Flight Test Safety Management in a small test group

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History
Current fleet

Cessna Citation II

Pipistrel Velis Electro SW 128
Research Topics

• ATM procedures (green profiles)
• Alternative fuels (biofuel, SAF)
• Avionics testbed
• Communication/datalink (VHF/SAT)
• Navaid calibration / procedure validation

• Flight test methods
• Flying Classroom (Delft University Flight Dynamics)
• Remote sensing (external pods)
• Zero/partial-gravity

TYPES OF FLIGHT TESTS:
• ROUTINE/LOW/MEDIUM risk categories (HIGH excluded)
• Part 21 category I/II/III/IV
• In- and out of certified flight envelope
Zero-g

Zero-G*

Normal flight | Pre-parabolic phase | Weightlessness phase | Post-parabolic phase | Normal flight

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A lot of work ...

**Design organisation**
- Modification design and approval

**CAMO and maintenance**
- Modification and config changes (on a weekly basis)
- Paperwork

**Flight operation**
- RFT / FTP / TCs
- Operational approvals
- Execution of flights
- Calendar is very full
Project example: ITARO (Integration of TMA, Airport and Runway Operations)
SESAR2020-PJ.37-W3 co-funded by SESAR3 JU under grant no 10107622

All photos credits: Royal NLR

See www.sesarju.eu/projects/itaro
Small organisation, limited human resources

- Small group, ~ 10 FTE
  - 2 FTE Management (AM, Q, S, Projects)
  - 4 FTE pilots (7 pilots, 5 with FTR)
  - 4 FTE CS
- Many part-time functionaries, people have other assignments in NLR or elsewhere
- A person may have several functions within the organisation
- Various positions throughout a project (the pressure stays on)
## Legal compliance

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Compliance</th>
<th>Manu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>National design approval, based on EASA Part 21</td>
<td>DOE</td>
</tr>
<tr>
<td>CAMO</td>
<td>Part CAMO and national approval</td>
<td>CAME</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Part 145 and national approval</td>
<td>MOE</td>
</tr>
<tr>
<td>Operations</td>
<td>• ICAO Annex 6 compliant (declaration)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Part SPO compliant where possible</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• ICAO Doc 8071 Radio Nav Aids testing</td>
<td></td>
</tr>
<tr>
<td>SMS</td>
<td>• ICAO Annex 19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Part CAMO</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• EC and national occurrence reporting regulations</td>
<td></td>
</tr>
<tr>
<td>FPD</td>
<td>Part FPD (Flight Validation)</td>
<td>OM Part FPD</td>
</tr>
<tr>
<td>Drones</td>
<td>UAS and U-space regulation</td>
<td>TBD</td>
</tr>
</tbody>
</table>

- Part OPS (ORO, NCC)
- Part FCL
- CS-AWO
- Part SERA
- Part AUR
- ...
SMS

1. Policy and objectives
   - 1.1 Management commitment (1.1, 4)
   - 1.2 Safety accountability and responsibilities (5)
   - 1.3 Appointment of key safety personnel (1.2, 5)
   - 1.4 Coordination of emergency response planning (14)
   - 1.5 SMS documentation (1.3, 12)

2. Safety Risk Management
   - 2.1 Hazard identification (6, 7, 13)
   - 2.2 Risk assessment and mitigation (7, 9)

3. Safety Assurance
   - 3.1 Safety performance monitoring and measurement (8)
   - 3.2 The management of change (13)
   - 3.3 Continuous improvement of the SMS (4, 11)

4. Safety promotion
   - 4.1 Training and education (10)
   - 4.2 Safety communication (10)

Ref: STO AGARDograph STO-AG-300-V32 Flight Test Safety and Risk Management
SMS – 1. Policy and objectives

Management structure
- Accountable Manager
- Safety Manager
- Safety Committee
- Safety Action Group

Safety policy
- Safety == responsibility of all personnel
- Just Culture applied
SMS – 2. Safety Risk Management

Occurrence reporting
- Small numbers (~10/year)
- Occurrences – pro-active reports – idea box
- Anonimity

Hazard identification and Risk Management
- Flight Test Safety Assessments (FTP)
- Management of Change
- Occurrences
SMS – 3. Safety Assurance

Safety Performance Indicators (SPI)

- ‘Safety profile’ => ‘area’s to be observed => SPI
- Little data
- How to look at these data?
  - Take average, compare with previous years (large fluctuations)
  - ‘Common sense’: understand and explain
  - Postholder view/assessment relevant

Yearly Safety Goal

2015 TCAS-RA’s (uncontrolled airspace)
2016 Promotion of Occurrence Reporting, stimulating pro-active reports
2017 Timely execution of SMS actions
2018/2019 Workload (prevention of too high workload situations)
2020/2021 Exposure/recency and lessons learned (communication and administration)
2022 Communication in a post-covid hybrid work situation
SMS – 4. Safety promotion (training and communication)

Communication
• MT/SAG meetings – monthly
• Management Review Safety Committee – once a year (MT/SAG twice)
• OPS meeting – monthly
• Operational planning meeting – monthly
• MX/CAMO – no scheduled meetings, daily contact (shared office)
• Design organisation – monthly
• Project related meetings – as required
• (Co-owners Citation – twice a year)

Training
• 2 yearly HF and SMS recurrent training (in-house)
Keeping up-to-date...

“Old School” Flight Test Risk Assessment
1. Identify hazards
2. Combine hazards into scenarios
3. Assess Severity
4. Assess Probability
5. Determine (unmitigated) risk
6. Define mitigating measures
7. Determine which measures can be implemented
8. Re-evaluate risk

+ Well known process
+ Embedded in legislation
- Not always practicable
- Not always complete?

<table>
<thead>
<tr>
<th>Probability</th>
<th>Catastrophic</th>
<th>Hazardous</th>
<th>Major</th>
<th>Minor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
<td>HIGH</td>
<td>HIGH</td>
<td>MEDIUM</td>
<td>LOW</td>
</tr>
<tr>
<td>Probable</td>
<td>HIGH</td>
<td>HIGH</td>
<td>MEDIUM</td>
<td>LOW</td>
</tr>
<tr>
<td>Occasional</td>
<td>HIGH</td>
<td>MEDIUM</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Remote</td>
<td>MEDIUM</td>
<td>LOW</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Improbable</td>
<td>LOW</td>
<td>LOW</td>
<td>LOW</td>
<td>ROUTINE</td>
</tr>
</tbody>
</table>
Keeping up-to-date... Changing processes is HARD!!

“Effectiveness of mitigating actions” replacing “Probability”

<table>
<thead>
<tr>
<th>Effectiveness of mitigation measures</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Catastrophic</td>
</tr>
<tr>
<td>Not effective</td>
<td>HIGH</td>
</tr>
<tr>
<td>Minimal</td>
<td>HIGH</td>
</tr>
<tr>
<td>Limited</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>Effective</td>
<td>LOW</td>
</tr>
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</table>

STPA applications
Look very promising...

- Define Purpose of the Analysis
- Model the control structure
- Identify Unsafe Control Actions
- Identify Loss scenarios

Control action

<table>
<thead>
<tr>
<th>Control action</th>
<th>Not providing causes hazard</th>
<th>Providing causes hazard</th>
<th>Too early, too late, out of order</th>
<th>Stopped too soon, applied too long</th>
</tr>
</thead>
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Challenges

- Limited time for reflection
- Limited human resources
- Insufficient performance data, few occurrences
- Keeping up to date
- Time pressure
- Staying compliant
- Part-time functions / multiple responsibilities

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