Use of Reactive Information to Enhance PA-RAST Safety Recommendations

PA-RAST/21 Meeting

Presented by: Brazil

Introduction

- PA-RAST Safety Enhancement Initiatives (SEIs) are produced through a data-driven process, supported by FDM/FOQA
- Such data reveals the main types of occurrences in a given location and/or route (“Hot Spots”)
- SET’s are supposed to analyze the data and to conduct some investigation work to detect the root cause of the concentration of occurrences

Assumption

- The PA-RAST safety recommendations (outputs of the 4 SETs) can be improved by adding to the current process the regular use of safety recommendations issued by investigation authorities
- Such safety recommendations, if selected by some criteria, could help explain the origin of trends currently revealed by ASIAS/FDX, and allow creation of more robust DIPs in the Pan-american region.

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **The Issue**

During the approach to Eindhoven Airport (The Netherlands) on 31 May 2013, a Ryanair Boeing 737-800 was radar vectored towards runway 21 for a landing with the aid of the ILS. The aircraft was flying under IMC. During the latter stage of the approach, the aircraft was above the intended 3 degree Glide Path. After the Localizer was captured, a Glide Slope intercept from above was executed. The Autopilot Flight Director System (AFDS) and the Auto Throttle (AT) were engaged. The Approach mode was armed and the aircraft was configured for landing.

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **The Issue (cont'g)**

At short final, at approximately 0.85 NM from the threshold, at 1060 feet altitude, the Glide Slope was captured. Upon Glide Slope capture, a pitch increase of 24.5 degrees aircraft nose up (ANU) occurred in about 8 seconds. The crew pressed the TOGA button for a go-around, almost simultaneously followed by the activation of the stick shaker warning. During the following approach to stall recovery manoeuvre there was a second stick shaker activation. The crew made a successful go-around and landed at Eindhoven Airport.

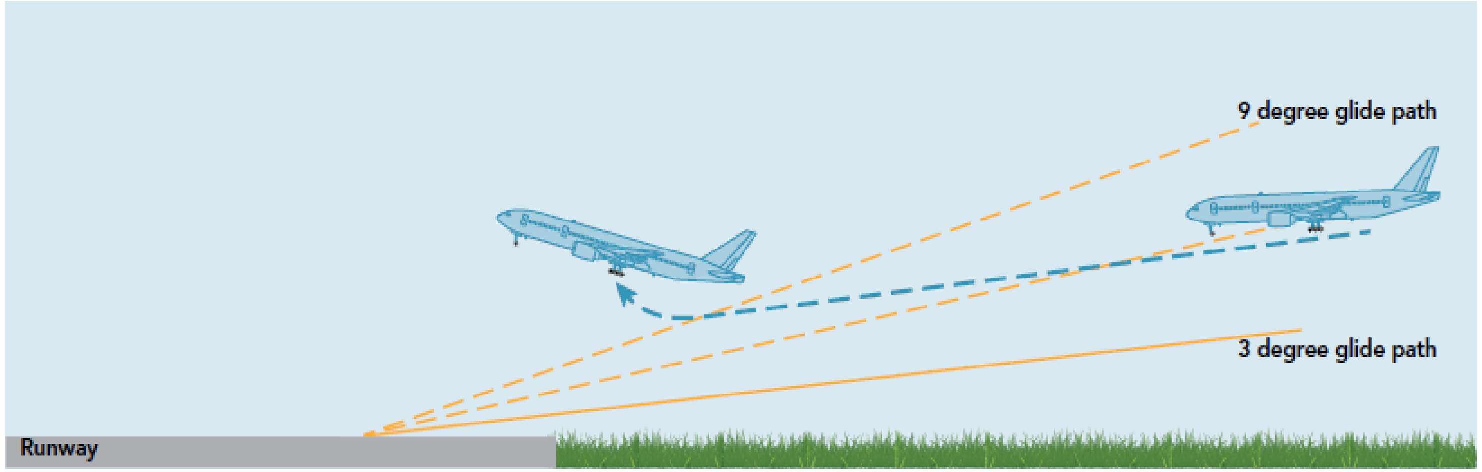
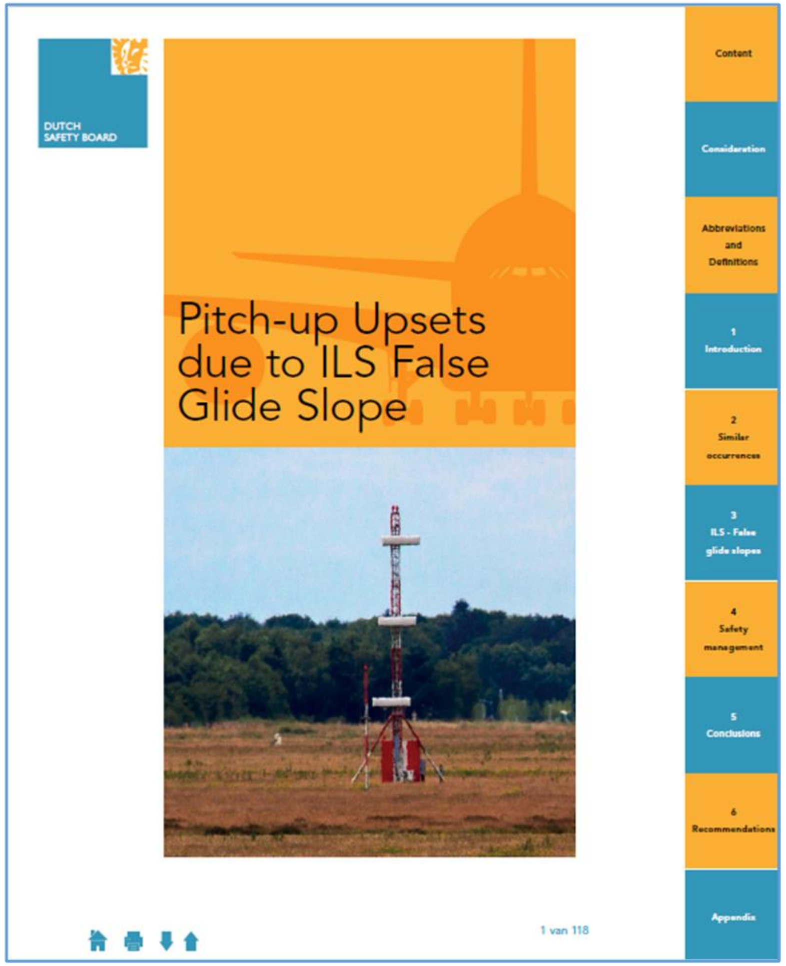


Fig. 1 – Example of Glide Slope capture with a pitch upset above 3 degree glide path

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Initial Investigation**

The activation of the aircraft's stick shaker during an autopilot coupled ILS approach in close proximity to the runway was a factor of interest that prompted the Dutch Safety Board to start an investigation. The occurrence has been categorized as a serious incident.



Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Significance of the Eindhoven incident**

Eindhoven investigation revealed characteristics of the ILS signal which was not fully understood and appreciated. Also, the Eindhoven incident **was not unique**. Four other occurrences with autopilot commanded pitch-up upset during ILS approach from above the 3 degree Glide Slope were identified (different types of aircraft, by different Airlines, on approach to different airports):

- Schiphol Airport, The Netherlands, 2011, KLM, Embraer E190
- Murcia Airport, Spain, 2011, Ryanair, Boeing 737-800
- Charles de Gaulle Airport, France, 2012, Air France, A340
- Treviso Airport, Italy, 2013, Ryanair, Boeing 737-800

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Significance of the Eindhoven incident (cont'g)**

The general belief is that false Glide Slopes invariably occur at regular intervals from the normal 3 degree angle. In addition, the general view is that a warning is given in the cockpit before the aircraft crosses a False Glide Slope. The identified incidents with different aircraft types seem to indicate differently.

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Significance of the Eindhoven incident (cont'g)**

These findings led the Dutch Safety Board to conclude that little known ILS signal characteristics pose a significant threat to aviation safety, as they may result in unexpected aircraft behaviour and may thus endanger the safety of passengers and flight crews. Because identified occurrences, combined with the potential severity of this hazard, the DSB decided to address this issue separately.

The fact that similar incidents in the past did not lead to mitigating measures also raises the question of effectiveness of the aviation Safety Management Systems (SMS) framework.

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Conclusions:**
  - The signal characteristics of ILS Image Type antenna system and corresponding cockpit instrument warnings do not correspond with received wisdom and training.
    - Glide Slope signal measurements revealed two different signal characteristics: False Null and Signal Reversal. Signal Reversal occurs **sometimes at approximately 6 degree Glide Path** and **always at the 9 degree Glide Path angle**.
    - Cockpit instruments do not present correspondent ILS warnings.

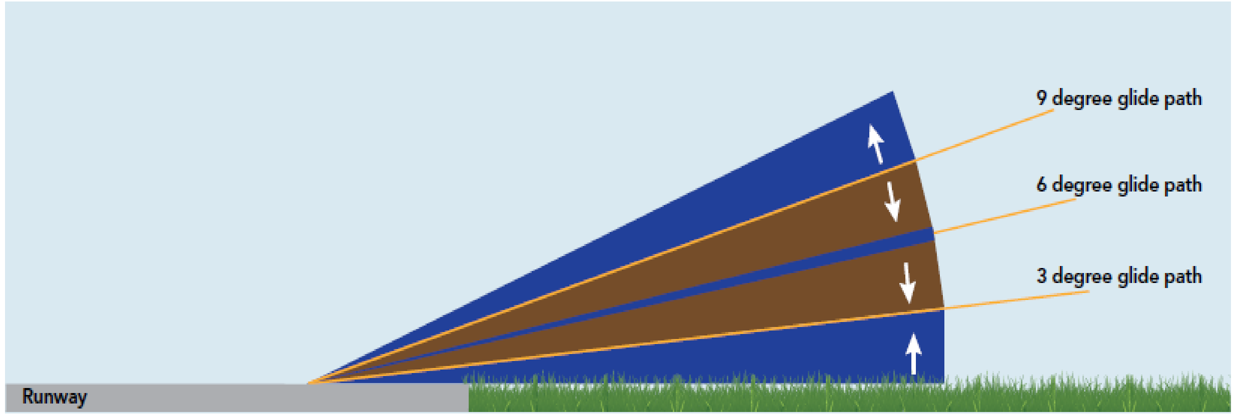


Fig. 2 – Cross section view of the M-Array ILS antenna system. "Fly up" (blue) and "Fly down" (brown)

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Conclusions (cont'g):**
  - The area above 5.25 degree Glide Path and onward, is not part of the ILS Flight Inspection programme, and therefore not part of the ILS ICAO certified volume of operation. Consequently, **aircraft flying above the certified volume of operation are exposed to risks related to ILS Signal Reversal and subsequent unexpected automatic flight system response resulting in severe pitch-up**.

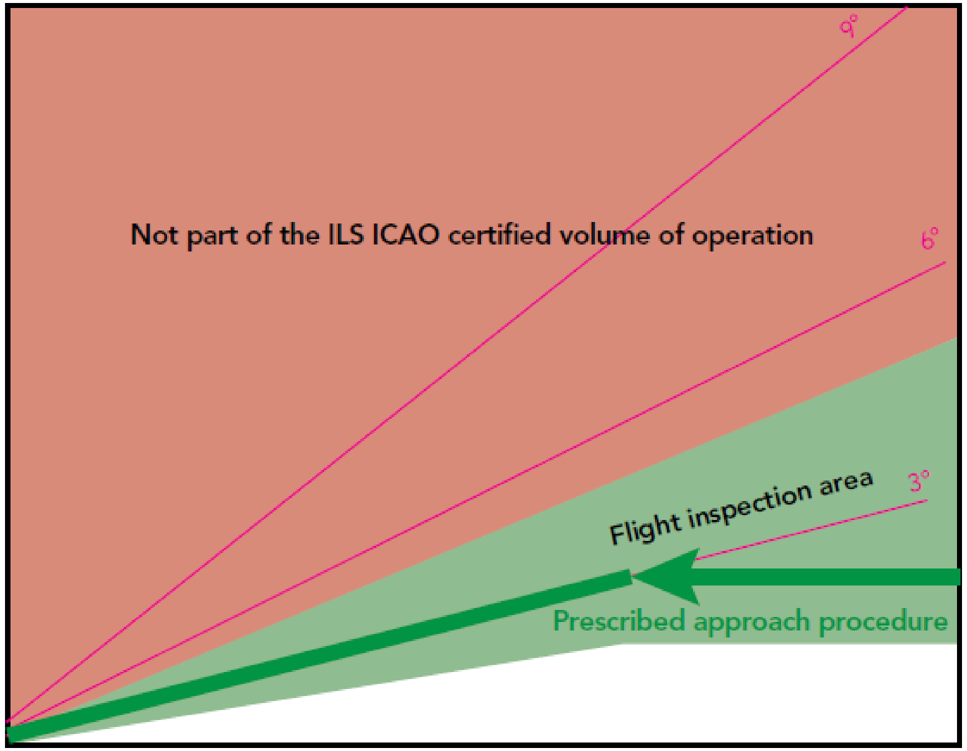


Fig. 3 – Cross section of ILS Glide Slope signal that is inspected and certified for operational use.

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Conclusions (cont'g):**
  - Automated on-board systems when in use must support the flight crew and should not bring the aircraft into danger without a preceding clearly recognizable warning and with ample time for flight crew intervention.

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Conclusions (cont’g):**

  - The existing framework of SMS neither identified the occurrences related to ILS False Glide Slope Signal Reversal as serious incidents separately, nor was the potential hazard understood and/or addressed. Contributory to this was that accessible information and received wisdom did not make a distinction between the two types of False Glide Slope characteristics. Also the exchange of occurrence report information between operator, manufacturers and (inter)national database managers was insufficient. The result was that a latent safety deficiency how the ILS was used remained unidentified.

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Conclusions (cont'g):**
    - Flight crews' decisions to execute a go-around or to challenge Air Traffic Control seems to be postponed too long when flying high above the normal vertical profile during an ILS approach. There is reason to believe that the high level of very reliable automation in the cockpit contributes to this and that altitude versus distance basic flying skills are insufficiently practiced.

Case Study – Pitch-up Upsets due to ILS False Glide Slope

- **Recommendations:**

The DSB made the following recommendations to EASA (Europe), FAA (USA), ANAC (Brasil), CAA (China), FATA (Russia), Civil Aviation Bureau (Japan) and Transport Canada:

- Information and awareness (manuals, training material) **A S**
- Short term measures (mitigating actions: operation and technical measures) **A S M N**
- Long term measures (development of new landing systems) **S M**
- Occurrence reporting and analyses (SMS assessment on operators, ANSP and manufacturers) **A S M N**
- Training regulations (review of initial and recurrent training, situational awareness) **S**
- International regulations (revision of ICAO Doc 4444) **I**
- Update of stabilized approach criteria (ALAR toolkit update) **F**

A – Airlines; **S** – States; **M** – Manufacturers; **N** – ANSPs; **I** – ICAO; **F** - FSF

Proposal

- PA-RAST to incorporate safety recommendations issued by investigation authorities (SET Teams workflow).
- The safety recommendations should be adopted after a prior assessment of which recommendations would be more relevant to mitigate safety occurrences in PA region.
- Selection criteria proposal:
  - Recommendations should be related only to LOC-I, CFIT, RE or MAC
  - Recommendations should involve minimum of three PA-RAST stakeholders: Airlines, States, Manufacturers, ANSPs, ICAO, etc.
  - Research would be made on reports no older than 2 years
  - Preference would be given to reports from authorities who deal with significant air transport numbers – See Attachment 1

Benefits

- Some trends revealed by FDX/ASIAS could be explained by the feedback provided by the investigation conclusions (e.g. Unstable Approaches rising in a given location, etc)
- Overall visibility of the operational concerns would be improved. SET outputs would be increasingly more robust.
- PA-RAST would also be a mechanism to promote implementation of reactive recommendations in the region.

Next Steps

- PA-RAST to evaluate proposal (Approve?)
- In case of approval, proceed to include a statement on PA-RAST Terms of Reference (TOR)
- Brazil volunteers to perform the continuous research on recommendations and report them regularly to PA-RAST
- After each report, SETs affected would analyze recommendations and potentially start using the information on DIPs development
- SETs workflow: 7-Steps affected?

Thank You!

Attachment 1 – Air Transport, PAX carried

- The World Bank - Air transport, passengers carried (*)
  - Countries with more than 25,000,000 PAX carried in 2014:

Country Name	Air Transport, Passengers carried (2014)
United States	762,560,000
China	390,878,784
United Kingdom	125,068,988
Japan	110,544,000
Germany	107,587,503
Ireland	100,962,395
Brazil	100,403,628

Country Name	Air Transport, Passengers carried (2014)
Turkey	92,624,865
Canada	75,528,607
Australia	67,686,801
France	63,434,263
Spain	53,038,503
Mexico	40,693,895
Netherlands	33,928,613

Country Name	Air Transport, Passengers carried (2014)
Switzerland	26,716,498
Italy	25,594,275
Colombia	25,053,386

(*) The World Bank, 2015. Both domestic and international aircraft passengers of air carriers registered in the country

Attachment 2 – Countries and Investigation Offices

Country	Investigation Office	Website
United States	NTSB	http://www.ntsb.gov
China	CAAC	n/a
United Kingdom	AAIB	http://www.aaib.gov.uk
Japan	JTSB	http://www.mlit.go.jp/jtsb/english.html
Germany	BFU	http://www.bfu-web.de
Ireland	AAIU	http://www.aaiu.ie
Brazil	CENIPA	http://www.cenipa.aer.mil.br
Turkey	MTMAC	n/a
Canada	TSBC	http://www.tsb.gc.ca
Australia	ATSB	http://www.atsb.gov.au
France	BEA	http://www.bea.aero
Spain	CIAIAC	http://www.ciaiac.es

Attachment 2 – Countries and Investigation Offices

Country	Investigation Office	Website
Mexico	DGAC	n/a
Netherlands	DSB	http://www.safetyboard.nl
Switzerland	BFU	http://www.sust.admin.ch
Italy	ANSV	n/a
Colombia	GIA	http://www.aerocivil.gov.co