EUROCONTROL
AVAL Project

AVAL Phase 1 findings
(presented by Thierry Arino)
Presentation content

Introduction

Safety benefits of ACAS

VLJs and LJs below 5,700 kg: what are they?

What are the safety implications?

- If VLJs & LJs are not equipped with ACAS
- If VLJs & LJs are equipped with ACAS

Conclusion & Recommendations
ACAS II (TCAS II) reduces risk of mid-air collisions

Mandated in 2 phases

- 1st January 2000: MTOM > 15,000 kg or more than 30 passengers
- 1st January 2005: MTOM > 5,700 kg or more than 19 passengers

Would there be safety benefits from extending use of ACAS to lighter jets?

- VLJs & LJs with MTOM < 5,700 kg
AVAL Project

- Assess the impact of VLJ and LJ operations on the safety benefits delivered by ACAS in the European environment
- Divided in two phases

Phase 1

- Determine if there is a need for further investigation

Phase 2

- Full safety study
- Determine the best approach for ACAS equipage on VLJs and LJs
- Phase 2 to be completed in 2009
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ACAS

- Last resort safety net independent from the means of separation provision
- Interrogates adjacent SSR transponders
- Provides two levels of alert: TA & RA to prevent risk of imminent mid-air collision

ICAO PANS-OPS

✓ “Pilots shall respond immediately by following the RAs”
Safety performance measurement

- No specific requirements on ACAS to achieve a Target Level of Safety

- Safety benefits of ACAS quantified through a safety metric

  $$\text{risk ratio} = \frac{\text{risk of collision with ACAS}}{\text{risk of collision without ACAS}}$$

- For typical IFR operations as observed in the European airspace, risk ratio = 22%

  ✓ Indicates a reduction in the risk of collision by a factor of 5
Factors influencing the safety benefits of ACAS

- Characteristics of the airspace
  - Any change in ATM operations and airspace design has an effect on the ACAS performance

- Level of ACAS equipage and operating mode
  - Unequipped < TA mode < RA mode

- Pilot behaviour
  - RAs must be followed promptly for maximum benefits

- Possible interaction between ACAS and other lines of defence against the risk of mid-air collision
  - Pilot must report RAs to ATC as soon as possible
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Conclusion & Recommendations
No internationally agreed definition of a VLJ category

Definition used in the AVAL study

- VLJs = turbofan-powered aircraft with MTOM < 4,540 kg (10,000 lbs) certified for single pilot operation
- LJs = MTOM between 4,540 kg (10,000 lbs) and 9,080 kg (20,000 lbs)
  Small LJs = LJs with MTOM < 5,700 kg
Definition of VLJs & LJs (2/2)

- **VLJs**
- **Light Jets**
- **Medium Jets**
- **Heavy Jets**

- **JAR/FAR part 23**
- **JAR/FAR part 25**

- Max take-off weight:
  - 5700 kg

- European ACAS Mandate:
European sales and growth

- European VLJs = 12 to 15% of the VLJ world fleet
- 25 to 33% of current business fleet replaced by VLJs over the next decade
- Between 2007 and 2016, sales of VLJs and LJs should be similar
- ~200 VLJs and LJs to be sold per year in the next decade
- 110,000 to 170,000 additional flights each year until 2015
Ceiling versus cruise speed

- **Mid-performance VLJs & LJs<5700 kg**
- **High-performance VLJs, LJs>5700 kg & Medium jets**
- **Low-performance VLJs & turboprops**
3 categories of VLJs

- Low-performance VLJs
  - Similar to turboprops
- Mid-performance VLJs
  - Most common
  - Similar to small LJs
- High-performance VLJs
  - Similar to medium jets and LJs with MTOM > 5,700kg

Mid-performance VLJs will fly in RVSM with lower performance than other RVSM aircraft
Distances and cruise FLs of small LJs

- Comparable to mid-performance VLJs
- Short haul flights
- Fly in RVSM

Turboprop-like operations

% of flight plans

Cruise FL
Small LJ operations

- Fly routes on demand
- Fly to secondary airports
- Many of these airports share TMAs with major airports
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Safety implications

Perspective for aircraft already equipped

- ACAS provides safety benefits to the equipped aircraft and to the whole airspace
- ACAS works better when both aircraft are equipped
- Reduction of the safety benefits delivered by ACAS

Perspective for VLJs and LJs

- No benefit from own ACAS
- If separation provision fails, only “see and avoid” remains
  - Inadequacy of “see and avoid” for jet aircraft
An example: ACAS mandate Phase II

- Aircraft with MTOM between 5,700kg & 15,000kg
  - ~10% of the fleet

- Fleet perspective
  - Huge benefits for small aircraft

- RA response rate
  - Significant factor
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Benefits & risks

- Risk reduction afforded by the carriage and operation of ACAS demonstrated by safety studies and observed operationally
  - Extent of benefit to be quantified taking into account key influencing factors

- Pilot response to RAs is critical
  - Maximum safety benefits obtained when all pilots respond to RAs
  - Poor pilot responses degrades ACAS safety benefits
Pilot response to RAs (1/2)

- Non responding, slow and aggressive pilots observed in mid-90s
- Current pilot response = Continuum around standard response

Most common pilot response

- Diagram showing the distribution of pilot responses with different axes for acceleration (g) and speed (fpm) and time (s).
- Non-responding pilots highlighted.
Pilot response to RAs (2/2)

- Single Pilot Operation for VLJs and small LJs
  - Higher non-response rate?
  - Increased risk of opposite response?
  - Increased probability of “last moment” response?
  - Increased likelihood that the pilot will report the RA late to ATC?

- New population of pilots operating ACAS
  - Professional with ACAS experience
    - Would behave as other airline pilots?
  - Professional without ACAS experience
    - Would behave as other airline pilots at the time of ACAS introduction (slow or aggressive response)?
  - Non-professional
    - Increased rate of non-response and non-standard manoeuvres?
Cost & technical aspects

Cost Benefit Analysis required

Technical considerations

✓ Fitting antennas on small aircraft
✓ Interference issues
✓ Avionics architecture
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Conclusion

- There is evidence that the new VLJs and small LJs will have an effect on the overall performance of ACAS as a safety net.

- If not equipped with ACAS, they will not benefit from the safety provided by this system.
  - May also influence the safety of aircraft equipped with ACAS.

- Safety benefits derived from an extended ACAS mandate need to be quantified.
  - Pilot response to RAs will be an important consideration.
  - Pilots need to be trained carefully in the operation of ACAS.
Recommendations

- Quantify implications of VLJ introduction in the European airspace on the performance of ACAS
  - For VLJs and small LJs
  - Other aircraft already equipped with ACAS

- Investigate the use of speed along with MTOM as a determinant for requiring ACAS carriage

- Proceed with Phase 2
Proposed Phase 2 work

- In-depth investigation using the established encounter model approach
- Adapt model to reflect operation of VLJs and small LJs in the European ATM system
- Define a set of operationally realistic scenarios
  - Possible scenario target date = 2015
- Sensitivity study on influential factors
  - Pilot reaction to RAs
  - TCAS equipage
- Provide elements for future ACAS policy decisions regarding VLJs and small LJs