TCAS pilot compliance assessment based on radar data

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21 September 2020, SAFOPS
Full report

- This presentation is a summary of full pilot compliance study.

- Currently, the report is subject to external and internal review.

- The report contains detailed data and statistics as well as the description of the methodology.
What are TCAS II and Resolution Advisories?

TCAS pilot compliance assessment (SAFOPS - 21 September 2020)
Comprehensive assessment

- Core European airspace
- Time period: 365 days
- Flight hours: 9 m
- All RAs confirmed by Mode S downlink: 010001100 110011001
Limitations


24,347 feet
1750 ft/min.

0100001100
1100110001
Assessment criteria of pilot responses

- **Followed**: Correct pilot response (with a margin of error)
- **Not followed too weak response**: Response with insufficient vertical rate subsequently, referred to as “not followed”
- **Opposite**: Opposite (vertical) sense response
- **Excessive**: Response with excessive vertical rate
Example – Climb RA

- 0 ft/min.
- 1200 ft/min.
- 2200 ft/min.

- **Opposite**
- **Not followed – too weak**
- **Followed**
- **Excessive**

- 1500 ft/min.
- 2000 ft/min.

Not to scale
General results

- **Encounters**: 1022
- **RAs (> 8 sec.)**: 1184
- **Subsequent RAs**: 188
Types of first RAs (> 8 sec.)

- Level off (while climbing): 407
- Level off (while descending): 354
- Climb: 151
- Descend: 122
- Other RAs (not assessed): 150
Pilot compliance 1st RA

- Followed: 38%
- Not followed: 24%
- Opposite: 34%
- Excessive: 4%
Pilot compliance 1st RA: by RA type

![Bar chart showing pilot compliance by RA type]

- CL: 57% Followed, 23% Not followed, 6% Opposite, 3% Excessive
- DE: 65% Followed, 18% Not followed, 4% Opposite, 6% Excessive
- LO (CL): 44% Followed, 42% Not followed, 4% Opposite, 10% Excessive
- LO (DE): 42% Followed, 40% Not followed, 12% Opposite, 6% Excessive
Pilot compliance 1st RA: by altitude
Pilot compliance 2nd RA

<table>
<thead>
<tr>
<th>Category</th>
<th>1st RAs</th>
<th>2nd RA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Followed</td>
<td>38%</td>
<td>48%</td>
</tr>
<tr>
<td>Not followed</td>
<td>24%</td>
<td>8%</td>
</tr>
<tr>
<td>Opposite</td>
<td>34%</td>
<td>5%</td>
</tr>
<tr>
<td>Excessive</td>
<td>4%</td>
<td>39%</td>
</tr>
</tbody>
</table>
Pilot compliance vs. Vertical Miss Distances (VMD)

VMD < 1000 ft

HMD < 1 NM

= 1
Average VMD

Average VMD – Climb RAs

- Followed: 661
- Not followed: 353
- Opposite: 294

Average VMD – Descend RAs

- Followed: 407
- Not followed: 268
- Opposite: 65
Pilot TCAS RA compliance conclusions

• A significant proportion of RAs are not flown correctly.

• Level Off RAs have with the highest level of compliance. The number of Level Off RAs are also the most frequent RAs.

• For Climb and Descend RAs, the compliance never exceeded 30%, with opposite reactions reaching 22%.

• The examination of Vertical Miss Distances confirmed that in the absence of correct pilot response, the vertical separation at the Closest Point of Approach is significantly reduced.
Assessment of TCAS operating mode selection
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- **Duration**: >5’
- **Altitude**: FL100
- **Time period**: 14 days
- **TA-only flights (daily average)**: 50
Assessment of TCAS serviceability

Days with TCAS u/s

- 5 days
  - Days with TCAS u/s: 126
- 7 days
  - Days with TCAS u/s: 72
- 10 days
  - Days with TCAS u/s: 20
- 14 days
  - Days with TCAS u/s: 14