Managing Ageing Threats on the RAAF PC-9/A Aircraft

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Outline

- Overview of steps taken to mitigate ageing threats to Royal Australian Air Force (RAAF) PC-9/A.
  - Ageing Aircraft and PWD Extension
  - Program Elysium
    - Ageing Aircraft Structural Audit (AASA) – Project Elixir
    - Ageing Aircraft Systems Audit (AASysA)
    - ASIP Recovery Project – Project Falkor
  - Conclusion
Ageing Aircraft and PWD Extension

  - 63 aircraft in operation
  - Provides advanced training to ADF pilots
- Planned Withdrawal Date (PWD):
  - Originally 2008
  - Several incremental extensions
  - Latest extension June 2016 to December 2019
- Increase in risk due to:
  - ‘Impending PWD’ limiting forward investment
  - Management focus on day-to-day operations
  - No review of previous PWD design decisions
Program Elysium

- PWD extension to 2019 necessitated:
  - Additional risk assurance.
  - Ageing threat management refresh to restore confidence.
  - Reassessment of ageing threats to confirm ability to meet PWD.
- Program Elysium initiated by Training Aircraft Systems Program Office (TAPSO).
- Purpose to ‘provide assurance that sustainability risks to PC-9/A operations to December 2019 are disclosed and managed.’
Program Elysium

• Project Elixir ‘Teardown’:
  - Satisfy outstanding Ageing Aircraft Structural Audit (AASA) requirements.
  - Provide confidence in Fatigue Management System (FMS) coverage.

• Ageing Aircraft Systems Audit (AASysA):
  - Provide assurance that ageing risks to PC-9/A aircraft systems are captured and managed through to PWD

• Project Falkor ‘ASIP Recovery’:
  - Rebuild confidence in Fatigue Management by implementing clear and comprehensive:
    • Aircraft Structural Integrity Management Plan (ASIMP) Volume 2
    • Instructions for Continuing Airworthiness (ICA)
PROJECT ELIXIR
TEARDOWN
Teardown - Background

- ADF Technical Airworthiness Regulations require Ageing Aircraft Structural Audit (AASA) at:
  - aircraft mid-life point, or
  - after 15 years in service.
- 2008 – AASA requirement waived by ADF Technical Airworthiness Authority.
  - Caveat that a gap analysis be conducted against ADF AASA requirements.
  - Outstanding AASA requirements not pursued due to ‘impending’ PWD.
- Major outstanding requirement for data collection of damage within non-inspectable structure.
- Post-2019 PWD extension: Decision to conduct full aircraft teardown to address outstanding requirements.
Teardown - Selection and Process

- One high life/high fatigue accrual fuselage and wing torn down.
- Targeted inspection locations defined through consideration of:
  - Structural classification and part criticality
  - PC-9 Empennage and Aft fuselage Recertification and Life Assessment (PEARLA) outcomes
  - Known susceptibility to Stress Corrosion Cracking (SCC)
  - Part accessibility
  - Usage, configuration and condition data of fleet and selected assets
- Teardown process involved:
  - Disassembly
  - Inspection (visual and targeted NDI)
  - Forensic Engineering
  - Analysis of Findings
Teardown – Results

• Damage found in Safety By Inspection (SBI) locations.

• Damage found in uninspected primary structure.
  - Expansion of SBI program necessary.

• Teardown article in overall good condition.
Teardown – Notable Findings – Aileron Nose Rib 1

- Extensive corrosion pitting and SCC at Aileron Nose Rib 1 hinge bolt hole.
  - Pilatus previously issued a Service Bulletin (SB) to:
    1. Check for SCC susceptible material.
    2. Inspect for cracking.
  - SB did not inspect bolt hole.
  - Inspection program expanded to cover bolt hole.
Teardown – Notable Findings – MLG Folding Strut Lever

- Fatigue cracks growing from lower attachment hole in Main Landing Gear (MLG) Folding Strut Lever.
  - Fleetwide inspection conducted.
  - Widespread cracking and corrosion found.
  - Fleetwide replacement instigated for MLG Folding Strut Levers and Support Struts.
Teardown – Notable Findings – Flap Bearing Half Bracket

- Widespread SCC, corrosion and pitting in bores of inner and outer Flap Bearing Half Brackets.
  - Damage indications in 11 of the 12 bracket halves installed on the aircraft.
  - Several instances of through-thickness damage.
  - Damage findings prevalent in fleet inspections.
  - Fleetwide inspection and replacement instigated for SCC susceptible components.
AGEING AIRCRAFT SYSTEMS AUDIT
Ageing Aircraft Systems Audit (AASysA) – Background

• Aims:
  - Identify and assess usage and age-related threats to PC-9/A aircraft systems integrity
  - Independent assessment of aircraft management processes
  - Identify patterns or trends pointing to future airworthiness, supportability or obsolescence problems.

• PC-9/A AASysA approach based on:
  - UK Military Airworthiness Authority (MAA) RA 5723 – Ageing Aircraft Audit.
  - QinetiQ UK AASysA knowledge and experience.
  - F/A-18 Classic Hornet AASysA framework and processess.
Ageing Aircraft Systems Audit (AASysA) – Phases

- **Phase 1 – Desktop audit and physical audit design.**
  - Review of TASPO management processes.
  - Assessment of in-service maintenance and management systems.
  - **Assessment of system/sub-systems and zonal threats.**
  - Validation of aircraft condition assumptions through General Condition Survey (GCS) activities.

- **Phase 2 – Physical audit and analysis of results.**

- **Phase 3 – Implementation of recommendations from Phases 1 & 2.**
Ageing Aircraft Systems Audit (AASysA) – System Threat Analysis

- On-board PC-9/A systems analysed for threats to ongoing operations.
- Risk based approach using Hazard Risk Index (HRI) methodology as per TASPO System Safety Program Plan.
- Ageing threat types considered:
  - Wear
  - Fatigue
  - Environmental Degradation
  - Maintenance Management
  - Accidental Damage
  - Overload
  - Configuration Control Management
  - Supply/Obsolescence
  - Design/Manufacturing Error
  - Change of Use
  - Change of Policy, Culture or Legislation

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Ageing Aircraft Systems Audit (AASysA) – System Threat Analysis

- Threat analysis largely based on:
  - Maintenance, defect and condition data.
  - OEM service bulletins.
  - RAAF modifications.
  - RAAF Special Technical Instructions (STIs).
  - Hazards reported within Defence Aviation Hazard Reporting and Tracking System (DAHRTS).

- Consideration given to:
  - Previous failures.
  - Reliability trends.
  - Item criticality.
  - Existing inspections and replacements.
  - Potential for previously unseen threats.
Ageing Aircraft Systems Audit (AASysA) – Zonal Hazard Analysis

- ZHA conducted to assess potential for failure propagation and associated implications.
- Conducted similarly to system threat analysis with aircraft split into 6 zones.
- Zonal threats considered:
  - Pressure
  - Heat, Temperature and Flammability
  - Friction / Mechanical Wear
  - Electrical
  - Vibration and Noise
  - Radiation
  - Contamination / Chemical Reactions
  - Miscellaneous
Ageing Aircraft Systems Audit (AASysA) – Outcome

- 639 threats to PC-9/A fleet identified throughout aircraft systems, sub-systems and zones.
- 64 Category A Recommendations – Specific response proposed.
- 30 Category B Recommendations – Further investigation required.
- Additional 4 systems recommended for physical audit.
  - Including inspection of aircraft wiring in multiple locations.
- Recommendations aim to:
  - Improve overall technical management of PC-9/A systems.
  - Ensure operational requirements of the fleet will be met up to the PWD.
- Recommendations currently being implemented by TASPO.
PROJECT FALKOR
ASIP RECOVERY
Project Falkor – ASIP Deficiencies

- Structural configuration not accurately captured
- Unable to assess effectiveness of EDM programs and establish emerging trends
- Unclear structural inspection policy and gaps in fatigue certification

ASIP Recovery Project (Falkor) initiated to support current PWD
Project Falkor – Rectification Activities

- Desktop audit of all Safety By Inspection (SBI) instructions for continued airworthiness (ICA) to identify FM deficiencies

  + Address fatigue certification recommendations

  + Repackage Safety By Inspection (SBI) program and SBI Instructions for Continued Airworthiness (ICA)

Establish a robust and efficient ASIP

- Fleet-wide structural audit to establish structural configuration and inspect aft fuselage locations

  + SCMS Reinvigoration Project (TASPO)

- Review EDMP effectiveness and trend SCM data (routine ASIP task)
Project Falkor – Consolidation of ASIMP Volume 2 Locations
Project Falkor – Physical Audit

• Fleet-wide audit to determine structural configuration of fatigue critical locations.
• Inspection layout based on consolidated ASIMP Volume 2.
• Physical audit instructions developed by QinetiQ and Airflite.
• Fleet-wide inspections commenced Apr 15, completed May 16.
• New structural condition database ‘VISION’ used to record all NDT reports, structural defects and Other Configuration Records (OCRs).
Project Falkor – Physical Audit Example

Non-standard repair at Frame 4A versus repair authorised by SBI policy

Stop drilled cracks in SBI locations do not adhere to current repair policy
Project Falkor – ICA Revision

- Revision of current SBI policy to:
  - Ensure all inspections included in NDT manual.
  - Remove contradicting instructions.
  - Simplify implementation policy.
  - Ensure the ASIMP Volume 2 captures all existing repairs to fatigue critical structure.

ASIMP Vol 2

Structural Repair Manual
Aircraft Maintenance Manual
NDT Manual

Inspection and repair instructions in various pubs, not always aligned with ASIMP Volume 2

Deviations
CFUs
SMRs

Non-standard configurations not tracked consistently

Technical Maintenance Plan
CAMM2

Not always aligned with SBI policy
Conclusion

• Proactive program of work conducted with TASPO and ASI-DGTA for PC-9/A fleet:
  − Minimised ageing aircraft risks to safety, sustainability and capability.
  − Regained confidence in ability of PC-9/A fleet to safely meet PWD.

• Achieved by:
  − Identifying potential threats (structural, systems, management).
  − Simplifying ASIP management.
  − Enacting rectification activity, where risk deemed unacceptable.