Lima FDA Seminar

Presented by Paul DUBOIS
AIRBUS - Airline SMS & FDA Assistance

ANALYSIS WORKFLOW

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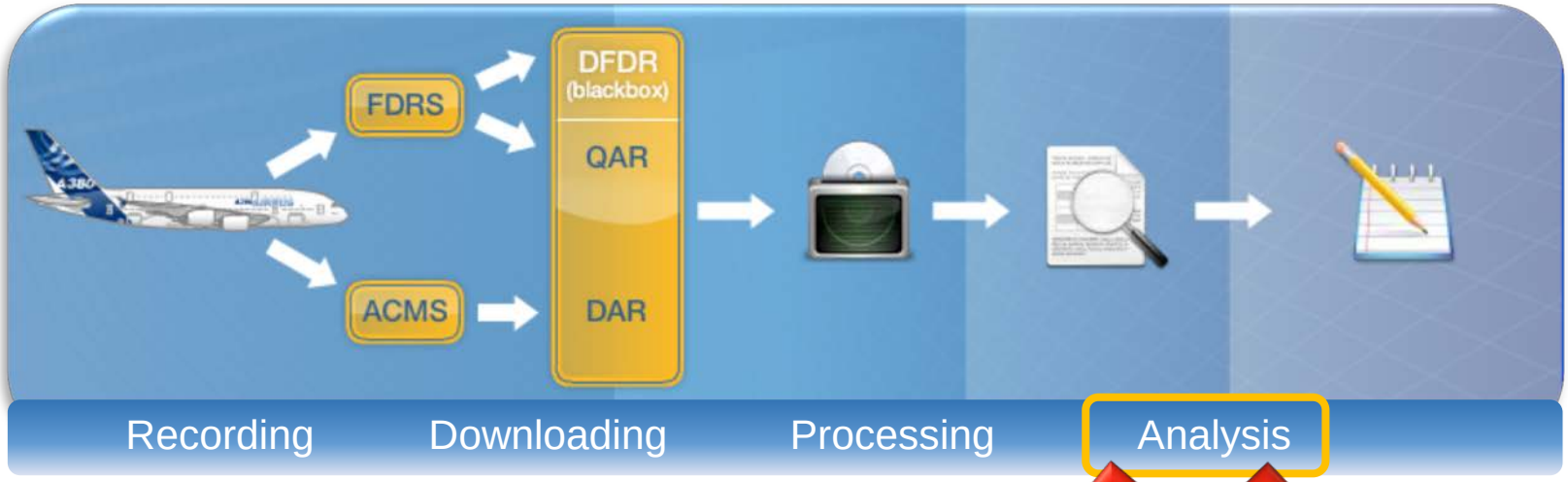
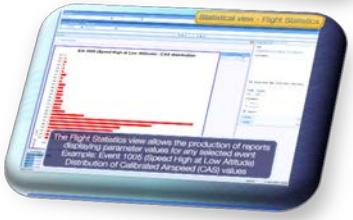
ANALYSIS WORKFLOW





FDA Objectives

- …
- Identify **potential and actual hazards** in operating procedures, fleets, aerodromes, ATC procedures, etc…
- Identify trends
- Monitor the **corrective actions effectiveness**
- **…**

FDA Workflow

Hazard Identification through

- Occurrences
- Trends

Monitoring

NEED OF A MEANINFUL DATABASE

Cleaning

ANALYSIS WORFLOW

CLEANING

HAZARD IDENTIFICATION

TRENDS MONITORING

FUNDAMENTALS

BEST PRACTICES

ANALYSIS WORKFLOW - CLEANING

Physically wrong Events / Flights can be generated by:

- Acquisition Chain failure
- FDA software algorithm logic limitation

Some others are not relevant because out of realistic environment

The Flight Data cleaning task is done systematically on the new data entering the system, this data cannot be used for aggregation or statistical purpose before the end of this cleaning process.

ANALYSIS WORKFLOW - CLEANING

All remaining reliable events are stored into a clean and meaningful database and will be investigated on a regular basis to highlight any trend that could show a latent or potential risk.
This guarantees a faster and more accurate occurrence analysis.

A cleaning is **necessary**,

but it is usually **difficult** and **time consuming**

TECHNICAL CLEANING

Detection of wrong flights

Goal is to detect invalid flights due to technical problem, e.g. flight phase detection, data frame counter, etc…

Some automatic special events can highlight possible wrong flights:

- corrupted data (100),
- incomplete flight (109),
- unknown phase (110).

TECHNICAL CLEANING

Detection of wrong events

Goal is to detect invalid events due to technical failure e.g. sensor failure, Bias etc…

Mainly identified though:

- very high deviation from operational envelop
  (e.g. speed at 300 kt at takeoff)
- and/or being out of operational reality
  (GPWS alert in cruise)

TECHNICAL CLEANING

Detection of wrong flights/events

When a flight or an event is identified as wrong or false, the cause should be investigated and related staff/organization should be informed.

And finally the flight/event should be **deleted** to prevent from polluting the database.

ANALYSIS WORKFLOW - CLEANING

A319

example

Events | Flight Phases | 3D | Configuration | Airport

Single Events

Event	Time	Description	Unit	Low	Medium	High
1917	10/07/2014 06:47:56 GMT	Stick dual input	(x>=2°) AND (y>=2°)	#	TOL>=0.25 sec	TOL>=3 sec
1917	10/07/2014 06:47:58 GMT	Stick dual input	(x>=2°) AND (y>=2°)	#	TOL>=0.25 sec	TOL>=3 sec
1404	10/07/2014 06:48:03 GMT	Rate Of Descent High in Approach (below 500ft)	IVV <: TOL = 3s	-1000 ft/min	-1100 ft/min	-1300 ft/min
1917	10/07/2014 06:48:15 GMT	Stick dual input	(x>=2°) AND (y>=2°)	#	TOL>=0.25 sec	TOL>=3 sec
1917	10/07/2014 06:48:21 GMT	Stick dual input	(x>=2°) AND (y>=2°)	#	TOL>=0.25 sec	TOL>=3 sec
1917	10/07/2014 06:48:35 GMT	Stick dual input	(x>=2°) AND (y>=2°)	#	TOL>=0.25 sec	TOL>=3 sec
1917	10/07/2014 06:48:37 GMT	Stick dual input	(x>=2°) AND (y>=2°)	#	TOL>=0.25 sec	TOL>=3 sec
1033	10/07/2014 06:48:39 GMT	Tail wind at Landing (below 100ft)	Average tail wind from 100 to 0ft >	8 kts	11 kts	15 kts
1917	10/07/2014 06:48:39 GMT	Stick dual input	(x>=2°) AND (y>=2°)	#	TOL>=0.25 sec	TOL>=3 sec
1914	10/07/2014 06:48:41 GMT	Overweight Landing	Landing weight > =:	#	#	61 + 1%
1917	10/07/2014 06:48:41 GMT	Stick dual input	(x>=2°) AND (y>=2°)	#	TOL>=0.25 sec	TOL>=3 sec
1023	10/07/2014 06:48:41 GMT	Speed Low at Touch down	CAS <:	VLS -5 Kts	VLS -8 Kts	VLS -10 Kts
1052	10/07/2014 06:49:52 GMT	High Speed Exit Detection	Info event	Info event	Info event	Info event

Trend Events

Event	Time /	Description
2004	10/07/2014 06:48:03 GMT	Continuously Steep during final

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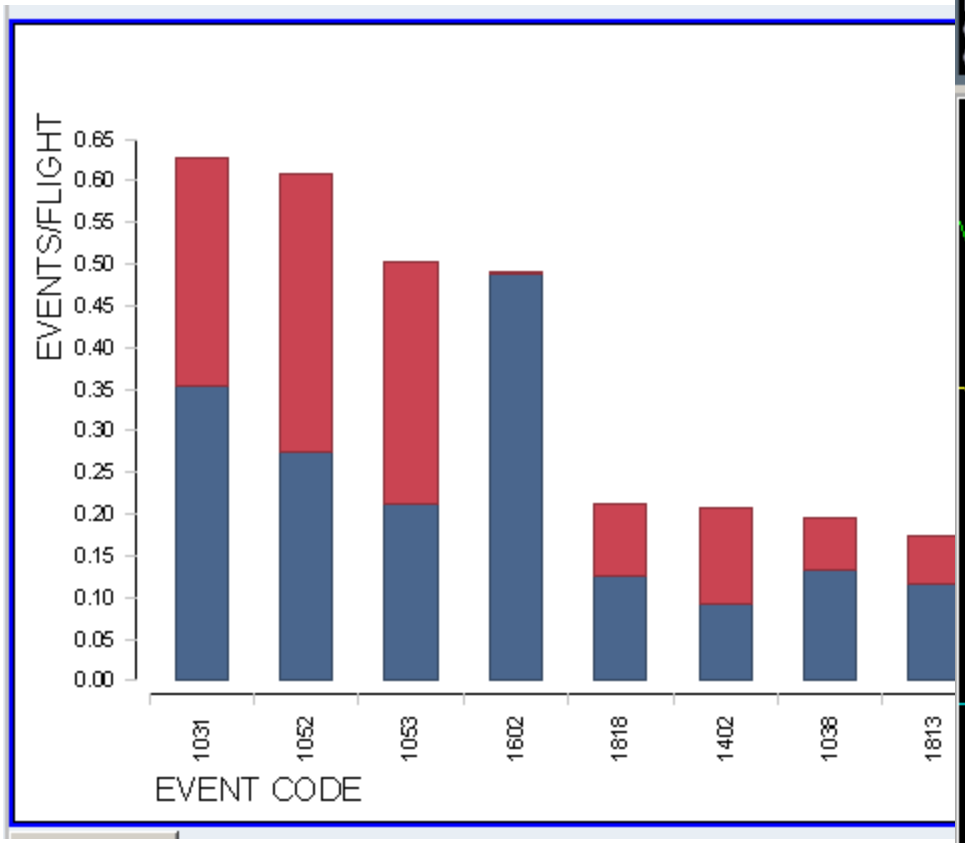
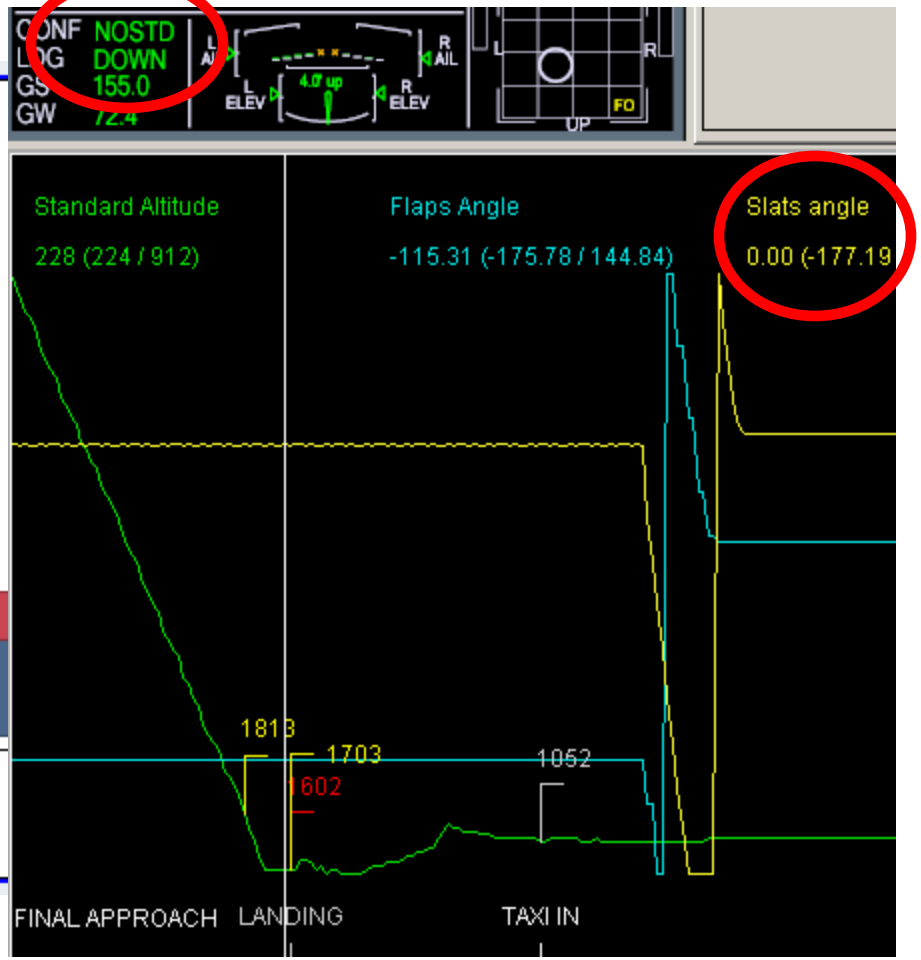
ANALYSIS WORKFLOW - CLEANING

example

This airline has 2 A/C (Red and blue)





Event 1602: Flaps questionable setting at landing

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OPERATIONAL CLEANING

Detection of specific flights

Goal is to remove flight from the database which are not relevant with normal operation like technical flights, training flights, etc…

On that flight many events will be generated (as engine failure or go-around) and these events if maintained in the database will give a wrong picture of the regular operations.

OPERATIONAL CLEANING

Detection of specific flights

Some automatic special events can highlight possible specific flights like event 101- Training Flight

The ideal is to check the flight planning and to remove from the database the related flight (usually identified by a specific call sign)

ANALYSIS WORKFLOW - CLEANING

OPERATIONAL CLEANING

Detection of irrelevant events

The goal is to remove events properly triggered but induced by operational constraint or decision: circle to land, visual approach etc...

We look at High Severity events which are rarely triggered or showing a significant safety hazard.

example

Panzhihua.mp4

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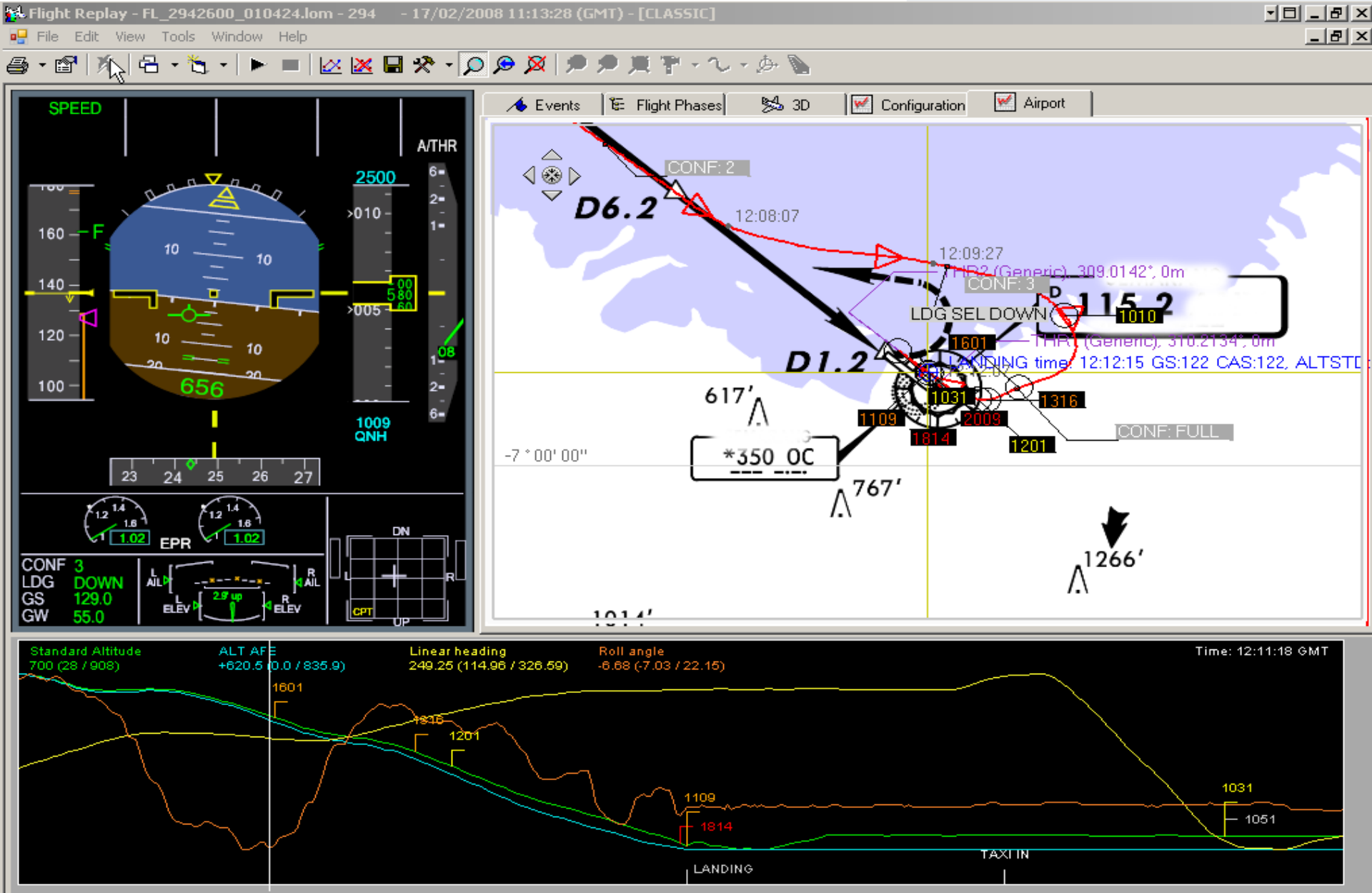
ANALYSIS WORKFLOW - CLEANING

example



ANALYSIS WORKFLOW - CLEANING

OPERATIONAL CLEANING

LOC_dev.lom

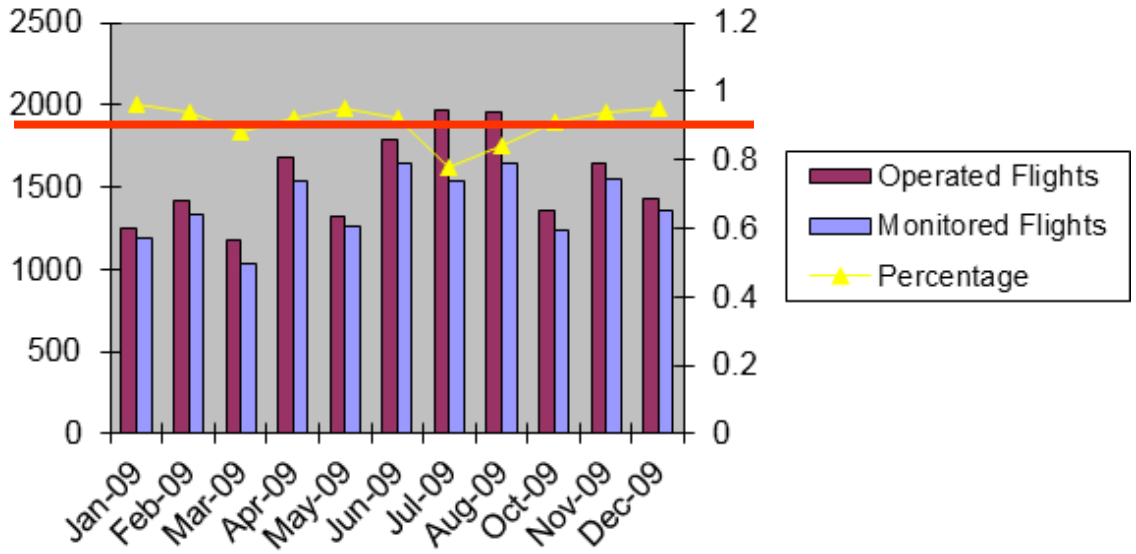
Some questions before deleting:

- *Is the flight replay representing the reallity?*
- *What is the operational goal of the event?*
- *What will be the consequences of deleting or maintaining it?*

ANALYSIS WORKFLOW - TOOL PERFORMANCE

At the end of the cleaning process it is possible to compare the number of retrieved flight with the number of operated flight.

The ratio Retreived Flight / Operated Flight is a Safety Performance Indicator that should be monitored.



ANALYSIS WORKFLOW

CLEANING

HAZARD IDENTIFICATION

TRENDS MONITORING

FUNDAMENTALS

BEST PRACTICES

What is an Hazard?

Condition or Object with the potential of causing :

- ➔ **Injuries to personnel**
- ➔ **Damage to equipment or structures**
- ➔ **Loss of material**
- ➔ **The reduction of ability to perform a prescribed function**

From Occurrences

Once the database is cleaned a flight safety team member will investigate

- ✓ Any flight with a **HIGH SEVERITY** Events

To understand and interpret the results properly, pilots who are conversant with flight data analysis and proficient on the aircraft type must be involved for their operational expertise.

ANALYSIS WORKFLOW - HAZARD IDENTIFICATION

The **flight operations interpreter** will try to understand and identify:

- Contextual elements
- Triggering factors
- Hazardous situation

With the FDA tool capabily using the flight replay, the navigation chart, airport visualization as well as the statistics module.

With, if needed, crew interview to get the exact context of the occurrence.

ANALYSIS WORKFLOW - HAZARD IDENTIFICATION

- Crew Interview process should be **clearly defined** and **agreed by all parties** within the Airline (gate keeper/ **flight crew contact person**).

- Crew interview should be performed in order to increase the understanding of a situation with the objective of improving safety.

- Crew interview should be prepared with real questions to be asked.

ANALYSIS WORKFLOW - HAZARD IDENTIFICATION

From the analysis of all these elements, hazard identification souhld have been completed.

The next step is to assess the risk.
The safety manager is in charge of the risk assessment.

A Safety Issue should be opened if it does not already exist.

A mitigation action could be requested at the SAG (Safety Action Group) or at the SRB (Safety Review Board) in order to maintain the risk at an acceptable level.

ANALYSIS WORKFLOW - HAZARD IDENTIFICATION

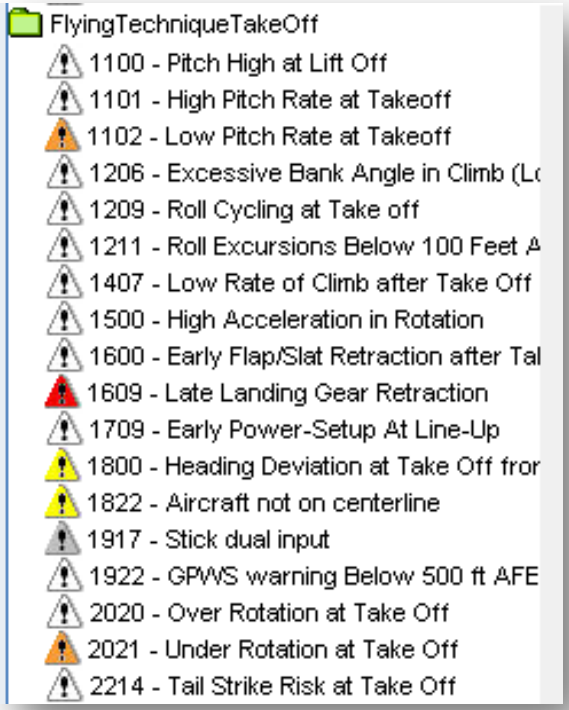
When the workload is too heavy to analyse all the red in a raw the **Flight Safety Manager** may decide to focus initially on **main identified issues.**

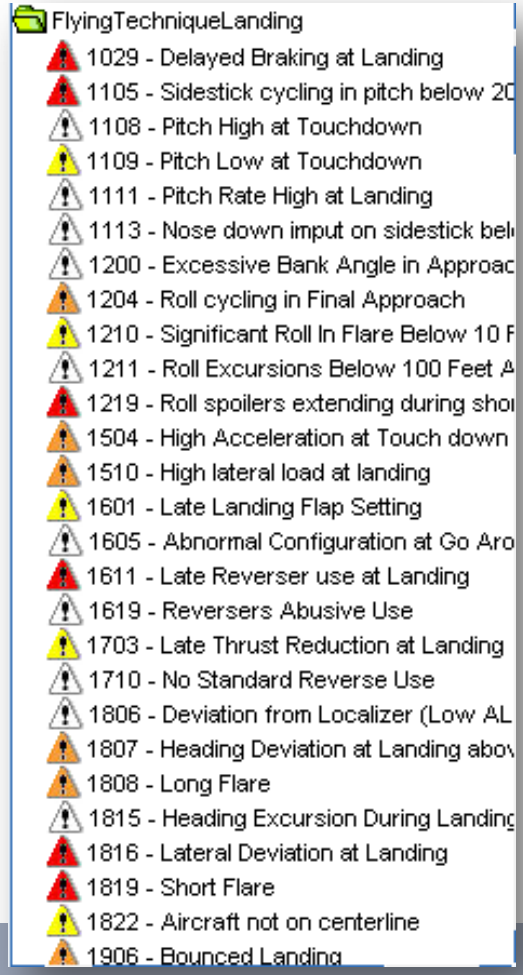
In that order **High Priority** event folders may be created into the FDA tool.

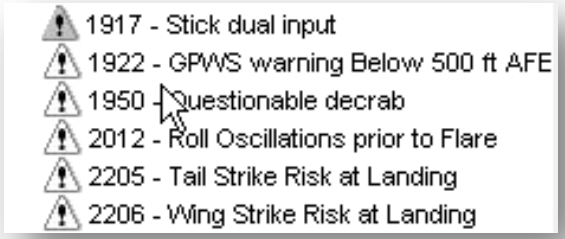
Examples of Customized Ever

ANALYSIS WORKFLOW - HAZARD IDENTIFICATION

Examples of Customized Event Folder in AirFASE B2



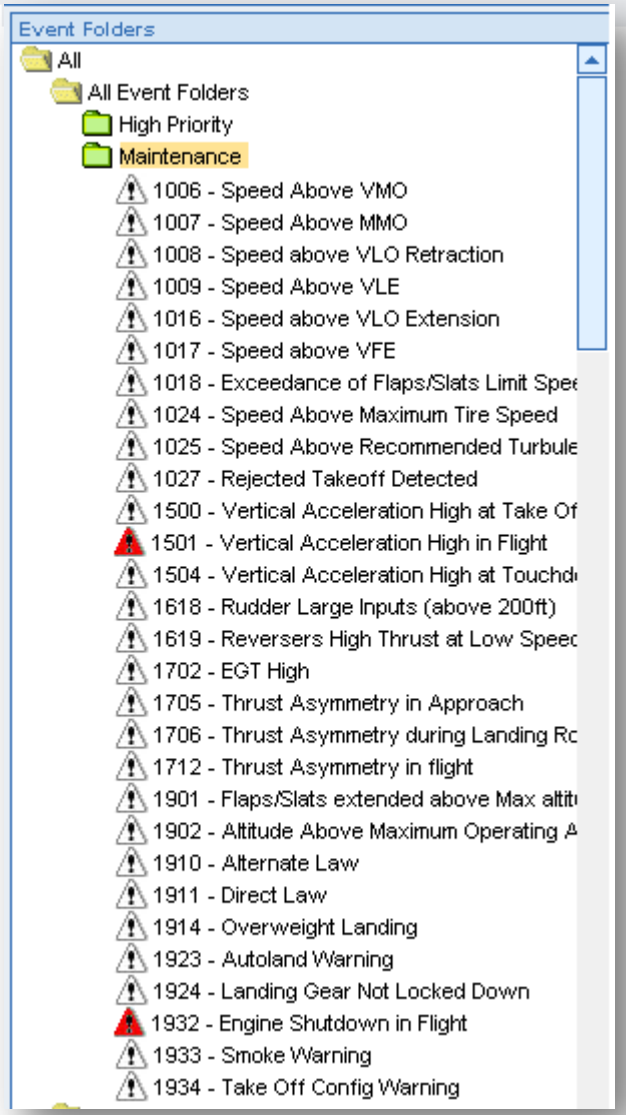




Maintenance Event

The objective is to monitor elements which can benefit the maintenance of the aircraft by crosschecking the **need of inspection** following events related to aircraft structural domain or system failures

In that order a specific folder can also be created



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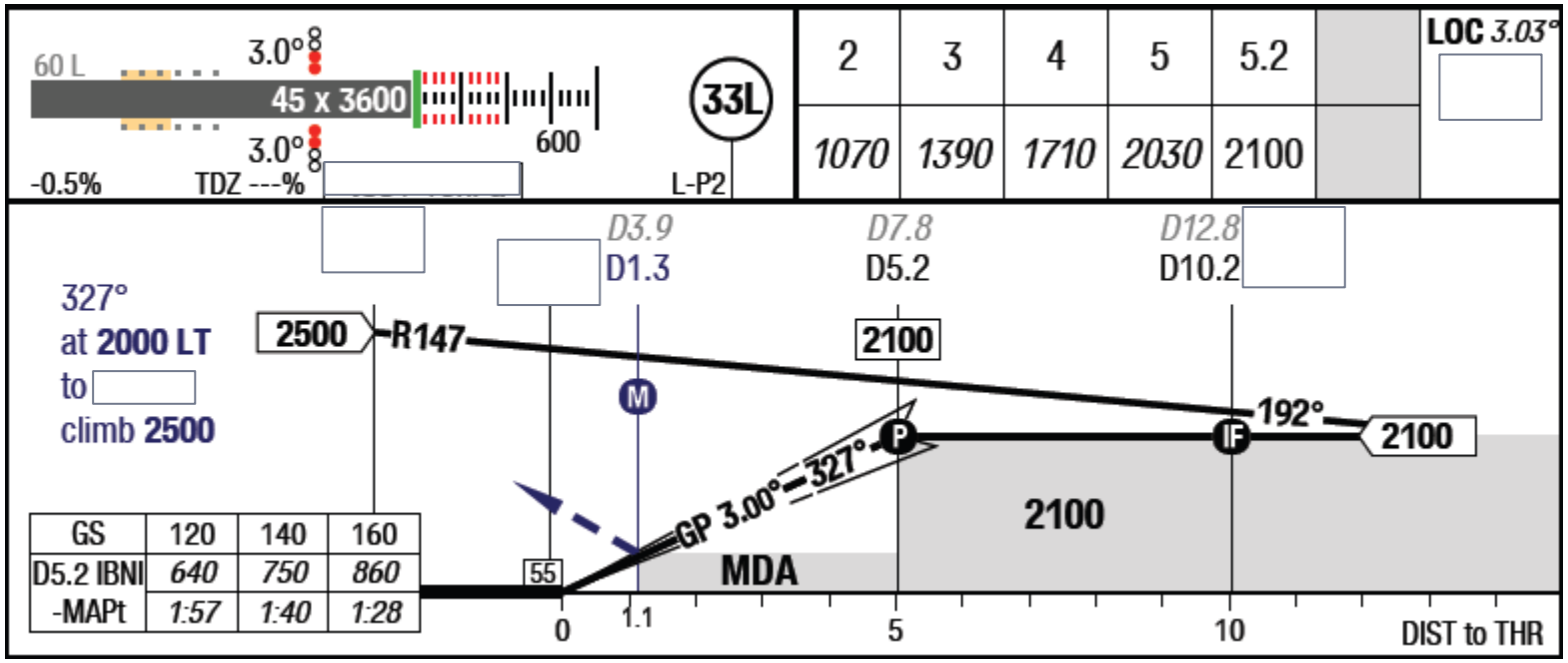
ANALYSIS WORKFLOW - HAZARD IDENTIFICATION

Customized folders are used only to **prioritize** the task of the safety team but by the end of the day all the **red occurrences** should be investigated.

ANALYSIS WORKFLOW - From Occurrence

example

On May 14th, XXX765 shown a **high severity short flare distance event** at YYYY airport on RWY33L.



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ANALYSIS WORKFLOW - From Occurrence

example

A Safety analyst opened the associated flight and replayed it.

By using different modules of the FDA tool, the Safety analyst was able to:

- ➔ Replay the flight,
- ➔ Visualize the descent profile according to the arrival charts
- ➔ Find out other associated **high severity** event like Path Low in Approach at 400 ft, G/S Warning
- ➔ Extract significant snapshots.

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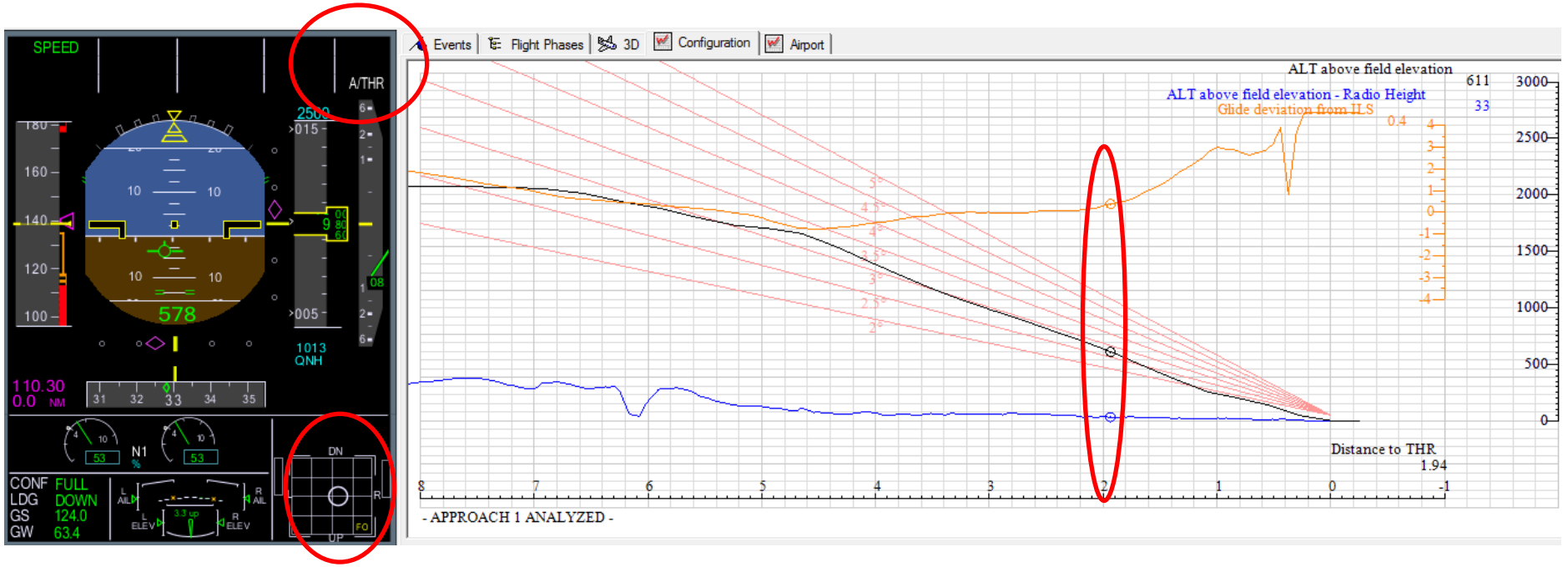
ANALYSIS WORFLOW - From Occurrence

example

At 620ft RA, AP and both FDs were disengaged and the aircraft was flown manually on F/O side.



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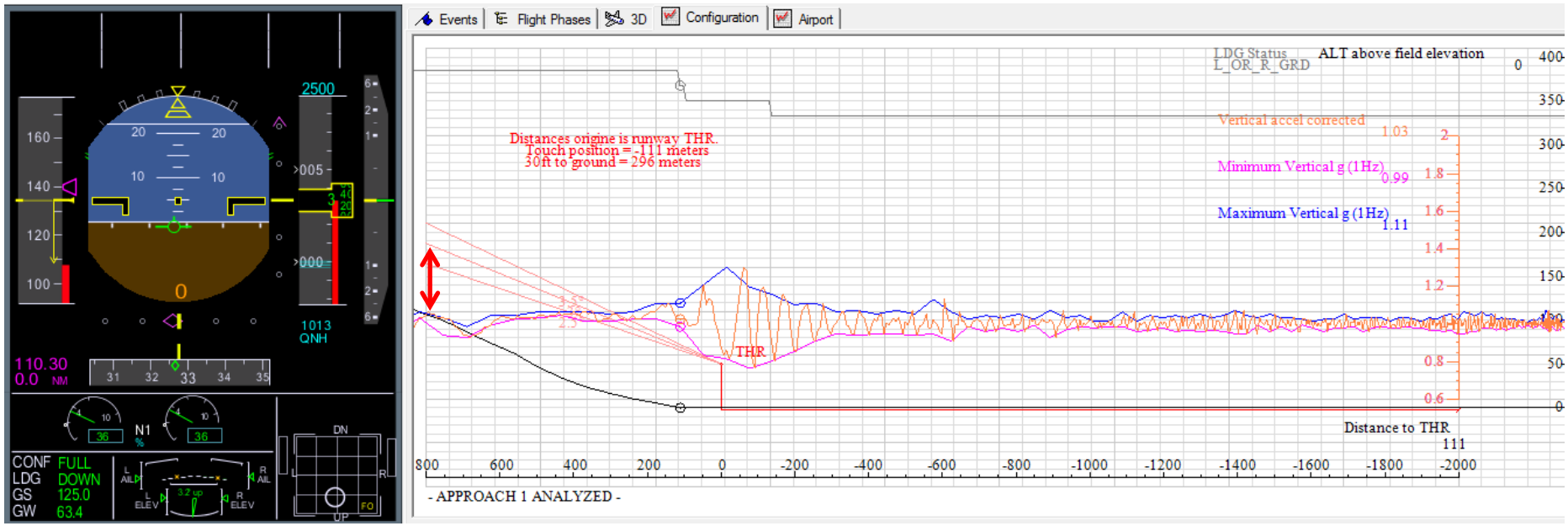
ANALYSIS WORKFLOW - From Occurrence

example

Then the vertical speed increases from -750ft/min to -930ft/min with strong headwind.
The aircraft consequently starts to fly a low path angle during the whole final approach (reaching 2 dots below the G/S at 320ft RA).



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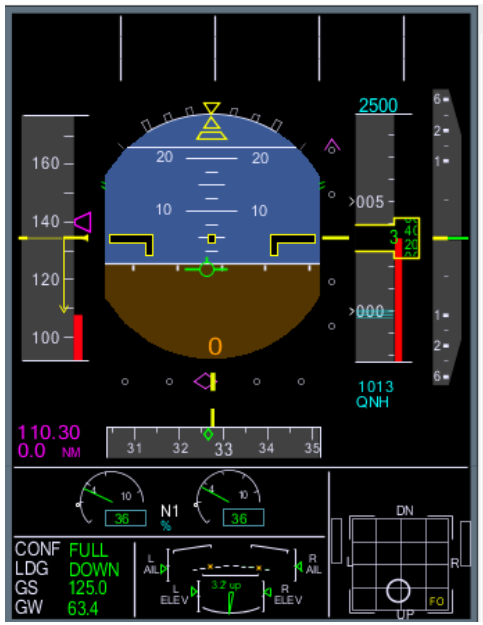
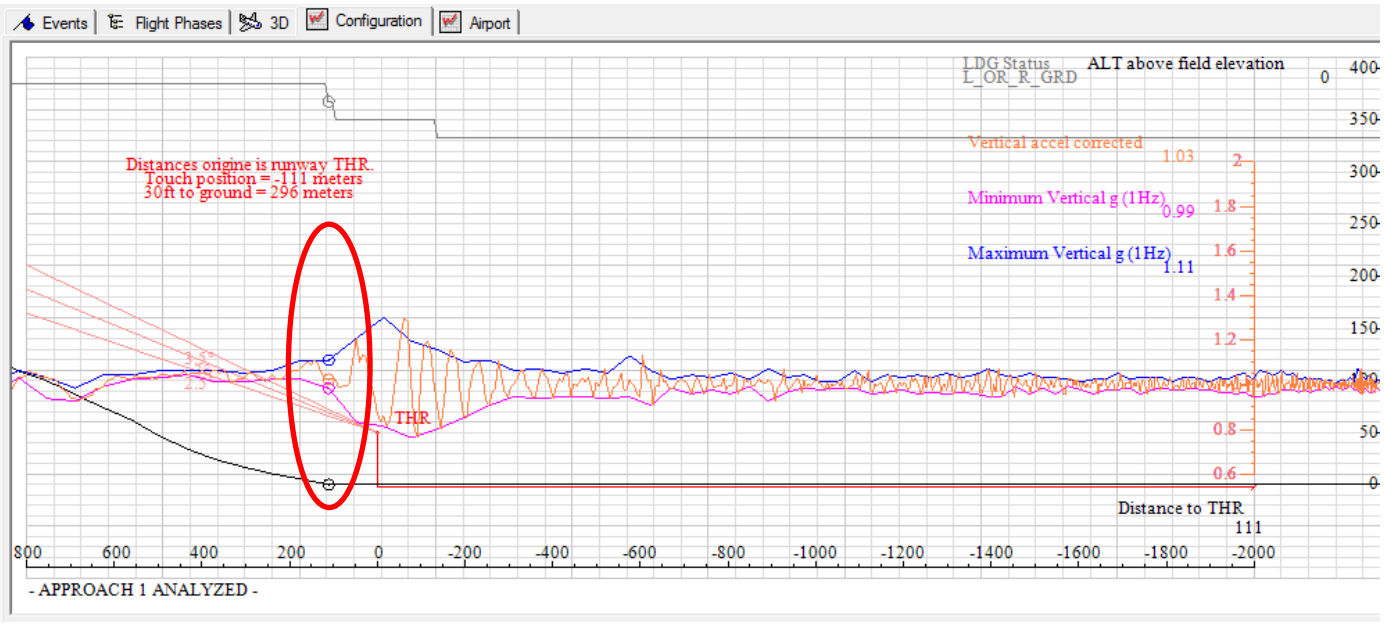
ANALYSIS WORKFLOW - From Occurrence

example

The aircraft touches down around **110m before the threshold**, triggering a positive “Short flare distance” event.





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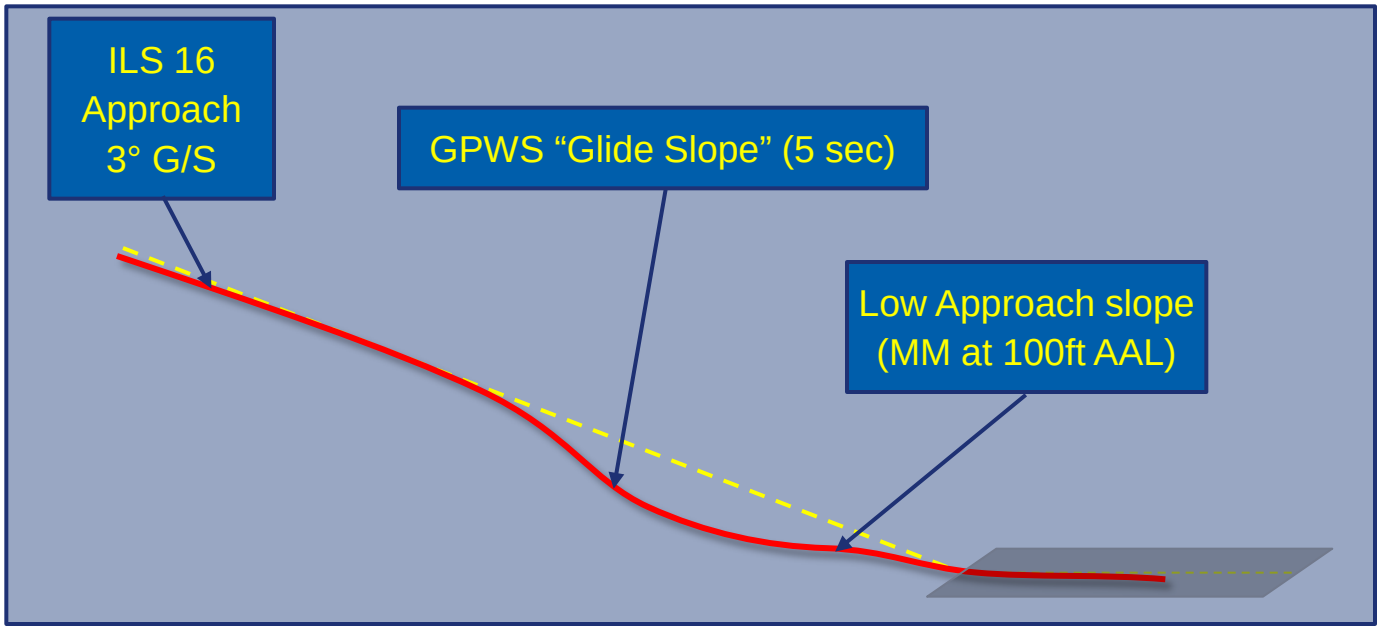
ANALYSIS WORKFLOW - From Occurrence

example

Main facts:

- ✓ Unstabilized approach
- ✓ Night time
- ✓ Manual Flight
- ✓ **T-VASIS**



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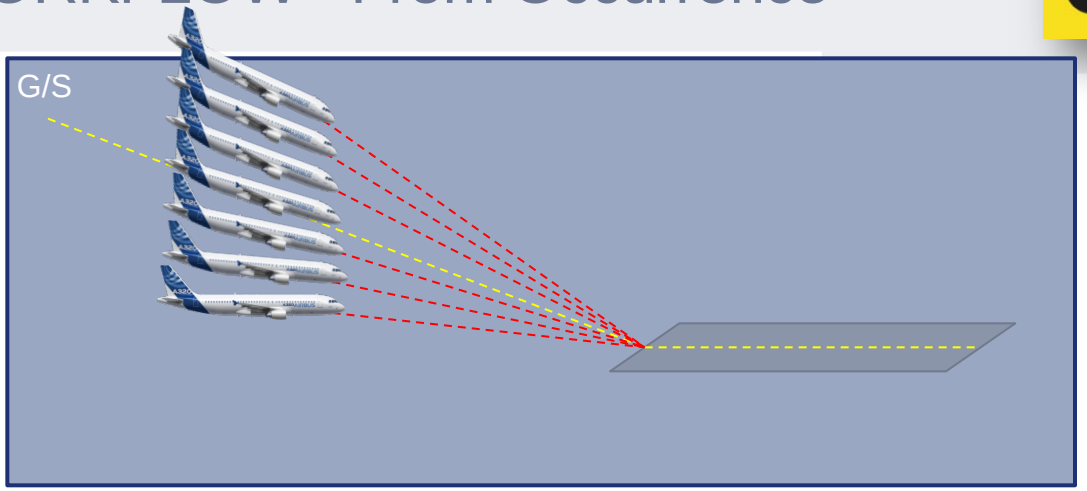
ANALYSIS WORKFLOW - From Occurrence

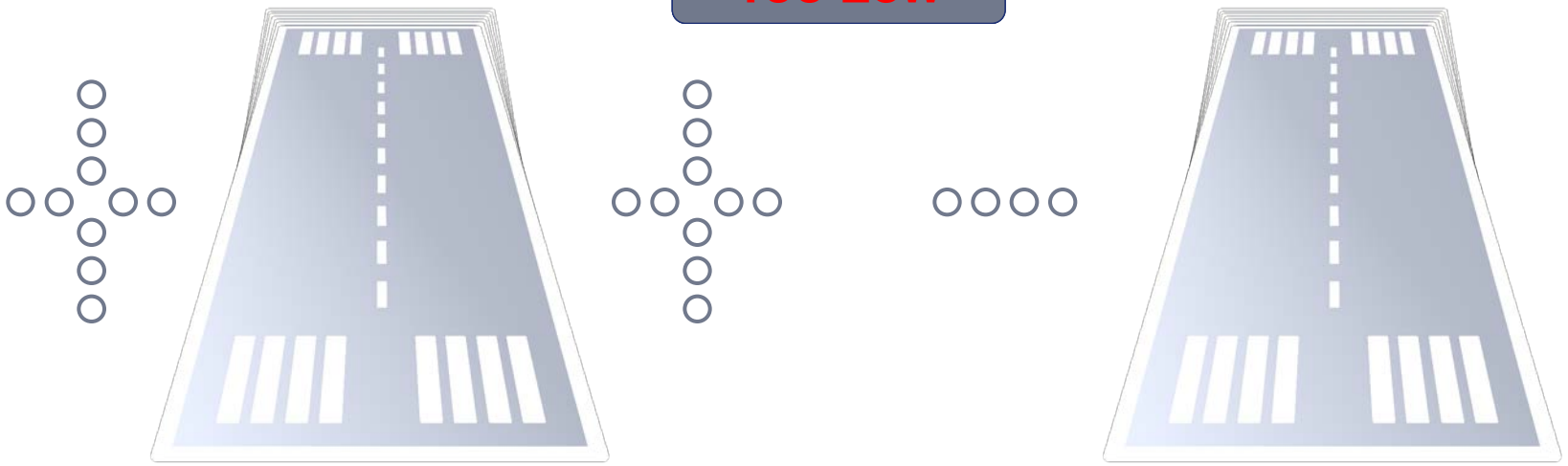
example



T-VASIS

Too Low

PAPI



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ANALYSIS WORKFLOW - From Occurrence

example

Of course a crew interview and a dedicated report from the crew has been requested.

Unstabilized approach, low path, very short flare distance and finally, landing before the threshold, demonstrate a serious Safety matter.

Enough to have the willpower to understand why it occurred in order to track down the weaknesses that must be corrected.

A **Safety Issue** should be opened

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ANALYSIS WORKFLOW - SAFETY ISSUE

A manifestation of a hazard, or a combination of several hazards, in a specific context.

Could be highlighted through recurrence of similar hazards

e.g. FDA tool frequently detects High rates of descent at a specific airport

Sometimes raised from one single potentially severe hazard or an event revealing a new systemic hazard

e.g. Landing on a taxiway (or before the threshold)

ANALYSIS WORKFLOW - SAFETY ISSUE

Any time an FDA study reveals a new Safety issue:

It must be submitted to the Flight Safety Manager for validation and risk assessment and handover to the Safety Action Group or the Safety Review Board for mitigation.

How to assess the risk?

By assessing for each hazards

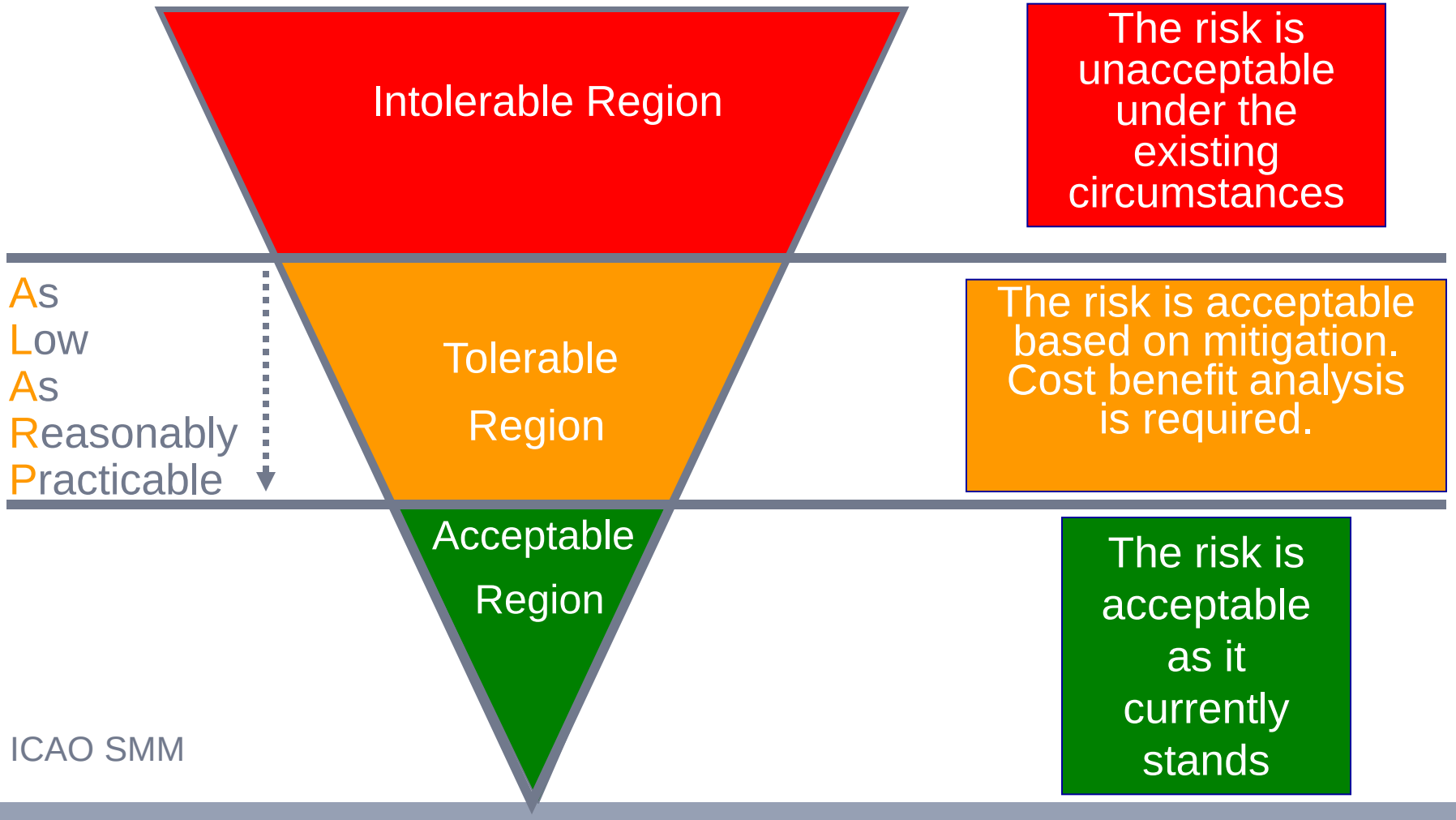
➔ The **severity** of the potential outcomes

➔ The **probability** that it will occur

Risk Probability		Risk Severity				
		Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent	5	5A	5B	5C	5D	5E
Occasionnal	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely Improbable	1	1A	1B	1C	1D	1E

ANALYSIS WORKFLOW - RISK ASSESSMENT

Risk Tolerability relative to this safety issue



ICAO SMM

ANALYSIS WORKFLOW - RISK MANAGEMENT

STEP 1) **Identification of elementary**:

Hazard(s), Risk(s) and Consequence(s)

For each Risk:

- STEP 2) Identification of defenses
- STEP 3) **Risk Assessment** of the consequence:
  - STEP 3A) **Severity** of the consequence
  - STEP 3B) **Probability** of occurrence of the risk

Risk Tolerability

STEP 4) **Risk Mitigation**

ANALYSIS WORKFLOW - From Occurrence

example

Elementary Hazards	Consequences	Associated Risk Index (ICAO Matrix)	Defense Domains	Actions Proposal
Flight Path Deviation	Controlled Flight Into Terrain (CFIT)	3A (INTOLERABLE)	- GPWS - Crew Redundancy - Visual Aids - ILS Signal	- SOP: Improved Approach Briefing - Communication on GPWS reliability
Unstabilized Approach	- Runway Excursion (RE) - Overshoot/ Undershoot (USOS) - Abnormal Runway Contact (ARC)	2B (TOLERABLE) 3B (TOLERABLE) 4C (TOLERABLE)	- Go Around - Stabilization Policy	- Information on unstabilized approaches (Improved safety awareness)
Night Flight	- Crew Fatigue	2B (TOLERABLE)	- Crew Rostering	?
Inconsistency between two visual aids	- Misinterpretation	4A (INTOLERABLE)	- Training - Crew redundancy	- Visual Aids Info Reminder (Urgent) - Info to Authorities

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ANALYSIS WORKFLOW - From Occurrence

example

- FDA revealed through unstabilized approach a misinterpretation of T-VASIS system. Thus, the following correctives actions could be considered:

Reminder (bulletin) to all crew on:
- T-VASIS characteristics
- Terrain which are equipped with T-VASIS
- Unstabilized approach procedure
- …

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ANALYSIS WORKFLOW

CLEANING

HAZARD IDENTIFICATION

TRENDS MONITORING

FUNDAMENTALS

BEST PRACTICES

ANALYSIS WORKFLOW - TRENDS MONITORING

Trends monitoring procedure allows the operator organization to be protected from the degradation of operational drifts.

FDA tool has statistics module in order to comply with the willing of continuously monitoring Event Deviations distribution and evolution.

ANALYSIS WORKFLOW - TRENDS MONITORING

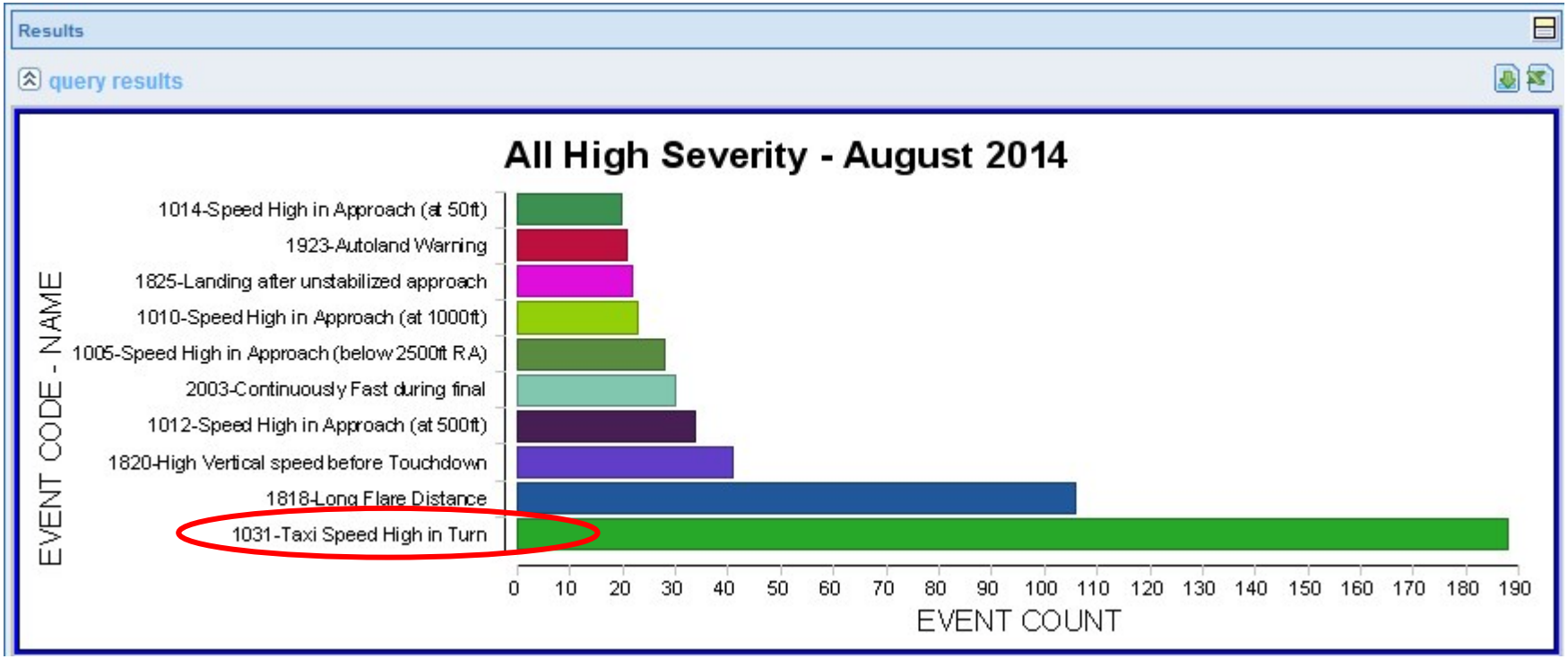
The monitoring procedure consists in regularly reviewing:

- ➔ the trend of High Priority Analysis events in order to decide when it is time to react in order to stop, even reverse the trend before it becomes unacceptable in term of risks,
- ➔ the effectiveness of a mitigation action,
- ➔ but also to highlight any new Safety issue.

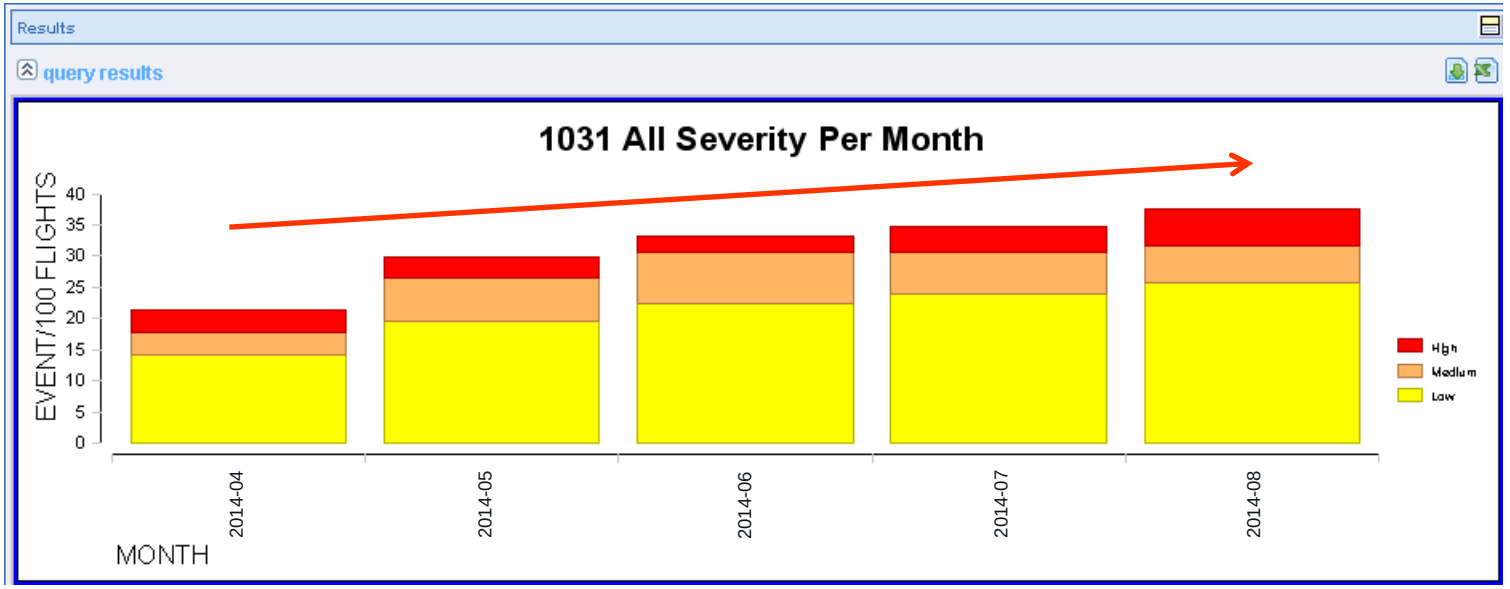
ANALYSIS WORKFLOW - TRENDS MONITORING

There are many different indicators that could be produced on regular basis. One of these indicators could be **All High Severity Events**

For a given month it represents one of the safety indicators directly linked to overall Safety performance of the operator.



ANALYSIS WORKFLOW - TRENDS MONITORING



A Safety issue should be opened in order to answer some questions:

- Are the associated risks acceptable ?
- What are the root causes ? What if this trend continues ?

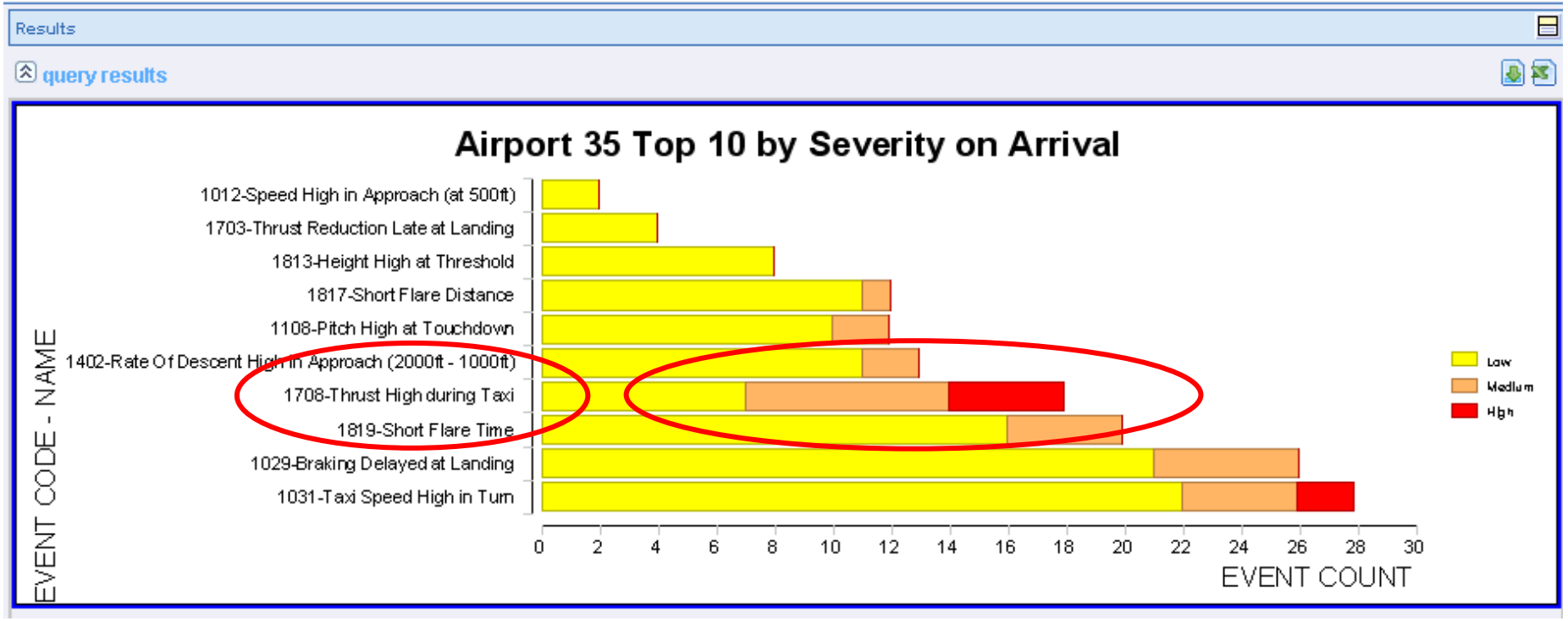
ANALYSIS WORKFLOW - TRENDS MONITORING

Examples of possible indicators

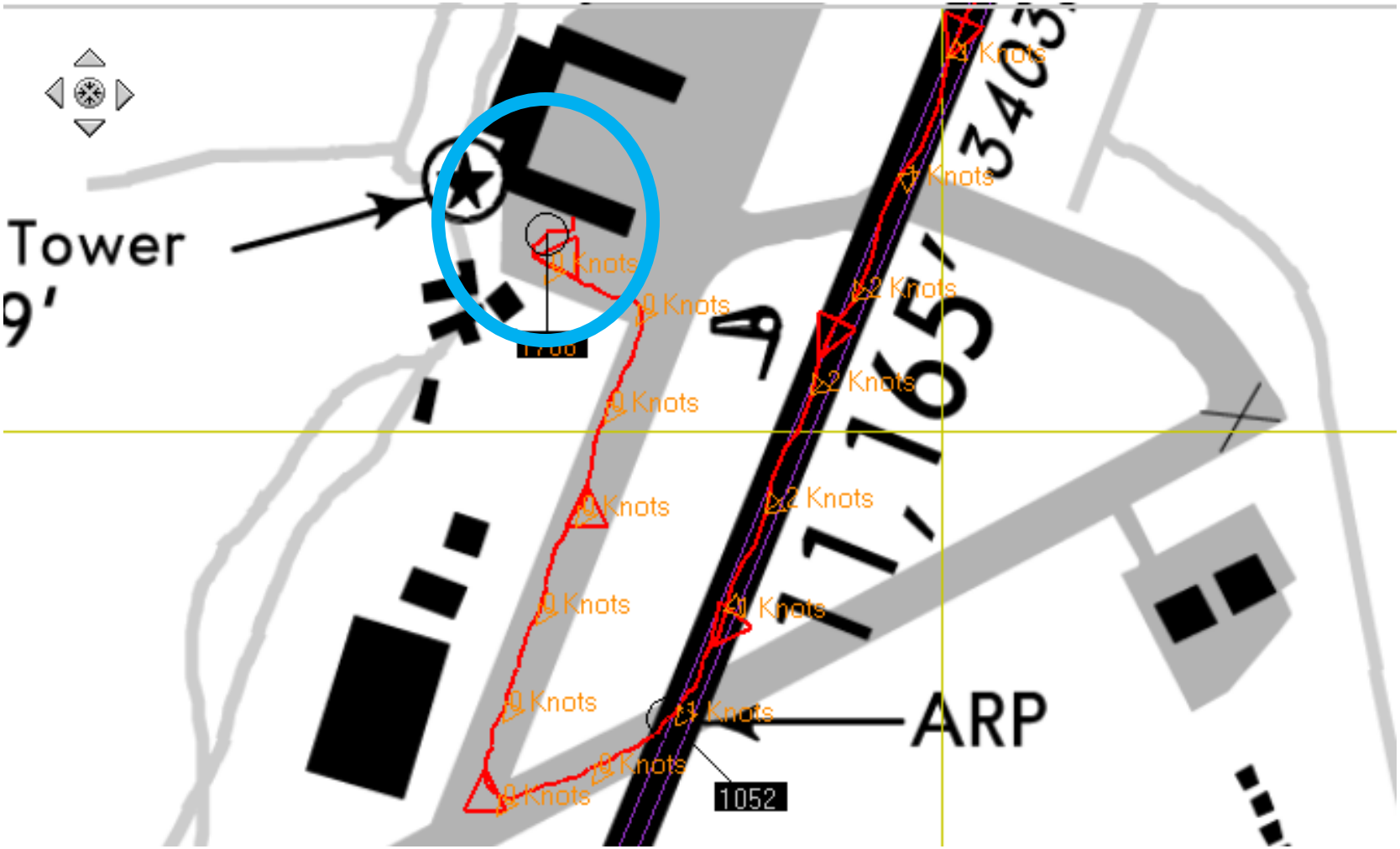
- All Red Events by Flight Phase
- Top 10 Red Events
- Ratio of Top 10 Red Events
- Top 10 all Severity
- Top 10 red ratio by departure
- Top 10 severity ratio by departure
- Top 10 red ratio by arrival
- Top 10 severity ratio by arrival
- All Severity ratio in Cruise

ANALYSIS WORKFLOW - TRENDS MONITORING

From the **Top 10 Red Ratio per Arrival** the necessity for a specific airport study can be highlighted.



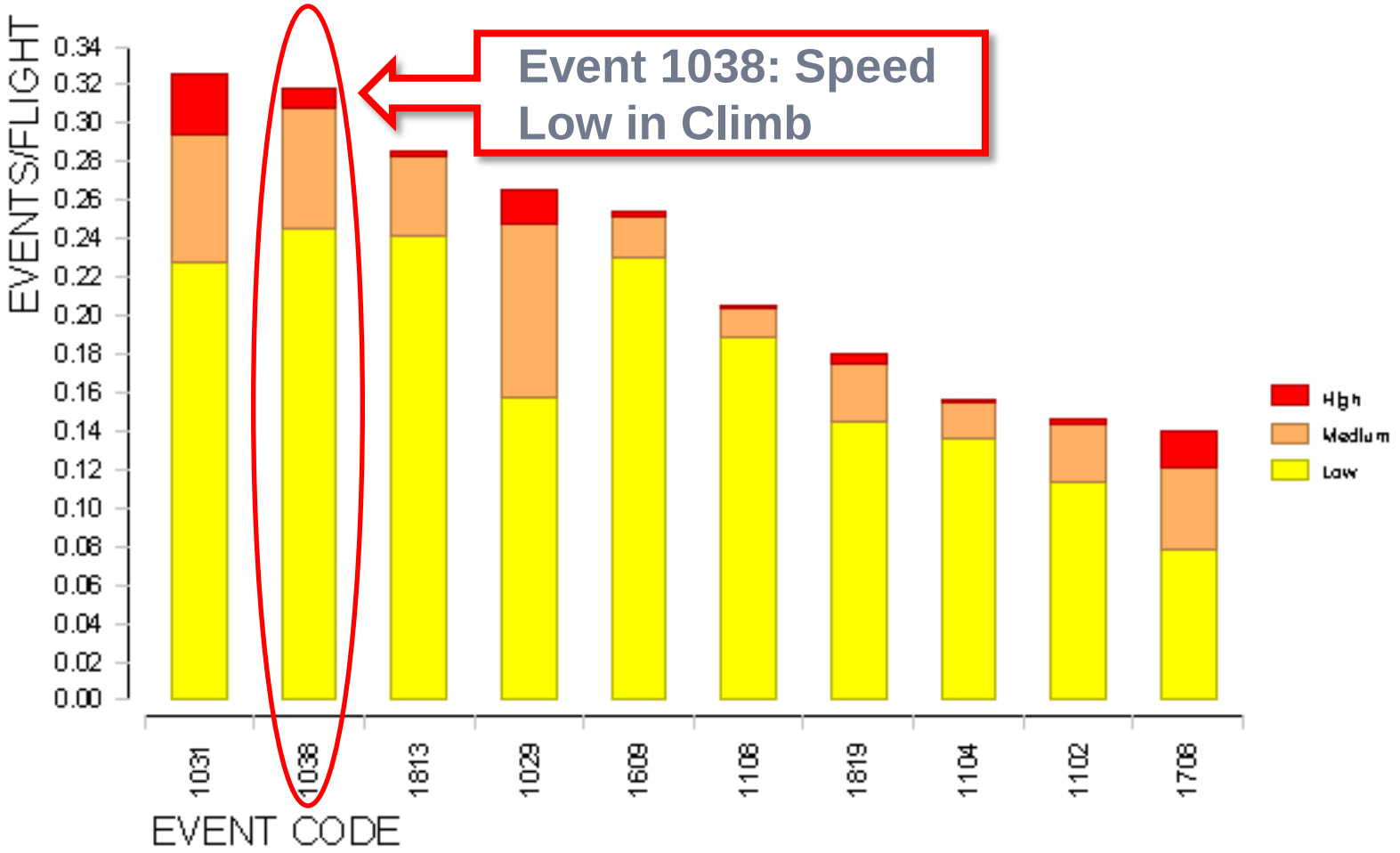
ANALYSIS WORKFLOW – TRENDS MONITORING



ANALYSIS WORKFLOW - TRENDS MONITORING

example

From the Top 10 Event Ratio - for a particular Month



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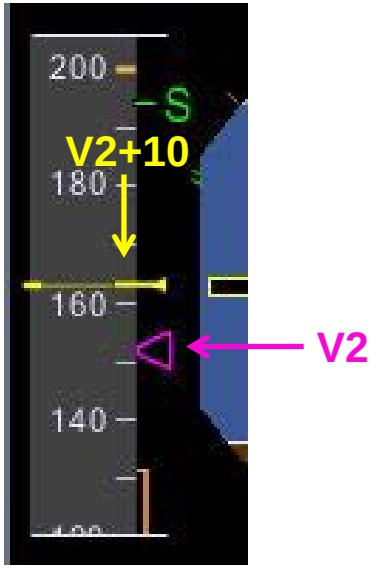
ANALYSIS WORKFLOW - TRENDS MONITORING

example

Event 1038 Speed Low in Climb

The AC should initially climb at close to V2 + 10 kts all engines operating.



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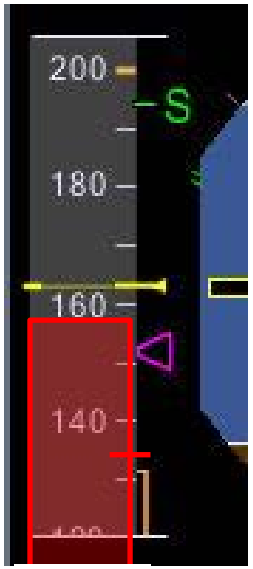

Event is triggered if initial climb airspeed is < V2 + 6 kts for more than 3”.

The lowest speed observed was VLS + 2kt.

A lower speed may indicate windshear or questionable handling technique, and safety margins may be affected if speed falls below V2.

This example concerns a mixed fleet of A330, A340-300 and A340-500.

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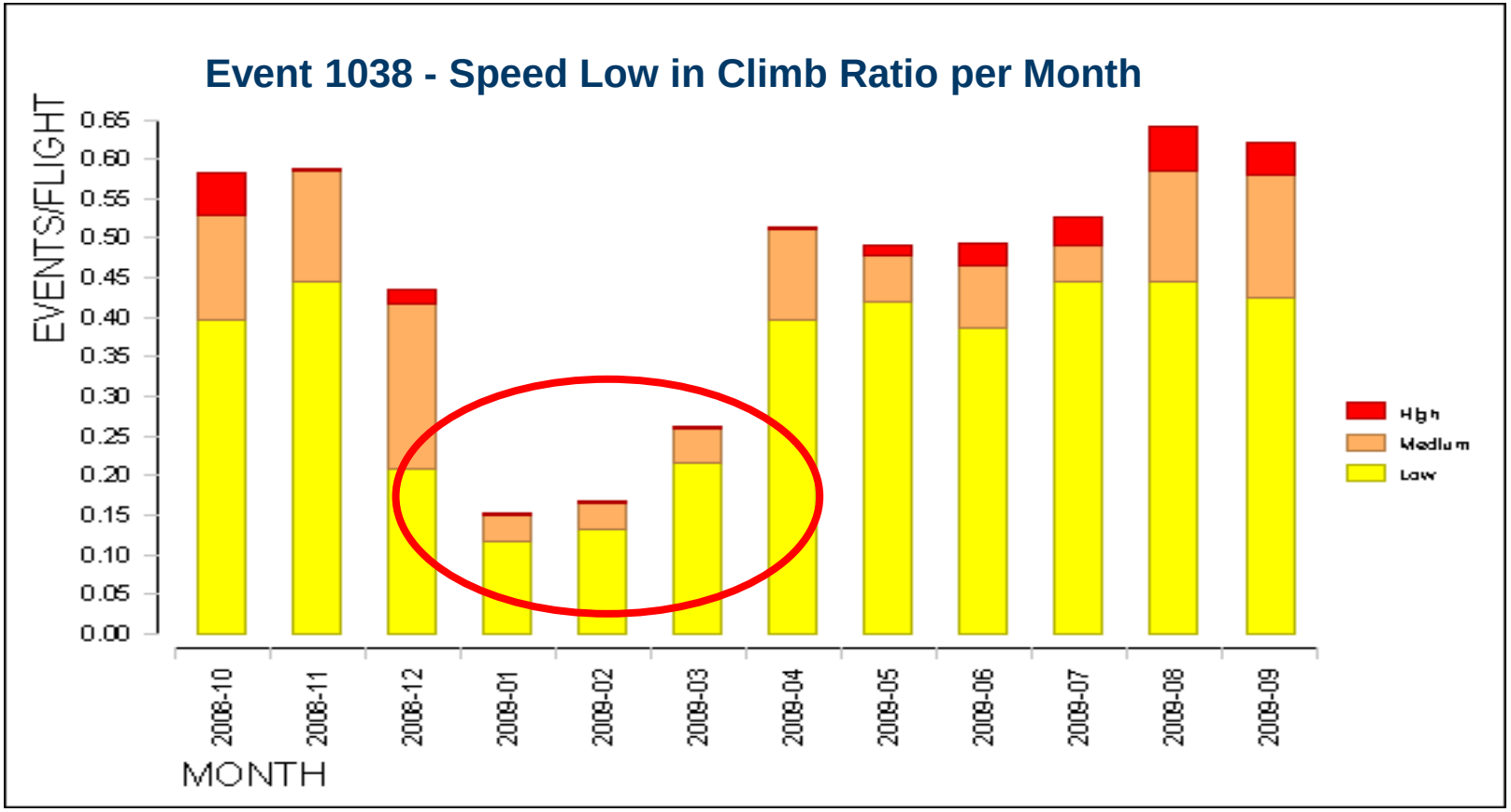
ANALYSIS WORKFLOW - TRENDS MONITORING

example



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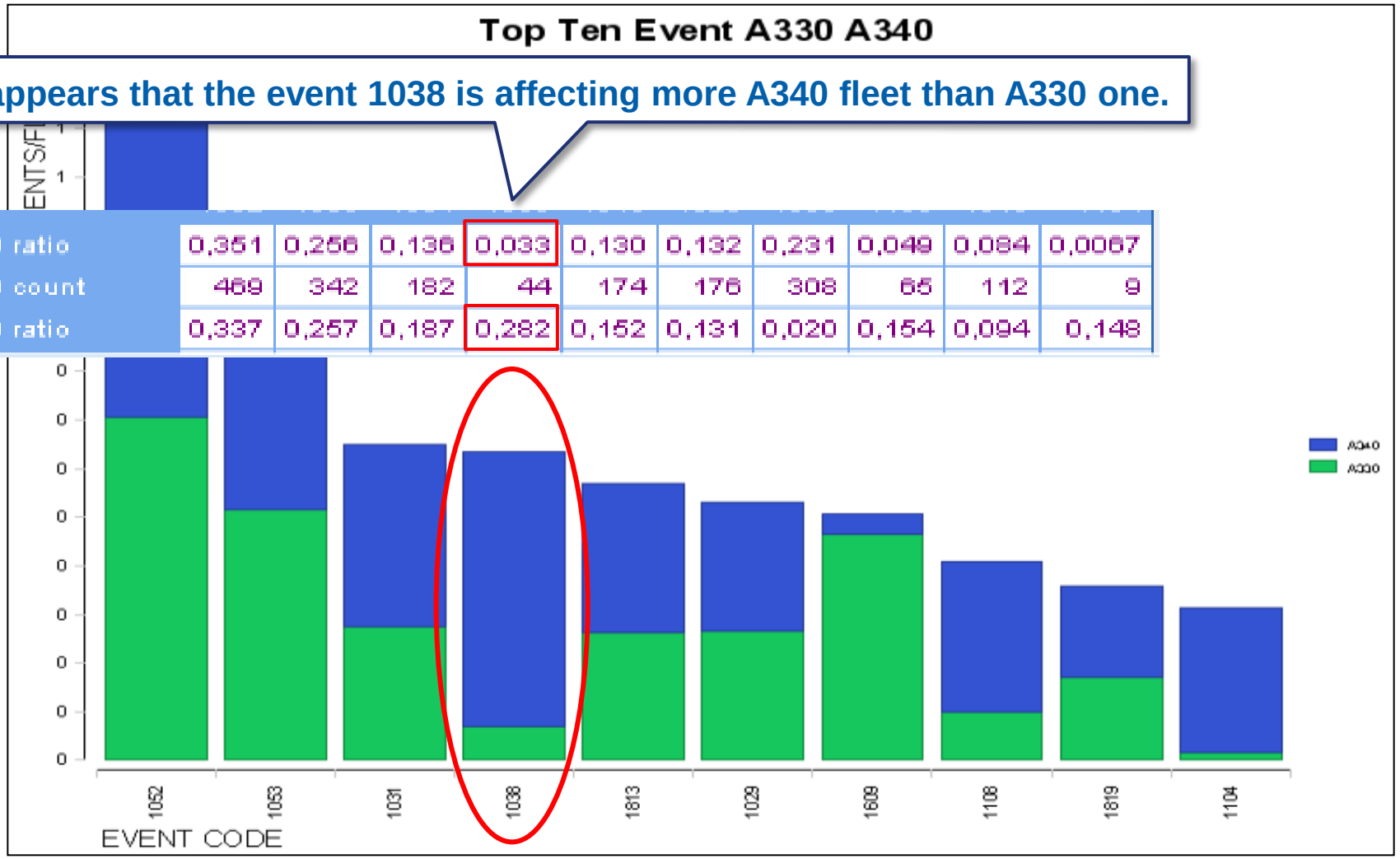

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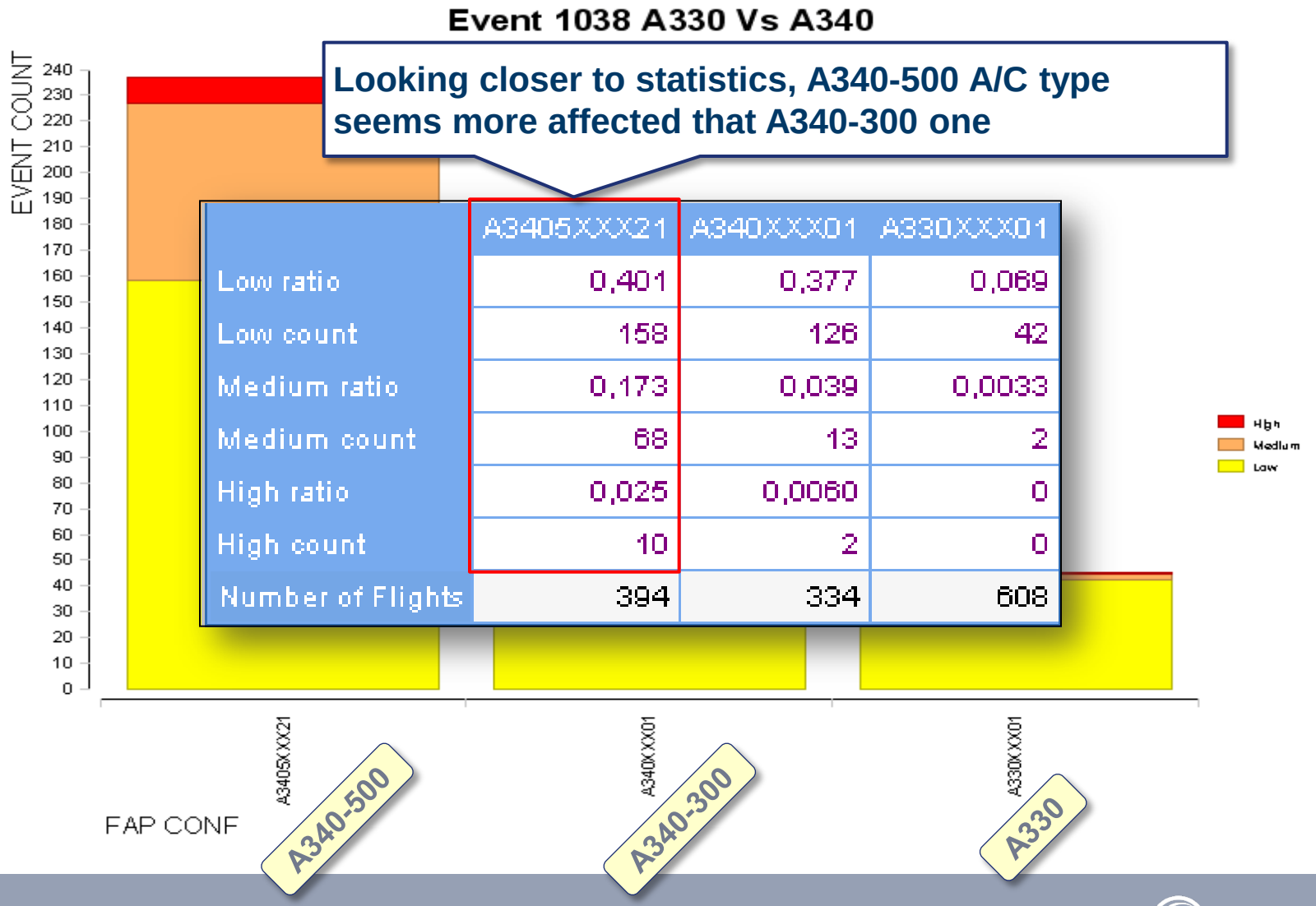
ANALYSIS WORKFLOW - TRENDS MONITORING

example



	A3405XXX21	A340XXX01	A330XXX01
Low ratio	0,401	0,377	0,069
Low count	158	126	42
Medium ratio	0,173	0,039	0,0033
Medium count	68	13	2
High ratio	0,025	0,0060	0
High count	10	2	0
Number of Flights	394	334	608

AIRBUS

FDA - Analysis - From Trends Monitoring

example

A **Safety Issue** has been opened.

The rotation technique was in accordance with the recommendations found in the Flight Crew Operating Manual: 3 degrees/sec to an initial attitude of 15 degrees for A345 or 12.5 degrees for A343.

AIRBUS

FDA - Analysis - From Trends Monitoring

example

Finally after performance study we found out that, in very hot conditions, the 15° initial pitch attitude was above the equilibrium 12.5° pitch value.

Accordingly the Flight Crew Operating Manual have been updated with a common initial pitch target of 12.5° for the whole A340 family.

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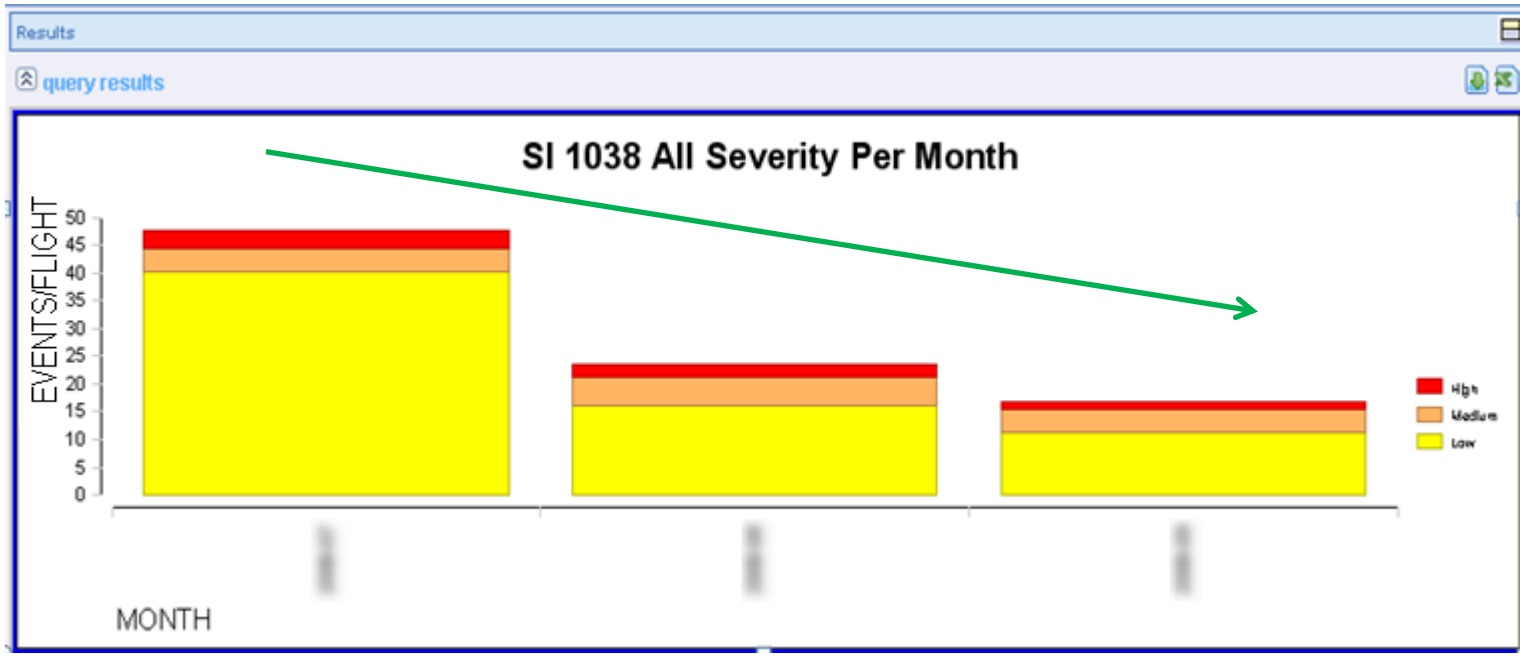
ANALYSIS WORKFLOW - TRENDS MONITORING

example

Then came the necessity to monitor the effectiveness of the corrective action



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ANALYSIS WORKFLOW - REPORTING & COMMUNICATION

The FDA team should provide the Safety manager with regular reports (monthly, quarterly, yearly).

These reports must give a global Safety overview and also highlight any special findings coming from the data base study or from any deeper investigation.

The Safety manager should use these reports for documenting the Safety Action Group (SAG), the Safety Review Board (SRB) and any concerned operator department according to critical Safety matters.

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ANALYSIS WORKFLOW - REPORTING & COMMUNICATION

A good practice is to save the basic templates.

The regularly use of these templates should help at detecting some deviations or new trends.

The reports could also include some other customized templates depending on the findings.

ANALYSIS WORKFLOW - REPORTING & COMMUNICATION

Communication is definitely a must.

It allows to make safety a reality by sharing informations on:

- new Safety issues,
- actions in progress,
- or any beneficial feedback.

Without communication any findings will remain partially hidden.

Benefit to individuals

CLEANING

HAZARD IDENTIFICATION

TREND MONITORING

FUNDAMENTALS

BEST PRACTICES

FDA Fundamentals

COMPETENT FDA TEAM MEMBER

- ✓ FDA systems record information on the way Aircrafts are handled.
- ✓ This information is very difficult to interpret without a large knowledge of Aircraft Type and Line Operations.
- ✓ FDA team members should have an in-depth knowledge of SOPs, aircraft handling characteristics, aerodromes and routes to place the FDA data in a credible context.

FDA Fundamentals

COMPETENT FDA TEAM MEMBER

- ✓ All FDA team members need appropriate training and experience for their respective area of data analysis.
- ✓ FDA team members should always stand back when looking at data.
- ✓ At least one experienced type-rated pilot should be part of the FDA team.

FDA Fundamentals

CONFIDENTIALITY

FDA data scattering risks can be:

- ➔ Use of data for disciplinary purposes
- ➔ Use of data for enforcement actions against individuals or the company
- ➔ Disclosure to the media and the general public
- ➔ Disclosure during civil litigation.

FDA Fundamentals

CONFIDENTIALITY

✗ Any disclosure for purposes other than safety management can compromise the required cooperation of flight crews.

✓ Thus, preventing the misuse of FDA data is a common interest of the operator and flight crews.

FDA Fundamentals

CONFIDENTIALITY

Data protection can be optimized by:

➔ Adhering to the agreement between management and the flight crews, if existing

➔ Strictly limiting data access to selected individuals

FDA Fundamentals

CONFIDENTIALITY

- Maintaining tight control to ensure that data identifying a specific flight are kept securely,
- Ensuring that operational problems are promptly addressed by management,
- A non-reversible de-identification of the flight data files after a time appropriate for their analysis.

FDA Fundamentals

CONFIDENTIALITY

A key actor, the **Flight crew contact person** (Gatekeeper)**:**

- has confidence with the top management as well as with the whole operator pilot community.
- must show high integrity and good judgment.

He should be the only person permitted to connect the identifying data with the event

FDA Fundamentals

JUST CULTURE

The trust established between management and its flight crews is the foundation for a successful FDA process.

To secure this trusted FDA process, the operator needs:

A just culture:

> An atmosphere of trust in which people are encouraged for sharing essential safety-related information - but in which they are also clear about where the line must be drawn between acceptable and unacceptable behaviour.

ANALYSIS

CLEANING

HAZARD IDENTIFICATION

TREND MONITORING

FUNDAMENTALS

BEST PRACTICES

ANALYSIS WORKFLOW - BEST PRACTICES

- ✓ The recorder chains health should be monitored
- ✓ The data base should be properly cleaned
- ✓ High ratios of flights should be recorded and analyzed.

ANALYSIS WORKFLOW - BEST PRACTICES

- It is very important, for the overall process quality, to have a workload managed at a constant pace.
- FDA team manpower should be adapted to the workload
- At the very least a team member backup is necessary

ANALYSIS WORKFLOW - BEST PRACTICES

- Flight crew should not fly the events instead of their plane

  If so, it means the FDA tool is used in a manner that impairs its initial goal

- To avoid this trap, FDA should be embedded within a Just culture environment

ANALYSIS WORKFLOW - BEST PRACTICES

- A close communication must be encouraged with the training department
- The training program adjusted according to Safety findings is really efficient
- Always step back and be critical in front of data

ANALYSIS WORKFLOW - BEST PRACTICES

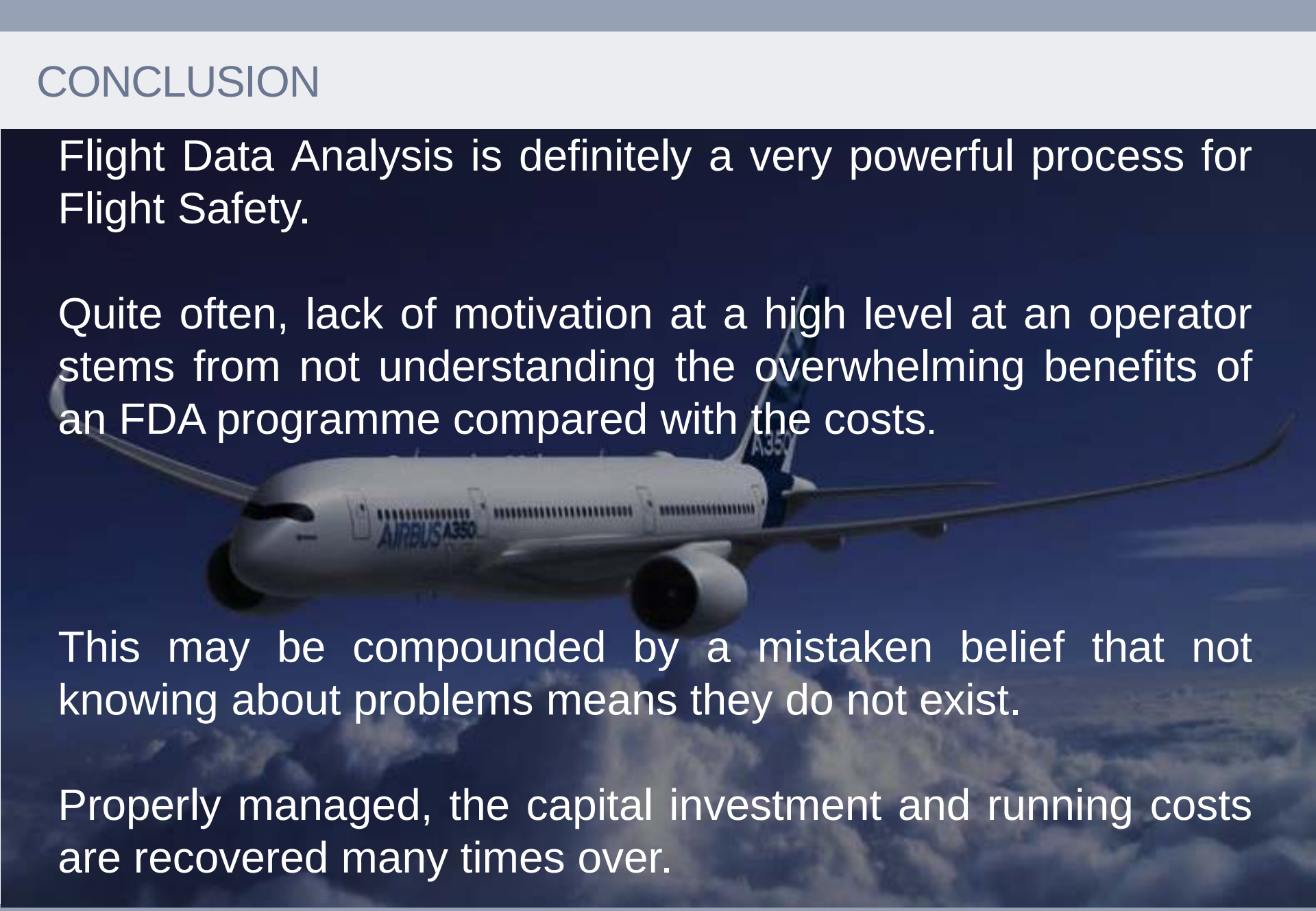
- ✓ Managing Flight Data Analysis, from raw recorded data to the SMS feeding process, is really a profession

- ✓ Pilot expertise should be used for operational validation and fine tuning analysis

CONCLUSION

Flight Data Analysis is definitely a very powerful process for Flight Safety.

Quite often, lack of motivation at a high level at an operator stems from not understanding the overwhelming benefits of an FDA programme compared with the costs.



This may be compounded by a mistaken belief that not knowing about problems means they do not exist.

Properly managed, the capital investment and running costs are recovered many times over.

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