Enabling Performance Based Operations.
Analysis of LIDAR wake vortex tracks

Relative analysis

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The following will be covered during the presentation

- Introduction
- Closely-parallel spaced runways
- Position of the LIDAR sensors
- LIDAR data
- Methodology of the relative analysis
- Conclusion
Introduction

Aim of the Dubai LIDAR campaign

- AVTECH worked for Dubai Navigation Air Services (DANS) on a wake vortex analysis. DANS conducted the safety case and AVTECH the wake-vortex analysis. The methodology of this analysis is presented here.

- In a closely-spaced parallel runway environment, wake transfer issues have to be addressed. The relative analysis is a way to compare wake-vortex hazards for different situations.
Dubai airport layout & location of the three LIDARs

12L
12R
30R
30L
A LIDAR track in ground effect

Track created by a heavy aircraft
This kind of bouncing can lead to encounters, more on slide 17.
Methodology for the relative analysis

ILS case
The methodology consists in comparing the proposed procedures to current existing procedures deemed as tolerably safe today.

Cumulative probability curves describing different procedures are produced and compared to each other.

These curves can be produced for all leader-follower aircraft pairs, and different separations.

The reference case is the ILS approach, the test cases are the new procedures that will be evaluated.
Cumulative probabilistic curves

Note: Source: DNVGL, Tim Fowler
Establishment of the cumulative probabilistic curves

From LIDAR data to cumulative probability curve

Curve may not reach 1.0 because WT may decay to background or because WT may be transported out of path of following aircraft.

Maximum WT severity that follower can encounter due to the leader at the specified aircraft separation.

A curve compiles the strength and the location information to describe the wake hazard at a specific time after creation.

Source: DNVGL, Tim Fowler
Reference curves

Heavy leader, runway 12L

- The red curve describes H-H separation. FDR data was used to establish that this situation is today operationally tolerably safe (ICAO separation).

- Reported encounter analysis, analysis of a 3 year weather database and Monte-Carlo simulations were part of the process of establishing the safety of these curves.
Test case 1: rebound from the lower to the higher glideslope.

Leader aircraft category: H
Test case 2: Transfer from the higher to the lower glideslope

Leader aircraft category: H
Conclusion about the relative analysis.

- The relative analysis is a method to assess the safety of a proposed operation compared to a reference situation (deemed as tolerably safe).

- This relative safety analysis based on LIDAR data was conducted in parallel to Flight recorded analysis data, weather analysis, reported encounters (1086 reports) data as well as Monte-Carlo simulation.
Further work that was carried out during this project

Cross validation FDR data/LIDAR data

- FDR data analysis gives wind data all along the descent, which is then correlated to the LIDAR track. This flight suffered two encounters, this figure shows the first one.
Further work that was carried out during this project

Cross validation FDR data/LIDAR data

- This figure displays the second encounter, the origin of this one is a bouncing on a 7 degree inversion layer.
Further work that was carried out during this project

Cross validation FDR data/LIDAR data/Monte-Carlo simulations (52 billion wake simulation)