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GUIDANCE MATERIAL ON DEVELOPMENT OF FLIGHT DATA ANALYSIS PROGRAMMES (FDAP)

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These guidelines are developed by RASG-EUR, as part of IE-REST/IE-FDG/01 deliverables to the enhancement of air operators' Flight data analysis (FDA) programmes, based on the work performed by the IE-REST Flight Data Analysis and Air Operator Safety Management System Group (IE-FDG) in collaboration with the ICAO EUR/NET Regional Office and the European Regional Aviation Safety Group (RASG-EUR).

Air Operator from Kazakhstan (Air Astana) agreed to champion the effort and developed its Flight Data Analysis Programme (FDAP) as a sample that can be utilized by other Air Operators in the region. This FDAP was approved by Civil Aviation Authority of Kazakhstan and was reviewed by expert of RASG-EUR.

Disclaimer

This document is intended to provide guidance for civil aviation regulators and aircraft operators, as well as other interested aviation stakeholders regarding development of Flight Data Analysis Programme (FDAP) and its relevant implementation aspects.

This document has been compiled by members of aviation industry to enhance implementation of relevant ICAO provisions. It is not intended to supersede or replace existing materials produced by the Civil Aviation Authorities (CAA) or in ICAO SARPs. The distribution or publication of this document does not prejudice the CAA's ability to enforce existing National regulations. To the extent of any inconsistency between this document and the National/International regulations, standards, recommendations or advisory publications, the content of the National/International regulations, standards, recommendations and advisory publications shall prevail.

1. Background

1.1 Flight Data Analysis Programme (FDAP) may be described as a non-punitive programme for routine collection and analysis of flight data to develop objective and predictive information for advancing safety, e.g. through improvements in flight crew performance, training effectiveness, operational procedures, maintenance and engineering, and air traffic control (ATC) procedures.

1.2 To capitalize on these benefits, a number of operators set up systems to routinely analyse recorded flight data. The aviation industry is increasingly analysing recorded data from normal operations in support of organizations' safety management systems (SMS). Flight data analysis (FDA) has provided management with another tool for proactively identifying safety hazards, and controlling and mitigating the associated risks.

2. Discussion

2.1 Recognizing the important safety value of such programmes, ICAO adopted their use and published Standards and Recommended Practices (SARPs) in Annex 6, Parts I and III, outlining the requirements for establishing and maintaining a flight data analysis programme (FDAP).

2.2 FDAPs are increasingly being used for the monitoring and analysis of flight operations and engineering performance. They are a mandatory type of safety data collection and processing system (SDCPS) of the SMS for operators of aeroplanes of a maximum certificated take-off mass in excess of 27 000 kg, and an advisable component for those that are below that mass threshold. Successful FDAPs encourage adherence to standard operating procedures (SOPs), and determine non-standard behaviour, thereby improving safety performance. They can detect adverse trends in any part of the flight regime and thus facilitate the investigation of events, including those which have had serious consequences.

3. Recommended Action

3.1 RASG-EUR encourages the States and aviation stakeholders to examine the attached Air Astana' Flight Data Analysis Programme (FDAP) as a good industry practices for compliance with relevant ICAO SARPs in order to facilitate developments and approval of FDAPs for national air operators.

JSC Air Astana

FLIGHT DATA ANALYSIS PROGRAMME

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CONTENTS

Chapter 1 Abbreviations and definitions

ACARS	Aircraft Communications Addressing and Reporting System
ACAS	Airborne Collision Avoidance System
ADRS	Aircraft Data Recording System
AOG	Aircraft on Ground
APASP	Accident Prevention and Aviation Safety Programme
APM	Aircraft Performance Monitoring
ASR	Air Safety Report
ASRB	Aviation Safety Review Board
ATC	Air Traffic Control
BAFDA	British Airways Flight Data Analysis
CEO	Chief Executive Officer
CSC	Corporate Safety Compliance Department
Doc	Document
FDA	Flight Data Analysis
FDAP	Flight Data Analysis Programme
FDE	Flight Data Events module
FDH	Flight Data Home module
FDP	Flight Data People (system provider)
FDR	Flight Data Recorder
FDT	Flight Data Traces
FM	Fleet Manager
DFDR	Digital Flight Data Recorder
EHM	Engine Health Monitoring
E&M	Engineering and Maintenance department
ETS	Emissions Trading Scheme
GPWS	Ground Proximity Warning System
ICAO	International Civil Aviation Organization
IQSMS	Integrated Quality Safety Management System
LOSA	Line Operations Safety Audit
MFD	Manager Flight Data
MFDR	Monthly Flight Data Report
MFDRC	Monthly Flight Data Review Committee
MOR	Mandatory Occurrence Reporting
QAR	Quick Access Recorder
RoK CAC	Republic of Kazakhstan Civil Aviation Committee
SAG	Safety Action Group
SDCPS	Safety Data Collection and Processing System
SF	Severity Factor
SO	Safety Officer
SOP	Standard Operating Procedures
SMS	Safety Management System
SMSCFO	Senior Manager Safety Compliance Flight Operations
SPI	Safety Performance Indicator
SPSFO	Safety Performance Specialist Flight Operations
SRC	Safety Reports Coordinator
SVPCSC	Senior Vice President Corporate Safety Compliance

SVPFO	Senior Vice President Flight Operations
WQAR	Wireless Quick Access Recorder.

Flight Data Analysis (FDA) is the systematic, pro-active and non-punitive use of digital flight data from routine operations to improve aviation safety.

Statistics- a series of data collected to support analysis process.

Chapter 2 Flight Data Analysis Objectives

1. INTRODUCTION

1.1 Air Astana established and currently maintains the Flight Data Analysis Programme (FDAP) in accordance with ICAO Annex 6, Part 1, and ICAO Doc 10000 requirements for an operators of an airplane of a maximum certificated take-off mass in excess of 27 000kg. The Kazakhstan Civil Aviation Committee order #179 from 15.05.2015 requires Operator to collect, replay and analyze flight data on a regular basis.

1.2 In accordance with ICAO Annex 6, Part I, paragraph 6.3.1.2.3. all Air Astana airplanes of a maximum certificated take-off mass of over 27 000kg for which individual airworthiness certificate first issued on or after 1 January 1989 are equipped with a Type I FDR. Kazakhstan Civil Aviation Committee order #419 dated 13.07.2011 requires Operator to equip all airplanes of a maximum certificated take-off mass of over 5700kg with FDR.

1.3 This Programme was developed with the aim to provide policy, process and procedure for the introduction and maintenance of the FDA within Air Astana as well as outline principles on how the FDA is to be embodied within the Safety Management System.

1.4 Air Astana's intention is to use FDA as a proactive and non-punitive system to improve aviation safety.

1.5 Flight Data Analysis provides a systematic tool for proactive hazard identification and also is used as a complement to a hazard and incident reporting and to a Line Operations Safety Audit (LOSA).

1.6 The integrity of Air Astana's FDA system rests upon protection of the FDA data. Any disclosure for purposes other than safety management can compromise the voluntary provision of safety data, thereby comprising flight safety.

1.7 The FDA aims at continuous improvement of the overall safety performance and integration in the safety assurance component of the Air Astana SMS. The FDA program helps to identify, quantify, assess and address operational risks through the analysis of detailed trend information. It also gives the scope to define normalized operations as well as promote actions to correct potential problems.

1.8 The FDA is targeted to improve not only safety, but also to improve operational efficiency and economy, to support a wide range of airworthiness. Data gathered in this programmme can:

- Identify unsafe trends;
- Identify hazards in operating procedures;
- Monitor the effectiveness of already implemented safety measures;
- Optimize the flight training of crew;
- Improve flight crew performance, engineering and maintenance procedures;
- Be used as a feedback for Air Traffic Control (ATC) procedures.

1.9 The data collected in the FDA system is used solely for incident/accident analysis/investigation and as a parameter for risk evaluation as part of the Safety Management System.

1.10 The ICAO Accident Prevention Manual (Doc 9422) outlines good practices and indicates what may constitute this programme to be acceptable to Kazakhstan CAC. It is intended to be regularly reviewed and revised by Air Astana in consultation with Industry as more widespread FDA experience develops.

2. OBJECTIVES

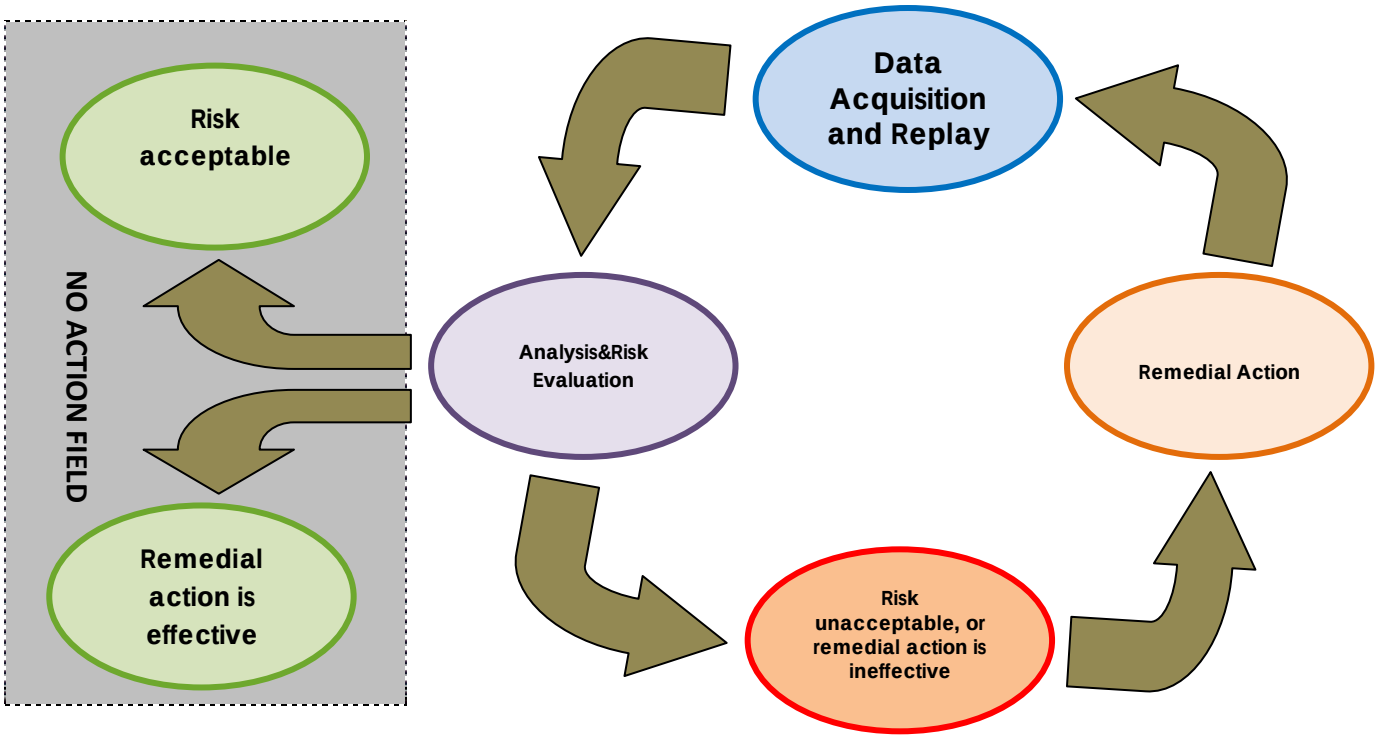
2.1 **Determine operating norms.** Determination of the operating norms is a continuous and recurrent process targeted to establish Safety Performance Indicators (SPI's) controlled by means of the FDA system. SPI's target levels should be based on average safe performance data gathered during a minimum of one year operations of the fleet. One year of historical data should be downloaded in to the FDA system at the beginning of the FDA system set up for getting comprehensive data base that enables to make calculations of SPI's target and alert risk levels in accordance with the provisions ICAO Doc 9859.

2.2 **Identify potential and actual hazards in operating procedures, fleets, aerodromes, ATC procedures, etc. by highlighting occurrences of non-standard, unusual, or unsafe circumstances.** Initially the FDA system will be used as a part of Air Astana Safety Management System to identify deviations from Standard Operating Procedures (SOP's) identify areas of hazard and to measure current safety margins. This will help to establish a baseline operational measure against which to detect and measure any change.

2.3 **Estimate safety risk of single and combined trends categorized by frequency and potential severity and act on unacceptable trend performance if it continues unabated.** Any increases in above rates, new events, new locations etc. identified by the system should be analyzed and evaluated for possible mitigating action or the issuance of recommendations.

2.4 **Set in place procedures to prevent trends from becoming unacceptable and monitor the effectiveness of mitigating action.** Once an unacceptable risk, either actually present or predicted by trending, has been identified, then appropriate risk mitigation techniques shall be used to put in place remedial actions. This should be accomplished while bearing in mind that the risk must not be transferred elsewhere in the system.

Risk mitigation diagram



2.5 **Optimize training procedures.** Recommendation or remedial action with optimization of training procedure should be considered after any unusual trend is identified for a fleet or particular crew member. Unusual trend tendency can usually be revealed during the following 2-3 months of operations, however, if new measures are introduced in to the system, then any unusual trend may only be identified only after having normal operational data. Remedial actions for a particular crew member should be considered only when the risk or trend becomes unacceptable, only then should an identification procedure be done.

2.6 **Compare flight data of the relevant flight with the fleet profile data during incident analysis, thereby facilitating analysis of the systemic aspects of an incident.** Such comparison techniques can most often be used when an incident happened while trending was acceptable. In this case, if the analyzed fleet profile data had been treated incorrectly, then additional FDA measures should be put in place for the identification of any unacceptable trending.

2.7 **Utilize FDAP data for the Engine Health Monitoring (EHM) programmes to produce reliable trend analysis, as manually coded engine data is limited in terms of accuracy, timeliness and reliability.** Engine limit exceedence events within FDA system are good tools for monitoring critical parameters. Once engine parameter exceedence or unusual trending is identified, the FDA team shall notify the engine health monitoring staff for further analysis and/or any further actions if required.

2.8 **Provide actual, rather than presumed performance measurement, for risk management purposes.** Data integrity can be achieved by introducing appropriate events within the FDA system for monitoring of performance indicators and by reaching 80% of data recovery rate or more. Based on the above conditions, the system will allow the gathering of reliable performance data for risk management purposes.

2.9 **Provide data to conduct cost-benefit analyses. A secondary function of the FDA system is data collection for fuel consumption and Aircraft Performance Monitoring (APM).** Fuel data and APM reports are pulled from the system on a monthly basis for each aircraft. The fuel report satisfies with the Emissions Trading Scheme (ETS) aviation software format. The APM report helps to determine the actual performance level of each airplane within the fleet with respect to the level in the manufacturer's handbook, but the fuel report allows Air Astana to perform various statistics regarding fuel consumption. As such, the fuel report is a good aid in defining the fuel policy.

2.10 **Keep false events to less than 0.1%.** Often, false events are the consequences of flight data corruption by the FDR equipment and flight data transfer media. False events can also be produced by the system through data replay when the trigger value or derived parameter for the particular event had been obtained inconsistently. A large number of false events requires significant additional time to deal with, hence increasing workload for the FDA team. Therefore, fixing FDR equipment and/or correction trigger logic expressions can help to decrease false events to below required level.

2.11 **Collection rate of downloaded data to exceed 90% of all flights on WQAR equipped aircraft and 80% on other aircraft.** The more data that is downloaded and processed, the more reliable the trending information will be, and the more accurate the analysis will be. Air Astana to set up the target levels for downloaded data after the consideration of facilities available for data transfer, collection, and processing as well as the reliability and integrity of FDA system outcomes have been made.

Chapter 3 FDA Description

1. ACCOUNTABILITY

The Senior Vice-President Corporate Safety Compliance (SVPCSC), as a custodian of the Accident Prevention and Aviation Safety Programme (APASP) including Flight data analysis, is accountable for effectively managing an FDA programme which includes identifying unsafe trends or events and transmitting them to the Senior Vice-President Flight Operations (SVPFO). The responsibility for managing the FDA system is delegated by the SVPCSC to the Manager Flight Data. The MFD reports to the SVPCSC, and is the person responsible for informing the Senior Vice-President Corporate Safety Compliance and Senior Manager Safety Compliance Flight Operations (SMSCFO) of any issues discovered through the FDA system. The SMSCFO has the broader responsibility to develop, administer, and maintain an effective SMS.

The SVPFO is accountable for taking action in a reasonable amount of time while taking in to consideration the severity of the event or events. The responsibility for correcting the notified unsafe events or trends is delegated to the Fleet Manager (FM) by the SVPFO. The FM reports to the SVPFO.

The SVPCSC will determine if any exceptional event data is to be identified ("gate-keeper"). The identification is delegated to the Flight Data Manager.

2. FDA EQUIPMENT GENERAL

2.1 Air Astana's FDA system utilizes an aircraft based Digital Flight Data Recording system (DFDR) that captures the flight data. Following this, the British Airways Flight Data Analysis (BAFDA), and as backup, the Aerobytes system transforms the data into an appropriate format for analysis, for generating reports and for visualization to assist in assessing the data. Analyzing flight data helps to identify if deviations from aircraft structural limits or SOP's have occurred. The events that are monitored constitute a dynamic set of data, continuously evolving in order to best adapt to the Air Astana procedures in place and to help in identification and measurement of safety risks. The event detection limits are continuously reviewed and updated to reflect the current operating procedures. The minimum set of data to be monitored by Air Astana's FDAP is listed on page #11, 12 of this Manual and entitled "Core events set".

For effective FDA the following equipment is installed:

- DFDR is an on-board device to capture and record data across a wide range of flight parameters.
- QAR and WQAR are the means to transfer the data recorded on board the aircraft to a ground-based processing server.
- BAFDA is a ground-based computer system (software) designed to analyze the data, identify deviations from expected performance, generate reports to assist in interpreting read-outs and etc. This software also provides flight animation capability to integrate all data, displaying it as a simulation of in-flight conditions, thereby facilitating visualization of actual events for analysis and crew debriefing.

2.2 Airborne Equipment:

- DFDR is a crash-protected recording device installed on board of the aircraft and is designed for recording the flight parameters that are received from Flight Data Acquisition Unit (FDAU). The FDAU also transfers Flight Data to an easily accessible device such as a Quick Access Recorder (QAR) or a Wireless Quick Access Recorder (WQAR).
- QAR or WQAR are optional non-crash protected recorders installed on the aircraft to record flight data in a low cost removable media such as a QAR or WQAR. The WQAR transfers the flight data to a ground based server using wireless means of communications (ex. TELEDYNE).

2.3 Ground-based computer system for flight data analysis:

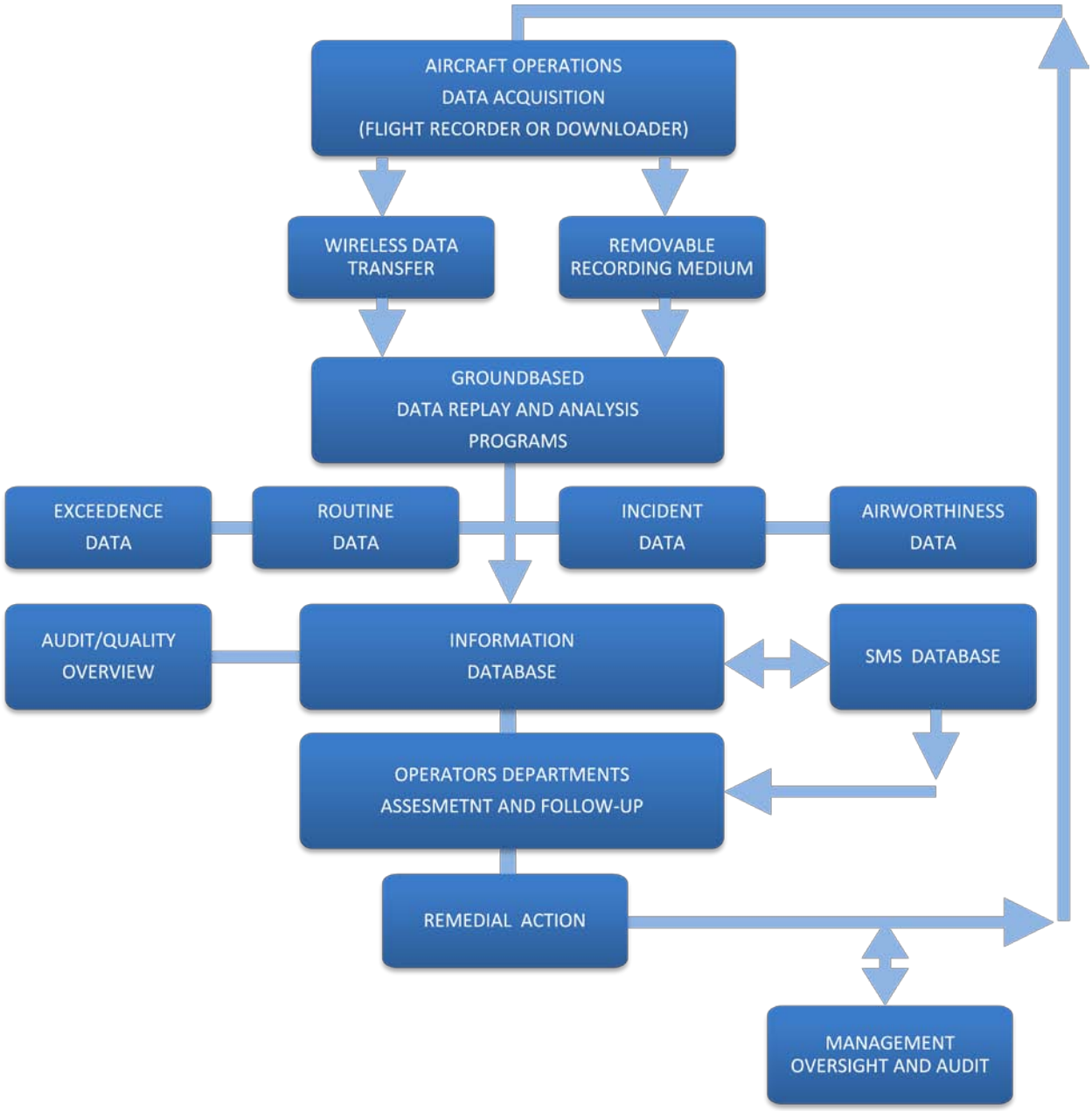
- Flight data is downloaded from the aircraft recording device to a ground-based computer system whereby the Air Astana Flight Data Server then transfers it to a BAFDA server. The data are then processed by analysis software, where it is held securely to protect this sensitive information.

  BAFDA analysis software facilitates the routine analysis of flight data in order to identify situations that may require corrective action and checks the downloaded flight data for abnormalities. The exceedance detection typically includes a large number of trigger logic expressions derived from a variety of sources

such as flight performance curves, SOPs, manufacturers' engine performance data, and airfield layout and approach criteria. Some of the trigger logic expressions are simple exceedences such as redline values or/and Airplane Flight Manual limitations. The set of trigger logic expressions is defined by Air Astana Flight Operations and Corporate Safety Compliance (CSC) departments.

- Exceedences and routine measurements are displayed on a ground computer screen in a variety of formats. Recorded flight data are shown in the form of color-coded traces and associated engineering listings, cockpit simulations and animations of the external view of the aircraft including Google Earth option.

2.4 INFORMATION FLOW



3. ANALYSIS TECHNIQUES

3.1 Exceedence detection, such as deviations from flight manual limits or SOPs, is one way of extracting information from flight data. A set of core events/parameters establishes the main areas of interest to Flight Operations and CSC departments. Exceedance data provides factual information which complement crew and engineering reports. Air Astana has modified the standard set of core events to account for unique parameters, values and established procedures. The event detection limits should be continuously reviewed to reflect Air Astana current standard operating procedures.

3.2 The Air Astana FDA system is configured to monitor a set of core events listed in the table below, but not limited to them, and may include the introduction any additional group of events that can help to gather data supporting SPIs measurement, EHM program etc.

3.1 CORE EVENTS SET

Event Group	Event Code	Description
Flight Manual Speed Limits	01A	Vmo exceedence
	02A	Mmo exceedence
	03A	Flap placard speed exceedence
	03G	Gear down speed exceedence
	03I	Gear up/down selected speed exceedence
Flight Manual Altitude Limits	04	Exceedence of flap/slat altitude
	05	Exceedence of maximum operating altitude
High Approach Speeds	06A	Approach speed high within 90 sec of touchdown
	06B	Approach speed high below 500 ft AAL
	06C	Approach speed high below 50 ft AGL
Low Approach Speed	07A	Approach speed low within 2 minutes of
High Climb-out Speeds	08A	Climb out speed high below 400 ft AAL
	08B	Climb out speed high 400 ft AAL to 1000 ft AAL
Low Climb-out Speeds	08C	Climb out speed low 35 ft AGL to 400 ft AAL
	08D	Climb out speed low 400 ft AAL to 1500 ft AAL
Take-off Pitch	09A	Pitch rate high on take-off
Unstick Speeds	10A	Unstick speed high
	10B	Unstick speed low
Target landing area	19	Long flare
Pitch	20A	Pitch attitude high during take-off
	20B	Abnormal pitch landing (high)
	20C	Abnormal pitch landing (low)
Bank Angles	21A	Excessive bank below 100 ft AGL
	21B	Excessive bank 100 ft AGL to 500 ft AAL
	21C	Excessive bank above 500 ft AGL
	210	Excessive bank near ground (below 20 ft AGL)
Height Loss in Climb-out	22D	Initial climb height loss 20 ft AGL to 400 ft AAL
	22E	Initial climb height loss 400 ft to 1500 ft AAL
Slow Climb-out	22F	Excessive time to 1000 ft AAL after take-off
High Rate of Descent	22G	High rate of descent below 2000 ft AGL
Normal Acceleration	23A	High normal acceleration on ground
	23B	High normal acceleration in flight flaps up/down
	23C	High normal acceleration at landing
	23D	Normal acceleration; hard bounced landing
Low go-around	024	Go-around below 1000 ft AAL
High go-around	24A	Go-around above 1000 ft AAL
RTO	026	High Speed Rejected take-off
Configuration	40C	Abnormal configuration; speed brake with flap

Event Group	Event Code	Description
Low Approach	042	Low on approach
Configuration	43A	Speed brake on approach below 800 ft AAL
	43B	Speed brake not armed below 800 ft AAL (any flap)
Ground Proximity Warning	44A	GPWS operation - hard warning
	44B	GPWS operation - soft warning
	44C	GPWS operation – wind shear warning
Margin to Stall	45A	Reduced lift margin except near ground
	45B	Reduced lift margin at take-off
	46A	Stick shake
Configuration	047	Early configuration change after take-off (flap)
Landing Flap	48A	Late land flap (not in position below 500 ft AAl)
	48B	Reduced flap landing
	48D	Flap load relief system operation
Target landing area	50	Deep landing
Glideslope	56A	Deviation under glideslope
	56B	Deviation above glides lope (below 600 ft AGL)
Buffet Margin	061	Low buffet margin (above 20,000 ft)
Approach Power	75A	Low power on approach

4. ROUTINE MEASUREMENTS

4.1 Data is retained from all flights, not just those producing significant events. A selection of parameters is retained that is sufficient to characterize each flight and allow for a comparative analysis over a wide range of operational variables. Emerging trends and tendencies are monitored before risk value associated with exceedences reach greater than acceptable levels.

4.2 All flight measurement, by the system for defining what normal practice is, may be accomplished by retaining various snapshots of information from each flight.

4.3 Statistics are a series of data collected to support the analysis process. Measuring statistics should be obtained through techniques such as measuring the number of flights flown per aircraft and sector details sufficient to generate rate and trend information.

5. VERIFICATION AND VALIDATION OF DATA

5.1 On occasion events highlighted by the Flight Data Software during the routine analysis, demand more detailed consideration and verification to distinguish between actual from false events. In this case, key parameters of flight are examined in more detail e.g. power of engines, speed, roll, pitch, etc. and the change of these parameters during various flight phases. These parameters can be compared to parameters of other flights which do not demand verification. After a detailed study and comparison of such parameters, and if necessary, with consultations involving pilots and engineers, it may be possible to draw a conclusion on the reliability of the event which is raising doubts.

5.2 Once verification of the data is completed and deviations from normal operation have been determined taking into consideration of environmental conditions, aircraft technical status etc., then the event shall be validated in the system, followed by evaluation by severity, keyword and finally, protection from changes. The FDA system accumulates validated events in the Flight Data Events (FDE) database for producing

histogram, graphs and trend information in a variety of visual options that contribute to a deep and comprehensive analysis.

6. INCIDENT INVESTIGATION

The FDAP provides valuable information for incident investigations and for follow-up of other technical reports. Quantifiable recorded data is useful in adding to the impressions and information recalled by the flight crew. FDAP data also provides an accurate indication of system status and performance, which helps in determining cause and effect relationships.

7. CONTINUING AIRWORTHINESS

Both routine measurements and exceedances are utilized to assist the Air Astana continuing airworthiness function. The Air Astana Engine Health Monitoring programme (EHM) looks at measures of engine performance to determine operating efficiency, predict impending failures and to assist in maintenance scheduling. The EHM utilizes “COMPASS” programme supplied by the engine manufacture for Boeing 757 equipped with Rolls Royce engines as well as Boeing 767 and Airbus 319/20/21 with Pratt & Whitney engines. Embraer data with General Electric engines transferred for processing to the software based at the manufacture site on daily basis. General Electric provides necessary EHM data and notifications to Air Astana E&M department, including data on current engine performance and sings of possible degradation. Also, all structural exceedences shall be reported to the E&M department to ensure continued airworthiness checks are done in a timely manner.

8. INFORMATION DATABASE

All of the information gathered is kept in linked databases that allow cross-referencing of the various types of data. These links include air safety and technical reporting systems to provide a complete view of the operation. Most of the exceedances produce an airworthiness report, flight data event and crew report. The crew report provides the context of the exceedance, FDA event, and a qualitative description, while the airworthiness report gives the results.

9. DATA ANALYSIS AND FOLLOW UP ACTIONS

9.1 Overviews and summaries of FDA data are compiled on a regular basis (monthly), whilst significant individual events would be expected to be followed up on in a more timely manner. All data is reviewed to identify specific exceedances and emerging undesirable trends and to disseminate this information to Flight Operations and Training Department Management. Flight crews are informed about specific exceedances and deviations on a daily basis by phone, email, or by contact person (MFD). Notifications from the Flight Data section to Flight Ops will be by email.

9.2 If deficiencies in the flight technique are recognized, the information is de-identified in order to protect the identity of the flight crew. Information on specific exceedances is passed to a flight crew through the MFD. The MFD maintains the needed contact with the flight crew in order to clarify the circumstances, obtain feedback and/or give advice and recommendations for appropriate action. Such actions and recommendations may include flight crew remedial training, revisions to operating and flight manuals, or changes to ATC and aerodrome operating procedures.

9.3 All events are archived in a database. The database is used to sort, validate and display the data in easy to-understand management reports. Over time, this archived data provides a picture of emerging trends and hazards which would otherwise go unnoticed.

9.4 Lessons learned from the FDAP are used for inclusion in the company’s safety promotion activities. Care is required, however, to ensure that any information acquired through FDA is de-identified before using it in any training or promotional initiative unless permission is given by all the crew members involved. FDM Team care should also be taken that, in order to avoid an exceedance, flight crews do not attempt to “fly the FDM profile” rather than follow SOPs. Such a behaviour could have a negative impact on safety.

9.5 The FDM Team should programme a proper value for triggering an exceedance and design it to include an acceptable buffer that will disregard minor deviations and spurious events. In addition, this value should allow for an adequate operational margin when flying the airplane through SOPs, and not lead the flight crew to focus on FDM parameters in order to avoid deviations.

9.6 As in any closed-loop process, follow-up monitoring is required to assess the effectiveness of any corrective actions taken. Flight crew feedback is also essential for the identification and resolution of safety problems and could, for example, include answers to the following questions:

- Is the implementation and effectiveness of corrective actions taken adequate?
- Are the risks mitigated, or are they unintentionally transferred to another part of the operations?
- Have new problems been introduced into the operation as a result of implementing such corrective action(s)?

9.7 All successes and failures are recorded, comparing planned programme objectives with expected results. This provides a basis for review of a FDAP and for the foundation of future programme development.

10. PROTECTION OF FDA DATA

10.1 Overall approach

Air Astana policy concerning protection of FDA data includes:

- not using data for disciplinary purposes;
- not using data for enforcement actions against individuals or against the company, except in cases of criminal intent or willful misconduct;
- not disclosing information to the media and the general public; and
- not disclosing data during civil litigation.

10.2 Any disclosure for purposes other than safety management can compromise the required cooperation of the affected flight crew in clarifying and documenting an event, thus, preventing the misuse of FDA data is of mutual interest to the Kazakhstan CAC, the Air Astana, and its flight crews.

10.3 Data protection is optimized by:

- strictly limiting data access to selected individuals;
- maintaining tight controls to ensure that any data identifying a specific flight is kept secure;
- ensuring that any operational problems are promptly addressed by management; and
- irreversibly de-identifying of the flight data files after a timeframe appropriate for analysis.

10.4 Air Astana has established two ways in which to accomplish the flight data transfer procedure in order to protect it from becoming accessible to unauthorized personnel:

a) Wireless data transfer protection is secured by 4 different SIM cards installed into a WQAR and are connected only to Air Astana file server by secured channels. SIM card numbers are only available to two personnel, one from IT and the second from the E&M department. The file server raw data files folder is secured by restricting access to its content.
b) Flight Data transfer through removable media involves more personnel than the wireless option. In this case, the engineer who is responsible for downloading the data and passes it to the tool store, tool store, then driver who delivers flash card from E&M to the FDA team in secured box. All personnel involved are responsible for the data's protection.

10.5 Policy on retention of data

Because of the large volumes of data involved, it is important that a strategy for data access, both online and offline, be carefully developed to meet the needs of FDA users.

10.6 The most recent flight data and exceedances are normally kept readily available to allow for fast access during the initial analysis and interpretation stages. When this process is completed, it is unlikely that additional data from the flights will be required, therefore, the flight data can be archived. Exceedances are usually kept available and online for a much longer period to allow trending and comparison with previous events. The MFD has the authority to unarchive old data in case there is a need to make a revision of some past event(s).

10.7 The FDAP shall maintain storage sufficient for:

- Full flight data for not less than 6 months;
- Analysis data for not less than 12 months; and
- Analysis results unlimited.

11. DE-IDENTIFICATION POLICY

Strict rules of access are enforced through the design of the FDA system, allowing restricted access to other staff involved in monitoring and investigative activities. In the case of a mandatory occurrence or accident, any data retained by the programme may not be de-identified or removed from the system prior to the investigation or prior to confirmation that it is not required. This will allow the safety investigators access to all relevant information. Crew identification procedures are described in Chapter 6, paragraph 2 of this Manual.

12. AUTHORIZED ACCESS LEVELS

The FDA ground-based computer system has the ability to restrict access to sensitive data as well as control the ability to edit the data. The MFD has full access however operations management and staff involved in monitoring and investigating activities have limited access to de-identified data and the ability to add comments and edit a few appropriate fields. All staff involved in monitoring and investigating activities are divided in four different groupes by access level:

- The MFD has full access and authority to grant user's access to the system.
- The Flight Data Analyst has full access to the system, but with no authority to enroll system users or grant access level to the system.
- The Senior vice President Corporate Safety Compliance (SVPCSC), CSC Specialist Safety Performance Flight Operations (SSPFO), Senior Manager Safety Compliance Flight Operations (SMSCFO), and Safety Compliance Engineer (SCE) have limited access to look at event traces, listing and Flight Data Simulation (FDS), crew profiles, make attachments, send messages about required actions to other people involved in an investigation, and write action comments. However, crew members cannot be tracked.
- Fleet Managers Flight Operations, Chief-Pilot, Manager Flight Operations and Senior vice President Flight Operations (SVPFO), all use the BAFDA Flight Data Home module (FDH) which contains events under investigation. This data is exported to the FDH module by the MFD after the crew identification procedure is completed. The FDH module supports all options to view event traces, listing parameters, and flight data simulation.

13. TECHNICAL SUPPORT

The FDAP successful functioning within Air Astana is ensured by maintaining continues serviceability of the BAFDA system by means of the provider. Operation of the system is provided by Flight Data People (FDP) who:

1. Are responsibile for the FDA server, including backup, archiving and hardware maintenance. Target availability for service shall be 98% in any 12 months period.
2. Assure a 48 hours server recovery time in the event of a critical system failure.
3. Maintain all software provided and rectificatify all defects within 30 working days of receipt of the report.
4. Provide a secure system environment including firewall, anti-virus and secure backup facility.
5. Monitor system activity & report any critical failure.
6. Provide remote access connectivity for Air Astana staff.
7. Maintain a folder to be used by Air Astana staff for access to backup of flight, event and analysis results data and an "image" of the backup of the Air Astana BAFDA system which can be restored as a replica of the primary server. Air Astana staff can access this folder for the purpose of generating a periodic backup of the BAFDA to the Air Astana site.
8. Establish technical support for critical system functions by telephone or e-mail on 24/7 basis. Critical system functions are defined as:
    - The BAFDA programme fails to load;
    - A BAFDA server failure;
    - A VPN access failure;
    - A website access failure.
9. Establish technical support for non-critical system functions by telephone or e-mail between 9 a.m. and 5 p.m. UK time, Monday to Friday.

Chapter 4 FDA Introduction

1. THE IMPLEMENTATION PLAN

Introduction of the FDA system within Air Astana should start with a review of implementation plan developed by national Kazakhstan Civil Aviation Authority that reflects ICAO requirements on FDM implementation and development. Since Kazakhstan Civil Aviation Committee (CAC) doesn't have so far guidance on FDAP development for operators, then Air Astana utilizes the EU community members experience on this issue for development of such a plan.

The implementation plan shall cover the following items:

1. Confirm Chief Executive Officer (CEO) approval and support for FDA implementation;
2. Identify key team members;
3. Agree aims and objectives;
4. Develop crew agreement (if applicable) and involvement;
5. Conduct feasibility study and develop business plan (people, processes, software and hardware);
6. Obtain funding and organizational approval;
7. Survey key areas in Operation for targets of opportunity;
8. Produce detailed specifications including level of SMS integration and place contract;
9. Put in place operating procedures;
10. Installation of airborne equipment (if required);
11. Provision of ground analysis station;
12. Conduct staff training;
13. Test data acquisition and analysis, complete manuals;
14. Produce completion report.

2. SELECTION PROCESS

After selection of the software provider that meets the Air Astana needs for establishing and maintaining FDAP, SVPCSC together with Human Recourse department should start the selection process for the FDA team members in accordance with minimal requirements defined in paragraph 4 of this chapter. The candidates for MFD and the Flight Data Analyst positions should have good analytical skills and preferably pilot's experience. Other team members can work for separate divisions but cooperate with FDA team when expert skills are required for making special analysis or investigation of the events.

3. SHORT AND LONG TERM GOALS

Staged set of objectives starting from the first weeks of replay, moving through early production reports into regular routing analysis, allows the system to "tick-off" achievements.

3.1 First establish data download procedure, coordinate required scope of works for data download with other departments if necessary, test replay software by comparison with aircraft manufacturer flight data replay outcome, identify aircraft defects.

3.2 The second task is to validate and investigate exceedence data to make sure system trigger logic expressions are correct.

3.3 In the initial stages it is useful to focus on a few known areas of interest, that helps to prove system's effectiveness. This is rather more likely to get success than a "scatter-gun" approach which, if properly constructed, should eventually hit these spots but will probably not get results as quickly.

3.4 For communication purposes to establish the FDA acceptable routing report format (FDA event memo, monthly, quarterly, annual reports), to highlight individual exceedences and statistics. In addition, annual report should include key performance indicators, also other modules can be represented in the report e.g. Continued Airworthiness, RW conditions etc.

3.5 Once one fleet data replay and analysis are established, then next fleet to be added to programme. In order to accumulate quickly required amount of data for defining operating norms, and set up key performance indicators, one year historical data should be loaded into the system. This step also helps to make comparative analysis between current operations and previous year.

3.6 Put network information across the Air Astana information system when FDA becomes mature. Ensure the FDA provision for Evidence Based Training (EBT), Competence Based Training (CBT), Alternative Training and Qualification Program (ATQP), Advanced Qualification Program (AQP) style training if Air Astana has adopted any of listed above options for flight crew training.

3.7 Having set stages objectives of the project, then all successes and failures should be recorded. This forms the basis of a review of the project and the foundation of future work.

4. THE FDA TEAM

4.1 The Air Astana FDM team is built to provide collecting, replay and analysis of flight data in efficient way, which can help the Air Astana to monitor current operations, identify potential operational risks and make suggestions for safety promotion in areas of operation monitored by the FDA system. The Air Astana FDM Team consists of:

4.2 **The Manager Flight Data (MFD)** is a team leader, who earns the trust and full support of both management and flight crews and acts independently of others line management to make recommendations that will be seen by all to have a high level of integrity and impartiality. The individual requires good analytical, presentation and management skills. The MFD is placed under the authority of the SVPCSC. The MFD is a contact person for confidential discussion with flight crews involved in the events highlighted by FDA.

4.3 **The Flight Data Analyst (FDA)** is responsible for the day-to-day running of the system, producing reports and analyses. Methodical, with some knowledge of the general operating environment, Analyst keeps the programme moving.

4.4 **The Safety Performance Specialist Flight Operations** of CSC department (SPSFO) can be made good use by the FDA division as Flight operations interpreter when required. The SPSFO is an experienced pilot in the type and operations who knows the Air Astana route network and aircraft. This person is in-depth knowledge of SOPs, aircraft handling characteristics, airports and routes, will be used to place the FDA data in a credible context.

4.5 **The Safety Compliance Engineer** of CSC department (SCE) can be made good use by the FDA division as Technical interpreter when required. This person interprets the FDA data with respect to the technical aspects of the aircraft operation and is familiar with the power plant, structures and systems, departments' requirements for information and any other engineering monitoring programmes in use by Air Astana.

4.6 **Engineering technical support** is provided by Avionics Technical Services Engineer of E&M department. This person is an avionics specialist, involved in the supervision of FDR serviceability. This team member is knowledgeable about FDA and the associated systems needed to run the programme.

4.7 **The Safety Reports Coordinator** (SRC) is a person who coordinates cross-references FDA information with other safety data sources, such as mandatory and confidential incident reporting programme with SMS, creating a credible and integrated context for all information.

5. TECHNICAL SPECIFICATION

5.1 All Air Astana aircraft are equipped with Type IA and Type I FDR in accordance with Annex 6, Part I requirement for airplanes of maximum certificated take-off mass of over 27 000 kg for which the individual certificate of airworthiness is first issued on or after 1 January 1989. The parameters needed to meet FDR Type IA and Type I requirements are listed in the Annex 6, Part I, Appendix 8. The FDR and Airborne Image Recorder (AIR) performance requirements are contained in the EUROCAE ED-112, Minimum Operational Performance Specifications (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.

5.2 To simplify flight data acquisition and to reduce workload for engineering department, all Air Astana aircraft are fitted with Quick Access Recorders (QAR) or Wireless Quick Access Recorders (WQAR). QAR and WQAR are installed in accordance with aircraft manufacturer specifications and usually in easy accessible compartment. The QAR records number of parameters defined by QAR Logical Frame Layout (LFL) on pre-installed recording media (flash card) which should be replaced with new one during daily check. Maximum size of data that can be recorded depends on memory capacity of flash card. WQAR is a unit with wireless data transfer feature and built-in memory media up to 8GB in size. WQAR equipment is provided by SAGEM and TELEDYNE manufacturer.

5.3 The Air Astana aircraft which are equipped with wireless data transfer, use method of download, which triggers such function after the flight completion. The flight data is transmitted through a SIM card of a mobile phone. WQAR system downloads “packets” of encrypted information via the mobile phone network, reducing the need for expensive airport equipment. Flight data file generates, and starts passing to the ground station as soon as aircraft is on the ground, engines are shut down, and main entry door is open.

5.4 Alternatively, for continued airworthiness Air Astana uses on-board analysis as the trigger mechanism for a post-flight action to download all the data stored for analysis. An on-board system linked to the Air Astana base equipment via Aircraft Communications Addressing and Reporting System (ACARS).

6. ANALYSIS PROGRAM SPECIFICATION

6.1 The FDA software provided by BAFDA has analysis program specification document, which is constructed to satisfy with the following requirements:

- Set down the complete process by which flight data can be turned into useful information
- To provide the system programmer with sufficient detail to code the data conversion and analysis software.

Analysis program specification gives a detailed technical specification of aircraft data systems that involves considerable research to ensure valid data extraction. This document issued as separate part of the contract placed for the supply of a system, but will continue to develop as the system matures and is refined.

6.2 Program describes download and data transfer methodology, serviceability and replay statistics, the analysis modules, exceedence workflow (allocation of responsibility, investigation results, actions taken, ASR data etc.), archiving and historical records.

6.3 BAFDA system is fully documented to assure transparency of the system construction, as well as the reasoning behind the code is clear to users. Changes, updates and fixes will be detailed and implementation dates are recorded.

6.4 At initial stage of the BAFDA system implementation testing data replay and conversion to engineering units are done.

6.5 Next step is testing exceedence detection by realistically manipulating normal data to simulate an event, by reducing the event limits such that normal flying will trigger events, or more acceptably, replaying historical data known to contain incidents that should trigger events. Exceedence detection testing should use set of events published in this manual Section 3, paragraph 3.

6.6 To ensure the quality of the system doesn’t change after significant program modification, routing check should be made picking up and resolving any unforeseen problems.

6.7 The basic set of events provided by BAFDA had been modified to tie with Air Astana SOP, as well as will need to be updated if SOP changes over time. Flight Operations department shall notify the FDA team about all changes made in SOP, OM-A and FCOM limitations, also the FDA team has access to Flight Operations publications site for viewing updates.

6.8 To satisfy with Air Astana areas of interest, that are not covered by core set of events, several new events had been added in to the system for better monitoring specific problems.

6.9 Additionally to exceedences the BAFDA produces all flights measurements by MaxVal module. This module might be used by Air Astana in the nearest future in determining trend information before there are statistically significant movements in event levels occur. Data for all flights with possibilities for substantial analysis breakdown by time, location, aircraft weight etc. become more feasible in comparison with the utilization of small number of events.

6.10 For better understanding of the system capabilities and design, the FDA team members should undertake training on analysis program specification including practical exercises.

Chapter 5 FDA within SMS

1. INTEGRATION LEVEL

In 2015 Air Astana established an Integrated Quality Safety Management System (IQSMS) for the purpose of risk management and ensuring the continuous improvement of safety operations. Since then, the FDA system (BAFDA) has been integrated with the IQSMS for better tracking of events which are subjected to reporting. As a result of this integration, reported events should have the following data to be exported into the BAFDA system:

- SMS event ID
- Area of occurrence
- Type of occurrence
- Event classification
- Status
- Due date
- Closed date
- Event date, time
- Reporter
- Flight number
- Report text
- Departure
- Destination
- Diversion
- Commander
- Summary of corrective action

The Safety Reports Coordinator (SRC) shall register any reported event in the SMS, however, high risk events that are not reported by the crew but that are identified by the FDA system and considered for investigation or/and follow up action, shall be registered in the SMS module upon receipt of the Flight Data Memo with event details. The MFD should ask the crew to file a retrospective ASR if the event severity is subject to conduct investigation and/or follow up action. If the FDA system design doesn't allow for the presentation of data in a way that identifies unsafe risks or unusual trend information, then the FDA system shall populate the SMS with pre-selected event data.

2. FLIGHT CREW PARTICIPATION

To ensure a successful FDA, Air Astana established a safety reporting system using an Air Safety Report form (ASR) which can be marked as "Confidential". In this case, an ASR recipient shall only be an SMSCFO who makes decisions on further and appropriate scope of actions. It is incumbent upon CSC management to provide assurance of the FDAP intent, conditions of use, and protection given to its employees. This trust is facilitated by:

a. Giving a presentation on the system design and operation of the FDA to the flight crews; and
b. Creating a formal agreement between management and the flight crews which would outline procedures for the use and protection of data.

3. SAFETY CULTURE

Characteristics of an effective safety culture at Air Astana include:

a. top management's demonstrated commitment to promoting a proactive safety culture

b. the cooperation and accountability of all departments and relevant personnel involved, that is, anyone believing to have identified a potential risk should feel able to report and expect follow-up actions to be considered. From the line pilot to the fleet manager, all have a responsibility to act

c. A written non-punitive company policy, that covers the FDA and makes clear that the main objective of an FDAP should be a safety promotion, and not the allocation blame or liability

d. a Senior Manager Safety Compliance Flight Operations whose role and functions are defined to follow the commendations of the Safety Management Manual (SMM) (Doc 9859)

e. staffing the FDA team by a dedicated personnel under the authority of the SVPCSC, with a high degree of specialization and logistical support

f. involvement of the SSPFO's and Safety Compliance Engineer with appropriate expertise any time when risks should be identified and assessed

g. A focus on monitoring of the fleet trend information aggregated from numerous operations, rather than on specific events (monthly, quarterly and yearly reports)

h. A well-structured de-identification system for protection of confidentiality of the data; and

i. An effective communication system designed to permit timely safety action, disseminating hazard information, and as a rule subsequent risk assessment made internally as well as using safety information of other organizations.

4. WRITTEN AGREEMENT

The trust established between Air Astana management and flight crews is the foundation for a successful FDA programme. This trust is facilitated by data security, and optimized by:

- strictly limiting data access to the selected individuals
- maintaining tight controls to ensure that identifying data is kept securely

An official agreement between the Air Astana management and the flight crew members should be signed to enforce procedures that will prevent disclosure of crew identity. This agreement shall be signed by authorized management and representatives nominated by flight crew members.
This agreement defines:

a. the aim of the FDAP;

b. the data access and security policy that restricts access to information to specifically authorized persons identified by their position

c. the method to obtain de-identified crew feedback on those occasions that require specific flight follow-up for contextual information by the Manager Flight Data or Specialist Safety Performance Flight Operations

d. the data retention policy, personnel accountability, and the measures taken to ensure the security of the data

e. the conditions under which an advisory briefing or remedial training should take place in constructive and non-punitive manner

f. the conditions under which the confidentiality maybe withdrawn for reasons of gross negligence and significant continuing safety concern

g. the possibility of participation by flight crew member representative in the assessment of the data, the action and review process, and the consideration of any recommendations

h. the policy for publishing the findings resulting from the FDA.

Once the agreement is signed by all parties, then the FDAP policy and procedures shall be incorporated into the company manuals in accordance with this agreement.

5. CONTINUOUS IMPROVEMENT

5.1 New safety issues identified and published by other organizations, such as safety investigation reports, safety bulletins by the aircraft manufacturer or safety issues identified by aviation authorities, shall be assessed for inclusion in a corresponding monitoring activity of the FDAP.

5.2 FDA processes and procedures shall be amended as the FDAP matures and/or each time there are changes in the operations, in the internal organization of the aircraft operator, with the interface between other data sources and processes.

5.3 A periodic review or an audit should be done in order to assess the general effectiveness of an FDAP. Such a review should help to determine:

- if anticipated safety benefits are being realized
- if the FDA procedures accurately reflect the actual operation of the FDAP, and to check if they have been followed
- whether the information provided to the FDAP users is accurate, timely, and useable
- if the tools employed to collect and present data are still adequate, and if other technology would be more effective

5.4 The FDA will compile monthly trend information and download reports to be distributed to the SVPCSC and the Event Review Committee, as well as the Safety Action Group Flight Operations (SAGFO). High risk events and selected trend information will also be shared with the Aviation Safety Review Board (ASRB).

5.5 The Corporate Safety Compliance and the Flight Operations departments will assess the effectiveness of the FDA program annually.

6. RISK IDENTIFICATION

6.1 A hazards resulting in unsafe conditions or should be identified before they culminate in accidents or incidents. Such identification will allow the risk mitigation to acceptable levels. An incident differs from an accident mostly due to the good fortune that allowed a different result (on this occasion). Similarly, hazards are events with accidents or incidents potential that have been identified through circumstances or through a protection measure that operated correctly. If the hazard is known and found to be acceptable within the defences set, then the hazard is considered manageable as long as the risk level is kept within these pre-defined acceptable limits.

6.2 Hazard Identification is the first step in achieving the goal of the SMS mission, namely, identifying and minimizing Operational Safety Risks to acceptable levels.

6.3 The hazard identification system is non-punitive, with a confidentiality option, and should be kept simple, direct and convenient for the reporter, administrators and management. The SMS is dependent on a reporting system and all effort are made to encourage, administrate and act on all sources of risk notification effectively while disseminating results to users/safety practitioners (staff). Non-punitive -- means that a hazard report will not be used to punish the reporter that brought the hazard to the attention of the company, subject to the Air Astana safety policy and the provision in the safety culture policy. Risk mitigation actions may, however, include additional training or working under supervision.

6.4 While “voluntary” reporting is the foundation for the hazard identification it should be noted that there is also a legal onus on staff (and Air Astana) to notify the Regulator of hazards detected. Failure to report compulsory events as defined in the RK Government Decree #828 may result in sanctions. Confidentiality regarding the Decree #828 events is therefore subject to the actions of the authorities.

6.5 Anonymous reporting is encouraged to allow notification of hazards that would not otherwise have been known. The staff is encouraged to report Human-Factor (and organizational) issues within Air Astana. The application of such a just-culture will help promote the reporting of these issues over the long-term.

6.6 Minor events, irregularities and occurrences often take place during normal operations and, often without noticeable consequences; however, it might be identified by Safety reports, the FDR, audits, and/or the confidential reporting system.

6.7 If the CSCD received information on a safety event that occurred and no SR was filed, the Safety Report Coordinator (SRC) is to send an email to the employee involved and to copy his/her manager. If no response is received within one week, the SRC has to ask assistance from the manager of the employee involved.

6.8 All hazard reports are analysed for cause and evaluated for risk, first by Corp Safety, then by relevant department, then by the Safety Action Group (SAG) and finally by the ASRB, if required.

6.9 The root-cause of the event will determine which effective risk control measures will be taken. In addition, the reporter should be encouraged, given their more intimidate understanding of the hazard, to identify what they consider to be an action(s) that could prevent a re-occurrence.

6.10 An accurate evaluation of risk depends on an accurate understanding of it, which naturally has an element of subjectivity. If a reported hazard is considered by the CSCD not to have risk potential, the reporter's interpretation must be clarified. The hazard report will, however, remain in the database with a risk value reflecting the CSCD's and SAG's risk interpretation.

Sources of Hazard notification:

1. safety and hazard reports including: all safety reports, flight (trip) reports (CAB and FLT), training reports, station reports and monthly reports (GRO), and SC audit reports (FLT and E&M)
2. audits and inspections
3. safety surveys, studies and reviews
4. safety investigations
5. flight data monitoring reports and memos
6. international safety investigations and risk analysis reports
7. domestic regulatory reports

7. OCCURRENCE CLASSIFICATION/CATEGORIZATION

7.1 Air Astana uses the IATA causational classification.

7.2 Accidents, incidents, and (safety) hazards are caused by unsafe acts or conditions. The severity of the possible result and the frequency with which the event may occur determines the risk tolerability. While accidents are defined, incidents require some interpretive judgment and hazards often require evaluation to determine classification. The difference between an accident and an incident lies in the result/outcome, which is in turn is influenced by either the activation of a risk control action or "luck". A safety filter is activated when somebody or something breaks the "chain of events". Activation of this filter (ususally) indicates a deficiency in the safety protective system (e.g. GPWS). Luck is an unacceptable "filter".

7.3 As mentioned above, the difference between a hazard and an incident is the (subjective) interpretation of an unacceptable level of risk. This interpretation can be further complicated by (1) not obvious link with reduced safety levels, and/or (2) an undefined likelihood of re-occurring, or (3) an undefined severity of the result. Therefore, acceptable safety levels tend to be subjective and are the best assessed through discussion and debate.

7.4 From UK CAA 382 App B, Part I, Note 3: "If in the view of the reporter, an occurrence did not endanger the safety of the operation, but if repeated in different circumstances, likely would have created a hazard, then a report should be made. What is judged reportable on one class of product, part or equipment may not be so on another, and the absence or presence of a single factor, human or technical, can transform an occurrence into an accident or serious incident".

7.5 A generator failure with redundancy is normally regarded as a low/no-risk component failure (and not an incident), however seen in conjunction with other failures or conditions it may be a hazardous occurrence. Additionally, continued generator failures may not pose a risk (per se), but the inability to rectify a repeated failure could pose a risk to operations.

7.6 Similarly "Human Factors" safety occurrences, arrested by procedures or equipment "filters", could be classified as hazards or incidents as well.

7.7 Air Astana has created the following classification of occurrences, which remain in effect unless otherwise decided upon at the monthly meeting:

- **Significant Event (SE)**: a hazardous condition(s) or act(s) with Tolerable Risk (Risk Value 6 (severity 2) or higher), but a primary defenses remained in effect (e.g. secondary hydraulic system) or conditions were such that an incident was possible but not likely as a significant event, (for example minor ramp damage reported prior to departure). However, only unruly passenger level 2 with Tolerable Risk is considered a SE.
- **Incident**. An occurrence, other than an accident, that falls into either the Tolerable or Unacceptable Risk categories (Risk value 8 (severity 2) or higher) see below Table #3, associated with the operation of an aircraft which affects, or could affect, the safety of the flight (Annex 13).

- **Serious incident.** A serious incident is an incident which falls into either the Tolerable or Unacceptable Risk categories (Risk value 8 (severity 3) or higher), Table #3 below, and involving circumstances indicating that an accident nearly occurred. The difference between an accident and a serious incident lies only in the result.

7.8 Unstable approaches events are agreed to be classified as follows:

- If the approach is stable before the MDA/DA/200ft (VMC), it is classified as a significant event.
- If the approach is stable after the MDA/DA/(200 ft for visual approaches), it is classified as an incident.
- If the landing has direct risk e.g. a 3 pointer or more glide slope deviation, then it may be classified as serious incident.

8. RISK ANALYSIS

8.1 There are two models available in IQSMS system to analyse safety risks. First one is the Risk Tolerability Matrix which is used as general guidance, to determine priority and resource allocation to risk resolution. Second one is the "Bow tie" model that is available in IQSMS risk management module, it is not completely implemented within in Air Astana and more guidance will be included in this chapter when the Bow Ties modules are developed.

8.2 Definitions:

- **Risk** is the assessed potential for adverse consequences resulting from a hazard. It is the likelihood that the hazard's potential to cause harm will be realized
- **Risk Analysis** is the process whereby the severity should a hazard result is analyzed separately from the probability that the hazard may result
- **Frequency of exposure** is considered part of the probability/likelihood

8.3 Risk Tolerability Matrix Process

All Air Astana events and hazards are risk assessed and classified by using Air Astana Risk Tolerability Matrix.

This assessment of the hazard(s) is based on two conditions, 1) the probability of the hazard precipitating an unsafe event and 2) the severity of the potential adverse consequences, or the outcome of an unsafe event. Probability can be defined as the "rate of exposure" to hazards, or, as the likelihood of adverse consequences becoming greater through increased exposure to an unsafe condition(s).

Risk acceptability is a factor of both conditions of the risk and this obviously is not rigidly dictated by any table and any rating with potential risk and should consider cause factors to identify as follows:

- **Managerial:** Is the risk covered by the safety policy, procedures and standards?
- **Affordability:** Does the nature of the risk defy cost-effective resolution?
- **Legal:** Is the risk is covered by current Regulatory standards or capabilities?
- **Cultural:** How will personnel, shareholders, customers and other stakeholders view the risk?
- **Market:** Will the airline's competitiveness be compromised by not reducing risk?
- **Political:** Will there be political implications for not reducing the risk?
- **Public:** How influential will mass media or special interest groups be in affecting public opinion?

8.4 Risk severity is the potential adverse consequences or the outcome of a hazard. For all assessments of severity level, the criteria in the "Nature" column are taken into account using the highest risk classification. All applicable criteria in the "Nature" column are taken into account and assessed.

Table #1: Risk Severity

Severity Level / Nature	Catastrophic	Hazardous	Major	Minor	Negligible
Injury	Multiple fatalities and/or permanent disabilities with serious illness	Fatalities and/or permanent disability with serious illness	Serious but non-permanent injuries (e.g. loss time injury)	Injuries requiring medical first aid treatment only	No or minor injuries (First aid treatment)
Non-routine incidents	Total loss or hull loss	Accident with serious injuries, fatalities, or significant damage	Incident with injuries and/or substantial damage to aircraft	Significant event with minor injury and or minor aircraft damage	Event or hazard with discomfort and/or less than minor system damage
Property or A/C damage cost	> 20 Mio USD	400.00 to 20 Mio. USD	10.000 to 400.000 USD	300 to 10.000 USD	< 300 USD
Reputation and Public Confidence	Fundamental change in the public perception of Air Astana as a safe airline	Extended international or nation-wide negative media coverage	Short-term nation-wide negative media coverage	Negative local media coverage	None
Customer Impact	Extensive shut down of services for an extended period	More than 10 flights cancelled, rescheduled or delayed	Between 1 and 10 flights cancelled, rescheduled or delayed	Between 1 and 5 flights rescheduled or delayed	1 flight rescheduled or delayed
Operational Impact	Fleet grounded for extended period	Brief fleet grounding up to 2 days	Aircraft grounding more than 2 days	Aircraft grounding 4 to 48 hours	Aircraft delay less than 4 hours
Equipment	Loss of critical equipment shutdown of organization	Major damage, results in major slow down and/or downtime	Minor damage, leads to organizational shutdown and/or minor downtime	Minor damage, potential organizational slow down and/or down time	No adverse consequences
Compliance	Significant disruption to scheduled service over an extended period of time	Substantial fine and disruption to scheduled services	Substantial fine but no disruption to scheduled services	No fine and no disruption to scheduled services	Minor breach by individual staff members
Process Breach	Several steps of flight critical process not followed or flight critical process non-existent	No steps of documented process followed or process non-existent	Majority of steps of documented process not followed or process unknown	Contiguous steps of documented process not followed or process partly unclear	Some single steps of documented process not followed

8.5 Risk probability of adverse consequences is the estimated likelihood or frequency, in quantitative or qualitative terms, of an occurrence related to the hazard. The probability level is suggested by IQSMS automatically based on the past performance. It is up to Air Astana to analyze the results of suggested level of IQSMS with the final decision remaining with the responsible risk assessor. As a guideline, the following classifications shall be used:

Table #2: Risk probability

Probability Level	Occurrences at Air Astana			Description
	Upper Boundary	Mean	Lower Boundary	
Frequent	Always	Once per day	3 per week	Long past history and will probably occur many times at KC
Occasional	3 per week	Every month	1 per month	Some past history has occurred occasionally and is possible in certain circumstances at KC
Remote	1 per month	Every year	Once per year	Has occurred recently but credible frequency is hard to establish. Has occurred seldom at KC or has occurred several times in the industry
Seldom	Once per year	Every 5 years	Once every 5 year	Has occurred in the aviation industry in some circumstances, but possibly only in exceptional circumstances at KC.
Improbable	Once every 5 year	Every 10 years	Happened once in history	No past history and considered very unlikely to occur. Not yet heard in aviation industry

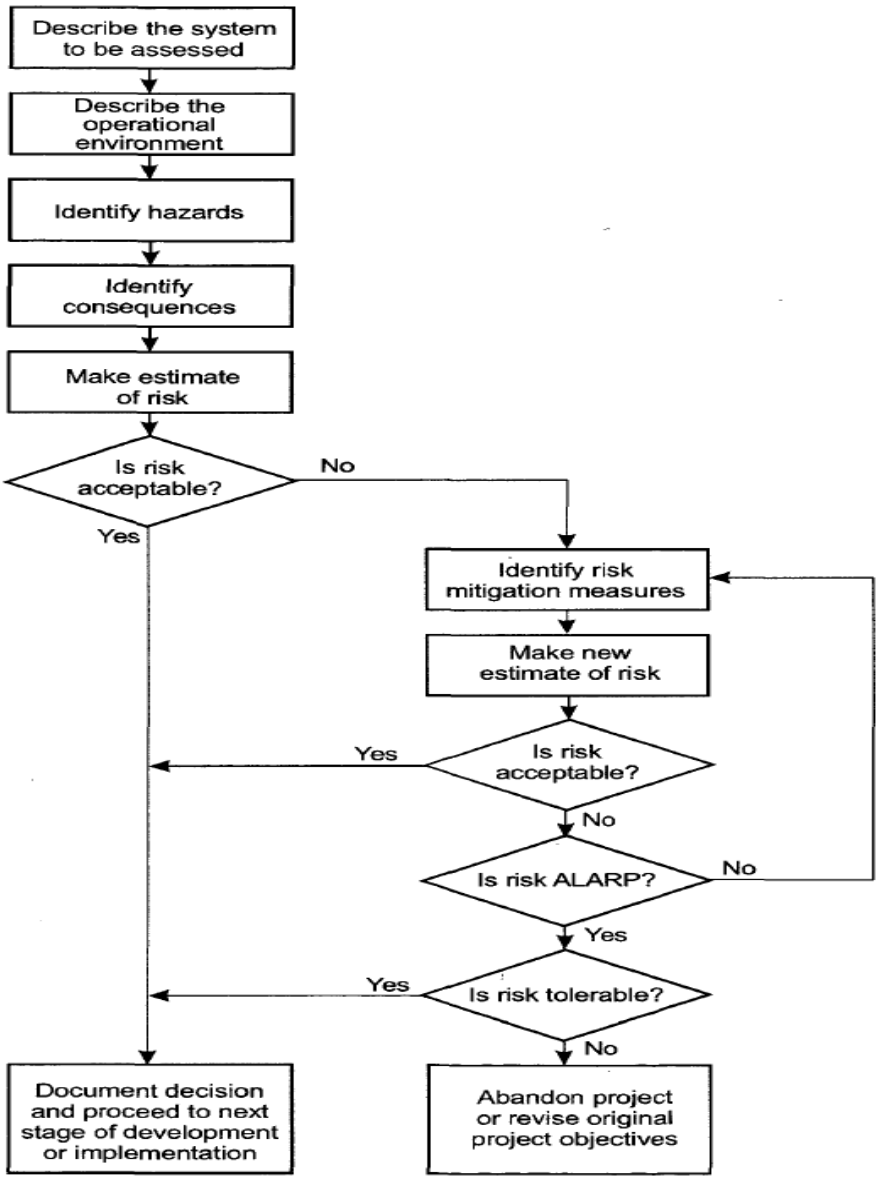
Table #3: Risk Tolerability Matrix

SEVERITY						
Catastrophic Total loss, multiple fatalities, fleet grounded > 2 days	**5**	5 Tolerable	10 Unacceptable	15 Unacceptable	20 Unacceptable	25 Unacceptable
Hazardous Significant ACFT damage, serious injuries, fleet grounded up to 2 days	**4**	4 Tolerable if reviewed	8 Tolerable if reviewed	12 Unacceptable	16 Unacceptable	20 Unacceptable
Major Substantial ACFT damage, injury, AOG > 2 days	**3**	3 Acceptable	6 Tolerable if reviewed	9 Tolerable if reviewed	12 Unacceptable	15 Unacceptable
Minor Minor ACFT damage, first aid only, AOG 4-48 hrs	**2**	2 Acceptable	4 Acceptable	6 Acceptable	8 Tolerable if reviewed	10 Tolerable if reviewed
Negligible Minor system damage/defects, no injury, delay< 4hrs	**1**	1 Acceptable	2 Acceptable	3 Acceptable	4 Acceptable	5 Acceptable
	PROBABILITY	**1**	**2**	**3**	**4**	**5**
		Improbable	**Seldom**	**Remote**	**Occasional**	**Frequent**
		Almost impossible (every 10 years)	Quite unlikely, rare (every 5 years)	Low, unlikely (every year)	Medium, possible (every month)	High, very likely (once a day)

Table #4: Risk classification (value)

1 to 3	Acceptable risk	No further action needed unless risk can be reduced at little effort or cost.
4-10	Tolerable or "Possibly" tolerable for limited period. Review	Every event must be reviewed on its merits, taking into account the benefits that will result from implementation of the proposed changes as well as the risk; this reduced exposure and may be acceptable for an interim period, while still providing a safety margin. Operation under these conditions could be used to check the effectiveness of the risk mitigation.
10-25	Unacceptable Risk Risk to be reduced to Tolerable level	Operations must cease until the risk has been mitigated to at least tolerable level. A mandatory investigation shall be performed.

Table #5: Risk Analysis Flow Chart



8.6 The majority of risk level indicators deduce the probability of physical harm based on incidents and accidents in the past. While this will allow an SMS to detect failure after the event, hence it is really required a predictive monitoring system. The aim of this is to flag up the trend at a much lower level, measure towards the exceedence of an acceptable level of hazard, before that level has been reached. This can be done by FDA system, Analysis of hazard groups including related safety barriers, and by evaluation of the common context Safety Performance Indicator (SPI) monitoring.

8.7 Where SMS has identified a risk, and then considered that risk has been reduced by mitigation procedure laid down in SOPs. Afterwards any failure to exercise that procedure should be identified and investigated.

8.8 While carry out monitoring flight operations, FDA helps to fill in to the SMS necessary information and assists in definition of what is normal practice. This gives assurance that SMS is managing actual rather than perceived safety issues.

9. FDM RISK EVALUATION

9.1 The risk value used in FDA system (BAFDA) is expressed in different format compare to SMS Risk Tolerability Matrix. If SMS Matrix uses 25 severity descriptors for 5 levels of severity, and 5 levels

probability, then BAFDA severity logic expressions are based on maximum 100% Severity Factor, which is equal to risk triggered by activation of GPWS Hard Warning (TERRAIN, PULL UP). So Severity Factor (SF) of the event is expressed as a linier function, where minimal quantitative SF is trigger value, but maximal 100% reaches when deviation from trigger value is dangerous or even lead to an incident or accident under certain circumstances. The more deviation from trigger value, the more SF is. Although some of the events like GPWS Hard Warning, GPWS Soft Warning, Go Around etc. have constant SF value. Air Astana calculated its own SF values that correlated with severity descriptors of SMS Risk Tolerability Matrix and divisible to 4, for example 4% SF is equal to risk 1 (severity descriptor), 8% SF is equal to risk 2 etc. At last severity logic expressions had been configured in the system to correspond SF depending on the quantitative deviation from trigger value.

9.2 Once system configured according to Air Astana SF matrix, then no any person allowed making changes in the SF expressions, unless such change is agreed with SMSCFO and approved by VPCSC. According to SF matrix, the MFD can update SF particular event manually after factual risk evaluation is completed, then SF value is marked by asterisk by the system.

9.3 First event classification/validation shall be done by Flight Data Analyst or/and MFD in accordance with FDA SF matrix. However, if event is reported or/and subject for registration in the SMS, then Safety Coordinator and/or SMSCFO shall continue further classification with regard to its severity, likelihood and possible safety risk in accordance with SMS Risk Tolerability Matrix.

10. FDA DEFINITIVE RISK DATA

The success of SMS operation requires knowledge of actual operations and cannot be achieved using assumed safety performance. One cannot know with a certainty that, because one audit point, say a check flight, measures up to standards, that the other 1000 flights will also be a satisfactory. In monitoring all flights, FDA can help to fill missing information and assist in the definition of what is normal practice. This gives assurance that SMS is managing actual rather than perceived safety issues.

Chapter 6 Organization and Control of FDA Information

1. DATA FLOW

1.1 Schedule of data download within Air Astana is different for certain groups of airplanes, depending on specifications of download equipment and specifics of operation. Based on this, most of Airbus airplanes of new modifications, Boeing 767 and Boeing 757 are equipped with WQAR, that enables to download FD files after every landing at any Kazakhstan's airport. However old modification Airbus airplanes are scheduled every 2 days for data download, using removable recording media. The same recording media is used for Embraer fleet, but download of information is scheduled every day during daily check. System is configured in a way to allow automatically flight data replay without operator's input, once data download has been completed.

1.2 The data verification is the initial procedure after data has been replayed, to ensure information is realistic and presents a consistent picture. Data verification can be made by provider organization which is accepted by Air Astana. Next step is validation of data, which is critical to FDAP successful operation. Before any action is instigated, the basic FDR information must thoroughly be checked.

1.3 Most of the flight data has small deviations from normal operations and should be processed routinely, however there is some number of events where FDA indicates that immediate action is required. Then fast procedure to ensure safety critical action should be placed. Basically, all structural exceedences require immediate response to satisfy with continued airworthiness checks of aircraft, however operational deviations and errors are not matter for quick response. **All structural exceedences shall be reported to E&M department as soon as over limit event has been validated.**

1.4 Any time event assessment has been completed and significant risk identified, or there is subject for further investigation, then one particular person or department should be allocated by CSC department for follow-up responsibility. Allocation of responsible department depends on severity of the event and gravity of impact to operations. For example, if event evaluated as low risk to operations affecting to trending side, in this case Corporate Safety Compliance department takes care of the follow-up actions, however if the event requires immediate actions to be taken for introduction additional defence into procedure, then Flight Operations department should be allocated for follow-up actions.

1.5 Inside CSC department allocation of particular person for follow-up actions should be done by SMSCFO after initial examination of the event circumstances by FDA team.

1.6 Once data validated in BAFDA system, then Flight Data Events (FDE) module keeps it in database ready for interpretation and further analysis. The system doesn't have an option to validate events automatically, hence every event triggered by the system shall be examined and marked by FDA team as valid, or deleted from the analytical module, however all history of generated events is stored in Flight Data Traces (FDT) module. Recording all false events will assist in later refinement and improvement of the analysis program.

1.7 Since FDA is an integral part of functioning system within SMS, then all actions arising from data shall be recorded. All this information can be useful to build complete picture of the event development, later to produce thorough analysis for particular problematic area or trend, and also an audit path to confirm remedial actions have taken place. For example:

A flap limit speed exceeded event-
Initial analysis action – validate, send notification to E&M, and set event in context of previous flap speed limit exceedence.
Action of informed party – E&M, action taken – checks, result – no damage or damage repaired.
Action of informed party – Flight Operations, action taken – flying assessed – crew interviewed, result – reviewed Flight Crew Training Manual section "Take-off and initial climb with Maximum Take-off Weight" (MTOW).
Ongoing analysis action – monitor MTOW events for recurrence or change.

1.8 Flight data recovery rate is one of the important statistics that shall be closely monitored for successful functioning of FDA program. System should reflect actual number of flown and replayed sectors, also

replay coverage for individual aircraft, fleet, and general data quality measurements. Based on success/error replay statistics for particular aircraft, remedial engineering actions can be defined whether it is quality of recordings issue or data transfer malfunction. Flight data recovery statistics are required to allow the derivation of overall and specific event rates, airfield and aircraft specific rates etc.

1.9 Optimised data flow, applicable for Air Astana, is laid down at next page of this manual. Timelines defined for data acquisition and replay ensure timely identification of serious incidents or significant events that need immediate action, such as, structural inspection. This also will allow increasing the likelihood of the crew recollecting the surrounding circumstances.

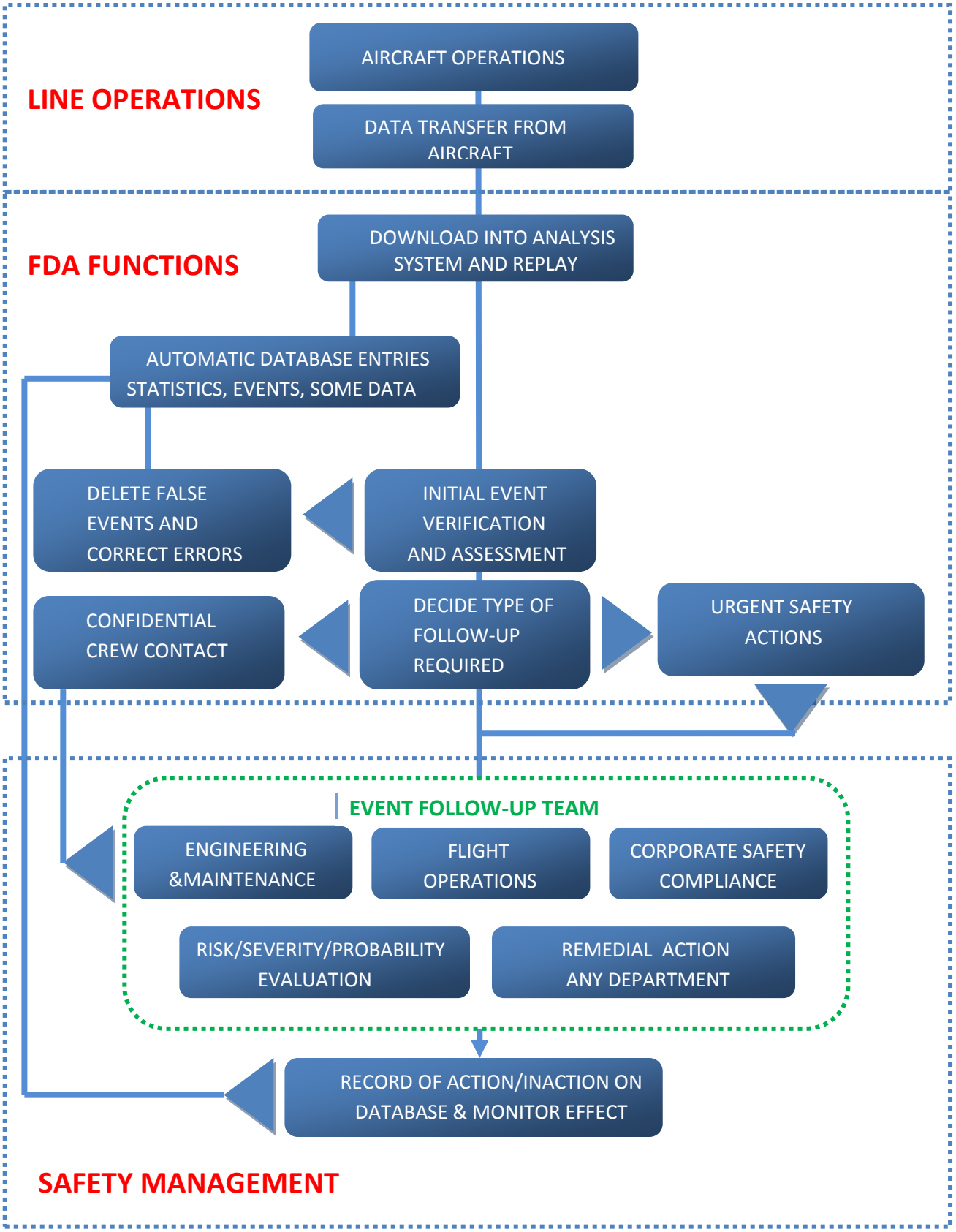
Flight data acquisition and replay timeline:

#	AIRCRAFT TYPE/DATA TRANSFER METHOD	NUMBER OF AIRCRAFT	FLIGHT DATA ACQUISITION AND REPLAY TIME	
			PLANNED	MAXIMUM (weekends)
1	B-767AND 757/WIRELESS DATA TRANSFER	8	2 HOURS	1 DAY
2	A-320-321/WIRELESS DATA TRANSFER	9	2 HOURS	1 DAY
3	A-319-320-321/QAR REMOVABLE MEDIA	4	2 DAYS	4 DAYS
4	E-190/QAR REMOVABLE MEDIA	9	1 DAY	3 DAYS

Note 1: Any deviation from maximum data acquisition and replay time shall be investigated and actions considered for correction. Records about delays shall be kept in the FDA system or special log for identification of systematic deficiencies in data transfer and replay procedures, and also being indicated in the report of replay statistics.

Note 2: In case of urgency, that might need prompt action – for example structural inspection to aircraft with QAR removable media, MFD will request to download flight data despite the planned date of data acquisition.

Schematic data flow:



2. CREW IDENTIFICATION PROCEDURE

2.1 Certain high risk events will be identified to ensure sufficient knowledge is gained on the cause allowing immediate preventative action. This practice has to be strictly structured to prevent the systemic deficiency to go unattended e.g. unstable approach that results in landing may be an individual failure, it may also be an (systemic) airport threat or a training deviation. Systemic failures will be investigated further to ensure the root-cause and contributing factors are addressed to obtain a satisfactory level of safety. If during routine analysis the FDA identifies that an immediate safety action is required, based on risk or significant non-compliance, a next steps have to be done:

- The Flight Data Analyst will immediately inform the MFD, who will initially make contact with the crew
- In the absence of MFD, the Flight Data Analyst is to discuss an appropriate form of actions with the SMSCFO in the first instance, who will inform the SVPCSC

2.2 The only exception to the de-identification procedure of FDA data should be made in case of accident or incident that is subject to Mandatory Occurrence Reporting, in accordance with the list defined in governmental regulation #828 from 18.07.2011 “Rules for investigation of aviation accidents and incidents”.

2.3 During initial contact with the crew, the MFD should request an ASR marked “confidential”. This report is to be treated as a confidential, and only be notified to SVPCSC, SMSCFO, and Safety Report Coordinator, who will then notify the Manager Flight Data on ASR registration.

2.4 The MFD will establish basic facts surrounding the event/s. If required, the MFD will request an investigation to establish all relevant information and facts.

2.5 This investigation should be carried out by Specialist Safety Performance Flight Operations (SSPFO).

2.6 An event analysis post investigation should then be passed to MFD, who will then in conjunction with the SMSCFO consider the identification process as detailed below. The SVPCSC must be briefed on the event details before identification is made. The SVPCSC, SMSCFO and MFD will jointly make the decision to identify a crew.

Note 1: If agreement cannot be made on identification of flight data, the SVPCSC as the owner of the FDA programme will make the decision to identify or withhold identity.
Note 2: In the event SMSCFO or SVPCSC is not available, and the event is to be identified, the MFD can directly contact the SVPFO. The process may not be delayed due to the non-availability of any one individual.

2.7 Strict rules of access are enforced during this period by FDA system design, which allows granting restrictive access to other staff involved in monitoring and investigation activities. In case of a mandatory occurrence event or accident, any data retained by the program may not be de-identified or removed from the system prior to investigation being completed, or before getting confirmation that it is not required. This will allow the safety investigators an access to all relevant information.

2.8 Once identification procedure has been completed, then event details shall be reported to SVPFO, Chief-Pilot, fleet manager. Reporting shall be done by email, copied to SMSCFO and SVP CSC, containing factual information of the event including risk values and recommended action(s). The event details should also be entered by Flight Data Analyst on the prescribed departmental secured system drive.

2.9 The e-mail will be followed up by a telephone conversation with the Chief Pilot (or his assigned representative) to ensure understanding. The Chief Pilot will confirm by e-mail their acknowledgement and will then delegate a fleet manager to investigate further.

2.10 In accordance with Post Flight Data identification process, the crew may be invited for a debriefing of the event/s with FLT OPS manager and CSC assigned pilot to establish cause and preventative actions. The Manager Flight Data may attend this debriefing if required.

2.11 Confidentiality exceptions shall be made in case of grossly negligent behaviour when crew failed to exercise care, skill or foresight as a conscientious people in his\her situation would exercise, then action to prevent repetition should be considered according to identification and investigation procedures.

3. INTERVIEWING TECHNIQUE

3.1 The crew member can be interviewed by phone, email or in office depending on the complexity and severity of the event. The MFD can conduct interview on simple event using phone or email, but when it is required to uncover all causes of complex event including circumstances that can aggravate the outcome, then crew should be invited in office.

3.2 The MFD can interview personally on the minor events, which do not require specific technical and/or SOP knowledge, however, interview on exceptional events shall be conducted by SSPFO or Fleet Manager, and the MFD can only assist in this interview by supporting Flight Data details.

3.3 The crew member shall be planned for interview with approval of Fleet Manager Flight Operations, sending official request by email on agreed with SMSCFO date. As soon as the change in the roster is published, the crew member should be invited for interviewing by telephone call.

3.4 Crew interview objectives are:

- Complementing facts, finding, process (communications, ATC, weather etc.)
- focusing on human factors and crew resource management
- advanced analysis and better understanding of occurrence (what's and why's)
- assessing safety awareness and safety culture
- identification of possible mitigation area

3.5 Interviewer should be prepared for the oncoming interview by examination of Flight Data, Review technical documentation, SOP, OM, Charts etc. and taking notes.

3.6 Interviewer shall not make conclusion on the cause of the event before the interview, but be wilful to uncover all causes which could contribute to the event development. Thorough examination of all aspects of the flight should be done starting from preparation for the flight, such as duty time period at time of the event, environmental conditions, as well as CRM issues followed the event etc.

3.7 Most preferable approach for interviewing is to draw brief plan on paper, highlighting what to ask and leave space for remarks (don't trust your memory). Don't send questions to crew in advance. For interviewing of the crew member is better to use separate room to maintain confidentiality of the talk.

3.8 Interview should be conducted by one, maximum two persons that will not put interviewee under stressful conditions. Interview should be conducted preferably not later than 5 days after the event that helps to get more accurate information, because most of the people cannot recollect details of the routing chain of events which took place week ago.

3.9 Interviewing crew members should be conducted separately for avoiding interference from other crew member, and also give interviewee chance to tell his own story about the event.

3.10 Face to face interview is a big challenge, however gives some flexibility and spontaneity in query (more specific questions and answers, repeat question etc.) by observing non verbal behaviour.

3.11 As a rule, interviewing should be started using closed-ended questions, requiring Yes or No answer. This type of questions will give exact statement on the crucial issues because they are not requiring description or explanation of the process or action.

3.12 Open-ended questions can be useful to give chance interviewee telling his story about the questioned subject as per he/she perception, and also fill in the gaps in data which is already obtained from other sources of information (ASR, FDR etc.).

3.13 Let the interview take its natural course, so don't interrupt interviewee and let him/her speak.

While interviewing crew:

- **Humanize your interaction and relax interviewee by starting slow, safe, and personal. Introduce yourself to interviewee and don't show animosity, also let interviewee introduce himself.**
- **Interviewer should coax interviewee but don't hammer. Explain the need for interview and crew contribution to safety, as well as benefit to all from lessons learnt**

- **do not blame or point finger at errors**
- **look at the person in the eyes and conduct interview like a conversation**
- **listen, listen and listen! Try to learn from the crew because each answer could later trigger a new question. Pay attention to what is not answered and only then start specific questions:**
  - **first, for clarifying what was said**
  - **second, for digging into the topic**
- **pay attention to the order of questions, also separate issues (don't raise two-in-one or complex questions)**
- **do not be afraid of pauses and silences (take time before raising a new question)**
- **in first place try to understand why it happened instead of who did**
- **use English language all the time while interviewing Expat pilot**

3.14 Interviewing should take reasonable time span and should not last too long. Terminate interview in thankful manner by heartily show your appreciation.

4. CREW DEBRIEFING POST EVENT

4.1 Debriefing aim is to establish root cause through a structured crew interview process. It is to identify if there is a need for procedural changes, training etc, through a detailed investigation. Recommendations made should be effective for the general improvement of safety throughout the Air Astana. During this debriefing a detailed threat and error management process should be adhered to.

4.2 Only in exceptional cases such as gross negligence or serious misconduct should disciplinary actions be considered.

4.3 Flight Operations will complete the investigation by providing a comprehensive safety investigation report, including findings and recommendations to the SVPCSC and SMSCFO.

4.4 The identified event should be investigated with a report sent within 10 working days of identification, unless differently instructed e.g. Unstable approaches to be assessed and initial actions taken within 3 working days (instruction from President KC Dec 2007).

5. FDA AND CREW INVOLVEMENT

5.1 Since Air Astana has not signed yet written agreement between crew members and Flight Operations management for enforcing procedures preventing disclosure of crew identity, restricted method by which crews are contacted and non-punitive use of FDA data, then company manuals contain all these clear policies and procedures for gaining crew confidence.

5.2 The FDA team keeps Air Astana crews informed of areas of concern and remedial actions contemplated using whether confidential scheme when particular pilot involved in the event or open scheme through Safety Notice when emerging trend information has common tendency among the fleet.

5.3 Confidential scheme of information means sending out "Crew personal profile" to pilot concerned his\her 6 or 12 months performance if number of repetitive events maintaining without changes for several months.

5.4 Safety Notice should be prepared and issued with authorization of SMSCFO, such informative paper should focus on problematic areas of operations, and has a primary goal to mitigate risks or prevent trending from becoming unacceptable.

5.5 Where it is decided by Fleet Manager and agreed with individual that retraining is appropriate then this should be scheduled into the training programme in a discrete manner to avoid highlighting the person. In this case it must be stressed that remedial or additional training is not to be considered disciplinary action but merely a safety improvement issue.

5.6 Examples of good airmanship found by means of reporting or FDA should be highlighted and commented upon. Such examples can be useful reference material when analysing or debriefing less well executed flights.

Chapter 7 Use of FDA Information

The most critical operation is interpretation and validation of the basic FDR data. Any inconsistency in parameter figures trend can distort measured value indication and will create multiple problems for data management and can affect the outcome of system operation.

1. CHECKING FOR VALIDITY

1.1 Validation of FDA parameters for correctness should be done on constant basis by FDA team. Most of the parameters are required for FDA programme are seen on every flight and these should be checked both by the programme and visually. Some parameters are basically used for more complicated events or investigation cases where more detailed analysis have to be done, hence these parameters should be validated whenever opportunity arises. And last group of parameters is rarely utilized for triggering warnings, operating modes etc. that can only be tested by complex procedures in the maintenance workshop, so such validation should be done during validation and recertification of the mandatory crash recorder. Requirements for validation and recertification of crash recorders are laid down in the Chapter 9 of this Manual.

Below are examples of parameter utilization:

Common use parameters: attitude, pitch, roll, airspeed, acceleration, heading, flight controls, altitude, main auto-flight modes etc.

Infrequently used parameters: less common auto-flight modes, TCAS and some GPWS warnings, alternate flap operation etc.

Difficult to check parameters: fire warnings, N1 over speed, EGT over limit, hydraulic pressure warning etc.

1.2 If there are a range of basic data faults can be established, then changes in the equipment or software is needed, but if data faults are transient and are caused by faulty sensor, then affected equipment shall be replaced.

Sensor error example can be described, using accelerometer design when it occasionally stick and have offset datum, say 1.3 rather than 1.0g when at rest, or lose damping so they are over sensitive and hence reading too high.

Data acquisition faults example can be explained using normal acceleration g sample that each second doesn't follow the trend of the rest of the data. This can be caused by the system picking sample from the previous second's data stream.

1.3 The Flight Data Analyst should have the ability to detect what data is different from normal or unusual. In this case analyst should know how normal data looks like and reasonable range to the corresponding phase of flight.

1.4 BAFDA shall monitor the performance of FDA analysis parameters and report any confirmed sensor failures in writing to FDA team.

1.5 Air Astana FDA team use CAP-739 table and technique of cross-checking between related parameters.

(CAP-739) Table illustrating Parameter Correlation:

#		Time	Altitude	Airspeed	Heading	Vertical Acceleration	Pitch Attitude	Roll Attitude	Manual Mic Keying	Engine Thrust	Longitudinal Acceleration	Pitch Control Position	Lateral Control Position	Yaw Control Position	Pitch Control Surface Position	Lateral Control Surface Position	Yaw Control Surface Position	Lateral Acceleration	Pitch Trim Surface Position	Trailing edge Flaps	Leading edge Flaps Slats	Trust Reverse Position	Air Ground Sensing	Angle of Attack
1	Time	■																						
2	Altitude		■	v	v	v			v	v				v			v			v	v		v	
3	Airspeed		v	■															v	v	v	v	v	
4	Heading		v		■			v					v			v								
5	Vertical Acceleration		v			■	v				v	v			v			v					v	
6	Pitch Attitude					v	■					**v**			**v**				**v**					**v**
7	Roll Attitude				v			■								**v**		**v**						
8	Press to transmit for each transceiver		v						■															
9	Thrust of each engine		v							■												v	v	
10	Longitudinal Acceleration					v					■							v	v	v	v	v	v	
11	Pitch Control Position					v	v					■			v				v					v
12	Roll Control Position				v			v					■			v								
13	Yaw Control Position		v											■			v							
14	Pitch Control Surface Position					v	v					v			■				v					v
15	Roll Control Surface Position				v			v					v			■								
16	Yaw Control Surface Position		v											v			■							
17	Lateral Acceleration					v		v			v							■						
18	Pitch Trim			v			v				v				v				■					
19	Trailing edge Flaps		v	v							v									■	v			
20	Leading edge Devices stowed/deployed		v	v							v									v	■			
21	Thrust Reverser stow/deploy (each eng)			v						v	v											■	v	
22	Undercarriage squat or tilt switch		v	v		v				v	v											v	■	
23	Angle of Attack						v					v			v									■

1.6 At the FDA introduction stage, in order to monitor SOP action points, typical flight had been provided with annotations that made easier to define number of events necessary to monitor SOP compliance. The FDA team should always keep data and events in the context of the fleet SOP, hence any change in SOP shall be monitored for timely system update.

1.7 The FDA team keeps examples of good and bad data as familiarization material for future training. Also annotated “normal” traces are used as a yardstick against which to compare an exceedence trace.

2. OPERATIONAL ASSESSMENT

2.1 Assessment of flight data using knowledge of the operating environment and standards is the next stage of data validation. At this stage safety lessons can emerge and action decided upon.

2.2 Operational assessment can identify subtle data problem if exists, hence such data inconsistency can be found only when investigating events where data seems inexplicable then errors in the data or program is present.

2.3 Events for take-off and approach phase should be taken in the context of the physical and procedural characteristics of the particular airfield such as location geography, altitude, runways, approach aids, special procedures etc. A weather conditions all the time shall be taken in to consideration when validating the event, for example stabilized approach criteria is different for VMC and IMC conditions as well as weather minima for specific type of approach.

2.4 All significant events should be correlated with relevant Air Safety Reports to give best picture of what happened. This practice prevents two separate investigations taken by FDA and follow-up team on the same case, each using only partial data. Therefore FDA team produces FDR Memo with description of context, details of the event, evaluates initial severity factor and sends it to SMCSCFO, Safety Coordinator and investigators for follow-up action, then all process of dealing with investigation and follow-up actions is controlled within Air Astana Safety Management System.

2.5 The MFD or investigation team can debrief crew at any stage of event assessment where background information is needed on the circumstances of the event. In this case confidential contact procedure should be strictly followed to obtain information details the sooner after the event the better crew recollection is. Contact person should obtain information missed in ASR to avoid duplication. Basically debrief information may include learning of: weather, ATC involvement, technical problem, CRM issues, operational lapses etc. but training objectives examples are: reminders of ASR requirements, re-enforcement of Manuals, commendation for well handled non-normal operations etc.

2.6 Initial severity assessment by FDA team is crucial task that enables resources to be targeted at the reduction of hazard. Any exceptional trend of low severity events should be prevented from becoming unacceptable or low number of high severity events should be eliminated as much as practicable. In assessing the severity value the FDA team should take in to account both direct and indirect risks. Indirect risk means a possible or/and probable consequence of those circumstances.

2.7 Assessing potential accident factors, FDA team should draw up a list of precursors and causal factors identified in previous accident. These precursors and factors may be relatively low risk events in their own right but good indicators of probability of further, more significant incidents.

2.8 The Flight Data Analyst should assess events in the context of previous experience. In one case series of events showing a trend, but sometimes a one-off event transforms to an incident in exceptional circumstances. Number of events may form a trend at particular airfield, on one aircraft, particular pilot or during a period of bad weather. So analyst using FDA database can produce trend analysis for variety of options to decide informed course of actions.

2.9 Regardless it is safety report or FDA revealed event, the MFD must decide if it is appropriate to take action to prevent repetition. Action may be considered due to safety (high) severity single event or trend of minor events that becomes unacceptable and can lead to financial or operational implications. All actions, decisions taken and conclusions with data used should be recorded in the system to support an audit path.

2.10 Any taken action shall be monitored for anticipated direct effects on the other hand FDA team should observe operational performance to ensure no risks transferred elsewhere. The best practice is before taking action for prevention of high risk or negative trend of events, MFD should suppose area where risk could be transferred. For example, for tyre speed limit exceedence events at take-off caused by slow rotation at airfields with high elevation, expect increase trend for high pitch attitude events at take-off after mitigation action is done.

3. COMMUNICATION

3.1 Efficient communication system, to permit timely safety action, for disseminating hazard information and subsequent risk assessments. Air Astana exercises safety communications internally within company and between external organizations. There are three levels of communication are in place for FDA division:

- Inside department;
- Between FDM team and Air Astana departments;
- Between FDM team and outside providers, contractors and oversight authorities through the Head of the CSC Department.

3.2 As a major means of communication between FDA team and other departments and outside organizations are FD analysis reports and meetings.
In order to make safety communication efficient FDA division shall prepare the following reports:

1. Monthly Flight Data report;
2. Monthly SRB report;
3. Monthly and quarterly SPI report;
4. Annual Flight Data report;
5. Other Reports, such as Special trend analysis can be made by request, detailed analysis reports for the purpose of investigation, Special reports as a part of presentation of Air Astana Safety management program.

3.3 Another means of communication are regularly meetings where FDM team has to participate:

1. Monthly Flight Data review committee;
2. Biweekly Exceptional events and trends meeting;
3. Biweekly internal Management meeting;
4. Other meetings that can be held on request, for example meeting with E&M personnel responsible for EHM, or flight data transfer equipment. Special called meeting on presentation of exceptional event.

3.4 The FDM team should provide both analysis of unusual trend of events if detected, and special detailed analysis of flight or technical issues for better understanding root cause of the events. Special analysis can also be done by request. Flight and Technical Safety Specialists may be requested to provide support in analyzing events where special knowledge is required.

3.5 Data can be interpreted in traces, listing, Flight Data Simulation (FDS), tables, spreadsheets, histogram, graph formats etc. Outcome of the specific trend of events analysis can be used for further communication within Air Astana or even manufacturers of aircraft/system. This communication will have to mitigate the risk to operations by changing procedure, training objectives, aircraft system design etc.

3.6 The FDA team communicates on constant basis with E&M department on airworthiness (Engine Health Monitoring (EHM) program issues, aircraft system operation or structural exceedances). When system captures events related to aircraft system, engine or structural exceedence, then the Flight Data Analyst or MFD sends notification by email to E&M contact person (maintrol) with short description of the event context, including list of some flight parameters required for the maintenance task completion.

3.7 Another monthly task for FDA team is to monitor Fuel Efficiency Report production for Operations Control department. Report should be ready by the end of every 7th day of the month. Additional data can be provided to Operations Control department by FDA team with SVPCSC approval.

3.8 The FDM team shall monitor timely production of Airplane Performance Monitoring (APM) report for Airbus and Boeing aircraft. Report should be prepared in the beginning of the month and sent to Flight Performance Engineer Flight Operations. Flight Data Analyst may pull additional APM report on some airplanes and send it to Flight Performance Engineer Flight Operations upon request.

3.9 The MFD communicates on constant basis with Flight Operations department through Chief Pilot and Fleet Managers on the issues reported by flight crews in ASR or Trip Reports. Chief Pilot can make requests to MFD to check FDR data of the event reported by flight crew.

3.10 Communication with IT department should be maintained by FDA team on constant basis on the issues related Data transfer, processing, backup and archiving. Outstanding issues with data transfer and processing shall be communicated immediately with taking actions on resumption of system operation. All cases related to flight data lost shall be investigated by MFD, then conclusion should be sent to Manager IT or E&M department for taking mitigation actions, the VPCSC shall be informed about FD lost incidents.

3.11 All communications with outside organizations on sharing any Flight Data information should be approved by MFD in written form. Air Astana supports Flight Data Exchange project in order to share with flight data information on international level. Participation in this project should give some advantages in promotion of safety operations by using data statistics available on the site, for example to look at rate of unstable approaches at the airport of intended operation or making comparative analysis for Air Astana current operation. The Analyst has credentials for access FDX site and shall upload all fleets flight data to FDX site on weekly basis http://flightscape.com/FDX/ .

3.12 A monthly review of FDA events will be held as a sub-committee of the Safety Action Group Flight Operations (SAGFO). A report, to serve as basis for minutes, will be provided to Flight Operations.

3.13 Monthly Flight Data Review Committee (MFDRC) is planned for every second Thursday of the month. Membership:

1. Chief Pilot;
2. Director of Standards Department;
3. Standards Manager;
4. Fleet Manager B-757/767;
5. Fleet Manager A-320;
6. Fleet Manager E-190;
7. Director of Training FO;
8. Fleet Training Managers B-757/767, A-320, E-190;
9. Senior Manager Safety Compliance Flight Operations;
10. Fleet Safety Compliance Specialists;
11. Manager Flight Data (MFD);
12. Flight Data Analyst.

3.14 Biweekly Exceptional events and trends meeting is conducted by SVPCSC discussing FDA issues according to agenda prepared by MFD. Agenda should include the following items:

1. Exceptional events (details, consequences, risk, identification, mitigation);
2. Monthly Flight Data Review Report;
3. Other (EHM, Fuel, APM reports, Flight data exchange);
4. FDM software issues;
5. IT issues,
6. Documentation, Policy, Process,
7. Staff;
8. Training.

3.15 The MFD shall attend biweekly internal Management meeting with prepared brief report about Exceptional events for the last two weeks and any trend of events if it has been identified. Reports are kept on protected file server CSC department in Internal Management Meeting Reports folder.

3.16 The MFDR should be prepared by Analyst, and checked by MFD. MFDR consists of six parts:

- **Section A** - Flight Data Recovery.

  This section includes Flight Data recovery rate, number of flown and analyzed flights for the last month by fleet and in total, also such a statistics for the last 12 months.
- **Section B** - All Fleet Summary, **Section C** – Boeing Fleet Summary, **Section D** – Airbus Fleet Summary, **Section E** – Embraer Fleet Summary.

  The structure of all these sections consist of histograms taken for the respective fleet for 10 top events by number and severity factored, top 10 events for three previous months by number, 12 months statistics for operating limitations exceedences, precursors to unstable approach, pitch events, and last month trend of events versus average number of events taken for the previous 3 months. In addition to the listed above items, there can be produced exceptional trend of event taken for aircraft, location, key word, phase of flight etc. Histograms should have description of negative trends with risk evaluation and recommendations for risk mitigation if needed.
- **Section F** – Detailed description of exceptional events that took place in previous month.
- **Section G** – Other issues, such as exceptional trend of events discussion, recommendations for risk mitigation.

3.17 Monthly ASRB report should include:

- Short description of flight data recovery rate, number of flown and analyzed flights for the last month by fleet, and in total.
- Histograms indicating top 5 events for the previous 6 months by number and severity.
- Short description of exceptional events that took place in previous month.
- Analysis of any exceptional trend of events or exceptional events if they have been identified.

3.18 Monthly and quarterly SPI's reports including statistics taken from FDM system on 5 major indicators:

1. Runway Excursion

- Unstable approach;
- Landing from unstable approach;
- Take-off configuration warning;
- Bounced landing;
- Deep Landing;
- High speed rejected take-off;
- Approach speed high.

2. Aircraft damage

- High load event;
- Hard landing;
- Abnormal attitude;
- Maximum landing weight exceeded;
- Airspeed high (VMO);
- Airspeed high (MMO);
- Take-off pitch high;
- Flap/slat speed exceedence;
- Gear speed exceedence.

3. Mid air collision

- TCAS RA;
- Level bust;

- Level bust during Go Around;

4. Controlled Flight Into Terrain

- GPWS terrain warnings;
- Glide slope deviations;
- Localizer deviations;
- Altitude/height lost;

5. Loss of Control

- Stall protection trigger (Alfa floor);
- Approach speed low;
- Wind shear warning (non-compliant);
- Excessive roll attitude;
- Speed decay;
- Go Around (non-compliant);
- Dual side stick input Airbus (more than 1 second).

3.19 The FDA Annual report shall be prepared by FDA team by the end of the March using histogram, tables, listing data etc.

FDM Annual report items are:

- Flight data recovery for previous year;
- Detailed analysis of three major safety concerns of the year with conclusion;
- Exceptional trend analysis report;
- Unstable approach report;
- Hard landing analysis;
- SPI analysis;
- Exceptional event analysis;
- Summary;
- Recommendations;

3.20 Other special reports may be prepared by Flight Data Analyst under MFD supervision and on SVPCSC request, as well as upon request of Flight Operations department, OPS Training, E&M. This report may have different format depending on data required.

Chapter 8 Reporting

1. SAFETY REPORTING

1.1 Safety and Hazard reports are the primary tools for awareness of risks that threaten safe operations in Air Astana SMS. Notification of hazards allows risk mitigation to acceptable levels as determined by Regulations and company standards. Acting upon reported hazards will prevent a repetition but spread information both within company and to industry to prevent “someone else’s accident”.

1.2 While various forms exist to address risks by functional discipline, any member of staff is welcome to send any written format notice to Corporate Safety including e-mail, handwritten note, sending via IQSMS etc. as long as the risk is notified. In case of any doubt or urgent situation any member may call to Safety Officer on after-hours duty, +7 702 702 02 86. The Safety officer (SO) is available 24/7. During office-hours SMSCFO or any of the CSCD staff should be contacted. The Operational Control Centre (OCC) is the 1st primary contact for any operations activity including safety hazards. The SO assists with the specific coordination of safety actions and should keep the OCC and if applicable Maintenance Control Centre (MCC) fully informed. After days off the SO should prepare report of the aviation occurrences happened these days and send the report to operation departments.

1.3 While Corporate Safety administrates Safety Reports, the onus is on the functional department to take action and ensure action is taken to reduce the reported risk. However, all of them shall be submitted to CSCD for statistical purposes.

1.4 Staff, as the safety practitioners who are also the last defence to prevent an accident or incident, should be kept up to date of SMS performance including Safety reporting.

1.5 All reports will be reflected in the data base maintained by CSCD. Where a report is not considered a safety risk, CSCD has to contact the originator to clarify the perceived risk and may then allocate an appropriate risk value but may not remove the (Risk Register) entry.

1.6 The risk value ought to be updated at appropriate Safety Action Group (SAG) meeting.

1.7 The most significant events reported by ASR or revealed by FDA shall be subject to Mandatory Occurrence Reporting to Republic of Kazakhstan Civil Aviation Committee (RoK CAC) and DCA Aruba in accordance with list of incidents laid down in “Defining Incidents and Serious Incidents Subject to Investigation”, approved by Decree of the Government of the Republic of Kazakhstan № 828 of July 2011.

1.8 MOR’s are not subject to FDA confidentiality agreement.

1.9 The FDA system has proven to be very effective tool in reminding crews to file safety reports. In case of significant event or incident found by FDA system, the crews should be encouraged to file retrospective ASR without prejudice or penalty to the crew concerned. Crews should be prompted to submit ASR on the following events:

- Hard GPWS, Stick shaker, Alfa Floor protection speed, over speed warning, major system warning;
- Firm landing, heavy landing;
- Tail scrape;
- Engine failure, shutdown;
- Rejected take-off, go-around from unstable approach;
- Severe turbulence, vortex wake encounters;
- Level bust;
- Flight control problems.

2. FDR DATA RETENTION FOR MOR's

2.1 The RoK CAC doesn't require sending FDR data to control investigations conducted by Air Astana however they expect to check written report of investigation supplemented with FDR data extracts, if it is necessarily for the reviewed case.

2.2 All of the recovered and replayed flight data are kept in the system for minimum 6 months regardless whether it is mandatory reported occurrence or ordinary flight data. Air Astana can use QAR data for investigations, however, if it is significant incident or accident occurred, then FDA team shall take all measures to obtain data from FDR or DFDR, and retain it for analysis and investigation. Flight data of incident or accident shall be kept longer upon request of RoK CAC.

2.3 After an incident, a quick decision has to be made, as to whether FDR data is likely to be useful in an investigation because data can be lost due to short overwriting time of DFDR's.

Chapter 9 Maintaining Aircraft FDA Equipment

1. EQUIPMENT SPECIFICATION

1.1 Air Astana aircraft carry flight data recorder systems not only for the purpose of flight data monitoring but for accident and incident investigation. Thereafter Air Astana maintains serviceability of aircraft FDR equipment in accordance with specifications laid down in Annex 6, Part I and RoK CAC decree #179 from 15.05.2015. An aircraft FDR equipment shall be subject for checking and testing according to respective time intervals described below in paragraph 2.

1.2 Prior to the first flight of the day, the built-in test feature for the E-190 flight data recorder shall be monitored by manual check and by automatic check for B-757/767 and A-319/20/21. Aircraft may be operated with unserviceable flight data recorder system in accordance with MEL requirements (8 further consecutive flights or 72 hours have elapsed since the FDR was found to be inoperative). In this case cockpit voice recorder operates normally. QAR, WQAR or DFDAU unit may be inoperative for dispatch, however for FDA purposes flight data should be downloaded from DFDR.

1.3 In accordance with MEL B-757/767 provisions the Flight Data Recorder is considered to be inoperative when any of the following conditions exist:

1. Loss of the flight recording function is evident to the flight crew during at the pre-flight check e.g. by means of a system status monitor, or
2. The need for maintenance has been identified by the system monitors, where available, with the setting of an indicator and the cause of that setting has not been determined, or
3. Analyses of recorded data or maintenance actions have shown that more than 5% of the total number of individual parameters (variable and discrete) required to be recorded for the particular aircraft, are not being recorded properly.

Note: Where improper recording affects 5% of the parameters or less, timely corrective action will need to be taken in accordance with approved maintenance procedures.

1.4 E-190 MEL statement for DFDR serviceability: DFDR may be inoperative when at least one Cockpit Voice Recorder (CVR) operates normally, and then repairs are made within 20 calendar days.

2. MAINTAINING EQUIPMENT PERFORMANCE

1.1 The FDA programme requires FDA team to monitor continued serviceability of flight data recorder systems installed on aircraft. Appropriate inspections and function checks, together with the intervals at which these need to be performed.

1.2 Annual DFDR and QAR (WQAR) inspections for E-190 and B-757/767 aircraft are carried out during C-check. A-319/20/21 aircraft DFDR and QAR (WQAR) equipment doesn't required annual inspection to be made because all data which is stored on a DFDR is internally checked by the DFDR-BITE. As soon as Read-after-Write-Test detects a discrepancy between the to-be-stored and re-read data words, the BITE will flag Solid State Flight Data Recorder (SSFDR) as faulty and a fault message is displayed on ECAM.

1.3 Annual FDR inspection records are used for recertification of airplane crash recorders and continued aircraft airworthiness.

1.4 Annual inspection records are kept on Air Astana file server under link: http://kcshare.airastana.com
FDA team can share these records with RoK CAC upon request.

Related Guidance Material

Manual on Flight Data Analysis Programmes (Doc 10000)

Safety Management Manual (Doc. 9859)

Operation of Aircraft (Annex 6)

- Part I International Commercial Air Transport – Aeroplanes
- Part II International General Aviation – Aeroplanes

Accident Prevention Manual (Doc 9422)

Flight Data Monitoring (CAP 739)

Approval, Operational Serviceability and Readout of Flight Data Recorder Systems (CAP 731)

ECAST Preparing a Memorandum of Understanding for an FDM Programme

General Operational Policies and Procedures order #419 - 13.07.2011 Kazakhstan Civil Aviation Committee

RK Government Decree #828 - 18.07.2011 ”Rules for investigation of aviation accidents and incidents”

Retention of FDR Information in Case of an Accident or an Incident order #179 from 15.05.2015 Kazakhstan Civil Aviation Committee

Instruction from President of Air Astana Dec 2007

Boeing 757/767 MEL

Airbus 319/20/21 MEL

Embraer 190 MEL