passed to engineering.

FDR data now contained sufficient parameters to be able to monitor flight crew performance effectively, and the UK CAA sponsored the Special Events Search and Master Analysis (SESMA) programme for FDM systems to be developed by British Airways. British Airways has continued to use this as its FDM programme with UK CAA involvement, and still keeps the name SESMA.

By the early 1970s, all British Airways' aircraft were monitored by an FDM programme. (FDR data was used for Cat 2/3 autoland certification for the B747 in 1971-3, and for the L1011/TriStar in 1974-77.)

Air France developed its own FDM programme in parallel, and in 1974 took the significant step of obtaining a formal agreement between management and crew organizations to implement a Flight Data Monitoring programme. See Section 3.3 for AIR FRANCE experience.

Since the 1970s, both Air France and British Airways have had similar experience and benefits from their FDM programs to those seen by the FAA FOQA 1995-2000 DEMOPROJ and quoted in Section 2.2.4.2.

For example:

- Autoland certification - Safety improvement, regularity in low visibility.
- Reduced rushed approaches - Speed/altitude "gates" specified on approach.
- Engine life improvement - From improved autothrust usage, use of Reduced Climb Thrust.
- Aircraft performance - Establishing individual aircraft corrections for flight planning.
- Airframe structural benefit - Monitoring 707 flap extension speeds reduced to 200 kts.
- GPWS development - Elimination of early false GPWS warnings.
- GPWS monitoring - Evaluating crew reaction to GPWS warnings.
- Fuel burn & noise reduction - Early descents highlighted, together with early flap and gear extension, causing increase in fuel burn and noise over surrounding environment.
- Route mileage monitoring - Discouraging deviations for "sight seeing".
- Optimization of transition and recurrent training from in service event monitoring.

The programs continue today in much the same form, but with modern computing and communications technology the number of parameters monitored has increased from hundreds to over 2,000 with increased sampling rates available, while the total processing time has decreased. More types of events are covered, but whereas the complete analysis used to take some 5 weeks, now most digitally recorded data can be analyzed within a day, and a crew member could then be sent a file to display the event on his home PC.

2.2 Regulatory Requirements

Regulatory Authorities, such as the CAAC and JAA require implementation of a quality system to cover Flight Operations Monitoring.

Such Authorities provide guidelines for organization and for documentation. Like other requirements, airlines must choose HOW to implement these guidelines and demonstrate to the authorities that the application is in accordance with the guidelines.

2.2.1 ICAO

2.2.1.1 Recent ICAO Highlights

- Clear safety benefit in those airlines having data analysis programs.
 - Increased use of regional jets with MCTM between 20 and 27 T.
- These are perceived as those which would benefit the most from the flight safety programmes.

- Data to be used for Flight Safety Purposes only.
- Data analysis to be NON-PUNITIVE.
- As there is a wide variety of legal systems, States shall determine protection and Operators shall establish internal safeguards.

2.2.1.2 ICAO Annex 6, Part 1, Amendment 26

- Recommended Practices:
From 1 January 2002: Operators of an aeroplane of a MCTM in excess of 20 000 kg should establish and maintain a flight data analysis programme as part of its accident prevention and flight safety programme.
- Standard:
From 1 January 2005: An operator of an aeroplane of a MCTM in excess of 27 000 kg shall establish and maintain a flight data analysis programme as part of its accident prevention.
- However, for the recommended practice, the situation will be re-examined in the future and, if proved useful or necessary, the time limit could be upgraded to a standard.

A database was set up using information on civil jet/turboprop aircraft obtained from the Airclaims CASE database:

ICAO database setup from Airclaims CASE database					
Manufacturer	Aircraft Type	Manufacturer	Aircraft Type	Manufacturer	Aircraft Type
Airbus	A300	Boeing	707	British Aerospace	1-11
Airbus	A310	Boeing	717	British Aerospace	VC10
Airbus	A319	Boeing	727	Bombardier	CRJ700
Airbus	A320	Boeing	737	Bombardier	Global Express
Airbus	A321	Boeing	747	Fokker	F28
Airbus	A330	Boeing	757	Fokker	70
Airbus	A340	Boeing	767	Fokker	100
Antonov	An-72	Boeing	777	Gulfstream	Gulfstream III
Antonov	An-74	Boeing - MD	DC-8	Gulfstream	Gulfstream IV
Antonov	An-124	Boeing - MD	DC-9	Gulfstream	Gulfstream V
BAE Systems	146	Boeing - MD	DC-10	Ilyushin	Il-76
BAE Systems	RJ Avroliner	Boeing - MD	MD-11	Lockheed	L-1011 TriStar
BAE Systems	RLX Avroliner	Boeing - MD	MD-80	Tupolev	Tu-134
		Boeing - MD	MD-90	Tupolev	Tu-154
				Yakovlev	Yak-42

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2.2.2 Chinese Regulations

(extracts from CAAC “draft” Regulation on Flight Quality Monitoring Management)

Chapter 2 : Equipment and Monitoring Requirement

Article 9: Any civil aviation aircraft, which is certified / validated according to CCAR Part 25 “Airworthiness Standard of Transportation Airplane”, Part 29 “Airworthiness Standard of Transportation Rotary-Wing Aircraft”, should install Quick Access Recorder (QAR) or other equipment having the function of quickly accessing records.

Chapter 3 : Organization and Personnel

Article 16: Airlines should create flight quality monitoring organization.

Chapter 4: Operations

Article 23: Airlines must establish detailed and feasible flight quality monitoring procedures and rules and regulations and submit them to the regional administration bureau and CAAC Aviation Safety Office on file, respectively.

2.2.3 JAR European Regulations

An operator shall establish one Quality System and designate one Quality Manager to monitor compliance with, and the adequacy of, procedures required to ensure safe operational practices and airworthy aeroplanes.

2.2.3.1 JAR OPS 1 subpart B

- JAR OPS 1.035 Quality system (extract) (See AMC OPS 1.035)
 - a) Compliance monitoring must include a feedback system to the Accountable Manager to ensure corrective action as necessary.*
 - b) The Quality System and the Quality Manager must be acceptable to the Authority.*
 - c) Notwithstanding sub-paragraph (a) above, the Authority may accept the nomination of two Quality Managers, one for operations and one for maintenance, provided that the operator has designated one Quality Management Unit to ensure that the Quality System is applied uniformly throughout the entire operation.*
- JAR OPS 1.037 Accident prevention and Flight Safety Programme

An operator shall establish an accident prevention and flight safety program, which may be integrated with the Quality System, including:

 - 1. Programs to achieve and maintain risk awareness by all persons involved in operations*
 - 2. Evaluation of relevant information relating to accidents and incidents and the promulgation of related information.*
- JAR OPS IEM 1.037 Accident Prevention and Flight Safety Programme
 - 1. Guidance material for the establishment of a safety programme can be found in:*
 - a. ICAO Doc 9422 (Accident Prevention Manual) and*
 - b. ICAO Doc 9376 (Preparation of an Ops’ Manual).*

Where available, use may be made of analysis of flight data recorder information (See also JAR-OPS 1.160(c).)

2.2.3.2 Information from JAA FDM Conference, Lisbon, November 2001

2.2.3.2.1 JAA Operators Known to have Implemented Flight Data Monitoring Programmes

JAA Operators with known FDM Programmes - November 2001		
Country	Operator	Aircraft No
Czech Republic	CSA	25
Czech Republic	Fischer Air	3
Finland	Air Botnia	9
Finland	Finnair	57
France	All operators required to have a Flight Data Monitoring programme	app 460
Germany	Lufthansa	239
Ireland	Aer Lingus	35
Italy	Alitalia	147
Moldova	Air Moldova	23
Moldova	Renan	6
Moldova	Valan	2
Scandinavia	SAS	156
Netherlands	KLM Royal Dutch Airlines	97
Norway	Braathens	33
Poland	LOT - Polish Airlines	36
Portugal	TAP - Air Portugal	34
Romania	TAROM	15
Slovenia	Adria Airways	7
Spain	Air Europa	24
Spain	Iberia	158
Switzerland	Swissair	76
United Kingdom	Air 2000	29
United Kingdom	Airtours International	33
United Kingdom	bmi british midland	44
United Kingdom	Britannia Airways	32
United Kingdom	British Airways	259
United Kingdom	British Midland Commuter	7
United Kingdom	GB Airways	10
United Kingdom	Go	14
United Kingdom	KLM UK	25
United Kingdom	Maersk Air Ltd	10
United Kingdom	Monarch Airlines	22
United Kingdom	Royal Air Force	38
United Kingdom	Virgin Atlantic Airways	31
United Kingdom	UK operators - total aircraft	554
European Operators - approximate total number of aircraft		2196

2.2.3.2.2 French DGAC

France is the only JAA country that has a Flight Data Monitoring Requirement.

- 1987: legal obligation for aircraft > 40 tonnes and flight crew > 2 (statistical analysis).
- 20 January 1992, A320 Mont St Odile crash into Strasbourg.
Recommendations of the board of investigation to develop analysis systems for recorded flight parameters.
- Adoption of JAR OPS 1 into French legal framework as “arrêté OPS 1”, including a national variant : paragraph 1.037.
- 1st January 2000: Obligation to set up a Flight Data Monitoring system (> 10 tonnes / 20 pax):
Detailed analysis of critical events.
Specific provisions for the system to be confidential and anonymous.

2.2.3.2.3 UK CAA

- Origins in 1960’s Research program:
CAADRP - the Civil Aircraft Airworthiness Data Recording Programme.
1970-2 Development of SESMA event detection program - CAA concept developed jointly with British Airways. Continued close co-operation with BA.
Special projects with other Operators.
- UK CAA supports adoption of systematic FDM.
The benefits are much greater when integrated within a Safety Management System.
Although operators have internal issues to be resolved, it has been demonstrated to work effectively.
- CAA uses the data to :
Continue improving FDM techniques.
Give informed advice and guidance to operators.
Give support for the UK’s Mandatory Occurrence Reporting Scheme/ASR.
Assist the formulation of airworthiness and operational requirements.
- Amendment of UK Legislation concerning The Air Navigation Order:
“With effect from 1 January 2005 Operators of aeroplanes of a Maximum Certificated Take-Off Mass in excess of 27,000 kg shall establish and maintain a flight data analysis programme.”
A Civil Aviation Publication (CAP) - will include details of what a flight data analysis programme is, what it should contain and how it should be implemented and controlled.
Operators would then include details of their programme in their operations manual.

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2.2.4 United States FAA

Flight Operations Monitoring is not yet mandatory in the US, but the FAA has been sponsoring FOM projects and encouraging its use. The results of the DEMOPROJ trials shown below are similar to those found earlier by several European Authorities and operators shown in Section 2.1.4.

2.2.4.1 FAA FOM History

In 1995 the FAA issued the first draft of an advisory circular (AC120-FOQA) related to Flight Operations Quality Assurance, in due course amending 14 CFR part 13 “Investigate and enforcement procedures”, by adding Subpart I : “Flight Operational Quality Assurance Program: prohibition against use of data for punitive enforcement purposes”. This rulemaking being to encourage the voluntary implementation of Flight Operations Monitoring programs in US airlines.

1995-2000 DEMOPROJ FOQA trial run with 4 major US carriers.

In December 1998, Flight Operations Monitoring Policy Statement stated that:

“The FAA therefore finds that encouraging the voluntary implementation of Flight Operations Monitoring programs by US operators is in the public interest.”

In June 2001 the FAA issued a rule to protect voluntary provided information from disclosure in order to encourage data sharing programs such as FOQA.

On the 30th Oct 2001, FAA issued a rule to protect the data collected under Airline FOQA programs from FAA enforcement action, except in criminal or deliberate cases. The enforcement protection applies only to airlines with an FAA approved program.

Currently 10 airlines have FAA approved FOQA programs .

2.2.4.2 1995-2000 FOQA Demonstration Study Results (DEMOPROJ)

- Analysis of FOQA data has indicated that for domestic operations to major US cities, the frequency of approaches for which the rate of descent exceeds 1000 feet per minute at 500 feet descent height is generally much higher than was realized previously. Analysis further determined that there is a correlation between the frequency of unstable approaches and specific airport in correcting a long-standing problem at one such location.
- FOQA data also have indicated that the manufacturer’s recommended maximum speed for a given flap setting in a given aircraft type is exceeded more frequently than had been realized previously. Although pilots have been required to monitor and report the occurrence of flap exceedances for many years, flight crewmembers can miss them because they can occur for very brief intervals during the busy approach-to-landing phases of flight.
- Analysis of FOQA data suggests that more emphasis on the safe and proper execution of visual approach maneuvers is needed. This result is of interest since the emphasis in pilot training programs previously has been primarily on the execution of instrument approach procedures.
- FOQA data indicated, however, that few performance problems are occurring with instrument approaches. Results from the demonstration study at one airline have indicated that the modification of recurrent training content to better emphasize the visual approach has produced quantifiable improvements in individual performance on that maneuver during line operations.
- FOQA data have provided a hitherto unavailable means of establishing a database of TCAS alerts, and of documenting specific aircraft responses to the occurrence of TCAS events. This type of hard data is essential to the integration of TCAS technology with air traffic control modernization.
- FOQA data from two airlines, related to the impact of wind gusts, turbulence, and landing on airframe lifespan integrity, has proven to be invaluable for use by the FAA for the purpose of updating airframe certification standards.

- FOQA data acquired by one airline have documented that auto throttle performance in one aircraft type was not in accordance with the manufacturer's specification, and that this circumstance was responsible for chronic engine temperature exceedances in that aircraft type. This information, which had not been available until the implementation of Flight Operations Monitoring in that aircraft type, was successfully employed by the airline to modify takeoff power setting procedures in order to compensate the auto throttle deficiency, as well as to initiate communications with the manufacturer targeted at correcting the problem. As a result, the airline was able to achieve savings from fewer engine removals, as well as increased aircraft availability, for that aircraft type.

This is a list of cost saving programs achievable through Flight Operations Monitoring:

- Engine on wing extension programs
- Detection of out of trim conditions
- Improved fuel management
- Reduced hard landing inspections
- Brake wear reduction
- And insurance premium reductions

2.2.4.3 FAA Regulatory Oversight Includes Benefits for Airlines with FOQA Programs

The FAA instituted the Air Transport Oversight System (ATOS) for 10 major airlines. This new approach to how an airline assumes regulatory compliance and resolution of safety concerns is revolutionary in that it relies on geographical inspectors to monitor airlines. The FAA has stated that airlines with FOQA programs will require less oversight due to the FAA's confidence that those airlines have a better *control* of their day-to-day flight operations

2.2.4.4 FAA Monitoring of Approaches GPS/RNP Approaches to Low Minima

The FAA is considering approval of airlines using GPS/RNP approaches to be able to operate to lower minima, after analysing a minimum number of successful approaches through a Flight Data Monitoring system.

2.3

2.4 AIRBUS Policy for Support of Flight Operations Monitoring

It has always been, and remains the policy of AIRBUS to reduce risks of incidents and accidents by:

- Providing means to assist airlines enhance their safety culture and to improve their safety standards.
- Gathering operational data which can be analyzed to improve the AIRBUS product, specifically:
 - Aircraft design
 - Standard Operating Procedures
 - Training content and standards

These goals can be achieved in two main ways:

2.4.1 Providing Airlines with the “Flight Operations Monitoring” Package which contains:

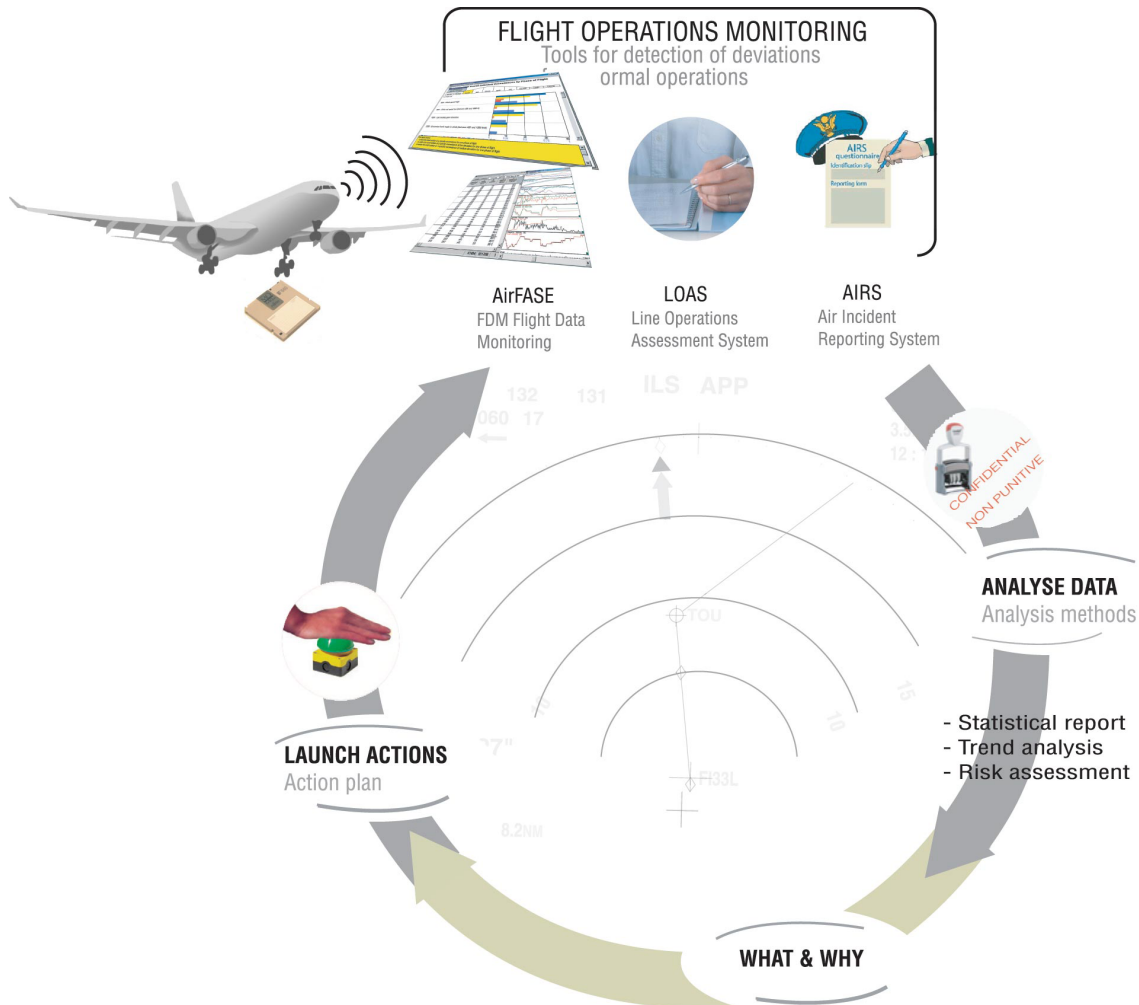
- The AIRBUS Flight Operations Monitoring software tools:
 - AIRFASE - Flight Data Monitoring analysis system
 - LOAS - Analysis of Reports made by Observers In Flight
 - AIRS - Analysis of Mandatory and Voluntary Reports made by Crew Members
- Related documentation, training and assistance for *implementation* of this package.
- Additional services and operational assistance if necessary for *continued use* of the systems.

2.4.2 Implementation of Data and Information Sharing between AIRBUS and airlines for:

- Improvement of AIRBUS aircraft, SOPs and training
- Feedback to the Airlines on lessons-learned in Safety and Flight operations monitoring

The final objective of AIRBUS is to enable every airline, whatever its size or experience, to achieve the highest level of flight safety by providing suitable tools and appropriate assistance.

This is illustrated in the following graphic.

AIRBUS Recommendation and Support for a Flight Operations Monitoring Program:**Systems:**

AIRFASE Analysis of Automatically Recorded Aircraft Data

to show **WHAT**

LOAS Analysis of Reports made by Observers of Crews In Flight

to show **WHY**

AIRS Analysis Mandatory and Voluntary Reports made by Crews

to show **WHY**

Documentation:

Flight Operations Monitoring Handbook

This document – for the complete FOM Program

Efficient use of Flight Data Monitoring

General information on Flight Data Monitoring

Flight Safety Manager's Handbook

Integration of FOM into a Flight Safety Department

Appropriate Assistance:

1. **Pre planning:** Together with individual airline, assess the organization and capability of the current Safety Department, and agree the equipment and personnel necessary to implement a Flight Operations Monitoring System. (For more details See Chapter 3.)
2. **Implementation:** Provide technical assistance to install and set up the computer systems, and operational personnel to assist with event analysis, risk assessment and appropriate remedial action.
3. **Continuing Support:** Provide technical and/or operational assistance as and when required.

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2.5 Components of a Flight Operations Monitoring Program

To be completely effective, a Flight Operations Monitoring Program must include:

- Tools for detection of deviations from operational standards, especially highlighting “precursors” that could lead to accidents if unchecked.
- Analysis systems to indicate safety trends and assess the safety risk status of the operator.
- Methods for taking corrective action and confirming effectiveness when implemented.

The AIRBUS FOM package contains 3 software tools, AIRFASE, LOAS and AIRS, which run on PCs:

2.5.1 AIRFASE Flight Data Monitoring tool, which:

- Records exactly what happened during each flight, using Quick Access Flight Data Recorders (Optical recorders/OQARs or PCMCIA/PC cards) fitted to the aircraft.
- Processes the data extracted from the Flight Data Recorder, measures deviations from a standard flight path, and creates Events associated to any deviations.
- Correlates the data for trend analysis, from which reports can be created which can be displayed graphically for operational assessment.
- Presents the progress of the flight on a PC screen that can be easily understood by those operationally qualified. 3 D view also gives a clear indication of the aircraft situation during the event without the need for piloting knowledge.

This allows easy and rapid analysis of events to establish their safety risk, and what action should be taken, if any.

This system complies with the Flight Operations Monitoring program specified in JAR-OPS 1.037, and with the FAA requirements.

The picture AIRFASE 1 below shows the opening screen after loading a flight into AIRFASE, displaying the flight profile from takeoff to landing and any events detected.

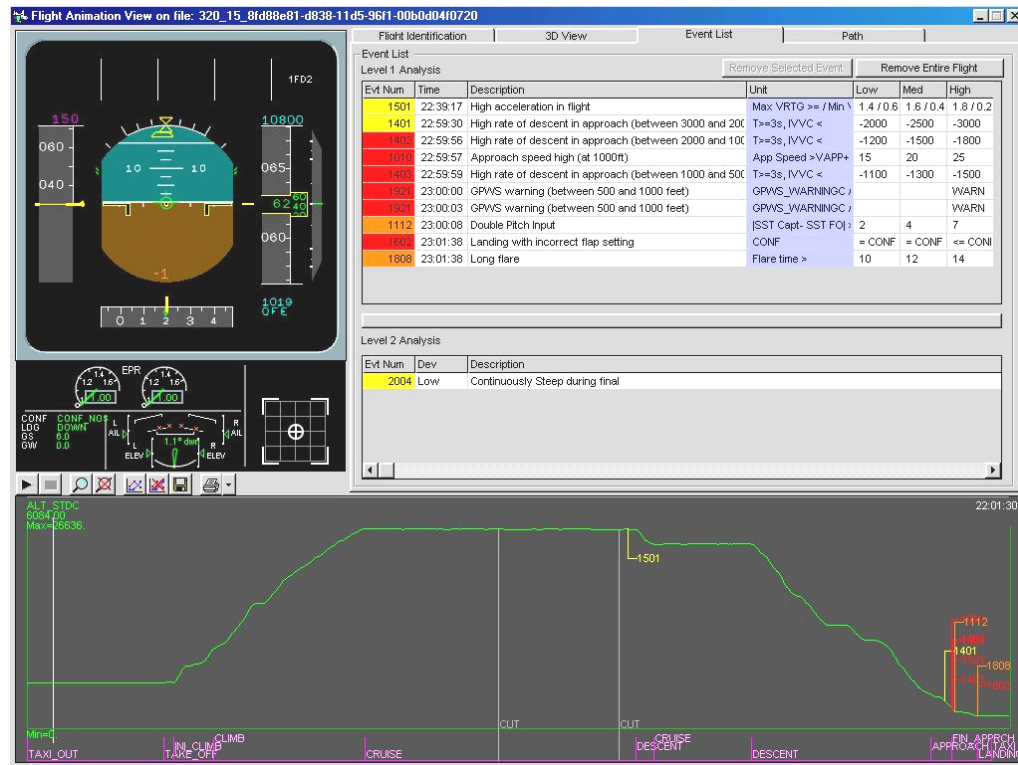
Events can then be selected and examined with the relevant parameters automatically displayed, as in the picture AIRFASE 2.

Path View draws the approach profile within 8 miles of the runway, giving an immediate indication of the nature of the approach and possible risks. AIRFASE 3 shows the vertical position of the aircraft in Path View at the event in AIRFASE 2.

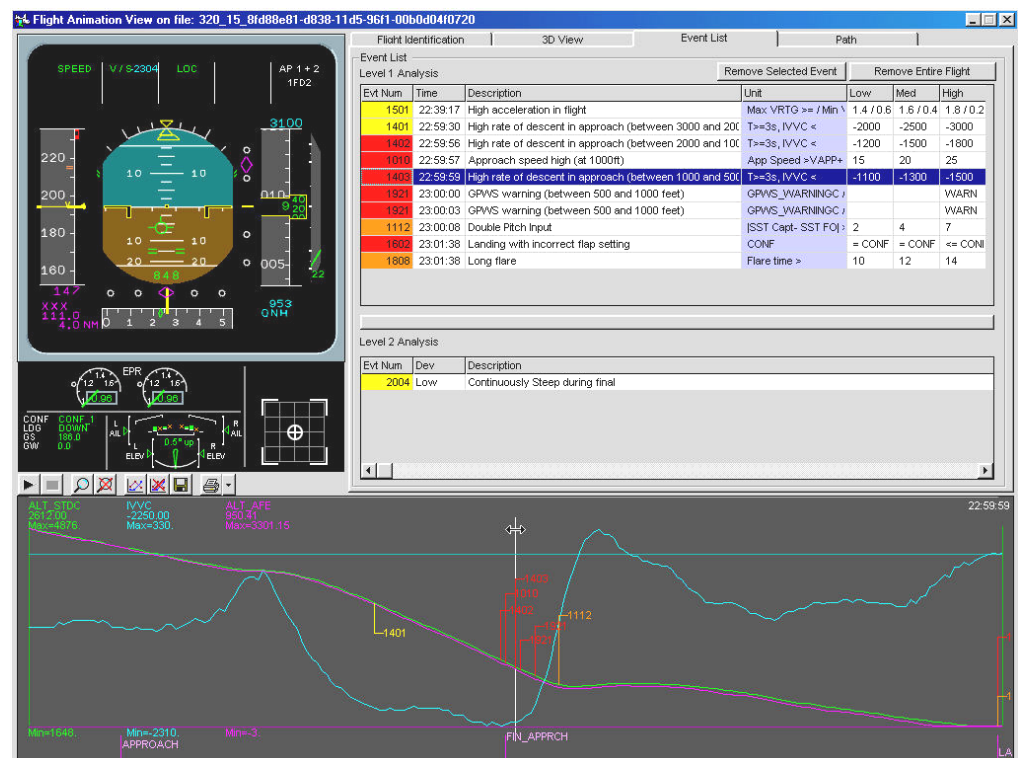
3 D View shows the aircraft in its current configuration, as seen from another aircraft from almost any angle. AIRFASE 4 clearly shows the risk of a take strike when an aircraft lands with high pitch attitude.

In 3D view the distance can be zoomed out so the complete approach profile can be seen in 3 dimensions, as in AIRFASE 5. Pilots’ views from the cockpit can also be selected.

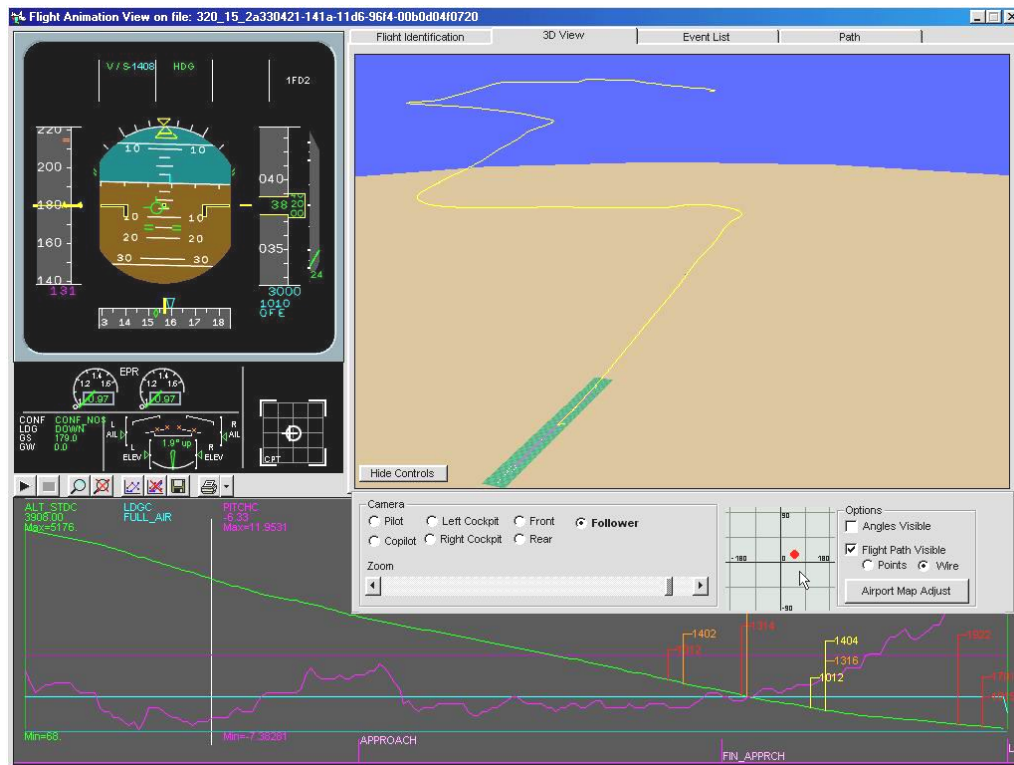
Besides investigating individual events, the main value in Flight Data Monitoring comes from trend analysis of the frequency of many type of events. AIRFASE is capable of producing suitable reports to support this essential activity, as in AIRFASE 6.



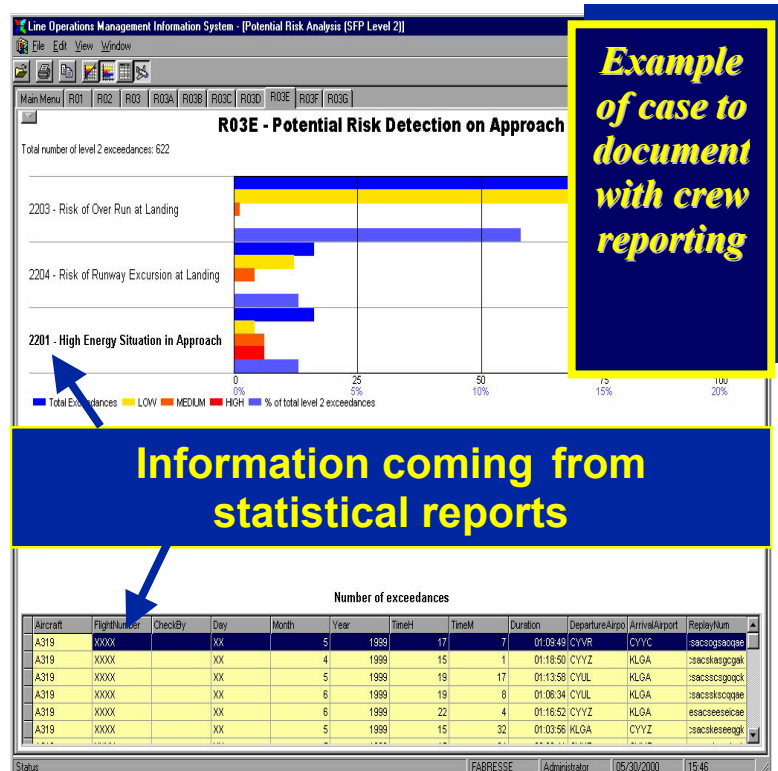
AIRFASE 1 – Opening Screen Shows Flight Profile from Take-off to Landing and Events Detected



AIRFASE 2 – Event Selected and Relevant Parameters automatically displayed in the Lower panel



AIRFASE 5 – 3D View Zoomed out to show Complete Approach Profile



AIRFASE 6 – Example of AIRFASE Report

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2.5.2 Analysis of In Flight Observations of Crew and System Performance – AIRBUS LOAS

An automatic Flight Data Monitoring system, such as AirFASE, reproduces exactly *what* happened throughout every flight, but in flight observations can tell *why*.

Ideally, a Flight Operations Monitoring system includes a system which can always establish *why*, by monitoring crew behavior on the flight deck, highlighting the problems or threats they encounter and how they deal with them, ATC performance, relationship with cabin crew, capability of ground support, etc. The results can be analyzed to help establish why events occur, what weaknesses exist in the whole operational system, and the necessary improvements made.

Such a system is not normally achievable on many flights at present, and certainly not with anything approaching the 95% monitoring coverage of an FDM system. However LOAS has been created to allow In Flight Crew Reports made by observers to be recorded on worksheets using suitable Keywords and stored in a database.

These Observations should be taken from as wide a source as possible, preferably made by an observer additional to the crew and whose presence does not influence their operational behavior. (Regulations require that all crew members must be Line Checked, normally annually by being observed by a qualified Check Captain. The flights can be part of LOAS, however not only is this a small sample, but crews might behave differently to normal because they are under check.)

Airline resources would not normally allow extra flight crews as observers on many routine flights. However on routes where difficulties are known to exist, for example if significant AirFASE events had been triggered, LOAS observer flights should be scheduled to establish the cause of the problems.

LOAS Keywords may also be used with training reports both on the simulator and in line operation.

In this way a worthwhile database can be built up to include items such as possible confusion over aircraft systems and instrumentation, crew CRM issues, etc.

LOAS is similar in concept to the surveys carried out under LOSA © – Line Operational Safety Audit – developed by the University of Texas, and supported by ICAO. To give airlines the benefit of compatibility of both projects, the relevant items in the LOAS worksheets are printed in the format used by LOSA, Copyright © The University of Texas at Austin 2001.

See Section 2.4.2 for further details of LOAS and LOSA ©.

2.5.3 Providing Airlines with the “Flight Operations Monitoring” Package which contains:

The AIRBUS Flight Operations Monitoring software tools:

AirFASE - Flight Data Monitoring analysis system

LOAS - Analysis of Reports made by Observers In Flight

AIRS - Analysis of Mandatory and Voluntary Reports made by Crew Members

Related documentation, training and assistance for **implementation** of this package.

Additional services and operational assistance if necessary for **continued use** of the systems.

2.6 Components of a Flight Operations Monitoring Program

To be completely effective, a Flight Operations Monitoring Program must include:

Tools for detection of deviations from operational standards, especially highlighting “precursors” that could lead to accidents if unchecked.

Analysis systems to indicate safety trends and assess the safety risk status of the operator.

Methods for taking corrective action and confirming effectiveness when implemented.

The AIRBUS FOM package contains 3 software tools, AirFASE, LOAS and AIRS, which run on PCs:

2.6.1 LOAS (Line Operations Assessment System) Analysis of Observation Reports on Crews

LOAS has been created to provide the same type of analytical information as AirFASE from in flight Observation Reports, on crews and all other parts of the operation, to show **why** events occur, and so to support the comprehensive information from AirFASE which indicates so clearly **what** has happened.

The LOAS worksheets used for recording observations, give guidance on assessments targets in the various flight phases to try to ensure standard grading.

			1	2	3	4
	S.O.P.	All flight desk tasks were performed according to SOPs. Call-outs were made and checklists performed correctly at the right time. <i>SOPs were well known and duly performed by the crew at all times.</i>				
	Ground Handling	Pushback and Taxi were conducted sensibly with regard to safety, passenger comfort and aircraft systems. <i>Appropriate separation with other traffic was maintained. Kept well within boundaries of taxiways. Speed and thrust were appropriate for surface conditions, brakes and tires.</i>				

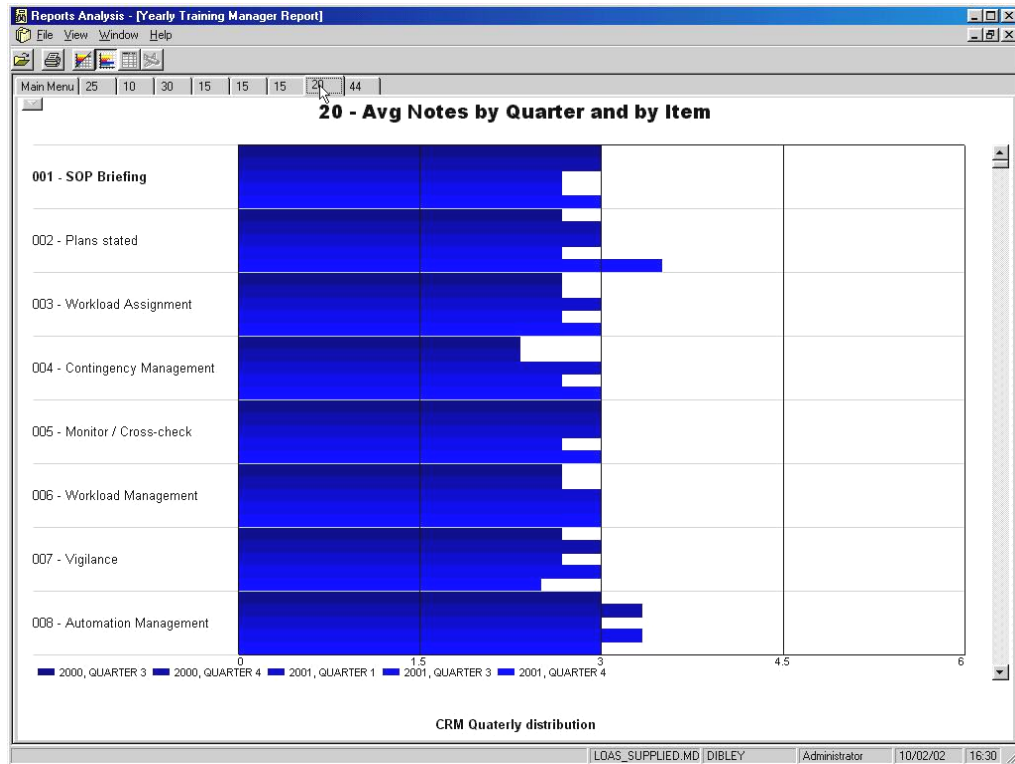
All aspects of the operation are assessed whenever possible, not simply the crew performance in the cockpit, but including Cabin Crew, ground support, ATC, weather information, etc.

Adverse grades of 1 and 2 require a Keyword to be assigned. The grading and Keywords are then entered into the database using the LOAS software.

Contingency Management

ID	Keyword
12	Effective threat management strategies
13	Anticipation
14	All available resources used

LOAS can then analyze the data and produce reports that are similar in presentation to those of AirFASE, as shown in LOAS 1. This can provide a more complete picture of the airline's operational safety situation, than only using AirFASE information.



LOAS 1 – Report produced by LOAS software tool, using database of In Flight Observation Reports

The source of the observations should be as wide and continuous as possible. Suitable Keywords could allow data to be taken from all operational activities including simulator and line training, This would create a database from which analysis could give insights into items such as:

- CRM behavior
- Application and suitability of SOPs
- Aircraft systems design
- Cabin crew interface
- Operations support
- Route infrastructure

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2.6.1.1 **LOSA ©(Line Operational Safety Audit)** developed by the University of Texas.

LOAS is similar in concept to LOSA © - Line Operational Safety Audit - developed by Professor Robert Helmreich of the University of Texas, and supported by ICAO.

To ensure compatibility for those airlines who might wish to take advantage of both projects when carrying out observations, the LOAS worksheets contain the LOSA © recording information in shaded areas, together with University of Texas copyright.

The difference in application is that LOSA © observations are made during a specified period agreed with the airline to be audited. Observers need not be qualified crew members, but all are trained to be unobtrusive in order to try and witness as normal an operation as possible.

After the observation period, the University of Texas analyses the data, and presents their findings to the airline for their action.

On the other hand, LOAS is intended to be on going, building up a database from assessments in all areas – from training as well line operations, even in simulators – using common Keywords. From analysis of this data, reasons may emerge for events triggered in AirFASE, besides highlighting weaknesses in other areas such as aircraft design, ground support, ATC, etc.

- For more information about the LOSA © program, contact:

Robert L. Helmreich, PhD, FRAeS
University of Texas Human Factors Project
The University of Texas at Austin
1609 Shoal Creek Blvd, Suite 101, Austin, TX 78712
Ph: 512-480-9997, Fax: 512-480-0234
Website: www.psy.utexas.edu/psy/helmrich

2.6.2 AIRS (Aircraft Incident Reporting System) Analysis of Crew Generated Reports

Crews are required to file mandatory Air Safety Reports (also referred to as Mandatory Occurrence Reports) whenever certain failures and/or incidents occur, such as an engine fire. Certain companies specify a larger range of events to be reported than those legally required by their National Airworthiness Authority.

Crews are also encouraged to file voluntary, confidential reports about any Human Factors problems they encounter, whether or not associated with an incident.

AIRS is part of the British Airways Safety Information System (BASIS) developed by British Airways to analyze these reports, in order better to understand the man-machine (Human Factors) events that occur in aircraft operations.

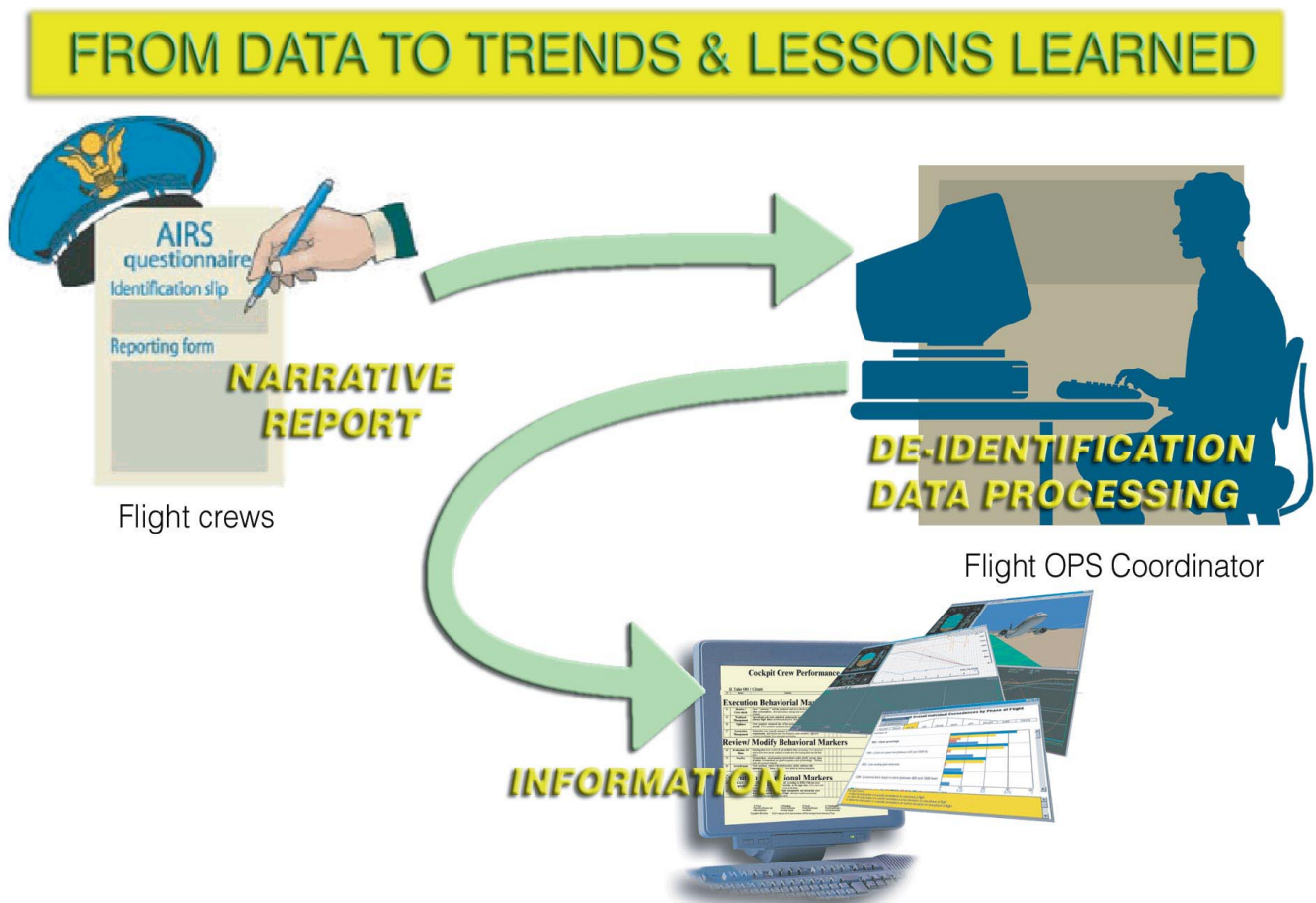
AIRS Includes 2 modules:

Air Safety Reports (ASR).

Human Factor Reports (HFR)

The AIRS software:

- Stores completed questionnaires from Flight & Cabin Crew.
- Analyzes the data to produce Human Factors reports that can identify trends.
- Highlights specific Human Factors difficulties.



AIRS Stores and Analyses Crews' Air Safety Reports and Voluntary Human Factors Reports

2.7 Organization Required for Flight Operations Monitoring Program

Section 2.4 describes the components of the Airbus Flight Operations Monitoring System, but even when being considered conceptually, no system is complete without including the people involved.

To show a musical analogy:



**The flight data recording system is the PIANO,
The flight analysis tools are the MUSIC....
But good music requires good MUSICIANS**

2.7.1 Flight Operations Monitoring Program Process

This principle is especially true of a Flight Data Monitoring system that involves disciplines and expertise across nearly all airline departments, which must work together harmoniously to achieve the maximum benefits from the system.

The nature of the Flight Data Monitoring process varies with the areas being covered. For example, aircraft engineering functions such as engine health monitoring can be completed largely automatically without the need for human intervention.

In contrast, the major operational function, Flight Event Analysis, at present requires considerable human involvement throughout the process. (Section 5 covers Flight Event Analysis in detail.)

This can be seen from the graphic on the next page which shows the process of the Flight Operations Monitoring Program.

After the aircraft raw data has been downloaded and filtered automatically, computer experts carry out fine filtering, event detection and initial classification.

Flight operational experts who know the aircraft and the route then confirm the validity of the events.

LOAS observations and crew created reports in AIRS can be combined with Flight Data Monitoring information generated by AIRFASE to produce information to be considered by the Flight Operations Monitoring Team, sometimes called the Flight Data Review Committee, which reviews and analyzes the information as described in Section 5. Various levels of reports are generated to:

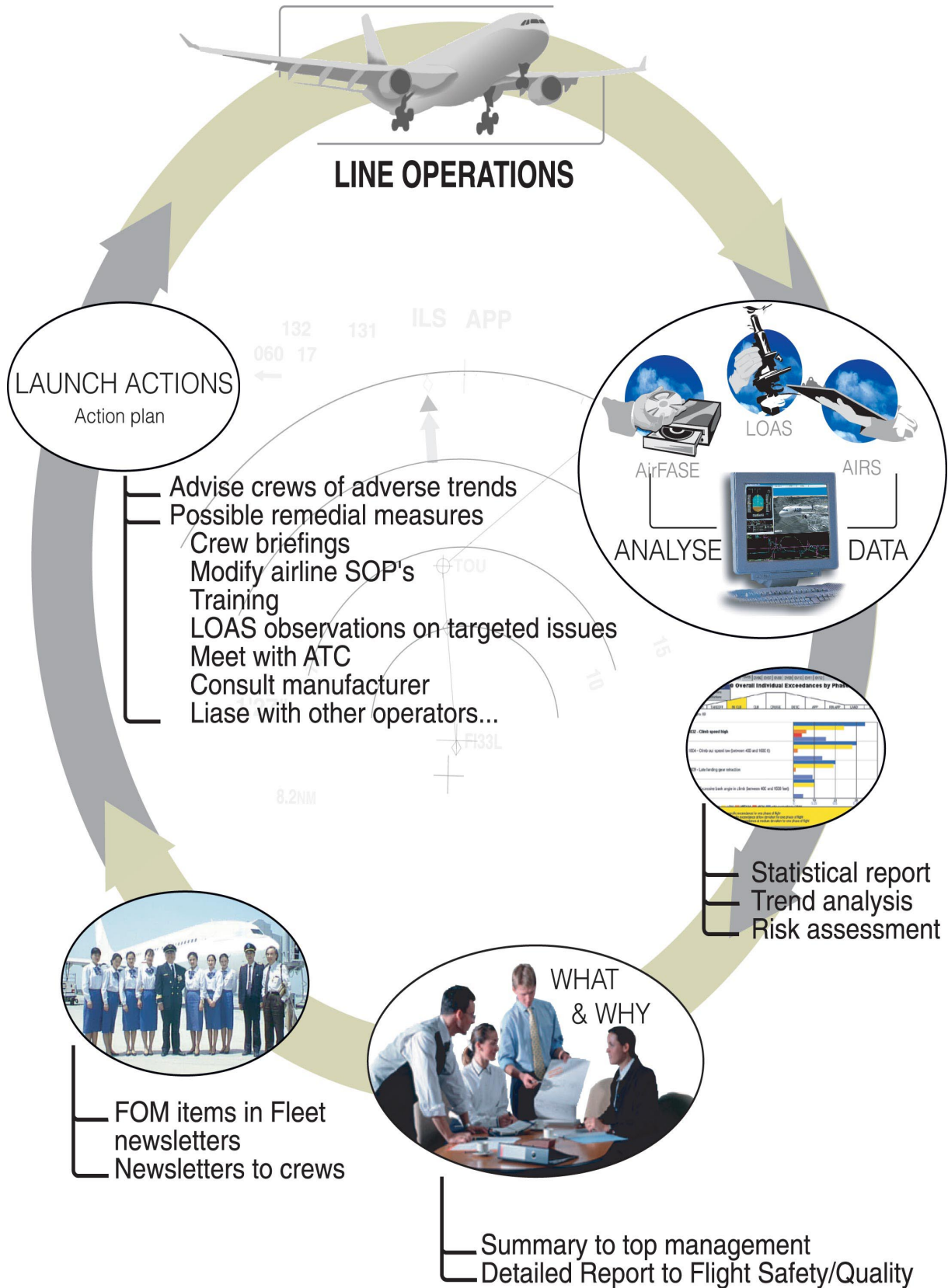
Flight Operations Management – Reports related to operational incidents and risk trends for particular aircraft types. Flight Ops Management can take the necessary action to prevent any precursors developing into possible accidents. The effect of these actions can be monitored for effectiveness by the system to “close the loop”.

Flight Operations can provide feedback to crews on type specific matters via their fleet newsletters, according to the size of the airline.

Air Safety/Quality Departments - Detailed reports covering all aspects of aircraft types, systems and routes.

Top Management – Summary of overall safety status.

All crews and interested parties - Newsletters on topical Flight Operations Monitoring items.

Flight Operations Monitoring Program Process:

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2.7.2 Consideration of an Organization to Run a Flight Operations Monitoring Program

Implementation of a Flight Operations Monitoring program is covered in Section 3, and Flight Event Analysis in Section 5, but study of the concept and components of such a system is not complete without considering the company organization and the people to be involved in planning, setting up and running the system.

Section 2 gives the Regulatory Requirements that are already or are coming into force worldwide. These generally state that a Quality audit system must be under the responsibility of a designated individual, but do not specify the organization containing the various necessary functions such as Flight Data Monitoring.

The integration of an FOM Program into an airline will depend upon its size and the organizational structure and matters such as its existing information technology. The following summary, based on the process diagram on the previous page, indicates the departments involved which need to be included the preliminary discussions:

Engineering and Maintenance:

Record the aircraft data on a suitable media, and supply this regularly to the FOM program.

Carry out analysis on engineering/maintenance related matters, such as engine health and aircraft performance monitoring.

Confirm the system remains serviceable and continues to provide comprehensive and valid data.

Information Management

Provide suitable hardware to run the analysis tools for engineering and the Flight Operations Monitoring programs.

Provide staff short term to approve, install and setup the various software tools.

Supply computer expert(s) long term to be part of the Flight Operations Monitoring team.

Flight Operations Monitoring Department

Responsible for the liaison between departments for the initial purchase of the system, agreement of the organization, the implementation of the system and the continued efficient running of the whole program, including event analysis, risk management and report generation. (Depending upon the organization of the airline, the Flight Operations Monitoring Department may be set up separately or be part of departments such as Flight Operations or Air Safety.)

Flight Safety/Quality Audit

In some airlines, the Flight Safety or Quality Audit Department is in charge of the Flight Operations Monitoring Program, and therefore takes on the duties listed under Flight Operations Monitoring Department. Otherwise Flight Safety and Quality Audit must agree with the FOM Department the detailed functions of the complete Flight Operations Monitoring program and the information to be supplied.

Flight Operations

Provide short term operational input to agree on the system to be purchased, events profiles, etc.

Provide long term operational experts from each aircraft type to work in the Flight Operations Monitoring Department. Analyze information from FOM reports and create action plans when necessary to modify operating procedures, advise crews, liaise with outside authorities, etc.

General Management/Other Departments

Other departments may be involved in matters such as finance, office space, security, etc. As explained in the next paragraph, the benefits of a Flight Operations Monitoring program can reach across the whole airline, therefore all departments likely to be affected should be invited to participate in the early stages of the program so that such potential benefits are understood and can be achieved.

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2.8 Benefits of a Flight Operations Monitoring Program

Introducing and running a Flight Operations Monitoring program is expensive but the benefits across the airline are considerable, a sample of which are given in this section.

It is essential that all departments are aware of these potential benefits, so that the planning and implementation of the program described in Section 3 can achieve the maximum number of rewards. By so doing, a proactive attitude towards the program can be engendered throughout the company.

2.8.1 Benefits to Flight Operations

A successful Flight Operations Monitoring program encourages adherence to Standard Operating Procedures, deters non-standard behavior and so enhances flight safety.

Flight Data Monitoring systems are designed to trigger events which detect operations outside the normal profile in any part of the flight regime.

Besides detecting serious hazards which require immediate investigation, these events can highlight “precursors” which may not have had serious consequences at the time, but which in future could combine with other difficulties to cause an incident, or have long term effects on aircraft or engine life. Examples include:

- Engine over-temperature
- Excessive rates of rotation
- Early/late rotation speed
- Risk of tail strike – on takeoff and landing
- Excessive bank angles after take-off
- Exceedance of flap limit speeds
- Exceedance of VMO MMO, Max Turbulence Penetration Speed (VRA)
- Low buffet margins
- Onset of stall conditions
- GPWS and TCAS warnings, validity and crew reaction
- False warnings of any system
- Unstable and rushed approaches
- Glide path excursions
- Contribution of Air Traffic Control in causing abnormal approaches
- Hard Landings
- Monitoring of fuel reserves
- Extreme weather conditions outside aircraft design limits

Other benefits to Flight Operations matters may be financial and environmental:

- Fewer resources required to comply with Quality Audits from reduced oversight agreed with the National Airworthiness Authority.
- Monitoring of excess fuel carried and effect on payload and regularity.
- Excess fuel consumption by suboptimum operation – use of inappropriately high speeds throughout profile; poor choice of cruise altitude; early descent, flap and/or landing gear extension, etc.
- Monitoring takeoff, approach and landing procedures for effect of noise pollution on the environment, etc, including the influence of ATC.

2.8.1.1 For Crew Members a properly developed and executed program must be:

- Confidential and anonymous.
- Non-punitive and without jeopardy to the crewmember's career.

Crew members should feel more secure in the knowledge that if they were to be involved in any incident or accident, then the indisputable facts from the FDM/AIRFASE would be available in assistance.

Given sensitive management, crew members should also be reassured that any deficiencies in their operating techniques may be recognized before serious problems occur, and remedial training given if necessary.

On some future aircraft, it may be possible to obtain a AIRFASE readout on the aircraft after the flight. This should be of an extra benefit to crews.

2.8.2 Benefits for Flight Training

The Flight Operations Monitoring results can be used to enhance training performance. This interfacing of Flight Operations Monitoring and training is fully in line with the AQP (Advanced Qualification Program) concept developed by the FAA to continuously optimize flight crew training.

It has also been used successfully by European airlines – see Section 2.1.4

Several applications can be investigated:

2.8.2.1 Building a Recurrent Training Curriculum

In the US FAA AQP concept, the recurrent training is adapted to the trainee's needs identified during the "first look".

Integrating Flight Operations Monitoring data (coming from the three types of tools) in the training feedback will allow to:

- Adapt the "first look" considering the weaknesses statistically detected in operations.
- Adapt and customize the recurrent training itself with appropriate exercises, if the weaknesses are confirmed during the first look.

2.8.2.2 Use AIRFASE for Debriefing LOFT Sessions

Interfacing AIRFASE with training simulators will help in the debriefing of training sessions, by giving trainees immediate feedback on their performance (list of events detected, replay of the relevant parts of the flight).

Training crews to the standards of AIRFASE event monitoring should also reduce operational deviations in subsequent line operations.

2.8.2.3 Use of AIRFASE for Monitoring Initial Operating Experience Flights (Line training)

The analysis of data from IOE flights can identify which types of event occur particularly during the pilots' initial training on the aircraft.

Improving the Type rating transition training, taking into account these results, could reduce the time necessary for IOE.

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2.8.3 Benefits for Engineering and Maintenance

The engineering Departments of several airlines use Flight Operations Monitoring data for fault diagnosis, engine health monitoring and fuel usage tracking.

It is generally agreed that it is possible to save US \$750,000 annually, on a long-haul international route, by identifying specific aircraft that have exceptionally high fuel-burn rate, there by being in position to adjust those aircraft's airframes and/or engines for greater efficiency and increase payloads on critical routes.

The advantages to maintenance also overlap those shown for operations, by avoiding aircraft damage/repairs.

- Exceedance of flap limit speeds
- Engine over-temperature events
- Exceedance of VMO MMO, Max Turbulence Penetration Speed (VRA)
- Hard Landings
- Risk of tail strike
- Reliability of warning systems – false GPWS, fire warnings
-

2.8.4 Benefits for Commercial and Finance Departments

Benefits to the Commercial Department:

- Improved payloads from improved airframe/engine efficiency and monitoring and refinement of reserve fuel.

Benefits to the Finance Department:

- Reduced insurance costs, from acceptance of improved operational monitoring
- Confirmation of ATC navigation charges

2.9 Flight Data Information Sharing

As Flight Operations Monitoring becomes more widespread across the aviation industry, there are suggestions that safety related data should be shared in varying degrees amongst operators, airworthiness authorities, manufacturers, ATC, research establishments, etc.

There are a number of current programs which share safety information, such as AIRS, part of British Airways BASIS, which forms part of the Airbus Flight Operations Monitoring System, and is described in Para 2.1.3. Another similar program is the IATA Safety Trend Evaluation, Analysis and Data Exchange System (STEADES).

The Global Aviation Information Network (GAIN) Program has been set up with the overall objective to “promote and facilitate the voluntary collection and sharing of safety information by and among users in the international aviation community”.

Captain John Marshall, of Monarch Airlines, has made a study of “Industry-Wide Exchange of Flight Data Monitoring Information” amongst 40 UK operators and other aviation bodies including Airbus. Extracts of his findings are shown for information.

2.7.1 Extracts of JR Marshall’s “Industry-Wide Exchange of Flight Data Monitoring Information”

2.9.1.1 Data Format Most Operators Willing to Share – FDM Statistical Information.

All the UK operators were positive towards sharing statistical data generated by Flight Data Monitoring programs. However this was not considered to be ideal, due to:

- The difference in event calculation between FDM programs, and aircraft performance, and
- The large amounts of data that would include relatively benign events of little safety significance.

2.9.1.2 Data Considered Most Useful to Receive – Lessons Learned

Operators were keen to receive the evidence and conclusions of other operators’ investigations into significant events. However, this was also the type of information that operators were least inclined to share. John Marshall saw the following advantages in this type of data:

- Information is not linked to a particular flight, thus protecting confidentiality.
- Events come from higher risk levels of the safety pyramid, thus do not involve large amounts of irrelevant data.
- Information is in a readily usable form without need for analysis.
- Even if from another region, the similarities in safety problems mean that such incidents are probably significant to other operators worldwide.

2.9.1.3 UK FDM Operators were Very Positive towards Sharing Raw Data with the UK CAA

UK FDM operators were very positive about sharing de-identified raw data, statistical data, and data in support of Mandatory Occurrence Reports with the UK CAA.

2.9.1.4 Majority of Operators Willing to Share Data with Aircraft & Systems Manufacturers

The majority of UK FDM operators were willing to share de-identified raw data and statistical data with aircraft and system manufacturers.

2.9.1.5 Significant No. of Operators Willing to Share Data with Research Agencies & Industry

A significant proportion of UK FDM operators were willing to share de-identified raw data and statistical data with research studies made by agencies in the UK or abroad, such as QinetiQ/DERA, NASA, or universities, and with areas of the industry such as ATC and airport authorities and flight training organisations.

2.9.1.6 None of the UK FDM Operators Willing to Share Identified Data

All of the UK FDM operators who responded to the questionnaire were unwilling to share identified data.

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3 IMPLEMENTATION OF A FLIGHT OPERATIONS MONITORING PROGRAM

Implementation of a Flight Operations Monitoring Program can be divided into a number of inter-related activities including:

1. Evaluation of available systems involving all relevant departments to promote a proactive culture towards the program. Purchase of selected system with modification for the airline specific operation if necessary.
2. Planning for the FOM program organization and integration into the airline structure.
3. Selection and initial training of members of the Flight Operations Monitoring Team.
4. Installation of equipment and software tools, and running the complete system over a suitable period, with on the job training of the core team.
5. Start of live operation, with on job training for the remainder of the monitoring team.

3.1 Evaluation, Selection and Purchase of an FOM System

3.1.1 Evaluation Process can Initiate a Proactive Company Culture to the FOM Program

A Flight Ops Monitoring Program is expensive in terms of tools purchased, installation, personnel involvement, training and general support.

Although becoming mandatory in many states, an FOM program might be seen by parts of the airline as a drain on already stretched resources.

Section 2.6 shows that real benefits from the program can be gained throughout the airline, therefore it is essential that departments likely to be affected are involved from the early planning stages to ensure that:

- a. Everyone in the airline is aware of the benefits that are available,
- b. The system purchased enables the maximum benefits to be achieved, and any possible compatibility issues or other difficulties are resolved at the outset.
- c. The program is received proactively throughout the company.

Introduction of a new program such as FOM, which can affect many departments, might be seen as a threat and provoke some defensive reactions. Proactive involvement can help overcome any such negative tendencies.

3.1.2 Selection and Purchase of a Suitable FOM System

Before starting the selection process, members of the selection team must be fully aware of the requirements and aims of the FOM program.

Para 2.3 shows that it is the policy of Airbus to provide support in these and other areas. Besides this Handbook, the Airbus publications “Flight Safety Manager’s Handbook” and “Efficient Use of Flight Data Monitoring” give suitable guidance.

Each airline has its own slight operational variations and needs, and it is likely that modification will be necessary to any FOM system selected, such as to the type of events in the FDM profile, reports produced, etc. These are types of requirements that should be included in the purchase agreement.

3.2 Planning for the FOM Organization into the Airline

3.2.1 Organization and Nature of the Flight Operations Monitoring Team

A Flight Operations Monitoring program requires a dedicated team with a high degree of integrity, specialization and logistical support.

Depending on the airline structure and size, a specific Flight Operations Monitoring department can be created. Otherwise, the FOM team can be incorporated in an existing department such as the Flight Safety or Quality Assurance Departments. In some airlines, Flight Data Monitoring is part of Flight Operations Technical.

Wherever the team is located, it is essential that everyone involved with FOM, recognizes that the program can only succeed if it remains founded on a bond of trust between the operator, its flight crews and the regulatory authority.

3.2.2 Relationship with Quality System and Accident Prevention and Flight Safety Programs

Flight Operations Monitoring is fundamental part of the Quality System and Accident Prevention and Flight Safety programs, such as required by the European Regulations shown in Para 2.2.3.

The organizational structure must ensure that the FOM program complies with the requirements of these airline departments, who in turn have their policies agreed by the National Airworthiness Authorities.

3.2.3 Secure Location of the Flight Operations Monitoring Equipment and Data

The data used by the FOM program is highly confidential. It is a basic agreement with all parties that any information that is published outside the department must be de-identified.

All FOM equipment and data must be absolutely secure. This must remain a top priority in the type and location of the computer system to be used, which may be a single system or networked according to the size and capability of the operator.

3.3 Flight Operation Monitoring Tasks and Qualification of Experts

3.3.1 Flight Operations Monitoring Tasks

Flight Operations Monitoring data management involves:

- Collection and processing of AIRFASE data
- Collection and processing of Crew LOAS Observations evaluation sheets
- Collection and processing of Crew AIRS Reports
- Analysis of results, including individual events, safety trends and risk assessment
- Publication of regular reports with appropriate recommendations when necessary to Flight Operations, Air Safety/Quality Departments, Top Management and the general airline community

3.3.2 General Rules for Creating Reports

The following basic rules should be used when creating Flight Operations Monitoring reports:

- Reports must be designed in consultation with and for each user, restricted to the data needed, and clearly understandable

3.3.3 Tasks and Qualifications of Computer and Operational Experts

1. System Engineers:

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- Run systems, perform data fine filtering, confirm event detection and initial classification
- Ensure that all data generated is securely stored
- Participate in production of statistical reports

Qualifications required for this position are:

- Advanced analytical skills
- Advanced electronic data processing experience
- Advanced knowledge in aeronautic principles and technology
- Good knowledge of global operating practices

2. Aircraft Type Qualified Fleet Analysts or “gate keepers”:

- Confirm events for operational validity
- Review high risk events in detail, contacting crews through agreed procedure if necessary
- Participate in producing statistical reports, safety trend and risk analysis
- Include operational comments an/or suggestions in reports when appropriate

Qualifications required for this position are:

- Air Transport Pilot Licence
- Qualified line pilot, type rated on the aircraft analyzed
- Wide experience of routes and type of operation
- Computer literacy
- Qualified in Human Factors
- Sound knowledge of Quality Management

These pilots must be approved by the pilot community, as they ensure confidentiality of the data and form the link with the pilot community.

Personnel for these positions should be selected in time for them to be trained and in place for the installation of the FOM system.

It must be a selection requirement for all members of the FOM team to be of an equable temperament, and thus be able to have the confidence of the entire airline community, especially amongst flight crew members who can have the most exposure from the system.

(See Section 5 for further details.)

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3.4 Installation of the FOM System and Training of Airline Personnel

Airbus provides appropriate technical and operational support for installation and training during the initial operating periods, as shown in Section 3. For AIRFASE, this is normally about 2 weeks initially, with short visits for further training after 3 and 6 months. Installation is quick and the system can be running within a few days.

3.4.1 Installation of the Hardware and Software Tools

Installation of the hardware is usually the responsibility of the airline and is straightforward, always remembering that all equipment must be housed in a secure area with the data remaining secure at all times.

Software tools such as AIRFASE are now mature and installation is also straight forward. An Airbus engineer is normally in support for about 2 weeks for installation and initial training.

The system may be run immediately, at first mainly involving the computer experts to confirm that the complete system is operating correctly from aircraft data download through to event detection and report generation, with appropriate security and confidentiality safeguards.

3.4.2 Running the Complete Program with Operational Data

Once the system is confirmed to be correctly matched to the airlines aircraft and operation, the computer analysts can be joined by the airline's pilot operational experts.

The complete program may then run on a trial basis using aircraft data through to event investigation, report generation, trend and risk analysis.

3.4.3 Initial Live Operation with Continued On the Job Training

After the program has run for a satisfactory trial period and the FOM Team is comfortable with report generation and analysis, the FOM program can go live, providing reports and data to the airline community.

Airbus engineers and pilots normally return after about 3 months for support training, and finally about 3 months later. Further training should not be necessary, but Airbus support remains always available on request.

3.4.4 FOM Programs are Continually Improving, but Must Remain Cost effective

As also explained in Section 5, the Flight Operations Monitoring Program is a developing process.

Although the software tools such as AIRFASE as are mature, as the operator's route and environment change, some elements of events and profiles may require revision. Modifications may be needed to cover specific information for projects requested by departments inside and outside the airline, such as ATC.

New technology will undoubtedly permit improvements in the speed and capability of systems.

However, the prime aim of Flight Operations Monitoring is to maintain safety standards at an acceptable level of risk, in which cost is a consideration.

As in any area of the airline business, all improvements and other work must be cost effective.

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4 AIRLINE EXPERIENCE IN FLIGHT OPERATIONS MONITORING PROGRAMS

4.1 AIR FRANCE experience

4.1.1 History of Recorded Flight Data Monitoring Implementation at AIR FRANCE.

Systematic flight data analysis, now commonly referred to as a component of FOQA (Flight Operations Quality Assurance), has been implemented at AIR FRANCE since 1974 as a result of a formal agreement between airline management and cockpit crew organizations. The key points of this agreement are:

- Anonymity and immunity of the crew involved (under conditions).
- Implementation of a Flight Data Analysis safety committee, gathering pilots from the management and pilots union representatives, who meet 6 times a year. They examine selected QAR/DAR events and may recommend corrective actions.
- Feedback from cockpit crew (through de-identified written reports).
- Publication of a Flight Data Analysis bulletin presenting the most significant events and lessons learned.

The main goal of Flight Data Analysis is safety management. But the use of Flight Data Analysis for maintenance (engine and aircraft performance monitoring, troubleshooting) and miscellaneous applications (such as checking invoices for ATC en route fees) results in some financial benefits.

All airplanes in AIR FRANCE fleet (210 on March 31st, 1999) are QAR (or DAR) equipped, and all recorded data is systematically processed. More than 500 tapes or optical disks are processed each week. Today, data from more than 85 % of legs flown were recovered (some data were lost due to technical problems and AIR FRANCE is working on solutions to improve this rate). The change from magnetic tape to optical disc brought a real improvement.

With such a large amount of data the challenge is to use it in the most efficient way for safety management.

4.1.2 Today's Organization

The Prevention and Safety Department is in charge of running the Flight Data Analysis activity which is part of a set multiple feed back channels made of confidential reports (human factor aspects), BASIS ASR tool, incident investigation reports and feed back from a team of 10 Flight Safety Officers (captains) in addition to exchanges with other airlines and safety organizations around the world. The department's chief is a captain, accountable for the compliance to the non punitive policy of the flight data analysis and the confidential system tool. He reports to the Executive VP Flight Operations.

Until today, the Flight Data Analysis tool was based on an in house software named CARINE 2. In 2000 Air France decided to buy the SAGEM tool "AGS" in order to take benefits of the lessons learned from a wider range of users and to "benchmark" in a more efficient manner their own use of the tool.

The Flight data analysis organization gathers a technical support for computer program, a team of analysts and a captain who selects and manages the analysis for the flight operation aspects. He is in charge of preparing the events presented to the flight data analysis safety committee and to collect the confidential crew reports about these events.

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4.1.3 Communication and Reporting: Confidentiality management, Type of reporting, Frequency.

Whenever a significant event is automatically detected and validated by an analyst, the captain in charge of the program assesses the event and, depending on its nature, sends questions to the crew.

This captain does not know the name of the crew members and a person chosen by both management and union is responsible of identifying the name of the crew involved and of sending the file to the crew. This person does not know the content of the file. Every two months, a selection of the few most significant events is presented to the Flight Data Analysis safety committee which may recommend corrective actions related to documents, training and even ATC or manufacturers. There is anonymity if the event is only known through the detection of the data analysis tool. There is no confidentiality in the rare circumstances when there is damage to the plane or complaints from ATC.

A selection of events presented to the flight data analysis safety committee is published in a Flight Data Analysis bulletin destined to all pilots and flight engineers. By doing this, the lessons learned can be shared. This is critical to obtain and maintain crew members adhesion to the process, together with cockpit crew organizations involvement in the flight Data Analysis committee. By publishing events, we introduce some transparency and make the process more real. Finally such a publication encourages to report by reducing fear or anxiety to be punished.

As a complement to the committee, statistics are used to assess practices and measure the effectiveness of some corrective actions.

Results of Flight Data Analysis implementation in operation safety, training and operational standards.

After 27 years of existence, Air France Flight Data Analysis system is widely accepted and is an integral part of airline operations. Despite some inherent limitations, it plays a key role in implementation of Air France A.R.M. (Accident prevention and Risk Management) which first task consists in making safety related event **visible, understandable and usable** for prevention.

Significant QAR/DAR events are understood as precursors of accidents. With trend data supported by statistics it helps to define (or modify) prevention strategies and corrective actions. However, we should bear in mind that our first priority should remain the prevention of “top four” accidents (CFIT, Loss of control in flight, Midair Collision and Runway Collision). To achieve this goal, Flight Data Analysis system is unable to detect some events such as runway incursions as well as taxiways confusions (failure to follow a taxi clearance), leading to runway collisions at high speed with an aircraft landing or taking off. We may assume that runway incursions are adequately reported by ATC and/or crews, but the fact is that we have to rely on sources other than Flight Data Analysis when addressing the risk of Tenerife type accidents.

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4.1.4 AIR FRANCE Case Study

Early 1992 a B767 took-off from San Francisco with a take-off weight of 134 tons. During the initial climb, the indicated air speed decreased to near V2 while the aircraft pitch attitude was steadily increasing to reach 24° at 2600 ft. Then, the Pilot in Command vigorously reacted by reducing the aircraft pitch attitude, but the indicated air speed continued to decrease till reaching V2 – 25 kt.

This event which occurred in 1992, illustrates one of the take-off speed regressions regularly detected through flight analysis since the B767 came into service. This above-mentioned regression to V2 – 25 kt was the most serious incident. Crew members were alerted about these repetitive events through notes and flashes issued by the Flight Analysis Department. Instructions to limit the aircraft pitch attitude to 20°, whatever information given by the flight director, have been added to the Flight Manual.

About three years later, early 1995, another B767 took-off from the 28R runway of San Francisco airport. The same type of incident happened again. Despite a decrease in their frequency, the speed regression phenomena had not yet disappeared. It was then necessary to start from the beginning to identify more clearly the source of the problem, find and implement a solution in order to resolve the series of incidents.

In conjunction with the Flight Analysis department, all 80 B767 take-off between February 28th and March 8th 1995 were systematically analyzed. The detailed analysis of these events finally revealed the source of the problem.

36 out of 80 take-off showed a speed regression in excess of 10 kt and 8 out of them nearly reached a V2 (V2 – 1 kt) minimum speed. The normal climb speed lays between V2 + 15 kt and V2 + 25 kt, which means that we managed to underline an almost 20 kt deficiency for 10 % of the take-off not exceeding 20° pitch attitude. Actually, the regressions occurred with 17°-to-19° aircraft pitch attitudes, probably commanded by the flight director.

In order to convince the crew members and to provide source for thought within the division, the most significant examples were displayed in the B767 Flight Safety Officer's office. Some of the crew members considered this notice a bit aggressive but it allowed most of them to realize the importance of the problem.

This notice underlined the very frequent crew error that had not been revealed by the comments done to the check pilots.

During the month of March 1995, we discussed a great deal of the matter and many pilots gave us their observations during the flight. The flight director functioning seemed to be the origin of the problem: aircraft pitch-up attitude corrections were often too important and late compared with the airspeed indicator tendency command.

We then informed Boeing of our incidents analysis and published an operational information to all the B767 pilots in April 1995 mentioning what revealed the flight analysis department and giving new instructions as well as some recommendations:

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- *“Memorize during the briefing the aircraft pitch attitude and the target speed to hold.*
- *Stop the rotation at 15° and then, depending on the airspeed and the airspeed excursion tendency, adjust the aircraft pitch attitude to obtain $V_2 \pm 5$ kt.*
- *Do not take into account information provided by the flight director between 0 and 1500 ft.”*

The crew members were also informed that another systematic examination would be done in June to check whether the instructions provided were efficient or not.

During the next two months, they discussed the matter. Instructors and check pilots relayed the information.

The instructions were displayed in the office of the flight safety officer and an Operational Information added to the technical Flight File used before each flight, in order to remind the crew members of this existence before each flight. The message seemed to be passing well.

At the end of June 1995, a new detailed analysis of 100 flights was carried out. Very encouraging improvements were noticed. After 10% of worrying speed regressions observed in March 1995, only one of this sample was observed, that is to say 1% (with a speed of $V_2 + 3$ kt and a aircraft pitch attitude maintained at 17°). Again, the new information was passed on to the crew members following the same crew member information method.

In July 1995, the preceding instructions were added to the Flight Manual and, the Flight Data Analysis department started to keep a close eye on initial climb speeds in order to react as soon as something would again go wrong. Then, the results of early 1996 were very satisfactory. We could even imagine that these problems would disappear.

In the last 1500 takeoffs, only two were pointed out by the flight analysis department with a speed inferior to $V_2 + 10$ kt. This achievement is the result of a whole working team, the best participant being the captain of the flight that has been analyzed early 1995. After he experienced such a scenario, he contacted the flight safety officer of the B767 fleet division to offer him to co-operate. This close collaboration allowed to properly steer the research and to really identify the problem. His analysis and his co-operation were crucial to the success of this action.

This case study demonstrates one of the numerous way we can use efficiently a good flight data analysis tool. Very recently a comprehensive study was made in order to assess the crew response to TCAS RA warning. This study is used today to document a training conference. An other example is advisory information which are published on some approach plates in order to warn the crew about stabilization problems related to airport where recurrent unstabilized approaches are detected (because of ATC instruction, tail wind component or other factors).

4.2 CATHAY PACIFIC experience

4.2.1 History

In 1989 the decision was made to equip CX aircraft with QAR's.

In 1992 a readout station to handle data from the L1011 and classic B747 was purchased.

By 1995 all aircraft were equipped with QAR's.

In 1998 control for flight data readout and analysis was transferred from the Engineering Department to the Corporate Safety Department (CSD).

Also in 1998 the current readout system, a Flight Data Company GRAF system, was updated.

A systematic Flight Data Analysis Program (FDAP), which is CATHAY PACIFIC Airways implementation of FDM, began in early 1999.

Collaboration with AIRBUS on AIRFASE began in 1999.

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CX also provides third-party FDAP services for DRAGONAIR (commenced in 1998) and for Air Hong Kong (commenced in 2000).

4.2.2 Fleet

22 B747-400

4 B747-200F

7 B777-300

5 B777-200

14 A340-300

12 A330-300

DRAGONAIR (A330 & A320/1) and Air Hong Kong (B747F) aircraft are also covered.

4.2.3

4.2.4 Parameters

<u>Date:</u>	<u>Fleet:</u>	<u>No. of Parameters:</u>
1981	B747-200F	139
1988	A320	404
1989	B747-400	428
1993	A340-300	434
1994	A330-300	403
1998	B777-200/300	1,321

4.2.5 What are the uses of QAR data?

- Engineering troubleshooting and analysis (eg. Engine overtemps, MMO/VMO exceedances, N1 fluctuations, IFSD due to engine vibration).
- Mandatory Occurrence Report and Air Safety Report investigations (eg. inaccurate weather forecasts, windshear and turbulence encounters, GPWS events, ATC procedures/clearances).
- Autoland analysis and regulatory compliance.
- Special scientific studies (eg. the Hong Kong Observatory are using QAR data in their study of turbulence and windshear at CLK).
- Flight Data Analysis Program (FDAP)

4.2.6 FDAP Organization

The FDAP is run by the CSD and is endorsed by the local pilots association, the Hong Kong Aircrew Officers Association (HKAOA). There is a formal written agreement between the company and the HKAOA governing the use of QAR data.

The sole purpose of the FDAP is to enhance flight safety and the company and the HKAOA have agreed that this data cannot be used to check an individual pilot's performance.

The FDAP enhances flight safety through the routine analysis of flight data and approximately 70% of all flights are scanned. While the aim is to scan all flights, in practice this is not achieved. The main reason is OQAR unreliability.

The recommendations that flow from this analysis can result in changes to training programs, SOP's, air traffic control procedures, airport maintenance and design, and aircraft operation and design. A FDAP can identify problems that were previously unknown or only suspected and by timely intervention prevent incidents or accidents from occurring.

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4.2.7 What are FDAP Events?

An event is recorded when preset criteria (parameter value and duration) are exceeded. Events have two thresholds, a detect limit and an alert limit. Alert limits reflect CX SOP's or flight manual requirements while detect limits can be used to show how often the alert limits are being approached.

For example:

Event	:	B744 MMO exceedance
Detect Limit	:	Mach > MMO 0.01 for at least 5 seconds
Alert Limit	:	Mach > MMO 0.03 for at least 1 second

CSD, the Flight Data Analysis Team and the Line Operations Monitoring (AIRFASE) committee regularly review the detect and alert limits and can change the limits. Detect limits are more likely to be adjusted than alert limits.

4.2.8 The Flight Data Analysis Team

This team evaluates all FDAP events. At this stage the data which is analyzed is not de-identified and all team members must sign a confidentiality agreement before joining.

The team comprises CSD staff and approximately 5 line Boeing pilots and 5 line Airbus pilots. The pilot input to the team is very valuable as it provides local knowledge of airports and ATC procedures as well as the flying experience. The pilot members can be Captains, First Officers or Second Officers. Pilots who are part of the check and training system are not employed in this function.

4.2.9 What happens if an event is triggered?

Event data is stored in a secure database (located in and controlled by CSD). Every two months event data is analyzed by the Flight Data Analysis Team for statistical and trend monitoring purposes. The Flight Data Analysis Team meets for 3 days and using their operational knowledge of the aircraft and CX ports they analyze the QAR data from various viewpoints. Identified trends can be applicable to all CX aircraft or to one particular fleet or to an individual port. Trends are compared with previous analysis periods and across fleets.

The team produce a de-identified report for review by the Line Operations Monitoring (AIRFASE) committee. The committee is chaired by GM Flying and includes CSD, Fleet Management, Simulator Instructors, HKAOA and Engineering.

Although QAR's record hundreds of parameters, the flight crew can sometimes provide valuable information that cannot be obtained from the QAR (such as ATC requirements, weather conditions eg. visibility and the serviceability of navigation aids). This information can be very useful in analyzing an event and understanding its significance.

Under the agreement with the HKAOA, any exceedance may be the subject of a confidential discussion between the commander of the flight involved and the Head of the CSD. Such discussion is for the sole purpose of establishing additional pertinent information. Only the Head of the CSD knows the commander's identity.

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4.2.10 The Flight Data Centre

The Flight Data Centre is located within the CSD and houses the readout equipment and storage for the QAR disks and tapes.

The Flight Data Centre has 3 staff members.

4.2.11 Feedback of FDAP Results to Crew

A newsletter, entitled *Heads Up*, is produced by the CSD and the Flight Data Analysis Team every two months to coincide with the event review cycle. The newsletter provides de-identified information about event trends and which airports/runways are over-represented in the statistics. It is circulated to all pilots.

4.2.12 An Example of FDAP In Operation

A member of the Flight Data Analysis Team, writes about a successful result of the FDAP:

“Since the Flight Data Analysis Team started QAR analysis in mid-1999, XXX has featured with some high sink rates below 2,000 feet and late landing flap events.

For those who do not operate into XXX, runways XXL & XXR are preferred by ATC for arrival. Most traffic arriving into XXX is from the north-east, east or south-east. Airspace is very limited due to a number of airports in the vicinity. Traffic density is high at the time of our arrival.

CX XXX is usually cleared to this overseas port by the XX STAR. The track is XXX degrees to the VOR, which is located at the field. Speed control is 250 kts below 10,000 feet. ATC usually hold arriving aircraft from the north-west at 10,000 feet until over the VOR.

Radar headings are then given for a short right or left downwind. A heading is then given to fit in with other arriving traffic, to intercept the ILS on XXL or XXR. This arrival procedure frequently results in very few track miles to lose the 10,000 ft from overhead the VOR/field. Even though aircraft were configured with flap/gear/speedbrake overhead the VOR, a significant number of high sink rate/late landing flap events and go-around have occurred at XXX.

When the Flight Data Analysis Team noted the sink rate and late land flap events, it was reported to the Line Operations Monitoring (AIRFASE) committee. The Chief Pilot (AIRBUS) then flew a pattern to XXX and visited the ATC Center to meet with ATC Management.

XXX ATC was appraised of the A340's low drag during descent and the difficulty in descending rapidly. **XXX ATC have requested that our crews inform them if more track miles are required when they are given the base turn.**

It is pleasing to note a reduction in XXX sink rate and late configuration events in the period since the Chief Pilot's meeting with XXX ATC. The trend will be monitored by the Flight Data Analysis Team and will hopefully continue.

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SECTION 5

FLIGHT EVENT ANALYSIS GUIDELINES

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5 FLIGHT EVENT ANALYSIS GUIDELINES

5.1 Introduction

5.1.1 Purpose

This document describes how to set up the analysis of significant events and operational deviations that are judged to be critical for the safety of airline operations.

From the routine collection of data recorded on each aircraft, the flight event analysis system should be able to:

- a. Identify potential voluntary or involuntary deviations from the Standard Operating Procedures
- b. Identify drifting attitudes or abnormal deviation trends from daily flights.
- c. Describe abnormal or hazardous events.
- d. Highlight any potential risks facing the airline.
- e. Provide airline management with relevant safety indicators.
- f. Support airline safety strategies and action plans.
- g. Monitor the efficiency of action plans.

5.1.2 Assumed Prerequisites – Flight Operations Monitoring Program and Organization

These guidelines presuppose that the Airlines have already developed a Flight Operations Monitoring program and have the following requirements in place:

- i An agreement with flight crews for strict anonymity and confidentiality in use of the data, and with all other personnel involved to ensure total cooperation in the project.
- ii A Flight Data Monitoring tool to process the data retrieved from the aircraft flight data recorders.
- iii A safety organization which includes a Flight Data Monitoring team fully trained to operate the tools and create reports.
- iv The capability to monitor and maintain the serviceability of the whole Flight Data program.
- v A monitoring system, which includes the aircraft recorders through to the analysis software.
- vi A definition of the airline safety strategy.
- vii A definition of the task and scope of the Flight Safety Review Board.
- viii Production and distribution of a newsletter to include the flight event analysis report and the crews' feedback, together with operational and educational material.
- ix A system to ensure the follow up of any safety related modifications and improvements to SOP, flight documentation, aircraft systems, ATC procedures, etc.

5.1.3 Supporting Programs – LOAS and AIRS

Information from in flight observations, crew reports or other channels should be used to corroborate the information from the flight data analysis system.

Airbus offers two tools in this regard:

Line Operations Analysis System – to analyze in flights reports made by observers on crew and infrastructure performance.

Airline Information Reporting System – to analyze Human Factors reports raised by crews.

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5.2 Overview of Flight Event Analysis, Objectives and Requirements

5.2.1 Processes Carried Out by the Software Package and the Analysis Team

The Flight Data Monitoring tool extracts and processes the flight data automatically.

However all monitoring systems have limitations and certain items may have to be resolved by expert human analysis.

Advanced flight data monitoring tools use software routines written specifically to combine several parameters or single events in order to detect hazardous events or abnormal situations. Such as detection of:

- Non-stabilized approach,
- Risk of tail strike
- High/low energy situation in approach...

When such programs are not installed, the analysis experts must analyze the flight data manually to detect critical events that may be able to provide evidence from which lessons may be learned.

The team should try to categorize events and to relate them to any precursors. (Precursors are events, which may forewarn of or possibly lead to significant incidents or accidents.)

The following tasks have to be performed by the flight event analysis team:

- i Confirmation that the maximum amount of data is being retrieved from the aircraft, by verifying the integrity of the sensors, the recording and retrieval systems.
- ii General validation of data after initial processing.
- iii Review of data integrity in high deviation events.
- iv Assess the relevance of high deviation events.
- v Trend correlation and statistical analysis.
- vi Provide a comprehensive report of the analysis results.
- vii Provide the airline management with safety trends.
- viii Monitor the efficiency of any action plan, including impact of changes to procedures, operational documentation and aircraft system modifications.

5.2.2 Qualifications of the Analysis Experts

The quality and the efficiency of the flight event analysis will always remain dependent on the experience and the skills of the analysis experts.

System Engineers:

- are in charge of technical matters such as flight data recorder serviceability and PC analysis programs.

Aircraft Type Qualified Pilots with Knowledge of the Route:

- are responsible for the operational aspects in the analysis.

Since analysis of the same event may lead to different conclusions, analysts need a good knowledge of aircraft characteristics, airline SOPs, management safety requirements, airline safety culture and the various operational environments.

It is essential to maintain a good relationship between the airline management, the flight crews and union representatives. This should be achieved by an appropriate, harmonious, organization of the safety department, whose members should all possess an equable temperament.

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5.2.3 Content and Targets of the Reports Produced by the Flight Analysis Team

The analysts must base their assumptions on statistics and/or analysis of specific events.

The statistical results are mainly:

- Used to indicate the progress of the safety program to management.

The lessons learned from specific events are mainly:

- Of interest to Flight crews, Flight Operations and Training Departments.

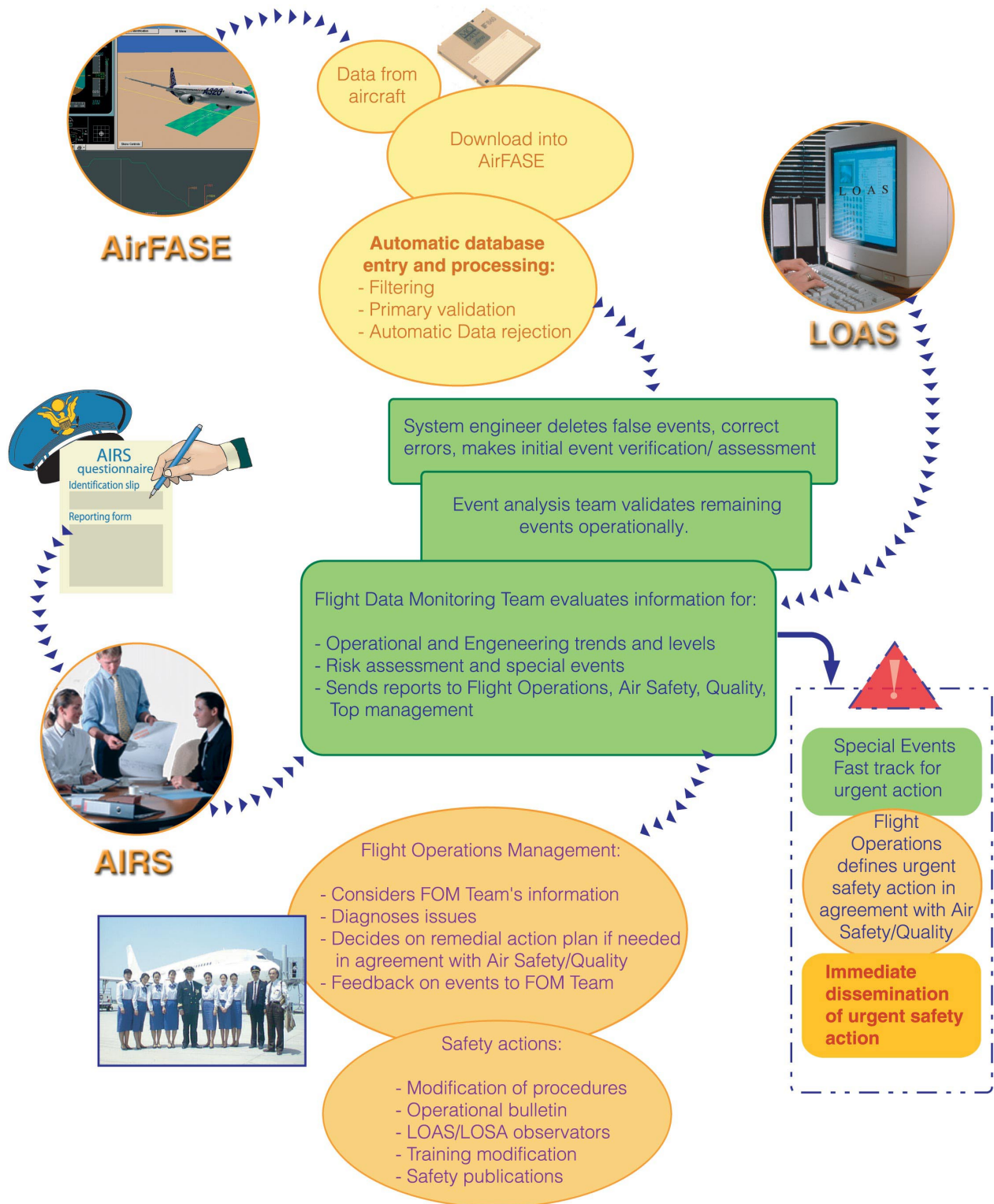
The reports should provide:

Each level of airline management with:

- A clear assessment of the current operational hazards and safety trends,
- Assessment of the safety margin that exists between critical events and unacceptable risks
- Highlights of good trends as well as weaknesses.

The analysis team does not usually recommend the remedial actions but reports regularly to the Flight Operations Management, which is normally responsible for defining and evaluating solutions to resolve the problems highlighted by the analysis team.

5.2.4 Process Overview:



5.3 Retrieval, Processing and Validation of Flight Data

The main purpose of data and event validation is to ensure that the data downloaded is complete and that the corresponding database is clean and accurate.

All doubtful flights or events must be removed and kept separate from the normal database.

5.3.1 Data Retrieval

The flight data-monitoring tool acquires and processes the appropriate raw data from the flight data recorders.

A high level of reliability of the recording media (optical disk, PCMCIA, tapes) is essential to retrieve a high percentage of usable data.

The percentage of data retrieved for use by the analysis system should

Tapes : From 40 to 80% of the total aircraft recorded raw data.

Optical disc and PCMCIA: At least 95% of the total aircraft recorded raw data.

The rate of retrieval and quality of the data should be monitored continuously, and action taken if necessary to ensure that the serviceability of the equipment is maintained.

5.3.2 Initial Processing

The raw data extracted from the aircraft flight data recorder cannot be read directly by the analysis software, and must first be processed to become usable by the analysis tool.

The particular process depends upon the type of data extracted, but must always be run before the analysis computation.

Airbus AIRFASE FDM program designates this as Level 0 of the Data Processing – see graphic Para 3.1.3.

During this filtering and conversion process, AIRFASE also defines the flight phases and some of the limitations (Max and Min speeds allowed: VMO/VLE, MMO, VLS...), as shown below.

5.3.2.1 Examples of the AIRFASE Filtering Process in Data Processing Level 0:

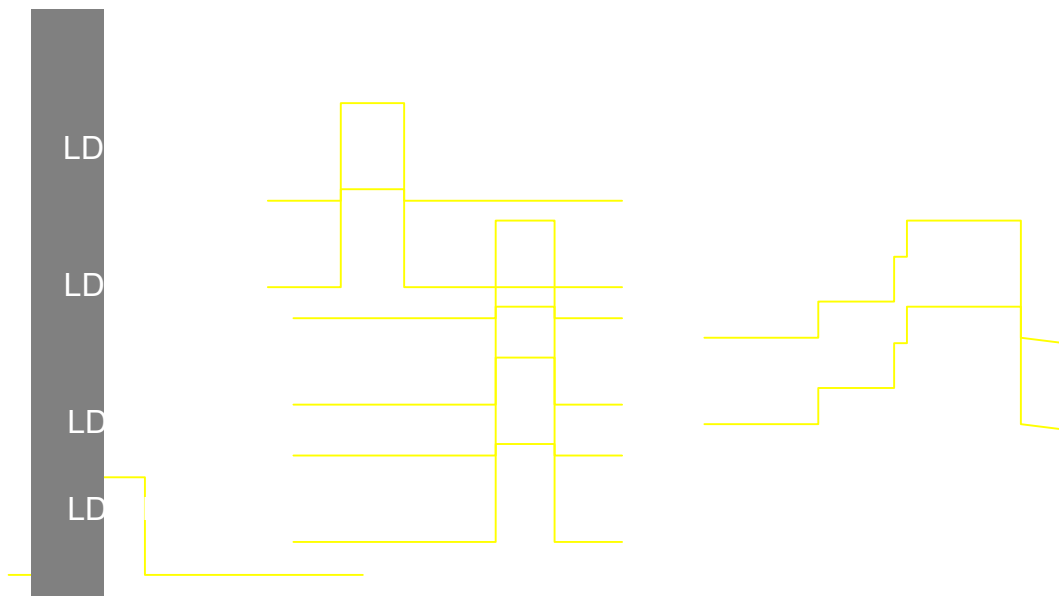
Filtering an Altitude :



5.3.2 Initial Processing - *continued*

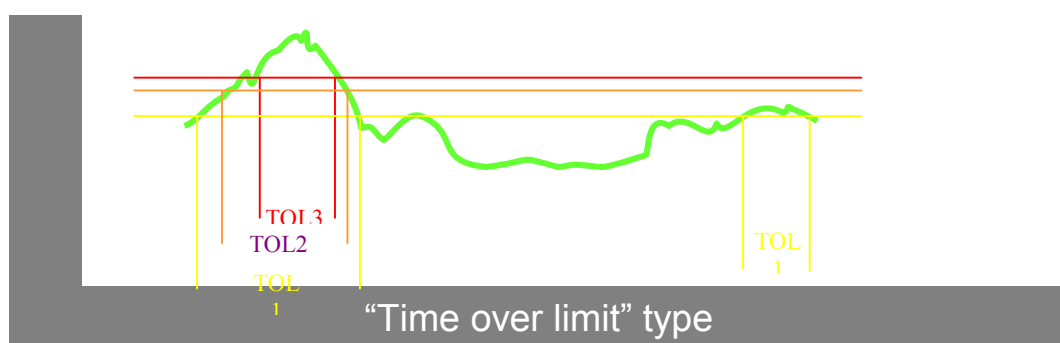
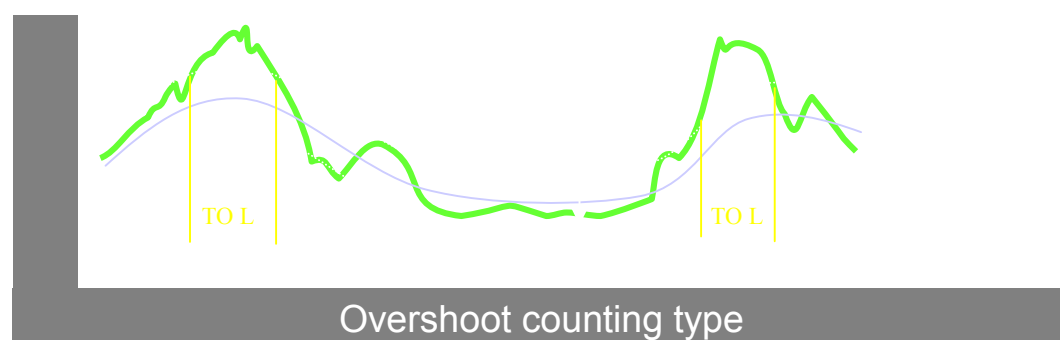
5.3.2.1 Examples of the AIRFASE Filtering Process in Data Processing Level 0:

Indicating the Landing Gear Extension/Retraction in a Simple Graph :



Creating different severity level deviations from the size and duration of the deviation :

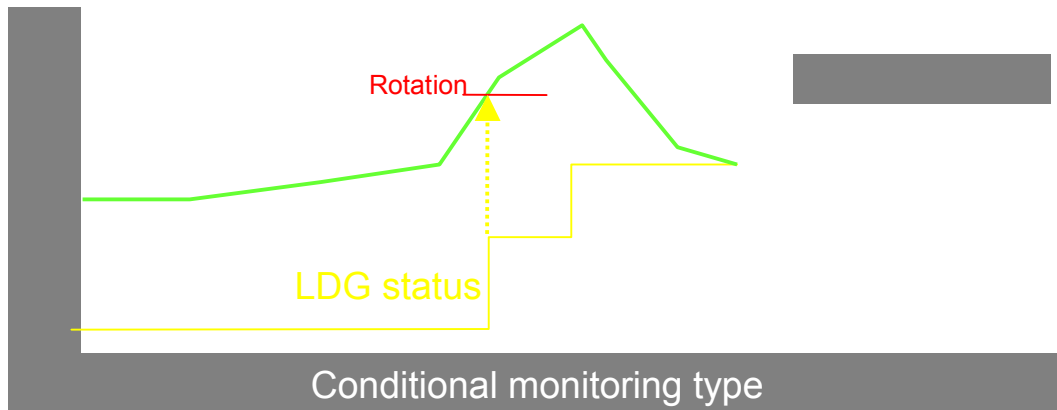
If the Time Over Limit does not exceed a given time and value, the TOL is identified as low. 2 higher values will define a TOL amber, and 2 higher still a TOL red.



5.3.2 Initial Processing - *continued*

5.3.2.1 Examples of the AIRFASE Filtering Process in Data Processing Level 0:

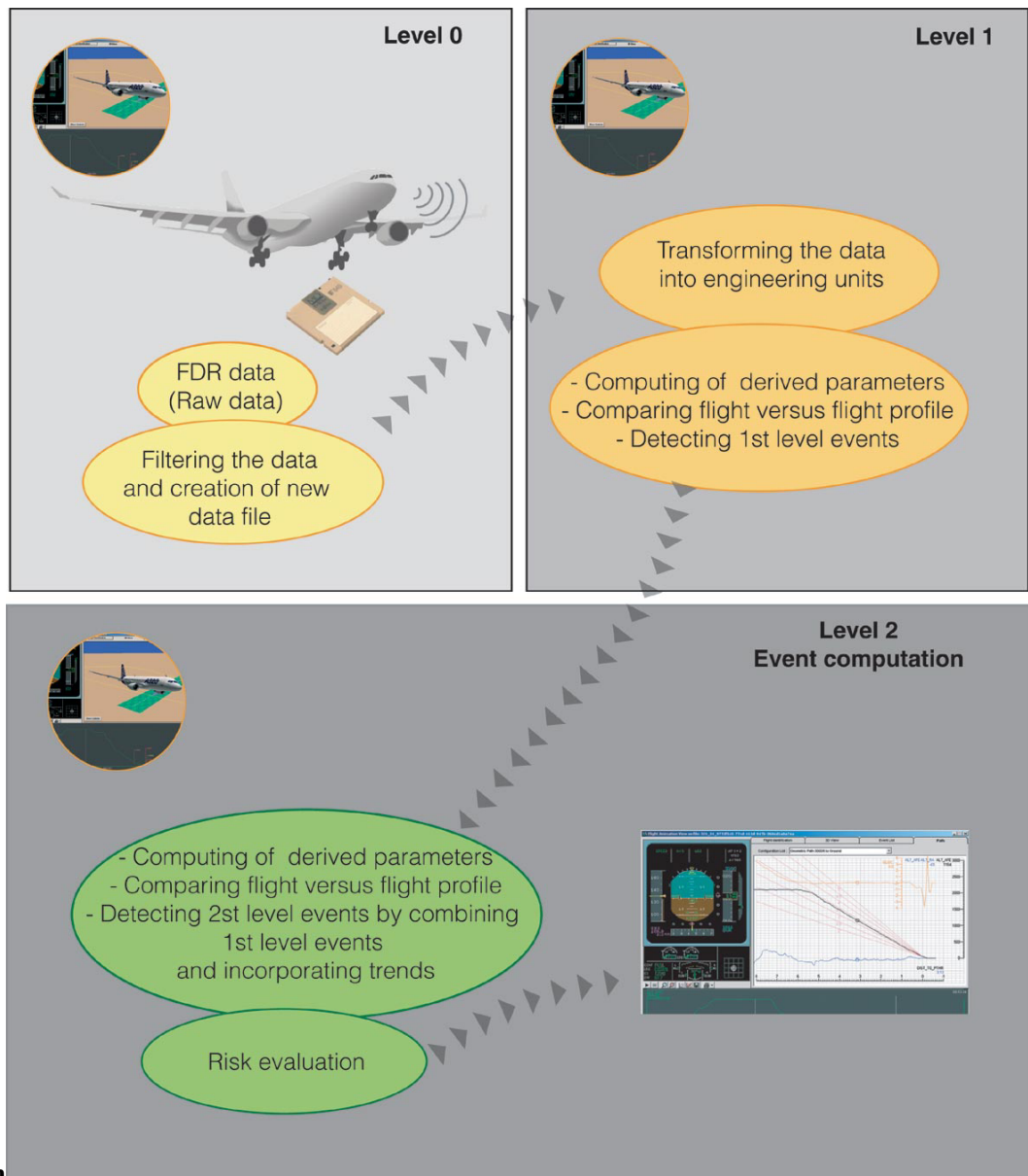
Conditional monitoring for an event (green line) linked to the landing gear position :



Creating a turbulence event from multiple deviations of vertical acceleration :



5.3.2.2 Data Process



5.3.2.3 Diagram



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5.3.3 Validation

5.3.3.1 Flight Data Validation (Data Integrity)

Integrity of data encompasses the recorders, the software analysis program and the integrity of the processing.

Proper validation of all the data throughout the monitoring process is a major task of the system engineer, and is essential for a correct analysis to be achieved.

Advanced flight data monitoring tools can perform a large part of these filtering, validating and data rejection operations, but manual validation is necessary to ensure the integrity of the final data that will be used.

A high level of reliability of the recording media (optical disk, PCMCIA, tapes) is essential to retrieve a high percentage of usable data.

The rate of retrieval and quality of the data should be monitored continuously, and action taken if necessary to ensure that the serviceability of the equipment is maintained.

Analysis results may be affected by:

- faulty transducers,
- insufficient sample of retrieved data,
- filtering process that modifies the original values,
- data not precise enough to be used for analysis.

Events are created by establishing the characteristics and range of parameters throughout a normal flight, and from that baseline the size of any deviations is compared with a programmed-acceptable range for air safety.

FDM programs perform the initial detection and filtering of events, whilst the system engineer performs the fine filtering before it is passed for final analysis.

It is important to establish why an event has been rejected and to take action to improve the quality of the data to avoid similar future rejections. If events are not validated properly, any conclusions and trends will be incorrect, possibly leading to inappropriate safety decisions.

5.3.3.2 Event Validation

An optimum event detection and validation process starts with the accurate definition of the events themselves.

According to Airline experience, a significant percentage of the events selected by the program can be suspect and need to be more deeply scrutinized.

The questions to be answered when an event is being validated, should include:

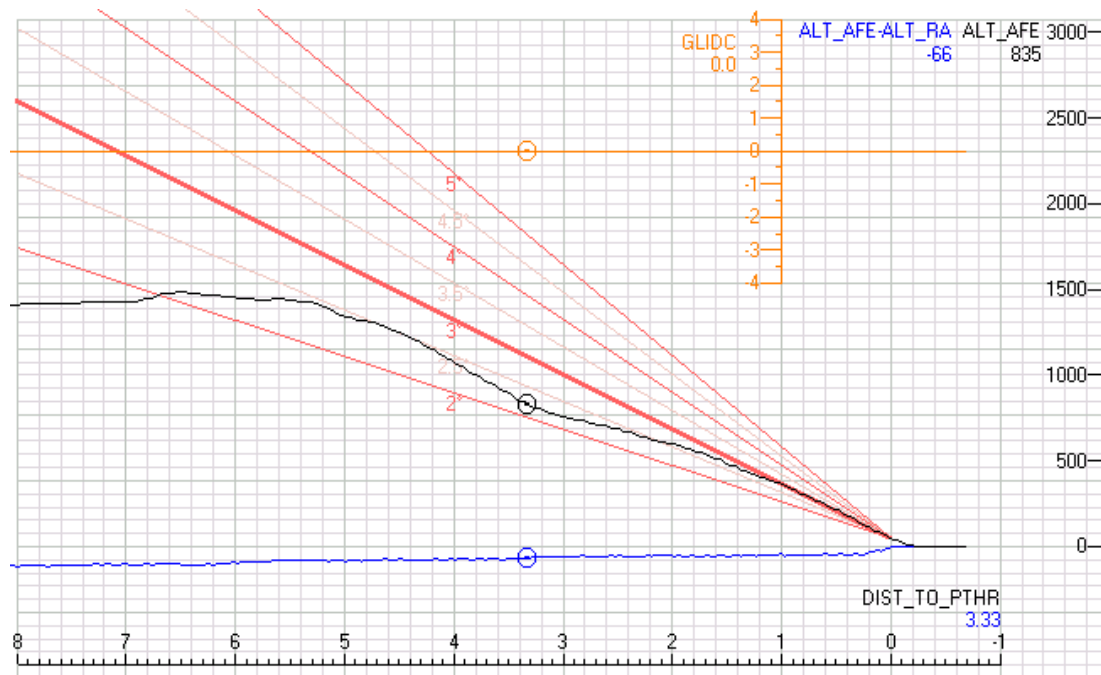
- Is the event in the category that is being searched?
- If the event is not confirmed, should it be retained for other purposes?

Events that are not validated may distort the results of the statistical analysis.

Therefore absolute values should not be considered reliable until the program has reached an acceptable and repeatable level of accuracy.

5.3.3.3 Examples of Flight Data Validation for an Event:

1st Example: Path Low at 800 feet AGL



The event detection is correct, the aircraft was flown about 1° below the normal 3° glide path.

The next level of analysis must determine:

- Could the event have been part of a normal procedure, eg a visual approach into the airport runway?

If so:

- What were the weather conditions at the time?

2nd Example: Late Gear Retraction After Takeoff

When a late gear retraction is detected after takeoff, the event must be analyzed since the FDM cannot provide a clear explanation,

The next level of analysis must determine if it is a crew omission or a special procedure to delay the gear retraction (hot brakes).

5.3.3.4 Method of Validation

Advanced FDM programs can replay the processed flight data on a display similar to the aircraft's flight instruments. Other parameters relevant to the understanding of event can be shown on request.

This process enables a simple, fast and accurate validation.

In most cases, a crew report is needed to complete the analysis of an event.

When an event is discarded for invalid data or other reasons, it must also be rejected from the data base. This will avoid distorting other results and statistics.

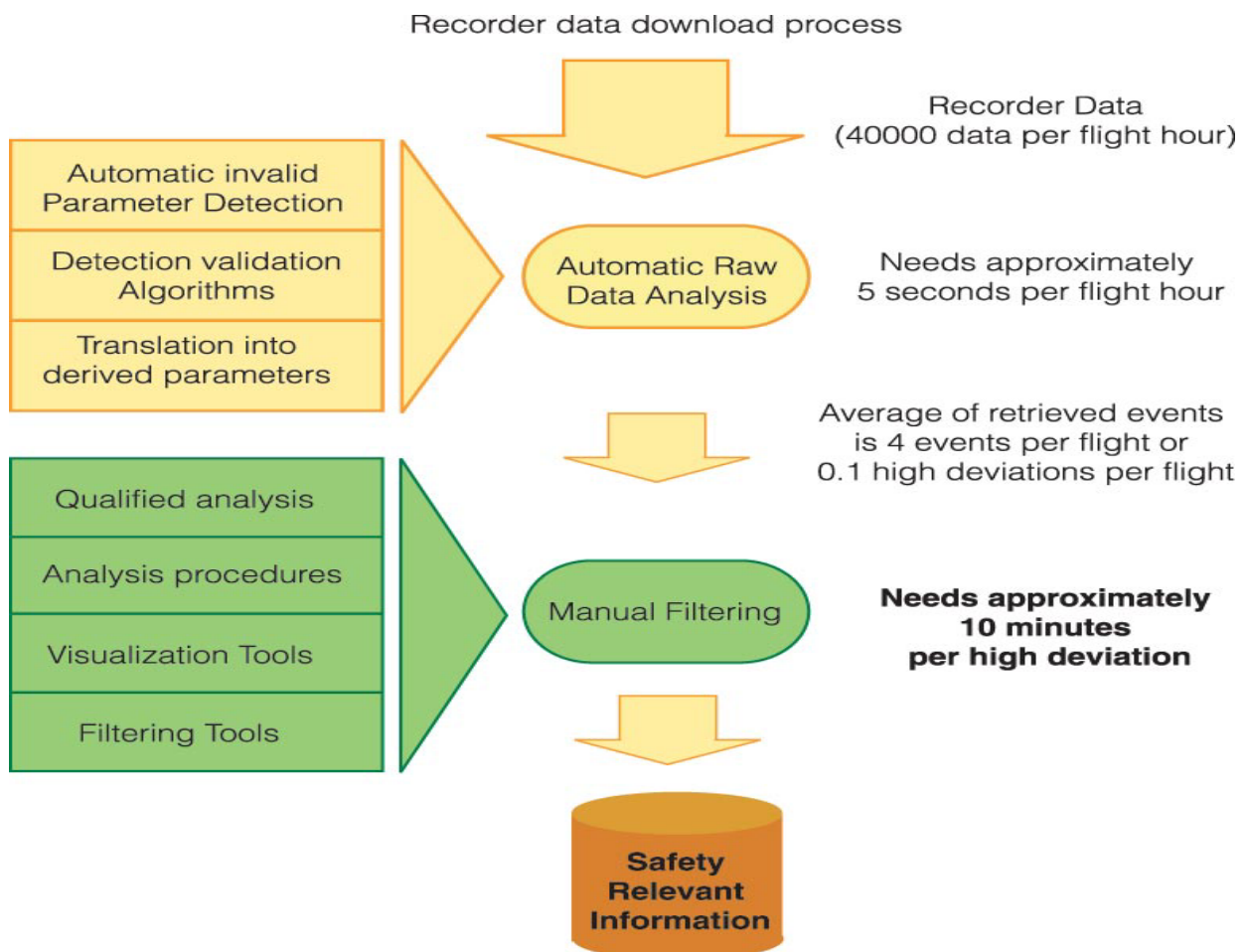
Examples of valid and rejected events should be retained for analyst training and familiarization.

New events must not be entered into the main database until they have been correctly validated.

Advanced FDM tools do not usually integrate data into the database unless it has been validated and authorized by the analyst.

5.3.4 Time Required for Retrieval, Processing, Analysis and Validation of Flight Recorded Data.

From Airline Experience Monitoring about 100 events with 3-degree severity levels



5.4 Selection of Events for Analysis

5.4.1 Prime Objectives of Event Selection

The prime objective of event selection is to identify any precursors of a possible incident or an accident.

Since the aircraft recorder systems can gather thousands of parameters, airlines must select the criteria which monitor the airline's operations most effectively for their safety program.

It is recommended to focus particularly on the precursors of the 4 following accident categories:

- CFIT
- Loss of control in flight
- Midair collision
- Collision on ground

Experience has shown that the current available data is sufficient to detect and monitor:

- Unstabilized approaches – that are precursors of CFIT
- Runway excursions – where the aircraft leaves the runway paved surface
- Hard landings
- Tail strikes

It is also possible to detect events such as:

- Reduced stall margin
 - Excessive pitch or bank angle
- that are precursors of loss of control.

Both CFIT and loss of control are causes of fatal accidents.

5.4.2 Selection of Events to Analyze in Detail

Should the team analyze all detected events?

No, since FDM programs retrieve thousand of events.

Only events that are considered significant in the current safety monitoring program should be validated manually, according to their severity levels.

Events can be classified into 3 severity levels depending upon the deviation values:

- Low severity: **Yellow**
- Medium severity: **Amber**
- High severity: **Red**

Yellow events:

Are statistically important because they can indicate the airline trend for a given event.

As long as the trend is consistent with the previous values, yellow events may be accepted without validation.

If the trend is abnormal, more attention must be paid to similar amber and red events.

Amber events:

Should be investigated as a group.

Red events:

Require a specific validation and analysis, which can require time and expertise.

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5.4.3 Investigation of Particular Problem Areas

When safety information is required for a perceived problem area, data containing the type of events to be investigated should be retrieved and analyzed to establish the number and severity level of any events.

The selection of events for analysis should be seen as a continuous and evolving process.

For example:

Investigation of the number of insufficient ground clearance events at takeoff, and the factors leading to this deviation.

Some aircraft are more sensitive to tail strikes than others, but the environment at airports may produce circumstances that can lead to tail strikes (steep approaches, frequent severe weather etc).

The analyst must weigh the different parameters and assess their effects on the events.

Therefore, events selected for analysis may differ slightly with the airport, airplane, crew qualification, SOP or airline culture, etc.

5.4.4 Events Using Combined Data:

When an event cannot be determined using a single item of data e.g. rushed approach, it is necessary to define an algorithm that will combine several items of retrieved data.

Some modern FDM systems are programmed to use specific algorithms to detect and select these events, but most often, it is the expertise of the analyst that detects such events.

As stated previously, the correct selection of automatic in-flight data retrieval is essential to build a proper safety follow-up program.

5.4.5 AIRFASE Definition of Single and Combined Events, and Total Risk Exposure

AIRFASE defines 2 levels of events:

Level 1: Single Event

Defined by one parameter. This single event is retrieved when the parameter reaches an abnormal value for a minimum duration.

Level 2: Combined Event

If the parameter reaches an abnormal value for a longer period of time, AIRFASE does not detect several identical events but considers this exceedance as a continuous event.

The Total Risk Exposure

is the result of the combination of events, taking into account the degree of severity of each event.

The lists below in 5.4.5.1 & 2 show events of High and Low risk eligible for specific analysis. It is an extract from the AIRFASE list of events.

5.4.5.1 List of Events with a High Potential Risk.

DESCRIPTION	REMARKS
Significant tail wind at landing	
Sustained double stick inputs	
Bank angle	
Path low/high on track during approach	
Alpha floor or stall warning	
TCAS RA warning	
GPWS warning above 1000 feet	
GPWS warning between 500 ft and 1000 ft	
GPWS warning below 500 feet	
Continuously low during final	Combined event
Continuously slow during final	Combined event
Continuously high during final	Combined event
Continuously fast during final	Combined event
Continuously steep during final	Combined event
Low energy situation in approach	Combined event
High energy situation in approach	Combined event

5.4.5.2 List of Events of Lower Risk, but which could be Significant in High Numbers

DESCRIPTION	REMARKS	<i>AIRFASE EVENT N°</i>
Rotation speed high		1002
Excessive speed at low altitude	Risk of midair	1005
High speed at landing	Referenced to VAPP	1022
Low speed at landing	Referenced to VLS	1023
Tire speed limit at landing	Specific airfield only	1024
Rejected takeoff	>50, <80, <100 kt	1027
Speed below VLS in final		1028
Pitch high at initial climb (h<400 ft)		1103
Pitch low at initial climb (h<400 ft)		1104
Pitch high at touchdown	12.5° for A319	1108
Excessive bank angle in final app (h<100 ft)		1200
Roll cycling in final approach		1204
Excessive bank angle in climb (h<100 ft)		1206
Significant roll during flare		1210
Altitude overshoot in climb		1306
Altitude overshoot in cruise		1307
High rate of descent below 50 ft		1405
Steep descent rate below FL 100 (to 3000 ft)		1406
High acceleration at landing		1504
Landing with incorrect flap setting		1602
Wrong thrust setting at takeoff or go around		1603
Abnormal configuration at go around		1605
Gear extension at low altitude on approach		1608
Reversers use		1611
Reversers abusive use		1619
Low thrust on short final		1701
Late thrust reduction		1703
Thrust high on ground during taxi		1708
Long flare		1808
Significant heading change in short final		1814
Maximum operating altitude exceedance		1902
Windshear warning		1903
Touch and go		1907
Overweight landing		1914
Low fuel at landing		1931
Engine shut down in flight		1932
Takeoff warning		1934
Tendency for landing short	Combined event	2007
Tendency for long landing	Combined event	2008
Tail strike risk at landing	Combined event	2205
Tail strike risk at takeoff	Combined event	2214

In-service events directly reported to the Airline maintenance department are valuable sources to detect or explain an operational event. Feedback from the maintenance department enhances an analysis program.

5.5 Analyzing and Interpreting Methodology

5.5.1 General Process

The Flight Data Monitoring process starts with the data retrieved automatically from the aircraft recording systems, and through analysis and interpretation produces lessons learned and associated recommendations.

Airlines who are experienced in Flight Data Monitoring generally aim to process the retrieved data within one day, although long haul flights may take longer.

Some operators analyze the data in batches of about 2 weeks. Certainly, the maximum interval between 2 analyses should not exceed 2 months.

The process described below is based upon the following principles:

- Provide a common structure for an analysis of all events.
- Create a system that can be programmed on a PC.
- Assist the analysts to identify the lessons learned and develop the recommendations.
- Confirm or reassess safety principles designed to prevent minor incidents or “precursors” capable of turning into accidents.
- Enable data exchange between safety organizations, airlines, manufacturers, etc.

5.5.2 Scope of Flight Data Monitoring – Coverage and Limitations

A Flight Data Monitoring (FDM) program is a powerful tool to help determine the actual airline safety level, the crew compliance with the airline procedure and policies, as well as the potential threats the Airline is facing in terms of safety. An FDM program allows in-flight operations to be continuously monitored.

However, while a flight data-monitoring tool produces concrete evidence of “what” occurs during flight operations, it has limited capabilities to explain “why”.

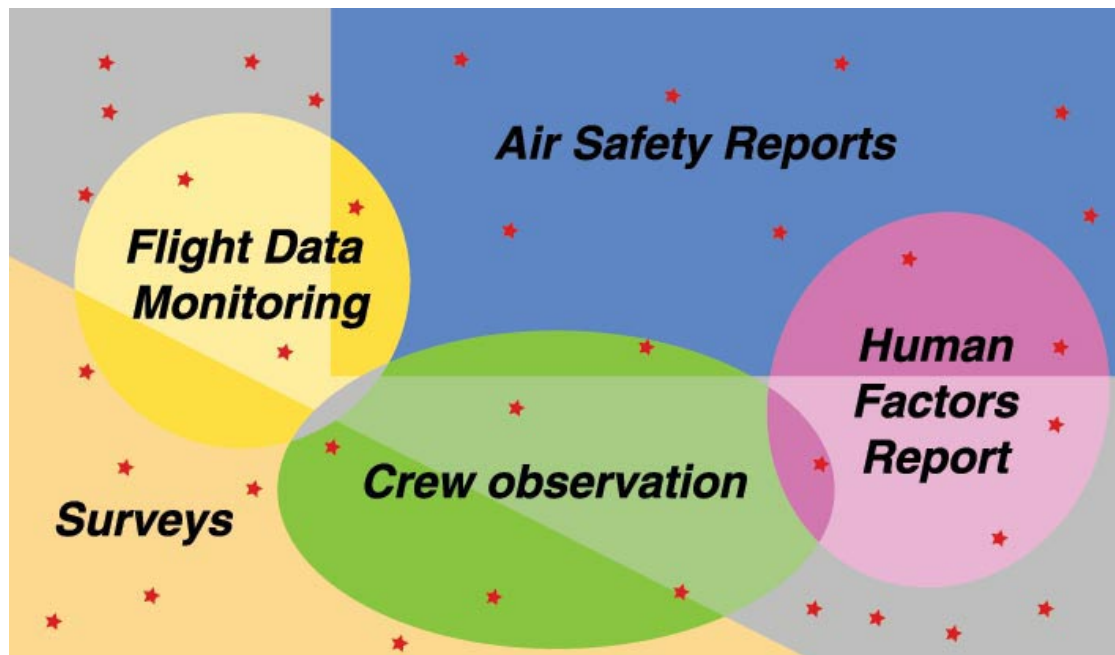
Systems such a LOSA © or an ASR program can provide the “why”, but the first is highly resource intensive whilst the second relies entirely upon the good will of the flight crews to submit voluntary reports.

Each component of the Flight Operation Monitoring program provides a flight operation aspect that complements the other.

The FDM program does not cover some in-flight events, e.g. bird strikes, navigation deviations, incorrect actions on aircraft systems, smoke and fumes incidents. More specifically, it cannot detect crew deviations from ATC instructions or ATC errors.

As a result, an FDM program will not detect runway incursions – where the aircraft enters a runway without ATC clearance, altitude busts or navigation deviations that are precursors of midair or runway collision.

If we consider the field of aviation threats as shown in the graphic 5.5.5.2, we see that the FDM program encompasses areas not covered by other programs, but also that there are still gaps in coverage of all threats represented by the outer rectangle.



5.5.2.1 Rectangular Area of Total Operational Threats and Coverage of Safety Too

5.5.3 Analysis of FDM Data

The analysis of the data retrieved from a flight data monitoring system is of two types:

1. Analysis of Statistical Data
2. Analysis of Special Events

5.5.3.1 Analysis of Statistical Data

The analysis team first compares the period's statistics with the general statistics of the previous periods to show the airline trends.

The task involves interpretation of the data in relation to the operational environment, and its success relies heavily upon the qualifications, knowledge and skill of the analysis team.

When the Airline starts a flight event analysis program, the analysts have to base most of their analyses on the statistical trends. But, as experience is gained, it becomes possible for the airline to define the different safety levels it wishes to set as a baseline.

When baselines representing the current level of the airline safety have been established, analysts are able to monitor the trends against these norms, as well as the quantitative statistics in terms of event numbers and severity.

5.5.3.2 Selection and Analysis of Special Events

Modern FDM systems are able to process a large amount of data and generate a considerable number of events and statistics. Therefore the analysts need to select the events chosen for detailed scrutiny with great care, always focusing on the safety program goals.

These events should be of significance because they are considered as precursors of severe incidents/accidents or those requiring special attention. Crew reports are essential for a complete analysis of such events.

Further information on analysis of Special Events is given in Para 5.5.7.

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5.5.4 Analysis and Interpretation Tasks Performed by the Flight Data Analysis Team

1. Use the program to present the period's events in lists, graphs and statistics. The results are compared to the previous period and to the overall results. The analysis team should make comments on the statistical results for clarification and to avoid misinterpretation.
2. Implement suitable statistical analysis to search for any new trends or events not picked up with the current programs/procedures.
3. Define new events when needed to cover the whole range of in-flight deviations.
4. Detect events relative to specific conditions such as a particular airport, a particular aircraft type or specific aircraft MSN, weather conditions, day or night operation.
5. Study aircraft or system reliability through the FDM program (e.g. sorting by aircraft MSN for example).
6. Try to uncover any potential risks contained in the statistical data. This subjective task relies upon the creativity of the analyst, but can draw valuable evidence from the raw data.
7. Use the statistics to confirm or challenge the effectiveness of Standard Operating Procedures. If necessary, the alert or deviation values entered by the FDM supplier should be modified to correspond with the airline's standard procedures.
8. When necessary, request the help of specific experts to refine the analysis.
9. Identify the events that should be considered as accident precursors.
Precursors are those events, which if unchecked and possibly combined with other risk factors, may lead to more severe consequences (accidents or significant incidents).
10. Provide information to the different levels of management.

5.5.5 Tasks Performed by the Other Departments

From the information provided by the Flight Data Analysis Team, other departments such as Flight Operations and Engineering evaluate the possible actions in terms of:

- Information to pilots
- Enhancement of documentation, training and/or procedures
- Enhancement of aircraft configuration/equipment, when necessary.
- Exchange of information with other safety related organizations.

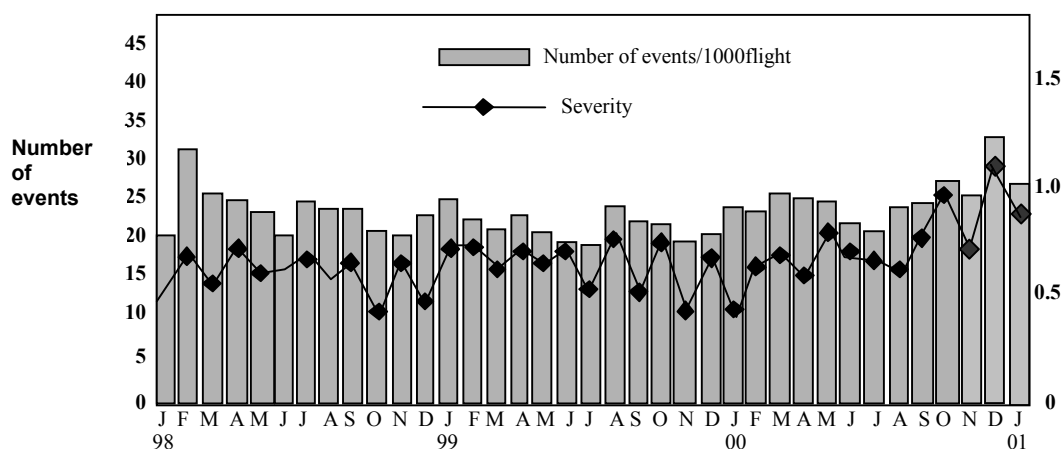
5.5.6 Statistics to be Reported Routinely

Some statistics should be systematically issued and analyzed for each analysis period and compared to the overall statistics and those for the previous period.

For example:

- Number of exceedances per severity level for each month - shown in Example 1 below.
- Alert events (High severity events) per number of flights - shown in Example 2 below.

5.5.6.1 Example N° 1: Overall event ratio per 1000 flights and per month



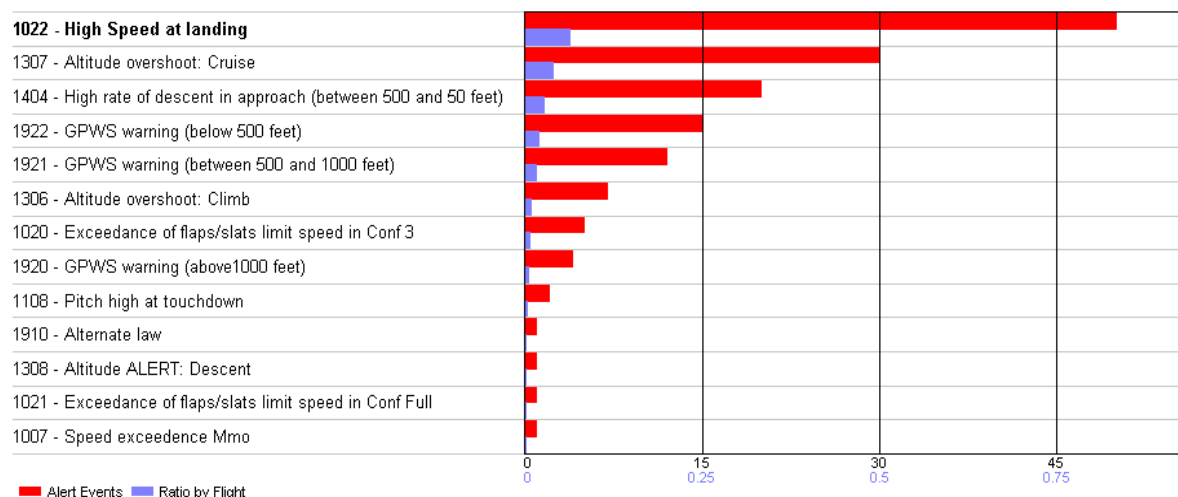
Comments:

December 2000 is the month during the last 2 years that recorded the highest number of events and the highest severity index.

Several causes explain this number:

- ◆ A bad weather hit the major part of Europe during this month.
- ◆ A new FDM program with improved performance and new event detection was introduced on one fleet, which triggered additional events.
- ◆ Work on the runway 05 at xxxx airfield was the cause of 12 identified events.

5.5.6.2 Example 2 : Alert Events (High severity) per Type of Events



Comments

The above graph shows a series of unrelated high speed at landing. But a detailed trend analysis on different airports shows that zzzz airport has a particular high frequency of excessive approach speeds at different stages of the approach with late stabilization.

Pilots who fly to this airfield, can know why. The data now supports that individual experience. The flight review safety board will recommend issuing a crew briefing and asking a flight operations representative to meet with the airport ATC.

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5.5.7 Analysis of Special Events

The analysis team should analyze an event selected by the FDM program when:

1. **The event can be considered as a precursor**
or
2. **The event severity level is high**
and
3. **There are significant lessons to be learnt**

5.5.7.1 Golden Rules for Analysis

- Ask for a crew feedback or use a submitted ASR to interpret the retrieved data. FDM program selects deviations (the "*Whats*") but does not establish the root causes of the problems nor provide explanations (the "*Whys*").
- A flight event should not be analyzed independently of the flight environment where it occurred. Therefore, the analysis team must include crew members qualified on the aircraft types and routes.
- Do not make public the names of the crews concerned (confidentiality and non-jeopardy are the keys).
- Deal only in facts.
- Always consider the Airline SOPs.
- Always correlate with other data (other similar reports, PFR, ATC info, FCOM abnormal procedures, supplementary techniques).
- If similar to previous events that have been studied, correlate the event with relevant past ASRs and other reports/data.
- Evaluate the potential consequences of accident precursors.

5.5.7.2 General Information Required for Special Events Analyzed

If the FDM system records the identifying details for each event, details of the events will be automatically retrieved.

Otherwise the analyst must complete the following questionnaire, as far as possible:

1. Flight number
2. Flight date
3. Flight duration
4. Airport arrival - ICAO code
5. Airport departure - ICAO code
6. Aircraft type and aircraft identification
7. Risk domain – see list in Para 5.5.8.
8. Flight phase, day or night
9. Type of event (RTO, missed approach, IFTB, ...) and related keyword.
10. Severity level
11. Weather conditions including relevant weather data that may explain the events (VMC or IMC, wind, runway condition, OAT, Icing,)

Caution: Some of this data must remain confidential to preserve the crew anonymity.

5.5.7.3 Types of Events

Classifying events by different types is an option that allows multi-criteria search and quick extraction from an event database.

If events are already classified in an associated database of the FDM program, this task may not be necessary.

Appendix 3 shows one such classification.

5.5.7.4 Event Severity Level

As detailed in the Chapter 3, each event should be weighted in terms of severity. Some FDM programs automatically classify events into severity levels.

Events identified by a high severity level should be analyzed.

Any other event will be analyzed when it is considered to be as a "*special event*".

e.g. Trend analysis shows an airport with a particular high frequency of excessive approach speed and/or high rate of descent at different stages of the approach with late stabilization.

5.5.7.5 Analyzed Event Report

A report should be raised for each analyzed event, which includes:

1. Event Narrative
2. Flight Crew Report
3. Flight Safety Review Board remarks on causes and contributing factors
4. Safety Principles Impaired (optional)
5. Human Factors Analysis
6. Lessons learned /proposed corrective actions and follow-up publication proposal

5.5.7.5.1 Event Narrative

The following is a list of relevant items that should be considered, when compiling the event narrative:

- FDM event involved
- Location and environmental conditions:
- When: phase of flight, day or night, dry wet or contaminated runway...
- Where: specific runway, specific approach, and specific airport...
- Forewarning signs
- Cockpit alert activated if any, other cockpit effects
- Consequences on flight operations(IFTB, emergency descent, overweight landing)
- Crew reports – ASR, HFR.
- Maintenance actions and findings (if known)
- Any other available and relevant information

The analysis team explains what actual facts have been considered to explain the event. The team uses DFDR or QAR/DAR parameters or any other source to confirm the different assessments.

Note on "Non Adherence To Procedure" event (NATP):

The flight data may not in itself resolve a Non-Adherence To Procedures. For example, it may show an unstabilized approach that was continued to landing, where the Company's SOP calls for a go-around, but it cannot be established "Why" the crew did not comply.

The event should be analyzed, and the narrative should include a remark that the reason for NATP was not known. Further clarification may be obtained from an associated ASR report and/or the flight safety review board may ask the crew for further information.

5.5.7.5.2 Crew Reports

Crew reporting is necessary to analyze an event. Several methods can be used to obtain a voluntary report from the crew:

- a) A letter from the flight analysis team to the relevant flight crew requesting a personal and anonymous answer from each crewmember involved.
(Refer to Appendix 6 for typical forms).
- b) Flight Safety Director requests the captain of the flight to come in for an interview. Usually a "no jeopardy" policy is in force and the captain may speak freely.
- c) A telephone call to the crew to obtain any comments on the selected event. This interview may be organized through a designated trade union pilot who contacts the captain and the other crewmembers, as per company agreement.

5.5.7.5.3 Flight Safety Review Board Remarks on Causes of Events and Contributing Factors

In some airlines the Flight Safety Board members express their remarks in this paragraph. They compare this event to previous similar events/occurrences and analyze the crew response, procedure handling and CRM behavior.

Finding the causes of an event can be a major challenge to the flight data analysis team and Flight Safety Board. Great care must be taken to confirm that the lessons learned are relevant, and to validate the subsequent proposals for corrective action.

5.5.7.5.4 Safety Principle Infringed (optional)

Safety principles are safety barriers or procedures aimed at firstly, trying to prevent the analyzed event, and secondly to recover from the event and the difficult situation it might have created.

The initial question to answer is "Which safety principle was involved and why?"

A list of safety principles is provided in Appendix 1.

5.5.7.5.5 Human Factors Analysis

Events involving human factors should be analyzed as any other event but a specific questionnaire is proposed in Appendix 2. This questionnaire is taken directly from the British Airways AIRS program.

5.5.7.5.6 Lessons Learned / Proposed Corrective Actions and Follow-up Publication

The Flight Safety Review Board defines and lists the lessons learned from significant events.

The event report must clearly state the facts of the event, communicate these to the crews, and share the experience and lessons learned to maintain the airline safety awareness level.

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5.5.7.6 Action to be Taken for Events Considered to be Possible “Precursors”

If a flight analysis detects a possible precursor of a critical incident, the following process is recommended:

1. Assessment of the potential exposure - probability of occurrence, severity of consequences.
2. Evaluation and definition of needs for enhancement of Airline operational documentation, procedures and/or training.
3. Recommendations to other parties/agencies (manufacturer, ATC, subcontractors)

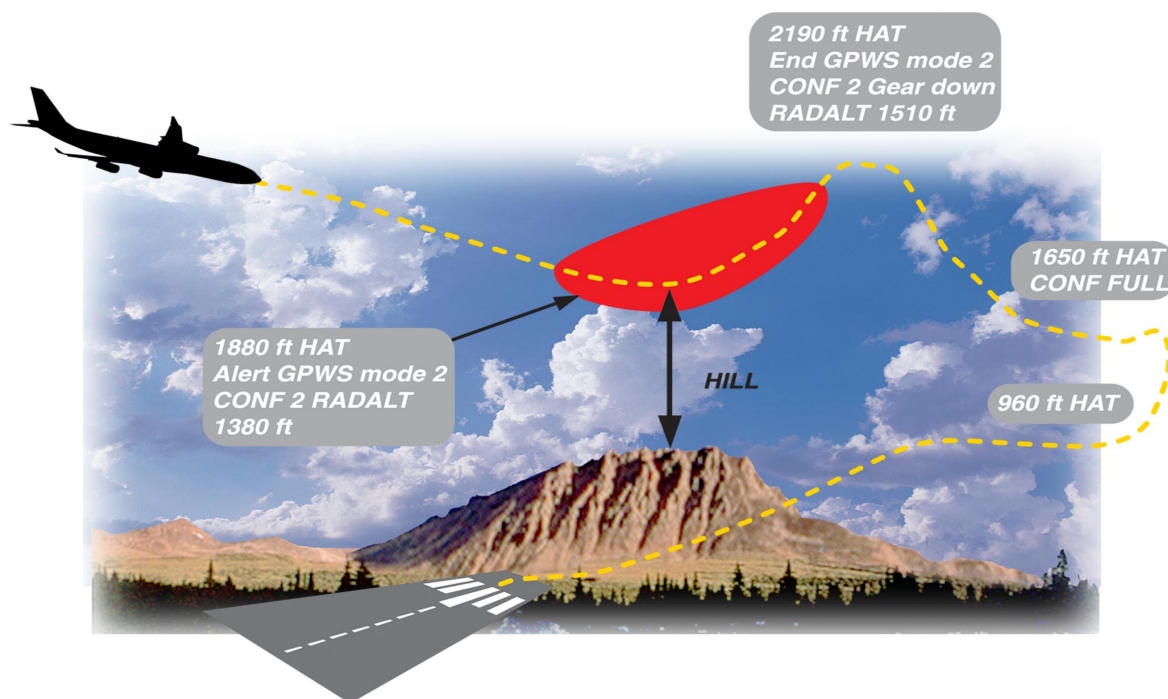
For precursor definition and information, refer to Appendix 4.

5.5.7.7 Real Example of Corrective Action

Following the FDM analysis of several approaches to XXXX airport runway 30, one airline detected that the number of unstabilized approaches was 7 times higher than for any other airport/runway. A special study was performed on this airport and the conclusions published in a Flight Crew Bulletin.

The circumstances at this airport are as follows:

- Visual MTO conditions are usually encountered.
- Crews are well aware that ATC allows visual approaches to be flown.
- Left and right hand patterns can be authorized on runway 30.
- Due to the vicinity of hills with steep slopes, GPWS alerts can be generated.
The radio altimeter receives a terrain closure rate that is the sum of the aircraft rate of descent and the gradient of the hill slope.
This generates the excessive terrain closure rate alert (mode 2).



Typical right hand pattern visual approach at XXXX

The Airline procedure detailed in the Airline safety bulletin emphasizes that:

- Any visual approach must be studied and the details discussed during the briefing.
- Speed reduction must be anticipated to avoid GPWS alerts.
- Speedbrakes should be used when necessary to reduce speed.
- If a GPWS alert is generated, the GPWS must not be switched off even in VMC.(A precursor here is that if crews routinely ignore GPWS warnings in VMC, they might ignore similar warnings in IMC, with catastrophic results. There have been several accidents of this type.)

5.5.8 Risk Domains

Incidents / accidents are classified into the following Risk Domains:

Current name	Definition
CFIT Controlled Flight Into Terrain	Collision with terrain/obstacles following a loss of situation (navigation) awareness, with a fully controllable aircraft.
Loss of control in Flight	Collision with terrain/obstacles or airframe breaking or any other source of damage following loss of control of flight dynamics
Mid-air Collision	Collision with another aircraft in flight.
Collision on runway	Collision with another aircraft or any obstacle during take-off or landing
Runway overrun	The inability to stop the aircraft before the physical end of the runway either at take-off or landing.
Runway excursion	An excursion off the side of the runway either at take-off or landing.
Other in-flight damage or injuries	Any other scenarios such as severe turbulence, severe hail, lightning, bird strike or degraded aircraft handling ...
Other ground damage or injuries	Any other scenarios on the ground (apron and/or taxi)

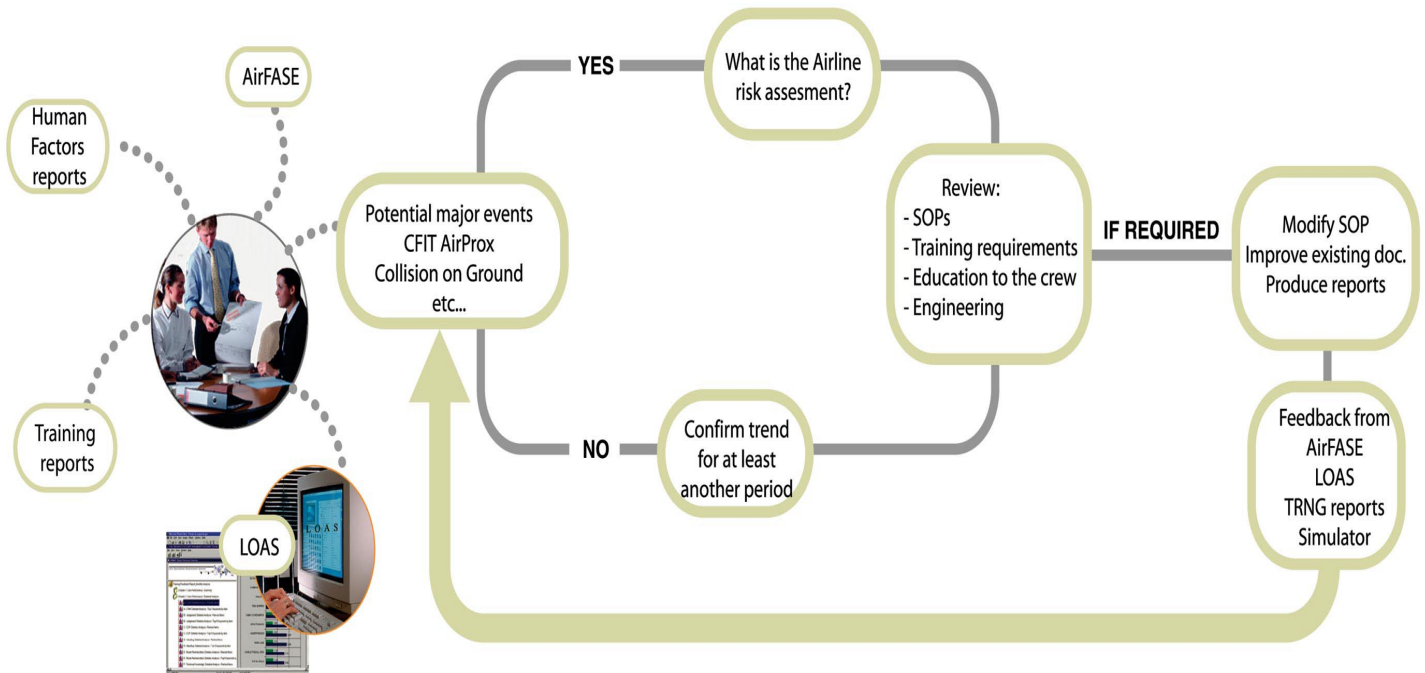
5.5.9 Flight Phases According to the Airbus FCOM

Parked	on ramp with flight crew on board
Taxi	On-ground operation from pushback or commencement of moving to holding point;
Take-off	From holding point to a height of 1500ft above the take-off surface or at which the first power reduction is completed whichever occurs last.
Initial climb	From end of take off to an altitude at which aircraft clean up (flap retraction) is completed.
Climb	From end of initial climb until the first cruising altitude is achieved.
Cruise <i>Normal, ETOPS</i>	From top of climb to top of descent (includes en route climb or descent).
Descent <i>Normal descent, Emergency descent</i>	From top of descent to initial approach fix.
Initial Approach	From initial approach fix to final approach fix.
Final approach <i>Precision, Non precision, Circle, visual</i>	Final Approach: from final approach fix to go-around initiation or runway threshold.
Go around	From go around initiation to missed approach fix.
Missed approach	From missed approach fix to initial approach fix
Landing	From threshold to runway exit.
Taxi in	From runway limit to terminal gate or engine stop

Note: Flight phase definitions are not currently standardized. For information, the ICAO definition is published in Appendix 5.

5.6 Using Analysis Results for Risk Reduction

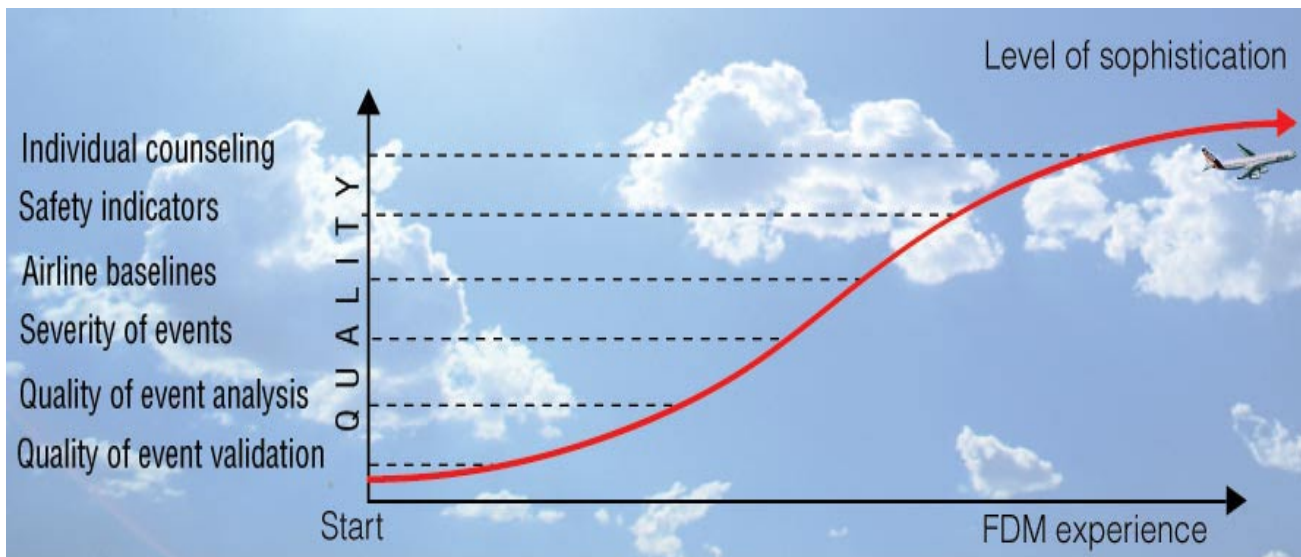
The following schematic shows the process that allows to get the best of a flight event program in relation with other programs used for safety indicators and safety improvement.



5.6.1 Development of the Flight Analysis Event Program

Airlines starting such a program will begin by analyzing trends and significant validated events.

Then as the analysts gain experience, the level of sophistication may be raised and the analyses can become more precise in evaluating event severity, trends, baselines, current level of safety, etc.



5.6.2 Individual Counseling

Some airlines have developed individual counseling programs in agreement with their respective aircrew associations.

If an individual is identified as regularly carrying out a bad practice, such as over-rotating an aircraft at take off, he will receive a call from a fellow pilot (it is much easier to accept than being called to the manager's office).

If the trait is not self corrected, a properly agreed remedial program will be set in motion.

One Airline has now introduced a further sophistication to its program in agreement with its pilot association.

Pilots, who do not necessarily trigger a "serious" event, may cause lesser events on a higher rate than others. A Poisson distribution is used to compare the average number of events for each pilot of a respective fleet against actual number of events.

Pilots that exceed this distribution (i.e. have a greater number of events than average) are highlighted by means of a confidential and unique identity number known only to the pilot association's "gate keeper". The pilots, so identified, receive a call from the "gate-keeper", which is normally sufficient to correct the problem.

Not every company or national culture will enable to accept these practices, but where it is possible it seems to have a positive result. It relies, however, on the clear understanding by all concerned that the process is one of remedial counseling rather than a disciplinary procedure.

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5.6.3 Content of Period Summary Report

The Period Summary Report should contain the statistics of the flight period and a summary of the analyzed events if any, as follows:

1. **Brief Review of the Period Statistics** including the main trends and the airline position versus the safety goals.

This optional paragraph is a quick summary to be read by the management. It should summarize the report in a few lines. (Sometimes called the “Executive Summary”)

2. **Significant Graphs, Tables and Diagrams** for the period.

This paragraph shows the Airlines safety status, the trends compared to the safety strategies and the significance of the different graphs and analyses versus the previous results.

This paragraph can be tailored to indicate different information to several levels of management.

3. **Review of the Analyzed Events** for the period

Analyzed events are reviewed together with their consequences on the safety program. The decisions that address these events should be described in this paragraph.

4. **Lessons Learned**

Lessons learned should highlight the weaknesses (or strengths) of the Airline's safety program.

These lessons should drive the management to review the Airline's safety philosophy and policies as well as the procedures and practices of flight operations and maintenance, plus those of outside agencies, such as ATC.

5. **Conclusion**

The period summary report and its conclusion are written as free text.

It should highlight the most significant facts, show trends since the last periodic report and emphasize the improvement or the deterioration of the safety level.

Any significant events for the period should be highlighted and the consequences analyzed in terms of safety and airline's image.

The report should always keep the reader's attention and contain only interesting/relevant data. It may be a thin document when no significant data/event needs to be reported.

5.7 Conclusion

The value of the flight event analysis lies in the validation of the data, the accuracy of the statistics, the quality of the analyses, the pertinence of the lessons learned and the relevant recommendations.

It is usually associated with an action plan.

The analysis report is the most visible part of the flight data monitoring program and it should be a document of reference rather than a document of discussion. Complete confidence must be established between the flight crews, the analysis team and the flight safety review board.

- Surprising or unexpected events should be reported. They are excellent eye-openers.
- Be aware of the FDM limitations and when possible use other tools to verify your data and to support your conclusions, recommendations and plan of action.

The Flight Data Monitoring is an integrated part of the Flight Operations Monitoring program that includes several other programs such as LOAS, LOSA ©, ASR, HF reports.

The future of the FOM program is progressing strongly. It will help airlines assess the risk to their fleets and act accordingly. Experience has shown that this will not only improve safety but also the airlines' operational efficiency.

The FOM working group composed of Air France, Cathay Pacific, Airbus and Aeroconseil representatives is engaged on this project. Other operators are welcome to participate.

5.7.1 Future improvement should be made in the following areas:

5.7.1.1 Risk Assessment

The FDM program can help to answer the question is “How safe is our operation and what are its greatest risks?”

The important point is to establish what defenses (e.g. SOPs) are in place to eliminate the risks or at least, to diminish the actual risks to your airline. This is where future analysis is heading.

5.7.1.2 Computer Analysis

The first step is to try to improve the amount and quality of data that is captured. This is primarily to do with the sensors, data buses, QAR/DAR and “on-board” programs.

The second stage is to improve the analysis program, so that there is a high level of confidence in the validity of identified events. This will allow the FDM program to become more automated and to link events together e.g. unstable approaches.

Finally, the program can progress to a sophisticated level of identified significant events, relevant safety indicators, individual counseling etc.

5.7.1.3 Individual Counseling

One of the concerns of making changes, based on the FDM program, is whether the events are “fleet wide” or attributable to a few individuals.

The individual counseling program, described in a previous chapter is an attempt to address this issue.

It is likely that other initiatives will be developed that enables the recognition of a pilot who causes frequent events, under a non-disciplinary and purely remedial system agreeable to all concerned.

5.7.1.4 Integration with other Programs/Data

Mention has already been made of the use of ASRs, HF Confidential reports, LOAS and training feedback, in conjunction with the FDM results. The result of such integration will offer a very useful tool to help answer the question concerning threats and errors and whether the SOPs, training and other strategies are sufficient.

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SAMPLE LIST OF SAFETY PRINCIPLES

Safety principles are rules defined at several levels of management to ensure a high degree of safety culture and safe airline operations.

The terms that are used to identify these different concept levels are known as Degani and Wiener 4P's:

- **Philosophy**
- **Policy**
- **Procedures**
- **Practices**

The safety principles applying to each of these levels should be applied at the relevant parts of responsibility within the airlines.

The following items may also provide guidance in the search for Safety Principles of any type:

- Crew competence: crew licensing, crew training
- Meteorology services
- Navigation: equipment and systems, aeronautical charts
- Operation of aircraft
- Airworthiness of aircraft
- Maintenance
- Aeronautical telecommunications: equipment and systems, procedures
- Anti-collision: Rules of the Air, Air Traffic Services,
- Airport design and operations
- Aeronautical information Services
- Security
- Transport of dangerous goods
- Search and rescue

The following tables give examples of the qualities that crews and Air Traffic Control should exhibit during a flight

:

TAXI

Crew receives and complies with ATC procedure/clearance for taxi
 Crew understands clearly and acknowledge start up clearance and procedures
 Crew accounts for inoperative items as per MEL
 Crew sets the correct takeoff trim

TAKEOFF

Crew ensures symmetrical thrust for takeoff
 Crew maintains directional control during the takeoff roll
 Crew applies correctly the RTO procedure: stop before V1 or continue after V1

CRUISE

Crew crosschecks the aircraft position regularly in cruise
 Crew briefs approach and landing and missed approach in adequate/sufficient time
 Crew obtains the weather information and runway conditions

DESCENT

Crew crosschecks the aircraft position when close to top of descent
 Crew crosschecks the altitude clearance versus the MSA during the descent
 Crew knows that VFR conditions requires at least one head up in the cockpit

APPROACH

Crew recognizes a non stabilized or a rushed approach
 Crew strictly adheres to the airline policy for continuing the approach
 Crew arms ground spoilers (and checks thrust reverser status)
 Crew recognizes the loss of required visual references
 Crew is mentally prepared for a go around
 Crew selects the best available nav aids for approach and landing

LANDING

Crew is aware of the runway conditions
 Crew applies a good recovery technique from a bounced landing
 Crew immediately recognizes a touch down beyond the touch down zone
 Crew knows and applies a good crosswind landing technique
 Crew is mentally prepared for a touch and go if necessary
 Crew uses the most favorable runway for the prevailing weather conditions
 Crew immediately recognizes a thrust asymmetry during landing and/or roll out

ROLL OUT

Crew verifies the A/THR disconnection at touch down
 Crew checks the ground spoiler deployment
 Crew always selects the thrust reversers at landing (maintained at idle if required per procedure)
 Crew reacts to asymmetric thrust reverser deployment
 Crew immediately recognizes and reacts to autobrake disconnection or malfunction
 Crew takes over from autobrake when necessary
 Crew uses a good differential braking technique
 Crew maintains a correct directional control
 Crew uses sufficient braking to ensure taxi speed when reaching the intended runway exit/ taxiway

STANDARD OPERATING PROCEDURE/ TASK SHARING
Crew applies the applicable procedures correctly, completely and in a sequential order
Crew plans, executes, verifies in this order
Crew respects standard task sharing
There are clear recommendations from flight operations on how to resume an interrupted check list and/or a normal procedure
Crew manages time pressure in order to be able to follow SOPs
Procedure and system description are complementary
Standard operating procedures are followed, including standard calls and normal checklists
Crew assesses/ validates ECAM actions before implementing / not implementing them
In case of conditional procedures, crew makes sure the conditions are satisfied before implementing the actions
Crew periodically reviews the ECAM pages

ABNORMAL PROCEDURES
There is a relevant procedure for this abnormal, emergency situation. It can be easily accessed
Crew knows which abnormal procedure to use and how to use it.
The abnormal procedure is clear, complete, ergonomically well presented and covers the scenario being experienced
The abnormal procedure is compatible with any operational conditions and can be easily read and followed
The content of the procedure (or the absence thereof) is considered as a possible factor in causing the event
Crew knows which procedures are not in the ECAM but only in the QRH (e.g. GA with flaps and slats jammed, fire in the galley)
Crew knows the ECAM procedures are the primary reference for abnormal situations as amended by OEBs
Crew uses the relevant procedure with the latest revision
Crew reads abnormal procedures and does not perform them from memory except where specified
Crew adheres to the procedure, does not take short cuts and does not use a personal, undocumented procedure.
The procedure for VMO/MMO exceedance is correctly applied.

FMS AND AUTOPILOT USE
Crew crosschecks the aircraft trajectory displayed on the Map with basic parameters on the PFD and on the primary instruments
Crew updates the flight plan in a timely fashion
Crew monitors the FMA and understands the current flight mode engagement
Crew calls out all FMA changes
Crew calls out any significant target changes
Crew calls out any significant action on automated systems e.g. arming autobrakes
Crew has a common understanding on actual targets and active modes
Crew crosschecks the EFIS with other information sources (instruments)
Crew respects standard task sharing when using the interfaces (MCDU, FCU, A/THR, RMP)
Crew checks the accuracy of the FMGS
In case of automation disconnection or failure (auto-crew, ATHR, ...), the PF flies the aircraft manually
Crew does not accept significant or major automation deviations
Crew checks FCU and MCDU inputs on PFD and ND
Crew cross-checks PFD and ND indications with raw data
Crew removes the FD bars/Flight Path Director (FPD), when flying visually. The use of FPV is recommended

CRM ISSUES

Crew members adhere to standard role and task sharing
Excessive workload is announced and acknowledged by the other crew member
In emergency situations, PF/PNF role allocation is performed knowing that most of the workload is on the PNF
Crew manages cockpit distractions and actions the interruption
Crew encourages cabin crew to report vital information to the cockpit
The Captain sets a tone to enable a free exchange of information
The Captain briefs cabin attendants with the purser (dependent on airline policy)
Crew stops disputes in the cockpit, with ATC, cabin crew, ground personnel, and any other personnel
Crew resolves disputes in the cockpit, with ATC, cabin crew, ground personnel, and any other personnel
Cabin crew are aware of circumstances that warrant breaking the sterile-cockpit rule
Crew remains vigilant in the cockpit

COCKPIT INTERFACE

Actions on interfaces are checked and cross-checked
Actions, cautions and warning messages are sufficiently attention catching (i.e. they cannot be missed.)

CROSSCHECK AND CALLOUT

Crew calls out their actions
Crew monitors the results of their actions
Crew does not transform call outs into routine calls
Crew communicates verbally when switching side stick priority

COMMUNICATION / ATC

Crew reads back ATC messages
Crew asks for repetition / confirmation in case of poor transmission (noise) or doubt
Crew considers what they read back (no routine read-back)
Crew speaks the same language (e.g. English)
ATC is aware of aircraft performance characteristics
ATC is aware of the problems associated with a late runway change (FMS, procedure change, circling...)
Crew hears and understands ATC feed-back (acknowledgement / correction message)
ATC updates the weather info anytime the wind (direction and/or speed) changes significantly and the runway conditions change.

DECISION MAKING

Crew sets objectives and priorities
Crew recognizes or clearly identifies the prevailing conditions, using a clear warning and / or available visual clues
Crew refers to available procedures

METEOROLOGICAL CONDITIONS

Crew ensures that the latest ATIS message has been received.
Crew knows the difference between METAR wind, ATIS wind, tower wind and wind displayed on ND.
Crew understands that tower wind is not an instantaneous wind but an average wind
Crew knows the meaning of runway friction coefficient versus actual runway condition
Crew knows what is the actual braking effect of the runway condition
Crew receives updated and accurate weather information from the tower before landing
Crew knows the aircraft limitations at takeoff and landing (max crosswind, braking capacity for actual runway conditions, autoland limitations, actual and authorized visibility).
Crew knows the effects of turbulence and windshear and applies the relevant precautions and procedures

LIST OF HUMAN FACTORS CRITERIA

This list is taken from the AIRS program of BASIS and published in this guide with the authorization of British Airways.

CREW ACTION

Factor	Factor type	Definition
Briefing	Positive or Negative	Briefings in this sense are to be understood as strategic. Short-term statements in response to, e.g., abnormal situations, do not come under this heading. The effective briefing [P] will establish a professional group climate, will be operationally thorough and interesting, addressing crew co-ordination, planning and potential problems. A poor briefing [N] will be deficient in one or more of these.
Crew communication	Positive or Negative	Indicates [P] that standard calls and cross-checks were totally in accordance with company procedures, or [N] were omitted, ineffective or deficient in some respect.
Decision	Positive or Negative	Communication on the aircraft was [P] or was not [N] effective in informing everybody (including ATC) of relevant operational decisions, uncertainties, intentions, actions and aircraft/system states. Informing other crew members of stress and overload are also important aspects of this topic.
Feedback	Positive or Negative	Feedback between crew members was [P] timely and appropriate or [N] untimely, inappropriate or omitted.
Group climate	Positive or Negative	Indicates [P] that a co-operative, communicating and supportive flight deck environment was actively established and maintained, or [N] was not. It is important to note that this is an activity - not a state of mind!
Handling	Positive or Negative (enhanced or degraded flight safety)	Flight handling is to be understood as the direct manipulation of aircraft flight path and configuration. This can be effected either through the use of normal flight controls or through FCU / AP/FD or FMS, however it should result in an immediate change of flight parameters or configuration. This factor is used when use of manual or automatic control can not be ascertained.
Handling auto	Positive or Negative	To be used when there is clear evidence that the aircraft was flown automatically.
Handling manual	Positive or Negative	To be used when there is clear evidence that the aircraft was flown manually
Lapse	Negative	A planned action was unintentionally omitted. We can assume that drills, checklists and procedures are 'planned'. Thus, forgetting to complete, for instance, the Before Takeoff checks is a lapse. See also 'Action slip' and 'Mistake'.

CREW ACTION (cont'd)

Factor	Factor type	Definition
Misrecognition	Negative	Perceptual misinterpretation of visual or auditory data. E.g., mishearing ATC clearance, misreading instruments.
Mistake	Negative	An action was carried out as planned but the plan was faulty. See also 'Action Slip' and 'Memory Lapse'.
Misunderstanding	Negative	Conceptual misinterpretation of information. E.g., fault misdiagnosis, misunderstanding of manuals or clearances.
Preparation Planning	Positive or Negative	Indicates [P] that tactical pre-flight or in-flight planning and preparations were thoroughly and effectively completed, or [N] ineffective, omitted or inappropriately abbreviated.
Procedures failed to follow	Positive or Negative	Indicates that crew member(s) deliberately failed to carry out a drill or procedure required by the SOPs. This should be coded negatively [N] unless the action was undertaken specifically to enhance safety in which case [P] should be assigned. (See 'Action Slip' and 'Memory Lapse' for unintentional acts.)
Role conformity	Positive or Negative	Crewmembers [P] kept properly to their assigned roles or [N] failed to conform to the detriment of safety.
Action slip	Negative	Indicates that a correct action was planned but an incorrect action was carried out unintentionally. E.g., selecting one switch in the belief that you had selected another, not because of ignorance of where each switch is but from absent-mindedness or distraction. See also 'Memory Lapse' and 'Mistake'.
System handling	Positive or Negative	This definition does not refer to flight controls - See Handling. Indicates [P] exemplary or [N] faulty handling of aircraft systems, e.g., mechanical or electronic, or strategic handling of flight control systems through the FMS (or whatever other type-specific term is employed).
Vigilance	Positive or Negative	Indicates [P] exemplary or [N] poor flight monitoring. This activity relates to the five situational awareness factors in the Personal Influences category: Environmental Awareness; Mode Awareness; Spatial Orientation; System Awareness; and Time Horizon.
Work management	Positive or Negative	Indicates [P] a very high standard or [N] failure of workload distribution, task prioritisation, and avoidance of distraction.

ENVIRONMENTAL

Factor	Factor type	Definition
Airport facilities	Positive or Negative	Airport facilities such as lighting, navigational aids or jetty docking facilities, were [P] excellent and functional or [N] of poor quality or design causing operational difficulties.
ATC communication	Negative	Indicates a problem with RT communications with ATC. E.g., Radio interference, jamming.
ATC services	Positive or Negative	ATC offered [P] good expert assistance or [N] that their instructions were unhelpful, led to unnecessary workload, conflicted with reasonable expectations or appeared to create an unsafe situation
Degraded information	Negative	Information from any source is unclear. Can result in Mis-recognition, Misunderstanding, reduced System Awareness etc.
Ergonomics	Positive or Negative	Design of controls, displays or systems made them [P] fit or [N] unfit for their intended purpose.
Language	Positive or Negative	A language problem or ambiguity made meaningful communication difficult or impossible.
Meteo	Positive or Negative	Any meteorological condition which [N] caused operational difficulties, or [P] facilitated, e.g. environmental awareness or handling.
Operational problem	Positive or Negative	Any situation or events that threatens or could potentially threaten the safety of the aircraft or any of its occupants. An Operational Problem will require the crew to consider the implications of the event and if necessary to act to eliminate or control the threat.
Other aircraft	Positive or Negative	Indicates [P] that another aircraft offered assistance (e.g., Comms relay) or [N] caused an operational difficulty (e.g., runway occupation).
Passengers	Positive or Negative	Passenger state or behaviour which influenced aircraft operation.
Technical failure	Negative	Any technical failure causing an operational difficulty.

INFORMATIONAL

Factor	Factor type	Definition
Electronic checks	Positive or Negative	Indicates [P] a high level of assistance from or [N] a deficiency in on-board electronic checklists, drills or libraries.
Manuals	Positive or Negative	Indicates [P] a high level of assistance from or [N] a deficiency in any permanent a/c library document, e.g., Technical Manual, MEL. (Not QRH or SOPs).
Charts	Positive or Negative	Indicates [P] a high level of assistance from or [N] a deficiency in charts, e.g., Aerad, Diversion Manual or electronic navigational databases or displays.
QRH	Positive or Negative	Indicates [P] that drills in the QRH gave a high degree of assistance or [N] were inappropriate, ambiguous, misleading or not relevant [N]. Wherever possible the analyst should identify the particular drill involved and note it in the 'Notes' page.
SOP	Positive or Negative	Indicates [P] that the SOPs gave positive and safe guidance or [N] were inappropriate, ambiguous, misleading or not relevant. Wherever possible, the analyst should identify the specific procedure and note it in the Safety Services Notes page.

ORGANISATIONAL

Factor	Factor type	Definition
Commercial pressure	Negative	Indicates pressure from sources directly related to commercial requirements of the Airline. E.g. departure deadlines, training / checking, industrial disputes.
Company communication	Positive or Negative	Helpful or informative company communication [P]. An unnecessary workload from company radio comms or difficulty with radio contact with company [N].
Ground handling	Positive or Negative	Implies [P] assistance from, or [N] a problem with ground operations. E.g., Engineering on the ramp (Tech 1 or 4), Pax handling, Loading (including loadsheets), Pushback, Taxying.
Ground services	Positive or Negative	Assistance from [P], or [N] a problem with non-ramp ground services. E.g., Met Services, AIS Briefing, Operations Control.
Ground violation	Negative	Pressure to conform to a procedure, which is contrary to SOPs but is nevertheless employed by many crew. This may or may not be implicitly condoned by management.
Maintenance	Negative	A known defect / deficiency / technical problem caused or aggravated an operational difficulty. E.g., 'Known History', 'Fleet Problem', ADDs/Allowable Deferred Deficiencies.
Recency	Negative	A possible organisational cause of flight crew under-performance. Recency problems can be caused by lay-offs, involuntary stand down, seasonal workload etc. See 'Currency' in Personal Influences.
Technical support	Negative	Information, advice or support from engineering (Maintenance, Ops Engineering, Tech Support) was timely, accurate and helpful [P], or not [N].
Training	Positive or Negative	Indicates [P] that training has been reported as effective and relevant or [N] a training deficiency is reported.

PERSONAL

Factor	Factor type	Definition
Auto complacency	Negative	Indicates a false belief that the automatic systems would 'cope'. Or that vigilance was reduced because of over-reliance on automatic systems.
Boredom	Negative	Under-arousal because of personal mood, or too low or too repetitive a workload.
Currency	Positive or Negative	Exceptional performance [P] due local knowledge or high level of recent practice or [N] under-performance due lack of recent practice, or unfamiliarity with an airfield.
Distraction	Negative	Indicates that crew member(s) allowed themselves to be distracted by task-irrelevant and/or non-operational issues.
Environment awareness	Positive or Negative	Exceptional (P) or poor (N) awareness of environment, e.g., other aircraft, communication between ATC and other aircraft, met conditions, terrain features and MSA.
Environment stress	Negative	Indicates that physical stress, imposed by environmental conditions, such as turbulence, temperature extremes, noise (e.g., automated warnings and call-outs) etc., affected the crewmember's performance.
Knowledge	Positive or Negative	Exceptional [P] technical, procedural or operational knowledge solved a problem, or [N] lack of knowledge caused or worsened a problem. An alternative in some circumstances could be 'Currency'
Medical crew	Negative	A medical problem or an injury in any crewmember, which caused an operational difficulty or occurs as the result of an incident.
Mode awareness	Positive or Negative	Exceptional [P] or poor [N] awareness of aircraft configuration and flight control system modes. The latter include such aspects as attitude / speed / altitude / heading, in armed / acquire / hold modes and the state of FMS data input and flight planning functions.
Morale	Positive or Negative	Indicates [P] that a high degree of enthusiasm enhanced operational safety, or [N] indicates a lack of enthusiasm to give full attention to operational demands because of personal, interpersonal or Industrial Relations reasons.
Operational stress	Negative	Stress causing operational difficulty because of high operational workload or poor workload management. E.g., difficult procedures and drills, high workload departures / arrivals, or everything happening at once because of poor planning or organisation.
Personal stress	Negative	Reporter indicates that personal stress (domestic, financial etc.) may have contributed to, or caused an operational difficulty.
Previous incident	Negative	Report of stress caused by a previous incident.
Spatial orientation	Positive or Negative	Exceptional degree of geographical spatial awareness which enhanced safety [P], or [N] poor awareness because of man-made or natural causes, or confusion induced by erroneous displays, FMS or navigational information.
System awareness	Positive or Negative	Exceptional [P] or insufficient [N] degree of system awareness. 'System' here relates to those technical subsystems defined in 'System Handling' in the Crew Actions category except for FMS systems awareness (see 'Mode Awareness' above).
Time horizon	Positive or Negative	Exceptional [P] dynamic awareness of time with respect to time required for procedures, time to base turn etc., or [N] insufficient mental preparation for future or potential aircraft situation.
Tiredness	Negative	Tiredness was reported to have reduced crewmember's performance or attention.

STATISTICAL CLASSIFICATION OF EVENTS

Unstabilized approach	11: Rushed approach 12: Steep path approach 13: Continuous low path approach 14: Excessive speed during approach 15: Low speed approach 16: Late line up
Others	17: Go around executed due to incorrect approach 18: Incorrect visual pattern 10: Other abnormal approaches
Incorrect aircraft control	21: Incorrect aircraft configuration (e.g. trim, flaps, autobrake sel.) 22: Error of system selection (e.g. flaps instead of landing gear) 23: Double stick input 24: Excessive speed or Mach with VFE or VMO/MMO overspeed 25: insufficient speed or Mach in climb or in cruise 26: Difficult capture of cruise FL 27: Nominal engine data exceeded (EGT,EPR) 28: Abnormal taxi in or taxi out 29: Firm landing 31: Long landing 32: Short landing 33: Abnormal attitude 34: Significant bank angle 35: Flap load relief activated 36: Flap extension above 20.000 feet 37: Early retraction of flaps after takeoff 38: Incorrect flying technique 20: Other abnormal aircraft control
Potentially dangerous trajectory	41: Altitude deviation 42: Tourist flight 43: Dangerous flight over ground elevation 44: erroneous ground track or erroneous destination 45: Abnormal vertical flight path 40: Any other dangerous trajectory
Contributive factors	51: Basic skill 52: Failure of automatism/avionics 53: Aircraft circuit/system anomaly 54: ATC 55: Aircraft structure (e.g. vibration) 56: ground installation (e.g. ILS, runway lights, ATC) 57: Weather conditions 58: Documentation 59: Procedure compliance or NATP (non adherence to procedure) 50: Other factors
Use of automatics	61: Error of mode engagement 62: Error of system selection 63: Wrong figure entry 64: Non voluntary mode engagement (e.g. AP/FD, A/THR) 65: Unknown functioning of a system 60: Other incorrect use

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PRECURSORS OF INCIDENT OR ACCIDENT

A "precursor" is a ground or an in-flight event that has generated minor consequences. This event, however, contained the major links of a chain of events leading to well identified incident/accidents such as CFIT, potential loss of control, runway excursion, tail strike etc.

Precursors are usually identified during an accident/incident analysis. They are warning signs that one can trace in several accidents.

Starting from accident families such as CFIT, loss of control or runway excursion, it is possible to list these precursor's events.

For example:

- An error or an omission in the takeoff configuration checklist may be a precursor of a loss of control.
- An excessive attitude or bank angle at touch down is a precursor of a tail strike or a wing/nacelle strike.
- A TCAS RA can be seen as a midair precursor.

Identified precursors will be used to assess the efficiency of the Airline lines of defense against potential accidents.

Lines of Defense

Lines of defense include checklists, procedures, specific crew actions, Airline policies and recommendations that shall reduce the probabilities of cockpit operation misbehavior.

The concept of line of defense can be extended to external personnel such as ATC, ramp personnel, Airline maintenance or manufacturers.

Through their event analyses, analysts should identify the precursors and the line of defenses. They must determine if the line of defense is defined, known and applied. They can assess how effective they are. In the opposite, they will identify their weaknesses.

The following tables list some of accidents associated to the relevant precursors and the lines of defense.

ACCIDENTS	PRECURSORS	LINE OF DEFENSE prevention/detection/mitigation
CFIT		
B747 Guam A320 Strasbourg B757 Cali MD80 Windsor lock B737 Kansas city DC9 Zurich RJ100 Zurich	<ul style="list-style-type: none"> - Flying below the initial flight path in climb - Lateral deviation in climb - Flying below the flight path - Lateral deviation in approach - Flying below the MSA - Baro setting error - No response to GPWS alert 	<ul style="list-style-type: none"> - Stabilized final approach - Lateral navigation monitoring: <ul style="list-style-type: none"> ▪ Navaids ▪ FMS, Dir to ▪ Baro setting check QNH/QFE - Vertical navigation monitoring: <ul style="list-style-type: none"> ▪ Safe altitude ▪ Final approach trajectory ▪ DME-altitude tables - GPWS and EGPWS maneuver - Go around decision - Operational documentation and or database quality - Monitoring of FMA modes - Monitoring of AP/FD behavior - PF/PNF Crosscheck
LOSS OF CONTROL		
B767 Lima (Anemo) B767 Puerto plata (anemometer) A310 Bucarest (A/THR) MD80 Miami (Dangerous goods) B747 Djakarta (Volcanic ashe) B707 New York (Fuel) A310 Aeroflot (unqualified PNF) A300 India (fuel) DC8 Fine Air (loading) A300/600 Nagoya (AP)	<ul style="list-style-type: none"> - Flying below minimum speed - Excessive bank angle - Excessive attitude - AP or A/THR failure - Assymetric thrust - Flight control anomaly - Anemometer anomaly - Trim anomaly - Slat/flap anomaly - CG anomaly - Loading anomaly - Dangerous good anomaly - Fuel anomaly - Severe windshear - Wake turbulence - Icing/de-icing anomaly - Smoke, burning smell - Volcanic ash - Severe turbulence/ storm 	<ul style="list-style-type: none"> - Fuel monitoring - Loading monitoring - Loadsheets monitoring - Dangerous goods control - Main flight parameter monitoring - Takeoff configuration control - Asymmetrical thrust at takeoff - Icing control - in flight Cabin control (fire) - Windshear avoidance proc. - Windshear procedure - Unusual position recovery proc. - Smoke procedure - Volcanic ash avoidance proc. - Emergency descent procedure - Maintenance quality control - PF/PNF Crosscheck - Cabin crew preflight check

ACCIDENTS	PRECURSORS	LINE OF DEFENSE Prevention/detection/mitigation
MID-AIR		
B747/IL76 Delhi B727/Cessna SanDiego SE210/SV4 Orly	<ul style="list-style-type: none"> - Altitude deviation - Lateral deviation - RA TCAS - Call sign mismatch - Insufficient lateral or vertical separation 	<ul style="list-style-type: none"> - ATC Communication check - In-sight traffic monitoring - Airport/ runway identification check - Monitoring of other aircraft comm. - Navigation monitoring in cruise - Altitude deviation monitoring - TCAS maneuver - PF/PNF Crosscheck
ON GROUND COLLISION		
B747/B747 Teneriffe DC9/B727 Detroit B737/Metro SFO MD83/C440 St Louis	<ul style="list-style-type: none"> - Runway incursion - Unauthorized takeoff - Unauthorized landing - Error of taxiway - Call sign mismatch - Airfield or runway confusion 	<ul style="list-style-type: none"> - ATC Communication monitoring and check, use of inappropriate terms - Monitoring of in-sight traffic - Taxi instruction check - Taxi in and out monitoring - PF/PNF Crosscheck
IN-FLIGHT DAMAGE OR INJURY		
B747 Johannesburg B747 Hawaiï MD11 China	<ul style="list-style-type: none"> - Storm encountering - Hail encountering - Severe clear air Turbulence - Wake turbulence - Pilot induced G load - Radar anomaly or misuse 	<ul style="list-style-type: none"> - Radar - MTO forecast and chart - Storm avoidance procedures - VMO/MMO exceedance procedure. - PF/PNF crosscheck
ON-GROUND DAMAGE OR INJURY		
B747 Bombay (RTO) B747 Rio (Reverse) B747 Delhi (RTO) B747 St Domingue (unstabilized app) B747 Papeete (Autothrust) B747 CDG (RTO) A320 Philippines (Reverse)	<ul style="list-style-type: none"> - Unstabilized approach (Without Go around) - Lateral control anomaly - Braking anomaly - Reverse anomaly - Long landing - RTO at high speed - Use of autothrust 	<ul style="list-style-type: none"> - Stabilized final approach - Visual approach procedure - Touch down control - Reverse extension control and knowledge of system - ATC comm's procedure - Taxi out procedures - Maintenance quality control - Go-around decision - PF/PNF crosscheck - Pre-flight cabin crew procedures and control

FLIGHT PHASE DEFINITION ACCORDING TO ICAO

Standing	Prior to pushback or taxi, or after arrival, at the gate, ramp, or parking area, while the aircraft is stationary.
Pushback towing	On-ground operation of the airplane from pushback or commencement of moving to holding point; and from runway limit to terminal gate or engine stop
Taxi	The aircraft moves on taxiways and runways under its own power prior to takeoff or after landing.
Takeoff/initial climb	<p>From the application of takeoff power, through rotation and to an altitude of 1000 feet above ground level or, for (Visual Flight Rules) VFR operations, the traffic pattern altitude, whichever comes first.</p> <p>This phase of flight includes:</p> <ul style="list-style-type: none"> • Takeoff. From the application of takeoff power, through rotation and to an altitude of 50 feet above runway elevation or until gear-up selection, whichever comes first. • Rejected Takeoff. During Takeoff, but prior to liftoff, from the point where the decision to abort has been taken until the aircraft comes to a stop. • Initial Climb. From the end of the Takeoff sub-phase to the first prescribed power reduction, or until reaching 1000 feet above runway elevation or the VFR pattern, whichever comes first
En Route/ Cruise	<p><u>Instrument Flight Rules (IFR)</u>: From completion of Initial Climb through cruise altitude and completion of controlled descent to the Initial Approach Fix (IAF).</p> <p><u>Visual Flight Rules (VFR)</u>: From completion of initial climb through cruise and controlled descent to the VFR pattern altitude or 1000 feet above runway elevation, whichever comes first.</p>
Approach	<p>Instrument Flight Rules (IFR): From the Initial Approach Fix (IAF) to the beginning of the landing flare.</p> <p>Visual Flight Rules (VFR): From the point of VFR pattern entry to the beginning of the landing flare.</p> <p>This phase includes:</p> <ul style="list-style-type: none"> ▪ Initial Approach (IFR): From the IAF to the FAF. ▪ Final Approach (IFR): From the FAF to the beginning of the landing flare. ▪ Circuit Pattern – Downwind (VFR) and base ▪ Circuit Pattern - Final (VFR): ▪ Missed Approach/Go-Around:
Landing	From the beginning of the landing flare until aircraft exits the landing runway or comes to a stop on the runway.
Maneuvering	<p>This phase of flight includes:</p> <ul style="list-style-type: none"> • Aerobatics: Any intentional maneuvering that exceeds 30 degrees of pitch attitude or 60 degrees of bank, or both, or abnormal acceleration (usually associated with air shows and military flight, or with related training flights). • Low Flying: Intentional low-altitude flight not connected with a landing or takeoff, usually in preparation for or during observation work, demonstration, photography work, aerial application, training, sight seeing, or other similar activity.

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FORMS FOR FLIGHT CREW REPORT

Each flight crew may report to the analyst team using anonymous flight crew reports.
The following forms are examples that are tailored to the different crew personnel.

To the Captain's attention
Flight xx NNN dd mmm yyyy

Dear Colleague,

The flight analysis team routinely reviews the parameters of all the flight of our company. The purpose of these analyses is to improve the prevention strategy and the flight safety of our Airlines.

Thanks to our mutual agreement with the flight crew trade unions, we try to go beyond the basic analysis of data to include the flight crews' viewpoint. This information enables us to understand better the anomalies or deviations selected by our Flight data monitoring program. This is particularly important when it is suspected that human factors may be involved in the cause.

We attach a file of the flight data parameters recorded during the flight number xx NNN flown the dd of mmmm yyyy performed on the A320 xxxxx. The detected anomaly is named xxxxxxxxx (e.g. rushed approach).

Description of the event:

For a more detailed analysis and to assess any preventive measures, please could you tell us what were the circumstances surrounding this event, such as any human factors involved, weather conditions, ATC influence plus any information that would be relevant and useful.

We include an additional set of data. Could you forward this to your first officer, and ask him to give his comments to yourself for you to return to the Safety Department.

We have informed your first officer by letter that an information request has been sent to you.

We will be very grateful if you could return the complete set of answers to our department. We shall use it to re-assess our preventative action and to benefit from your experience.

Thank you very much for cooperating with us for the sake of flight safety.

XXXXXXX
Captain,
Flight Safety Department Director

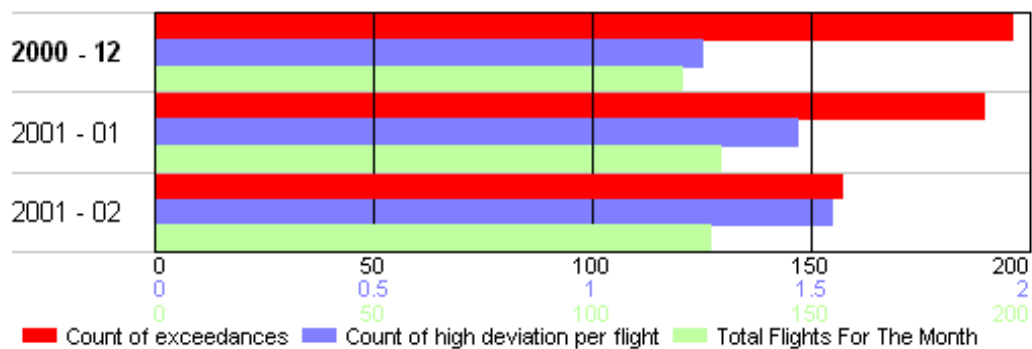
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Answer Form for an Anonymous Report:

Writer: Captain xxxx (or FO yyyy or Flight Engineer zzzzz)

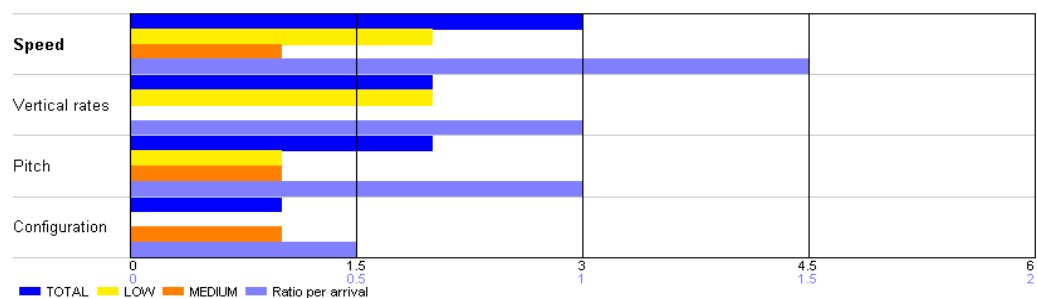
Date of reception of the request form:

- Each crew member involved should send their answer forms to the Captain of the flight who will forward them to the Flight Safety Dept.
- We offer the following headlines to help you give your answer:
 1. Give a description of the event and its circumstances (weather conditions, day or night, ATC influence, any anomaly from the aircraft or cockpit display or ground installation)
 2. How did you analyze this event? How did you react personally and as a crew?
 3. Did you find any help in the ops documentation, procedures, checklists?
 4. Was your previous training (technical or CRM) of any help? To what extent?
 5. Will you act differently if you encounter a similar event in the future?
 6. Do you have any suggestions how to avoid a similar event to your airline colleagues?

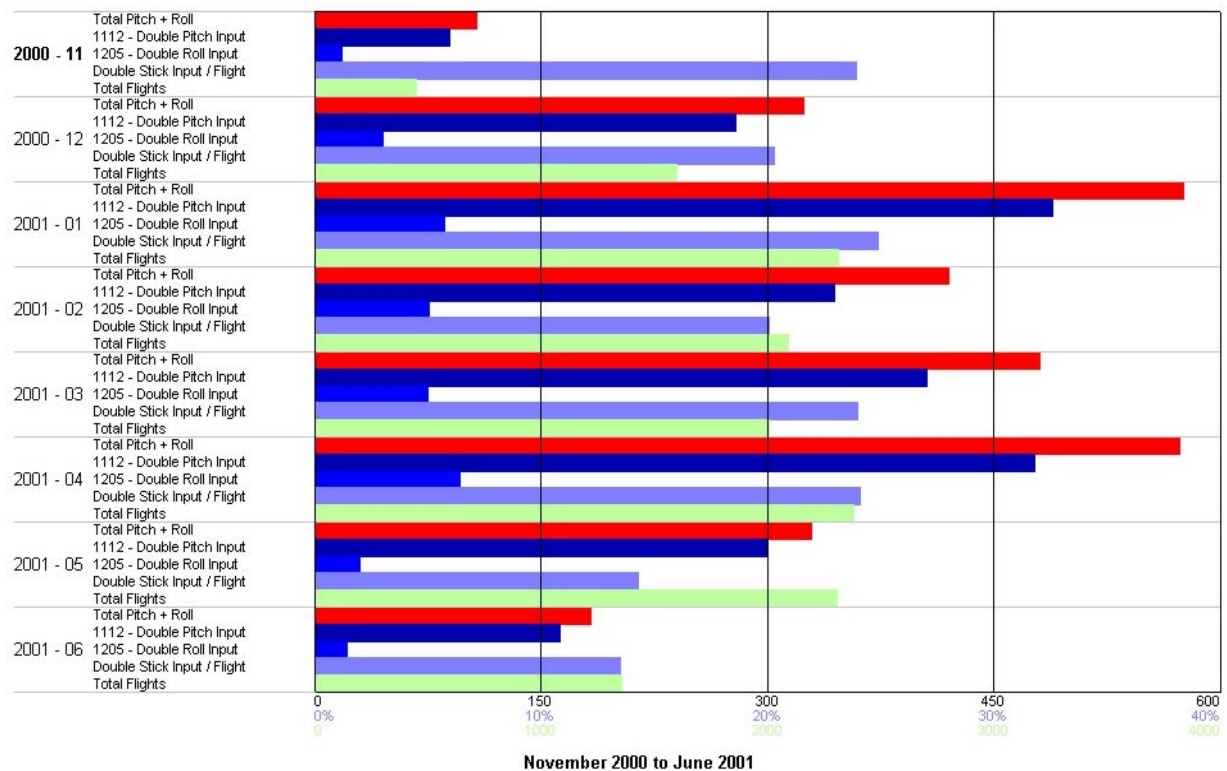
AIRFASE –**AIRBUS/TELEDYNE FLIGHT DATA MONITORING PROGRAM****TYPICAL GRAPHS AND STATISTICS****A320 High Deviation Event Trend****Monthly distribution over a period of 3 months****A320 - Overall Events per Airport Arrival**

Number of arrivals for the selected airport: 2

	TOTAL	LOW	MEDIUM	Ratio per
Speed	3	2	1	1.500
Vertical rates	2	2	0	1.000
Pitch	2	1	1	1.000
Configuration	1	0	1	0.500



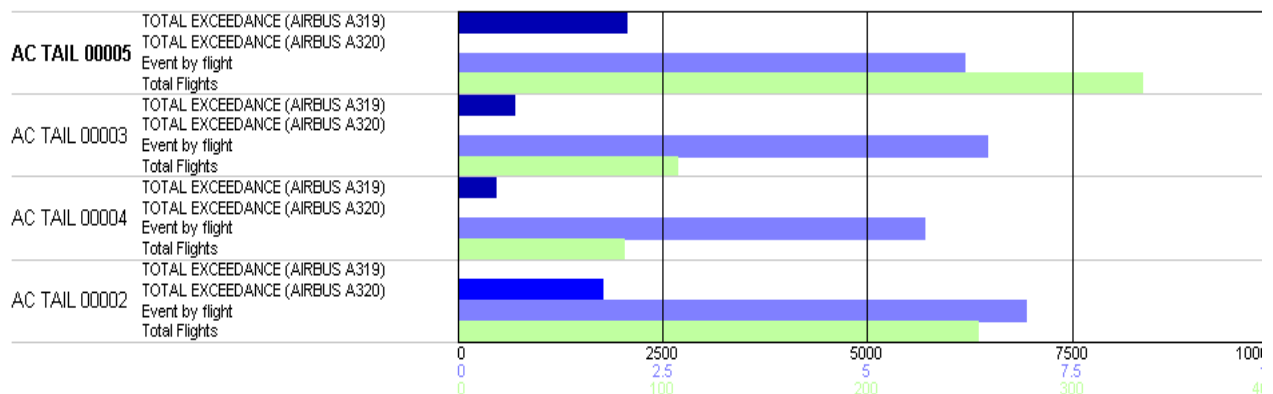
A320 - Double Stick Input over 8 Months of Revenue Service



A320 Exceedances by Tail Number



5 - Event ratio by aircraft tail



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APPENDIX 8

Flight Operations Monitoring GLOSSARY

Some of the following abbreviations and definitions, have been extracted from the results of the FAA Flight Operations Monitoring sponsored project (DEMOPROJ), and various on-going Flight Operations Monitoring assistance projects provided by AIRBUS and its partners.

Acronym	Full Title or Meaning
ACARS	Aircraft Communications Addressing and Reporting System. ACARS is a VHF air/ground data link that uses nearly 600 VHF frequency locations throughout North and Central America, Hawaii, the Caribbean, and several U.S. territories. It relays Aircraft Operational Control (AOC), Airline Administrative Control (AAC), and Air Traffic Control (ATC) messages between ground-based organizations and the cockpit.
ACMS	Aircraft Conditioning Monitoring System. An airborne unit that can create reports such as long-term trend data and aircraft/engine monitoring. ACMS is mainly used for maintenance applications.
Aggregate Data	Detailed data grouped according to some criterion and combined using mathematical or statistical methods (e.g., sum, count, average, standard deviation).
AIRS	Aircrew Incident Reporting System
ASR	Air Safety Report
Air Carrier	An organization that undertakes -- either directly by lease or some other arrangement -- to engage in air transportation.
AQP	Advanced Qualification Program. An alternate qualification program for personnel operating under Parts 121 and 135 of the Federal Aviation Regulations and training centers certificated under Part 142 that provide training for such operators. AQP differs from traditional programs by integrating numerous training features and factors aimed at improving airman performance. The principal factor is true proficiency-based qualification and training. This proficiency base (expressed as performance objectives) is systematically developed, maintained, and validated.
ARINC	Aeronautical Radio Incorporated. The ARINC organization is the technical, publishing and administrative support arm of the Airlines Electronic Engineering Committee (AEEC) groups. AEEC standards define avionics form, fit, function, and interfaces.
ATC	Air Traffic Control. A service operated by appropriate authority to promote the safe, orderly and expeditious flow of air traffic.
Auditor	An auditor is a person trained to perform a quality audit.
CRM	Crew Resource Management
Corrective Action	Corrective action is a measure taken to rectify any condition that has an adverse effect on quality.
Critical Event	A critical event is a finding jeopardizing the operator flight safety and which requires the operation or process to cease until it is rectified.
DAR	Digital ACMS Recorder. See ACMS.
De-identified Data	Data from which any identifying information that could be used to associate it with a particular flight, date, or flight crew has been removed.
Deviation	A deviation is an event triggered by a FOQA System. It is considered as a departure from training and / or operating standards. An exceedance defines a "work error" in aircraft handling by the operating crew.
DFDAU	Digital Flight Data Acquisition Unit Acquires aircraft data via a digital data bus and analogue inputs, and formats that information for output to the flight data recorder in accordance with requirements of regulatory agencies. In addition to the mandatory function, many DFDAUs have a second processor and memory module that enables it to perform a limited amount of ACMS functions/reports. The DFDAU can provide data and pre defined reports to the cockpit printer, or display for the flight crew, or directly to ACARS for transmittal to the ground, or to a QR for recording/storage of raw flight data.

Acronym	Full Title or Meaning
DFDMU	Digital Flight Data Management Unit A unit performing same data conversion functions as the DFDAU with the added capability to process data onboard the aircraft. Some DFDMUs have ground data link and ground collision avoidance systems incorporated into the unit.
DFDR	Digital Flight Data recorder Records pertinent parameters and technical information about a flight. At a minimum, it records those parameters required by the governing regulatory agency, but may record a much higher number of parameters. A DFDR is designed to withstand the forces of a crash so that its information may be used to reconstruct the circumstances leading up the accident.
DMU	Data Management Unit The DMU is a powerful data processor designed to perform airframe/engine end flight performance monitoring and analysis.
Event	Events represent occurrences in which pre-determined limits of aircraft parameters have been exceeded. Events may be categorized at different levels based on the degree to which those limits were exceeded. Events may be limited by the available parameters on a given aircraft. Events are normally tracked for use in FOQA analysis.
FAA	US Federal Aviation Authority
FDAU	Flight Data Acquisition Unit: See DFDAU
FDM	Flight Data Monitoring System capable of recording aircraft parameters, converting and processing the data in crew performance monitoring software that detects safety related events.
FDM Program	Flight Data Monitoring Program
FDR	Flight Data Recorder Required recording equipment designed for post-crash analysis. See DFDR.
FMT	FOQA Monitoring Team A group comprised of representatives from the pilots association and the carrier. This group, sometimes referred to as the Exceedance Guidance Team (EGT) or Event Monitoring Team (EMT), is responsible for reviewing and analyzing flight and event data and determining and monitoring corrective actions.
FOQA	FAA Flight Operational Quality Assurance program Similar to FDM/Flight Data Monitoring in Europe.
FPD Symbol	Flight Path Director. AP/FD display usually associated with FPV to display the FMGS orders.
FPV	Flight Path Vector
Flight Operations Management	Flight Operations Management Department which is responsible for the airline's Standard Operating Procedures, and which can implement changes considered suitable as a result of the information supplied by the Flight Operations Monitoring Team.
Flight Operations Monitoring Team	Also known as Flight Data Review Committee. Team of engineers and flight operations experts who analyse the FOM data to produce appropriate reports for airline management.
Flight Safety Review Board	Used in some airlines: Group of pilots & analysts responsible for the FDM actions. Also called "Review committee" or "FDM Review Board".
FOM	Flight Operations Monitoring.....(Program or System)
Gatekeeper	The gatekeeper is the FOQA team member who is primarily responsible for the security of identified data. The gatekeeper is the only individual that can link FOQA data to an individual flight or crewmember. The gatekeeper is normally a member of the pilot association.
GDL	Ground Data Link. See WDL.
HFR	Human Factors Report

Acronym	Full Title or Meaning
HAT	Height Above Threshold
I&O Plan FAA FOQA sponsored project (DEMOPROJ)	Implementation and Operations Plan. A detailed specification of key aspects of a FOQA program to be implemented by an air carrier including a description of the operator's plan for collecting and analyzing the data, procedures for taking corrective action that analysis of the data indicates is necessary in the interest of safety, procedures for providing the FAA access at the carrier's offices to de-identified aggregate FOQA information, and procedures for informing the FAA as to any corrective action being undertaken.
IATA	International Airline Transport Association
IFTB	In Flight Turn Back
Internal Audit	An internal audit is a quality assurance audit carried out by the Operator to evaluate its own performance.
LAN	Local Area Network. A communications network that serves users within a confined geographical area typically linked together by cable.
LFL	Logical Frame Layout. An LFL, or data map, describes the format that is used to transcribe data to a recording device. This document details where each bit of data is stored. The LFL became standardized for all Boeing airplanes manufactured after 1991.
LOAS	Line Operations Assessment System Airbus system for recording, storing and analysing In Flight Observer Reports
AIRFASE	Airbus/Teledyne Flight Data Monitoring software package (FOQA)
LOSA ©	Line Operational Safety Audit © Copyright: The University of Texas at Austin 2001 In flight audit system on crew behaviour developed by The University of Texas
MCTM	Maximum Certificated Takeoff Mass
MSN	Manufacturer Serial Number
Major Event	A major event is a Finding that involves serious non-compliance or non-conformance, but does not affect safety.
Mapping	See LFL.
Minor Event	A minor event is a Finding that involves low to medium non-compliance or non-conformance.
NAA	National Airworthiness Authority, eg Chinese CAAC, French DGAC, UK CAA, US FAA
NATP	Non Adherence To Procedure
Non-compliance	Non-compliance is when a specific regulatory requirement has not been fulfilled.
Non-conformance	A non-conformance is when a specific Company requirement or standards has not been fulfilled.
OAT	Outside Air Temperature
OEB	Operation Engineering Bulletin
OQAR	Optical Quick Access Recorder. See QAR.
Parameters	Measured sensory data.
PCMCIA/PC card	Personal Computer Memory Card International Association. The industry group organized in 1989 to promote standards for credit card-size memory or input/output (I/O) devices for notebook or laptop computers. PCMCIA cards are used for data storage and transfer on some QARs. Also now simply referred to as PC cards.

Acronym	Full Title or Meaning
QAR	Quick Access Recorder. A recording unit onboard the aircraft that stores flight-recorded data. These units are designed to provide quick and easy access to a removable medium, such as an optical disk or PCMCIA card, on which flight information is recorded. QARs have now been developed to record an expanded data-frame, sometimes supporting 2000+ parameters at much higher sample rates than the FDR. The expanded data-frame greatly increases the resolution and accuracy of the ground analysis programs.
RTO	Rejected Take Off
RA TCAS	Resolution Advisory Traffic Collision Avoidance System
Review Committee	See Flight Safety Review Board.
STEADES	Safety Trend Evaluation Analysis and Data Exchange System – FDM sharing program of IATA
SSFDR	Solid State DFDR. A DFDR that utilizes solid-state memory for recording flight data.
Severity Index	Index to indicate the Severity of an event or combination of events
Special Event	Event detected by FDM system considered worthy of detailed/special investigation
TA TCAS	Traffic Advisory Traffic Collision Avoidance System
TOL	Time Over Limit
WAN	Wide Area Network. A communications network in which computers are connected to each other over a long distance, using telephone lines and satellite communications.
WDL	Wireless Data Link. A system allowing the high-speed transfer of on-board aircraft data to ground facilities using various wireless technologies. It may also allow for upload of data to the aircraft. Sometimes referred to as Ground Data Link (GDL).

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APPENDIX 9

Potential Risk EVENTS

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In AIRFASE, three categories of events are defined:

Standard Events

A standard event is one that is detected when its related parameter deviates beyond a specified limit for a minimum period of time.

Specific Events

When a parameter deviates beyond the limit for a period considered to be excessive for aircraft safety, instead of detecting numerous identical events, AIRFASE detects a synthetic event called “steady behaviour”.

Logical Combination of Events: Risk Assessment

Since a Risk Situation is the result of the combination of several events, when Standard or Specific events are detected simultaneously, then AIRFASE detects a higher level of risk:

Inputs: Standard or Specific Events

Output: Potential Risk Situations

No	ID	Level *	Description
1	100	1	Rejected and degraded flights
2	1001	1	Early rotation
3	1002	1	Late rotation
4	1003	1	Climb out speed low between 50 and 400ft AFE
5	1004	1	Climb out speed low between 400 and 1000ft AFE
6	1005	1	Exceedence speed at low altitude
7	1006	1	Speed exceedence Vmo
8	1007	1	Speed exceedence Mmo
9	1008	1	Gear retraction VLO
10	1009	1	Gear down speed exceedence (VLE)
11	1010	1	Approach speed high at 1000ft AFE
12	1011	1	Approach speed low at 1000ft AFE
13	1012	1	Approach speed high at 500ft AFE
14	1013	1	Approach speed low at 500ft AFE
15	1014	1	Approach speed high at 50ft AFE
16	1015	1	Approach speed low at 50ft AFE
17	1016	1	Gear extension above VLO
18	1017	1	Exceedance of flaps/slats limit speed after take off
19	1018	1	Exceedance of flaps/slats limit speed in approach
20	1022	1	High speed at landing
21	1023	1	Low speed at landing
22	1024	1	Tire limit speed high
23	1025	1	Airspeed overshoot in turbulences
24	1027	1	Rejected take off
25	1028	1	Speed low
26	1029	1	Delayed braking at landing
27	1030	1	Taxi speed exceedance straight
28	1031	1	Taxi speed exceedance in turn
29	1032	1	Climb speed high
30	1033	1	Significant tail wind at landing
31	1034	1	Questionable VAPP in short final
32	1035	1	Questionable braking at landing
33	1051	1	U-turn detection after landing
34	1052	1	High speed exit detection
35	1100	1	Pitch high at lift off
36	1101	1	High pitch rate at take off
37	1102	1	Low pitch rate at take off
38	1103	1	Pitch high initial climb below 400ft AFE
39	1104	1	Pitch low initial climb below 400ft AFE
40	1108	1	Pitch high at touchdown
41	1109	1	Pitch low at touchdown
42	1111	1	High pitch rate at landing

No	ID	Level *	Description
43	1200	1	Excessive bank angle in final approach below 100ft AFE
44	1201	1	Excessive bank angle in final approach between 100 and 400ft AFE
45	1202	1	Excessive bank angle on approach between 400 and 1000ft AFE
46	1203	1	Excessive bank angle above 1000ft AFE
47	1204	1	Roll cycling in final approach
48	1206	1	Excessive bank angle in climb below 100ft AFE
49	1207	1	Excessive bank angle in climb between 100 and 400ft AFE
50	1208	1	Excessive bank angle in climb between 400 and 1000ft AFE
51	1209	1	Roll cycling at take off
52	1210	1	Significant roll during flare below 5ft RA
53	1211	1	Roll excursions below 100ft AFE
-	1306	1	<i>Reserved for Further Use</i>
-	1307	1	<i>Reserved for Further Use</i>
-	1308	1	<i>Reserved for Further Use</i>
-	1309	1	<i>Reserved for Further Use</i>
-	1310	1	<i>Reserved for Further Use</i>
54	1311	1	Level off below 1400ft AFE, no G/S FMA
55	1312	1	Path High at 1200ft AFE
56	1313	1	Path Low at 1200ft AFE
57	1314	1	Path High at 800ft AFE
58	1315	1	Path Low at 800ft AFE
59	1316	1	Path High at 400ft AFE
60	1317	1	Path Low at 400ft AFE
61	1400	1	Descent slope steep from TOD to FL100
62	1401	1	High rate of descent in approach above 2000ft AFE
63	1402	1	High rate of descent in approach between 2000 and 1000ft AFE
64	1403	1	High rate of descent in approach between 1000 and 500ft AFE
65	1404	1	High rate of descent in approach between 500 and 50ft AFE
66	1405	1	High rate of descent below 50ft AFE
67	1406	1	Descent rate steep from FL100 to FL30
68	1407	1	Low rate of climb after take off
69	1500	1	High acceleration during rotation
70	1501	1	High acceleration in flight
71	1504	1	High acceleration at touch down
72	1600	1	Early flaps/slats retraction after take off
73	1601	1	Late landing flap setting
74	1602	1	Landing with incorrect flap setting
75	1605	1	Abnormal configuration at go-around
76	1606	1	Use of speedbrakes during final approach
77	1607	1	AP off in cruise
78	1609	1	Late landing gear retraction

No	ID	Level *	Description
79	1611	1	Late reverser use
-	1612	1	<i>Reserved for Further Use</i>
80	1613	1	Airbrakes out with Thrust on
81	1616	1	Late armed Speed-Brakes
82	1617	1	Early Gear retraction
83	1618	1	Rudder position in symmetrical flight above 200ft AFE
84	1619	1	Reversers abusive use
85	1701	1	Low power on short final
86	1702	1	Excessive EGT at take-off or GA
87	1703	1	Late thrust reduction at landing
88	1705	1	Thrust asymmetry in Approach
89	1706	1	Thrust asymmetry in Reverse
90	1708	1	Thrust high on ground during taxi
91	1709	1	Early power set up at line up
92	1800	1	Heading deviation at take-off from 100 kts to lift off
93	1801	1	Deviation below glideslope above 1000 feet
94	1802	1	Deviation above glideslope above 1000 feet
95	1803	1	Deviation from localizer above 1000 feet
96	1804	1	Deviation below glideslope below 1000 feet
97	1805	1	Deviation above glideslope below 1000 feet
98	1806	1	Deviation from localizer below 1000 feet
99	1807	1	Heading deviation at landing above 60 kts
100	1808	1	Long flare
101	1812	1	Height low at THR
102	1813	1	Height high at THR
103	1814	1	Significant heading change below 500ft AFE
104	1815	1	Heading excursion during landing roll
-	1816	1	<i>Reserved for Further Use</i>
105	1817	1	Short touchdown
106	1818	1	Long touchdown
107	1901	1	Exceedance of flap altitude limit
108	1902	1	Maximum operating altitude exceedance
109	1903	1	Windshear warning below 1500ft AFE
110	1904	1	Go around
-	1905	1	<i>Reserved for Further Use</i>
111	1906	1	Bounced landing
112	1907	1	Touch and go
113	1909	1	Alpha floor
114	1910	1	Alternate law
115	1911	1	Direct law
116	1914	1	Overweight landing

No	ID	Level *	Description
117	1915	1	Sustained double stick input from FO
118	1916	1	Sustained double stick input from CAPT
119	1918	1	TCAS RA warning
120	1920	1	GPWS warning above 1000ft AFE
121	1921	1	GPWS warning between 500 and 1000ft AFE
122	1922	1	GPWS warning below 500ft AFE
123	1924	1	Landing gear not locked down below 1000ft AFE
124	1930	1	Stall warning
125	1931	1	Low Fuel at Landing
126	1932	1	Engine shutdown in flight
127	1933	1	Smoke Warning
128	1934	1	Takeoff Warning
-	1935	1	<i>Reserved for Further Use</i>
129	1936	1	Long Holding
130	1937	1	Engine Fire
131	1938	1	Lavatory smoke
132	2000	2	Continuously Low during final
133	2001	2	Continuously Slow during final
134	2002	2	Continuously High during final
135	2003	2	Continuously Fast during final
136	2004	2	Continuously Steep during final
-	2007	2	<i>Reserved for Further Use</i>
-	2008	2	<i>Reserved for Further Use</i>
137	2009	2	Late Offset in Short Final
138	2012	2	Roll Oscillations prior to Flare
139	2020	2	Over Rotation at Take Off
140	2021	2	Under Rotation at Take Off
141	2022	2	Poor Bracketing on Final
142	2200	2	Low Energy Situation in Approach
143	2201	2	High Energy Situation in Approach
-	2202	2	<i>Reserved for Further Use</i>
-	2203	2	<i>Reserved for Further Use</i>
-	2204	2	<i>Reserved for Further Use</i>
-	2205	2	<i>Reserved for Further Use</i>
144	2206	2	Wing Strike Risk at Landing
-	2207	2	<i>Reserved for Further Use</i>
145	2210	2	Low Energy Take Off
146	2211	2	High Energy Take Off
-	2212	2	<i>Reserved for Further Use</i>
147	2214	2	Tail Strike Risk at Take Off

* Level 1 are single events, Level 2 are combined events.