Example Application
of
Analysis Ground Station
(AGS)

Prepared by:

Sam Wellington
Marketing and Support Manager
SAGEM Avionics Inc.
2701 Forum Drive, Grand Prairie, TX ; 75052 USA
Tel: +1 314 3600
E-mail: ags.support@sagemavionics.com

In Conjunction with:

GAIN Working Group B, Analytical Methods and Tools

September 2004

Global Aviation Information Network
ENHANCING AVIATION SAFETY THROUGH SHARING

Preface

This example application has been prepared by SAGEM Avionics in conjunction with the Global Aviation Information Network (GAIN) Working Group B (Analytical Methods and Tools) (WGB) as one of a number of such examples of the use of analytical methods and tools described in the "*Guide to Methods & Tools for Airline Flight Safety Analysis*". The intent of these example applications is to illustrate how various tools can be applied within an airline flight safety department, and provide additional information on the use and features of the tool and the value of such analysis. GAIN WG B hopes that these example applications will help increase the awareness of available methods and tools and assist the airlines as they consider which tools to incorporate into their flight safety analysis activities.

Each example application of an analytical method or tool is posted on the GAIN website (*www.GAINweb.org*). Readers are encouraged to check the website periodically for a current list of example applications, as further examples will be added as they become available.

AGS – Analysis Ground Station

1 Introduction

The AGS is SAGEM's tool for Flight Data Monitoring, and is used by over 80 customers world wide for FOQA (Flight Operations Quality Assurance), MOQA (Maintenance Operations Quality Assurance) or in many cases both programmes. Since the tool is designed for data readout and analysis it is also fully compatible with Flight Investigations and with FDR readouts.

1.1 Flight Data Monitoring – FOQA and MOQA

Flight Data Monitoring is the generic name used to encompass the use of data generated during the flight for the purposes of Flight Operations Quality Assurance – FOQA, and Maintenance Operations Quality Assurance – MOQA. These are broken down and described individually below:

FOQA -

The term FOQA was coined by the Flight Safety Foundation in 1993, which defined it as "a program for obtaining and analyzing data recorded in flight to improve flight-crew performance, air carrier training program and operating procedures, air traffic control procedures, airport maintenance and design, and aircraft operations and design."

A FOQA program is therefore a loose definition for a program which uses the data generated by the aircraft either contained in any onboard storage device or obtained through aircraft-to-base online transmission, to generate an understanding of the quality and standardization of the airline's operations. Most FOQA programs depend on complex software which 'scans' the flight information detecting anomalies in the operations comparing the data with pre-programmed exceedence levels for each type of aircraft.

FOQA does not differ greatly from all existing airline Flight Safety Programs such as "Air Safety Reports" (ASR) in its principle, which is to identify underlying risks in the operation and take the appropriate action to reduce these risks. Where it does differ, is that rather than depend on human perception and reporting of risk situations, the program depends upon the concept that aircraft generate data during flight which describes the behavior of that aircraft during that flight. For regulation reasons, this data is stored in crash resistant devices known as Flight Data Recorders (FDR), to be used for the purposes of investigation if that aircraft were to suffer an accident. Since their use was made obligatory, the number of parameters of the flight which are available for recording - and the number which are recorded - has changed greatly. This data, if analyzed after a normal flight, and compared to a list of parameters set out according to the tolerance thresholds determined by the Flight Operations Department of the airline may show situations where certain parameters exceed these thresholds. These situations are known as exceedences, and if enough flights are analyzed, generating a database of exceedences, their locations, aircraft - this will allow the airline to assess its risks and propose ways to reduce these.

Today this data is made available most frequently though a series of different forms of non-crash resistant recorders, some making a copy of the FDR recordings, other far more flexible with the ability to record parameters not currently present on FDR recordings, or at a faster rate.

MOQA-

The concept of MOQA can be understood along similar lines of FOQA programs, but with a different focus. MOQA programs depend basically upon results leading to the greater understanding of the aircraft operationally from a maintenance stand point.

2 Input Data

Originally the input data to Flight Data Monitoring programmes was generated exclusively by earlier generation Flight Data Recorders (FDR), which were originally intended for post accident or serious incident investigations. With time these grew in capability from the original 6 parameters recorded on foil to the modern generation storing 50 hours worth of about 1000 parameters.

Another advance that led towards the modern FOQA approach was the introduction by manufacturers of non crash-resistant recorders on board aircraft. These were initially intended for trouble shooting purposes, since the availability of certain data from the flight can be essential to understanding known problems with certain airplanes or flights.

The use of data recorded on these non crash-resistant, easily accessible recorders, known as Quick Access Recorders (QAR) for the purposes of a FOQA program quickly became obvious. The efficiency of any program implemented in a company operating aircraft with QAR installed would be clearly greater. Eventually recording capability was added directly to the data management or data acquisition units, allowing for a direct access to the data to be recorded, and therefore a recording which was user configurable, and easily modifiable since this was no longer tied to the signal being sent to the FDR – this capability became known as Direct Access Recorder (DAR).

The AGS is capable of accepting data from all commercially available FDR, QAR and DAR sources on the market due to its capability for input frame customization.

3 Analytical Process

The data input process is relatively automatic, with its setup varying from one airline to another due to differences in onboard recording systems. In general this consists of a tower of drives capable of reading the type of media recorded by the aircraft, into which the media from the aircraft are placed. If the airline chooses to keep track of media serial numbers for the purposes of media quality tracking these can be entered manually, otherwise most recorders on the market allow for the recording of a tail number or aircraft registration which the AGS can detect. The data entry window can be seen in figure 3.0.

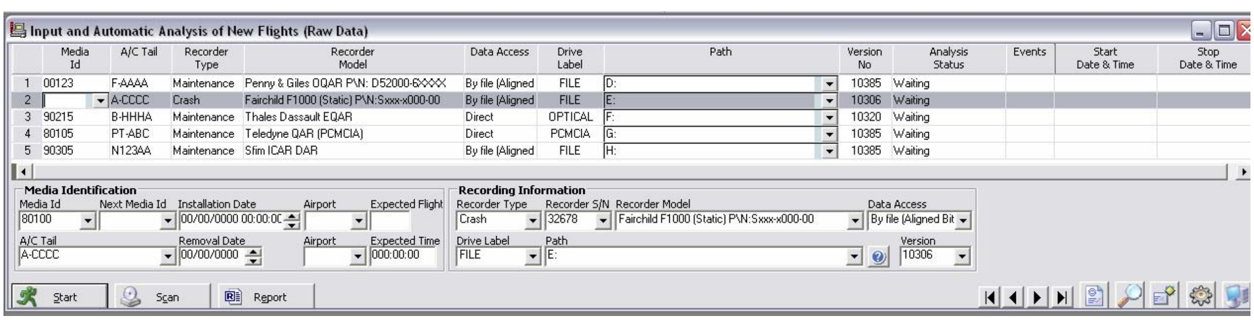


Figure 3.0 **Data Entry Window showing sample tails and media**

During the process of data entry the raw data file is physically stripped of its identifying characteristics to be chosen by the customer (usually flight number and day), and this information is stored in a separate file, linked by a password known only to the person elected as gatekeeper if it is necessary to regain this information for further investigation or understanding of a detected anomaly. The file with the identification is usually deleted after a customer defined period of time.

This data can then be accessed by a lost which can be ordered by media inputted, flights detected events detected or flight snapshots detected; a definition of these terms follows below.

3.1 KEYWORDS & CODING

3.1.1 Media Information

Within the context of the AGS the media is defined as the source of the data for the AGS. If a PCMCIA card or an optical disk is inserted with a certain number of flights it is always possible to search only for the flights that came from that particular media. Other types of media of course can be direct access to the FDR themselves, Mini or Micro QAR recorders and magnetic tapes from QAR.

3.1.2 Flight Information

The AGS has the capability of editing the raw file to detect the different phases of the flight, its origin and destination, the duration of the flight and other identifying features of the flight. This allows the user to search through all the information entered by any characteristic of the flight – say the destination airport.

3.1.3 Event Information

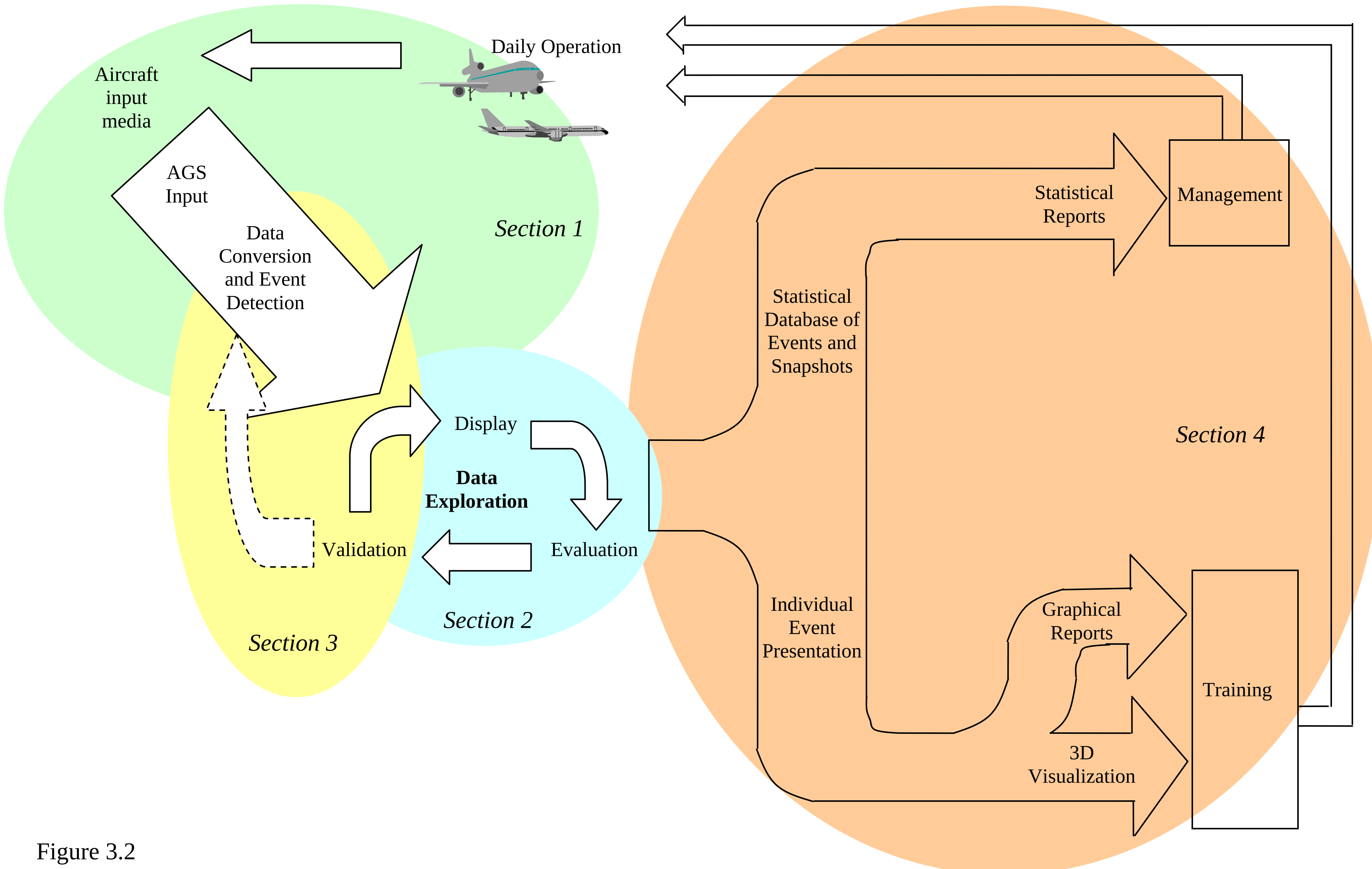
One of the primary goals of any Flight Data Monitoring software is the ability to compare the existing data to a pre-defined set of limitations for a particular parameter or a combination of parameters. Exceeding this value by a predetermined amount of time is known as an Event. The ability to sort the information by events allows the user quick access to the information, and therefore a greater ease to visualize the event itself in order to judge its validity in the context of the data; this is described more fully in section 3.2.

3.1.4 Snapshot Parameters

The ability to record the value of certain parameters at specific moments in every flight allows the company to have a greater understanding of their operation. These values are known within the AGS as snapshot parameters, and what needs to be recorded and at which time is defined by the AGS user. Examples of this tend to be memorization of specific parameters at 1000 feet above ground level on approach, or at touch down.

3.2 What is the generic procedure for the program?

The day to day process of flight data monitoring should be considered an iterative process. The diagram below in figure 3.2 illustrates the full process of flight data monitoring. The steps in section one of the diagram illustrate the data entry process, the frequency of which will of course be dependant upon the number of flights that the airline operates. Section two of the diagram describes the daily procedure of the data analysts who review each event either in tabular or graphical form. This process may lead to an understanding that the triggers for detection of that event were not well defined, which can lead to a small iterative loop labelled section 3. Finally, section four demonstrates the presentation of the data to the airline – this can be done through two branches, the first for an individual event which illustrates an anomaly of operations, from which all the pilot group can learn, or the training department can exploit to change training procedures, and the second branch uses a built in data mining software to generate statistical reports which can be used to describe the airlines operations.



Daily Operation
Aircraft input media
AGS Input
Data Conversion and Event Detection
Section 1
Display
Data Exploration
Validation
Evaluation
Section 2
Section 3
Statistical Database of Events and Snapshots
Individual Event Presentation
Statistical Reports
Management
Section 4
Graphical Reports
3D Visualization
Training

Figure 3.2

3.3 Event Definition – Trigger levels

One of the most essential elements of a Flight Data Monitoring Program, be it for FOQA or MOQA, is the ability to define your own events – or exceedence trigger levels. The AGS goes beyond simply having a predefined set of events for which it searches where the user can change the trigger levels. The user can interact directly through the software's user friendly programming language to define any key data the operator may wish to detect an exceedence of. This is a key factor, especially in markets where there are very specific operations (approach and departures) which a particular user may wish to monitor, and would not necessarily be of interest to other users. Complex definitions such as unstable approaches which may vary significantly from operator to operator are also better detected when the user has access to their definition.

3.4 Additional Parameter Definition

On many occasions aircraft will not be programmed to record all the parameters required for an adequate analysis of the data. These may, however, be derivable from the data at hand. This was traditionally done for parameters such as vertical velocity, but in many occasions may reach to corrections of parameters poorly recorded, the correct value of which may be ascertained through computation based on other parameters – fuel quantity based on gross weight change can be done when the quantity is unreliable. Again this interface is open to the user, so that corrections and computations beyond those programmed before delivery can be entered by the operators.

4 Tool Output

The tool outputs for the AGS as suggested in section 3.2 are basically of three different types, which are outlined below;

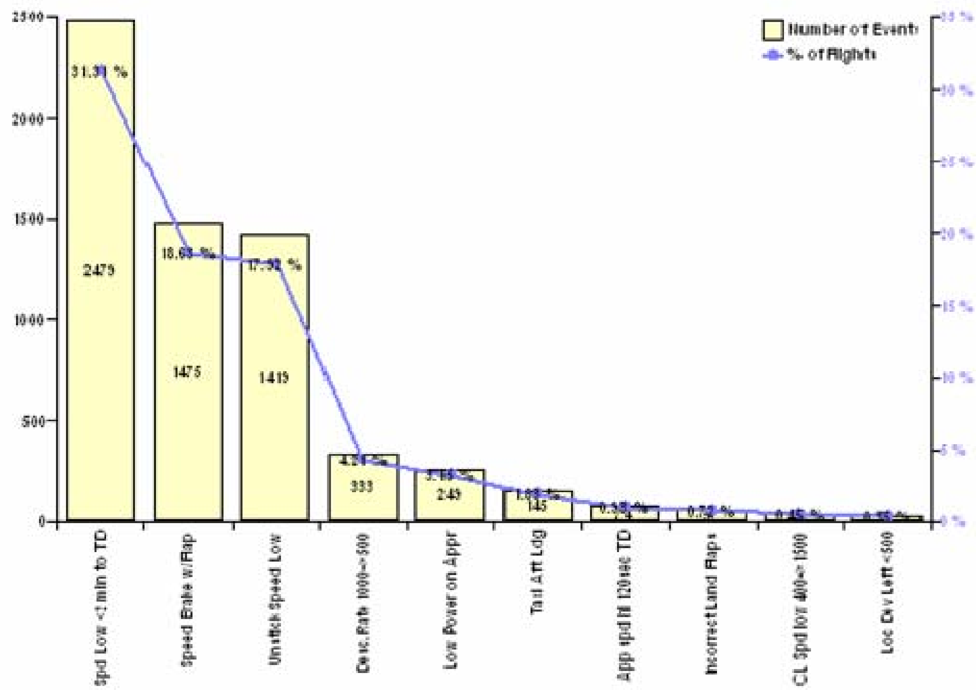
4.1 Statistical Reports

The AGS generates through its standard operation a database of detected exceedences and a database of parameter values at specific points in time – here defined as snapshots and often referred to in the market as routine operational measurements. Statistical reports can be made from either of these, filtered in which ever way the user wishes, be it through timeframe, aircraft type city-pair and so on, or even a comparison between two periods, fleets and so on. These two kinds of reports tend to have different applications and are described below individually for such reason.

4.1.1 Statistical Event Reports / Exceedence reports

By far the most well known and expected result of any good Flight Data Monitoring program particularly those geared to FOQA. Whilst the AGS is geared to assess all the times that parameters have exceeded a predefined limitation, it is the statistical part of the software which allows the user to have a picture of how often this is happening, and in doing so understand the level of risk that the company is exposed to. These reports tend to work on a "top ten" basis and be divided on a monthly, quarterly or yearly time base, and tend to be made more relevant through allowing comparison between two time periods – and for some airlines two fleets. A further level of assessment leads to breaking down graphically the occurrence of a particular event by a different characteristic, say a particular city pair route. An example of this is below in figure 4.1.1.

Top 10 Class 3 Events - 2003



Event Short Name	Number of Events	% of Flights	Avg Time Exposure	Avg Max Value
Spd Low <2 min to TD	2479	31.31 %	32 sec	119
Speed Brake w/Flap	1475	18.63 %	28 sec	69
Unstick Speed Low	1419	17.92 %	141 sec	40
Desc.Rate 1000->500	333	4.21 %	10 sec	-1803
Low Power on Appr	249	3.15 %	17 sec	277
Taxi Aft Ldg	145	1.83 %	42 sec	114
App spd hi 120sec TD	74	0.93 %	80 sec	261
Incorrect Land Flaps	57	0.72 %	1 sec	2
CL Spd low 400->1500	36	0.45 %	7 sec	135
Loc Dev Left <500	28	0.35 %	11 sec	2

	Event Count	Event %
Average	179.31	2.26 %
Standard Dev	517.80	6.54 %
Standard DevP	510.55	6.45 %

Figure 4.1.1

4.1.2 Snapshot Reports – Routine Operational Measurement Reports

These reports draw on information that was entered into the database about every flight that met a certain condition – such as a touchdown, a take-off or crossing the threshold.
Many times these reports are used for specific studies of a particular aspect of the certification. The few examples below demonstrate touchdown points on a runway, and localizer/glideslope deviation.

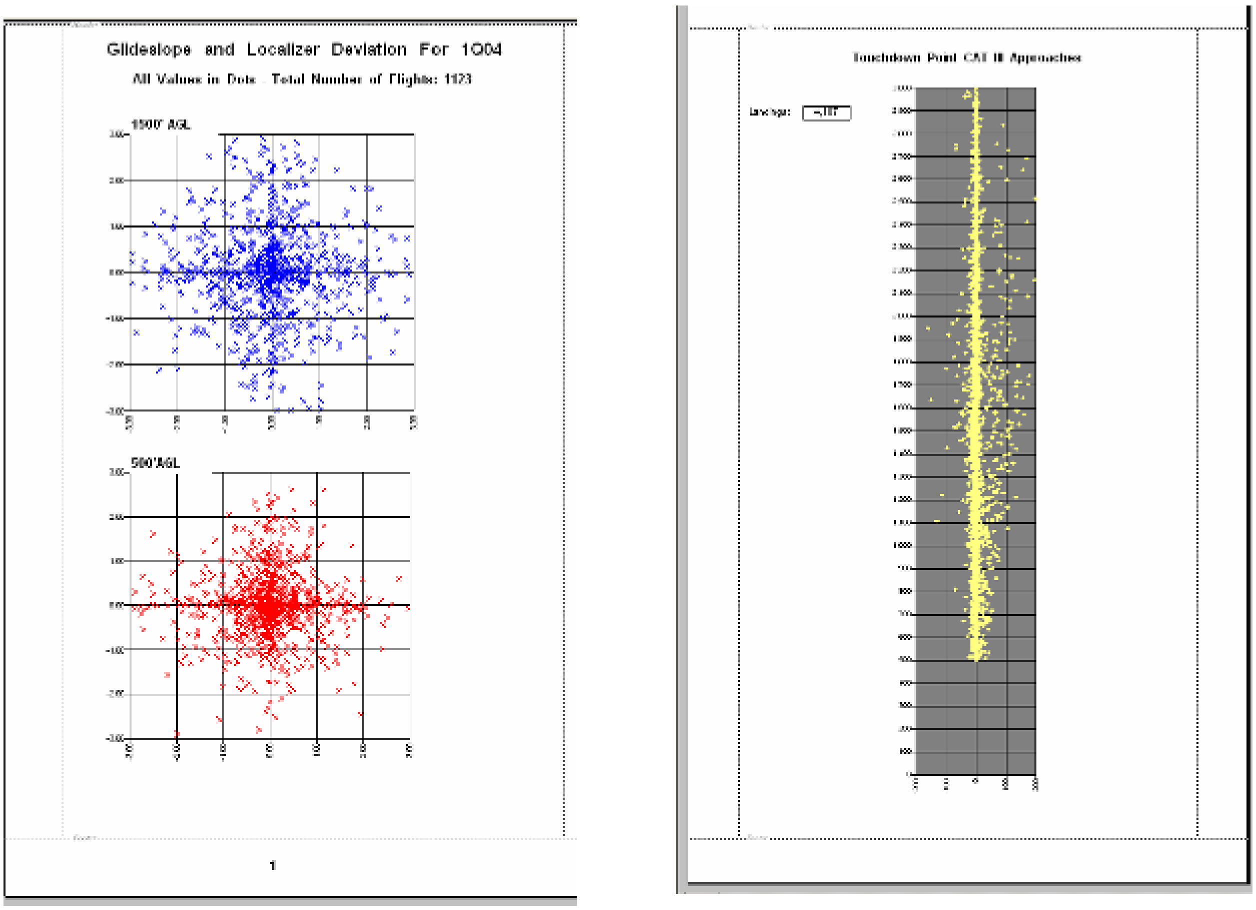


Figure 4.1.2

4.2 Individual Event Analysis

Although the statistical reports above describe the airlines operations, many times it is necessary to understand a particular occurrence – and in many cases generate reports or visualizations from this occurrence to allow crews to understand what has happened and avoid these situations in future. The AGS allows this to be done graphically or in tabular form, and interfaces with many visualization softwares available on the market. Screenshots of this are available below in figure 4.2.

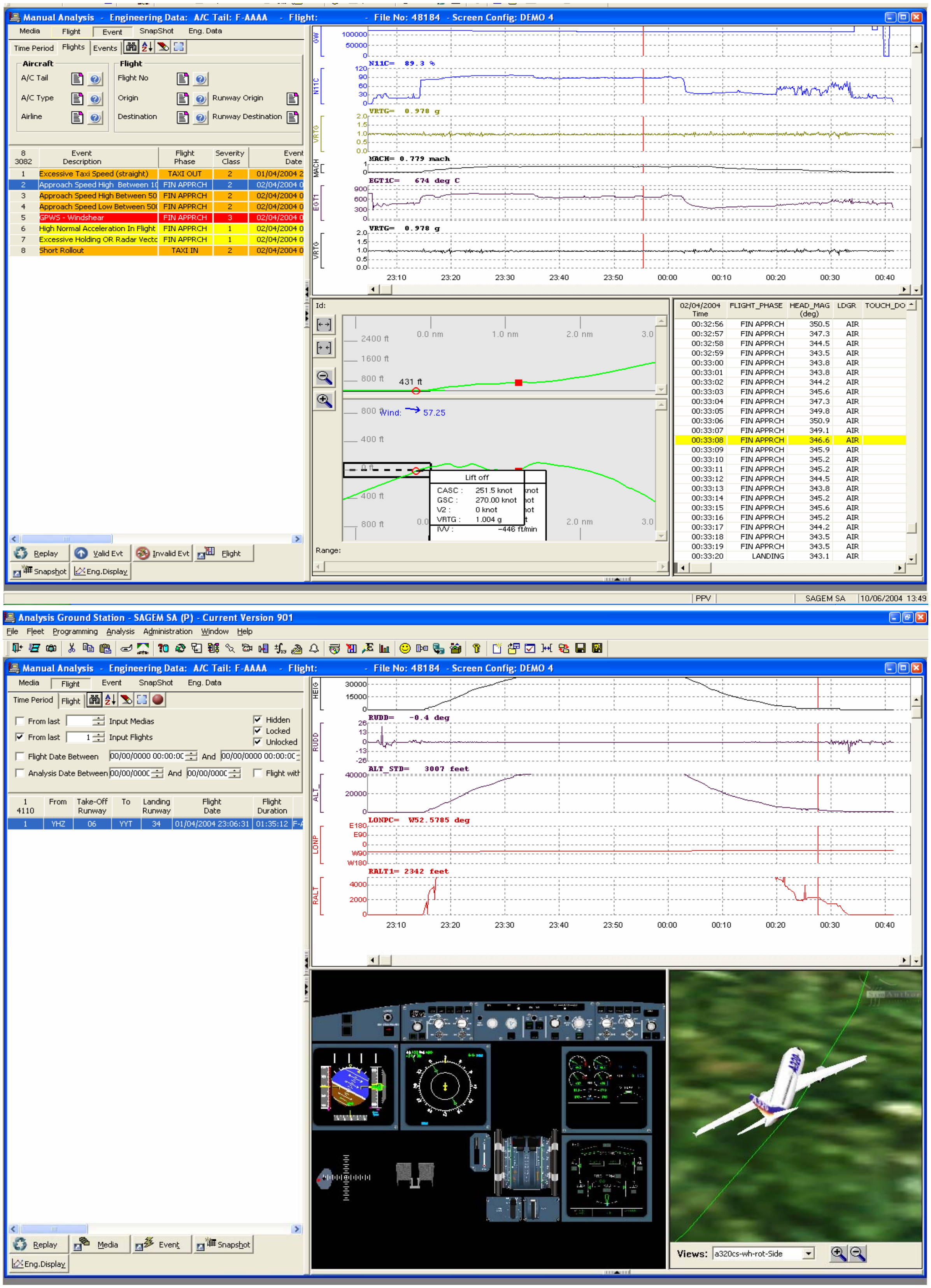

Manual Analysis - Engineering Data: A/C Tail: F-AAAA - Flight: - File No: 48184 - Screen Config: DEMO 4
Media Flight Event SnapShot Eng. Data
Time Period Flights Events
Aircraft
A/C Tail
A/C Type
Airline
Flight
Flight No
Origin
Destination
Runway Origin
Runway Destination
Event Description
Flight Phase
Severity Class
Event Date
Excessive Taxi Speed (straight)
Approach Speed High Between 10
Approach Speed High Between 50
Approach Speed Low Between 50
GPWS - Windshear
High Normal Acceleration In Flight
Excessive Holding OR Radar Vecto
Short Rollout
TAXI OUT
FIN APPRCH
TAXI IN
N11C= 89.3 %
VRTG= 0.978 g
MACH= 0.779 mach
EGT1C= 674 deg C
Wind: 57.25
Lift off
CASC : 251.5 knot
GSC : 270.00 knot
V2 : 0 knot
VRTG : 1.004 g
IVV : -446 ft/min
Range:
FLIGHT_PHASE
HEAD_MAG (deg)
LDGR
TOUCH_DO
Replay
Valid Evt
Invalid Evt
Flight
Snapshot
Eng.Display
PPV
SAGEM SA
10/06/2004 13:49
Analysis Ground Station - SAGEM SA (P) - Current Version 901
File Fleet Programming Analysis Administration Window Help
From last
Input Medias
Input Flights
Hidden
Locked
Unlocked
Flight Date Between
Analysis Date Between
And
From
Take-Off Runway
To
Landing Runway
Flight Date
Flight Duration
YHZ
06
YYT
34
01/04/2004 23:06:31
01:35:12
RUDD= -0.4 deg
ALT_STD= 3007 feet
LONPC= W52.5785 deg
RALT1= 2342 feet
Media
Event
Views: a320cs-wh-rot-Side

Figure 4.2

5 Application of the Analysis Results

In summary the AGS is a multiple functionality flight data monitoring tool, allowing for Flight Safety use as well as Maintenance/Engineering/Troubleshooting use which the industry has termed FOQA and MOQA respectively. The philosophy of the software is to allow full user flexibility in the configuration of the tool, and maximum compatibility with sources of data, including of course airline specific data configuration from non-crash resistant easy access recorders (QAR/DAR). The AGS is designed to plough through the data, performing physical data de-identification if required by the user, compare this data to series of pre-set limits of time and value thus generating information about non-standard conditions of flight.

The software also has the ability to generate values in its database of parameters at key moments of the flight, allowing for a statistical “image” of the airline’s operation at that particular moment in flight, allowing for studies of many aspects of flight – one of the most typical being the analysis of glideslope and localizer deviation at different heights AGL.