

Propellor Departure During Engine Run



14 Feb 2022

Caveats

It is not the purpose of the aircraft incident investigation to apportion blame or liability. The sole objective of the investigation and the report is the prevention of accidents and incidents.

- I will not reveal the identity of those involved. I will not reveal the type nor location. I will not blame, shame or defame!
- If you do know the identity of those involved, do not reveal their names either verbally or in chat (or by any other means) during this webinar.
- It is important that we have a SOAR / Defect reporting system that members can expect to be treated with confidentiality and a 'no blame' culture.



Introduction

This is not a story about a propellor coming off a sailplane with potentially fatal consequences. **This is a story of a missing bolt.**

- What happened
- Sequence of events
- Swiss cheese slices
- Human Factors
- Questions



What Happened?

- During a post maintenance engine run, the propellor assembly separated from the pylon at approx 4500 rpm.
- The propellor travelled forward and down and struck the upper fuselage between the pylon and the rear edge of the cockpit.
- The propellor then travelled forward and left and struck the person operating the engine from outside the cockpit.
- The propellor continued a further 30 meters, narrowly missing the safety observer, and eventually stopped after colliding with parked trailers.
- The engine operator required 15 staples to the back of the head.

What Happened?

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Propellor Strike

Pylon

Recreation of engine operator position post incident. Sailplane has been moved into a workshop. Propellor strike on upper fuselage. Propellor pylon visible at bottom right.

Sequence of Events

- Propellor had damage from the propellor yoke (used to fold prop during retraction). Sailplane being operated as unpowered sailplane with engine bay taped closed and minor defect entered in maintenance release. (3.71.1 *AIRW-M15 Permissible Unserviceabilities*)
- Propellor + pulley assembly and spindle (hub) is removed by owner and an assistant. Propellor + pulley assembly, and spindle (hub) is shipped as one unit by sailplane owner to Europe for overhaul and repair.
- Sailplane owner identified pylon system was missing parts and propellor yoke gas strut under strength.
- Aug 2021: Prop assembly returns from Europe.
- Sept 2021: Annual inspection. Requested to be ready by 24 Sept 2021. More defective parts found on pylon system. Missing and defective parts ordered from Europe. Propellor + pulley assembly and hub fitted. Independent inspection not carried out as engine was not able to be used and propellor + pulley assembly would need to be removed to fit new parts.



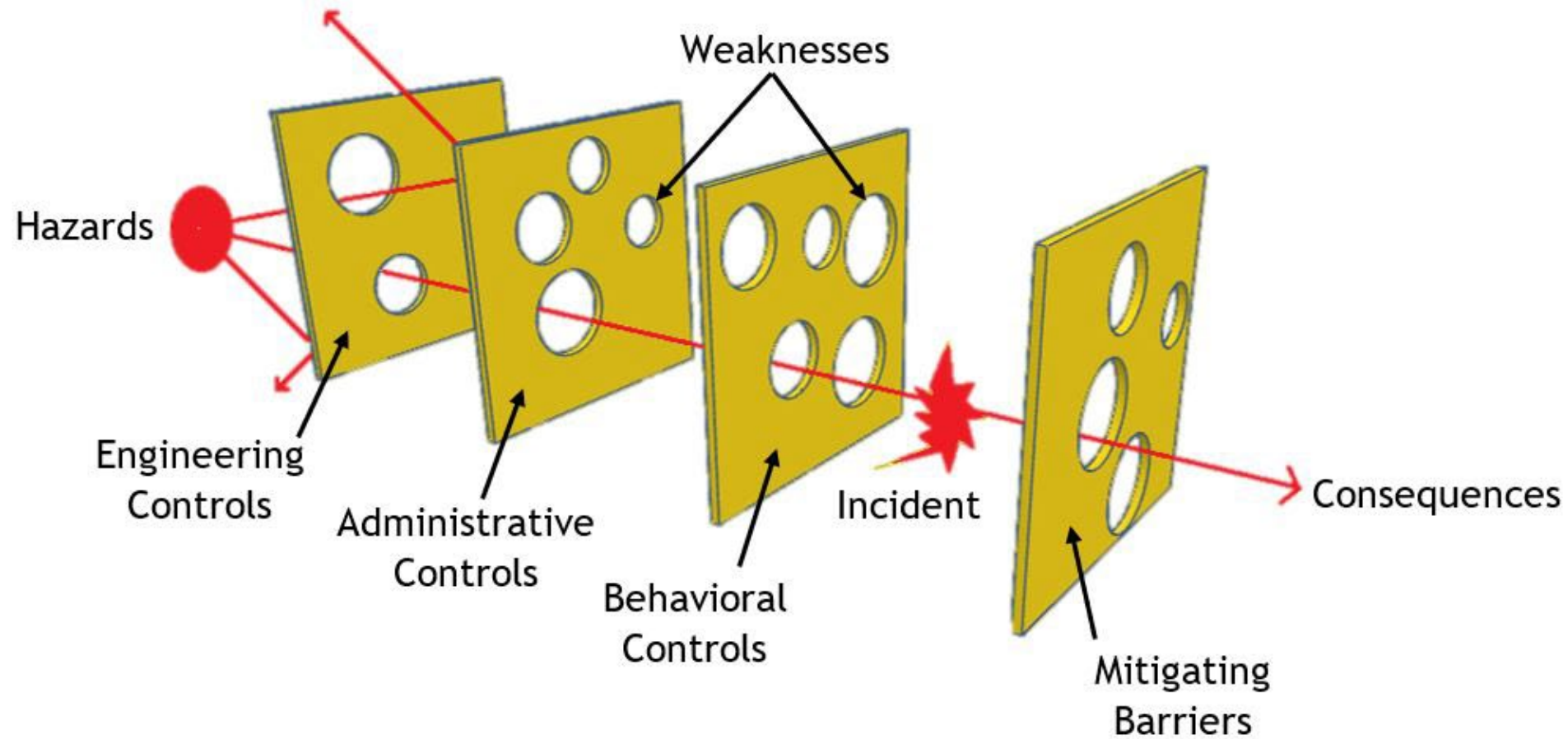
Sequence of Events

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- Feb 2022: Pylon parts arrive. Sailplane returned to maintenance venue to have replacement parts installed. Requested to be ready by 12 Feb 2022. Propellor + pulley and hub assembly removed, new parts fitted and propellor and pulley assembly refitted. Independent inspections carried out.
- 11 Feb 2022: First attempt at engine run. Engine failed to start.
- 14 Feb 2022: Minor engine maintenance carried out. Second attempt at engine run. Engine started. Incident occurred.

M10 mounting bolt that secured prop + pulley to spindle (hub) was not fitted. Thrust from prop was sufficient to pull prop + pulley off the spindle.

James Reason Model – aka Swiss Cheese



Swiss Cheese

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I will use a slightly different version of the Swiss Cheese model.

The slices will be the steps along the way where doing something different or intervention would have changed the outcome.

- Prop removal
- Maintenance manuals
- Prop overhaul
- First prop installation
- Second prop installation

Audience exercise – make notes of all the human factors as we step through the slices of cheese.



Cheese slice 1: Propellor Removal

- Propellor removed by people who did not have appropriate airworthiness rating. Breach of MOSP 3 Section 10.
- People removing prop followed the maintenance manual - mostly. Steps at the end were missed.
- Poor use of the word 'hub' in the maintenance manual caused confusion over what was to be removed and not removed.
- M10 bolt was 'bagged and tagged' and put into plastic lunch box.



Cheese slice 1a: Maintenance Manuals

- Maintenance manual probably translated from German to English.
- Maintenance manual uses the words: Prop, pulley and hub.
- Poor use of the word 'hub' in reference to spindle. Conventional use would have 'hub' as the assembly that the blades attach to.
- Prop manufacturer wanted prop hub and pulley together for O/H. Created confusion on what was needed to be removed.
- If in doubt, ask!



Cheese slice 2: Propellor Overhaul

- Propellor + pulley and spindle sent to manufacturer as one item without the M10 mounting bolt.
- Propellor + pulley and spindle overhauled / repaired and returned without the M10 mounting bolt. EASA Form 1 Certificate attached.
- Form 1 created the assumption that the entire assembly as returned was complete, serviceable and able to be installed as one item.



Cheese slice 3: 1st Propellor Installation

- Further problems found with pylon system. Parts ordered from manufacturer.
- Delays in receiving parts. Prop + pulley and spindle fitted as one item so sailplane could be operated with engine system u/s.
- Independent inspection not carried out. Engine was not able to be used and the prop + pulley assembly and spindle were going to be removed again when the new parts arrived.
- People involved were appropriately rated, were not completely familiar with this particular system, but had worked on the sailplane previously.
- E-mail chain shows that maintenance people were informed of the M10 bolt and had it in their possession in box along with other assorted parts.

Cheese slice 4: 2nd Propellor Installation

- After ~4 months new parts arrived.
- Prop + pulley and spindle removed from pylon and parts fitted.
- Prop + pulley and spindle installed by a different person and replaced the same way as first time – effectively copied the mistake.
- Independent check on the refitting of the propeller failed to identify the M10 mounting bolt was missing.
- Left over parts check not carried out.

Cheese slice 5: Mitigation

- Engine operator running engine outside the aircraft. Some protection would be afforded by being inside the cockpit.
- Safety person was present and raised the alarm. If engine operator had been incapacitated, then a good chance of dying at scene from injury or blood loss unless emergency services called and first aid applied.
- Where should a safety person be standing? Is safety person ready to act?
- Higher risks for activities immediately after maintenance eg: engine runs, assessment flights etc. Best chance for finding out something not done properly. Higher risks deserve greater mitigations.

Human Factors



Lessons that can be learned

Human Factors

Human capabilities and limitations can significantly impact airworthiness.

Misinterpretation:

- Unqualified person doing work and misunderstanding maintenance manual.
- Maintenance manual could use better terminology. Didn't seek clarification.
- EASA Form 1 certificate caused assumption for entire assembly

Parts control:

- M10 mounting bolt was at the maint venue. Got lost in the noise? Was bolt placed somewhere 'safe' for later?

Delays:

- Forgotten details
- What was done before?
- Where were parts stored?



Human Factors

Time pressure: *Very common!*

- Working 'faster' and potentially missing critical steps.
- Taking short cuts? By-passing procedures?

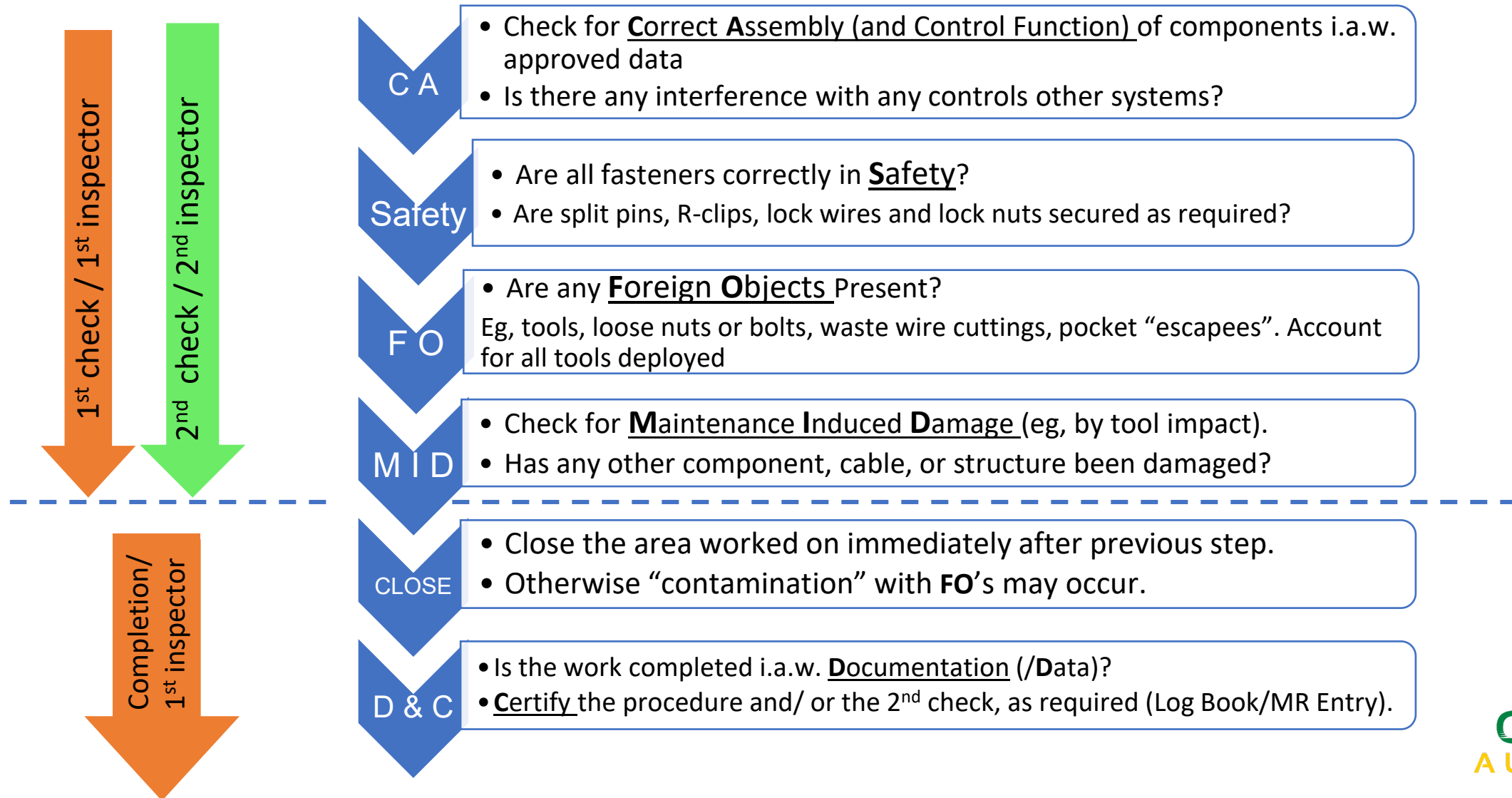
Assumptions:

- The part installation looks obvious – no need to check the maintenance manual?
- Copying the installation from the first time.

Confirmation Bias: Seeing what you expect or want to see, rather than the reality.

- Checked the work that was done?
- Check for work that wasn't done?

Independent Inspections



Independent Inspection Procedures

- Access applicable data during the check procedure
- The checker needs to be briefed (and to access the Approved Data)
 - Explain what was worked on, what items need to be in-safety, what tools were used
 - Explain that a procedural closure check is required
- The checker must not assume that work is error-free
- **ALL** hidden areas need to be checked: Use a mirror and appropriate illumination & other inspection tools (eg, boroscope)
- If any stage of the check procedure is not passed, take corrective action then recommence the check procedure from the start.
- DO NOT “LEAD” the 2nd checker, this compromised independence
- DO NOT interrupt or distract the 2nd checker

Questions

