

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

- 1987 – Pilatus PC-9/A inducted by Royal Australian Air Force (RAAF).
 - 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.

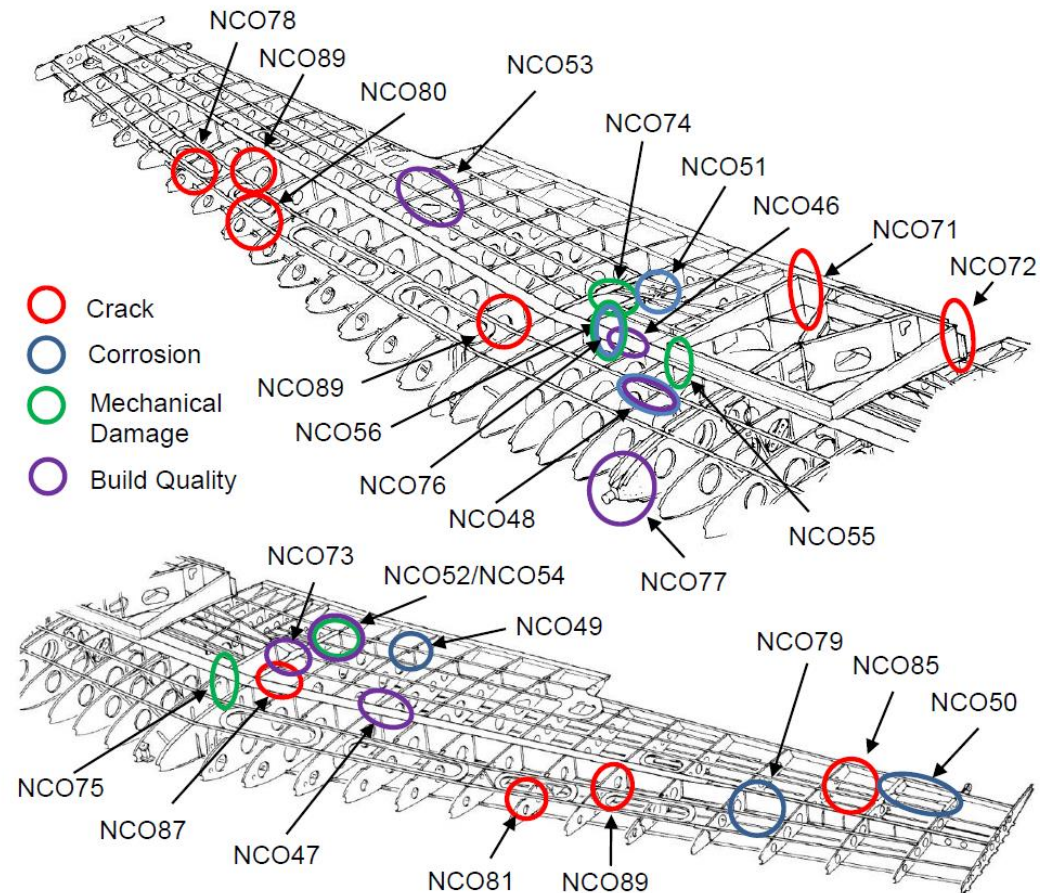
Teardown - Selection and Process

- 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



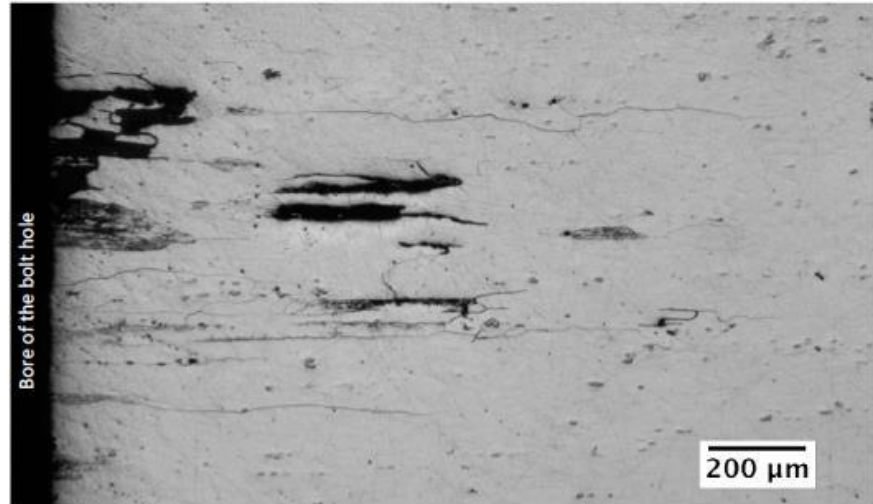
Teardown – Results

- 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.



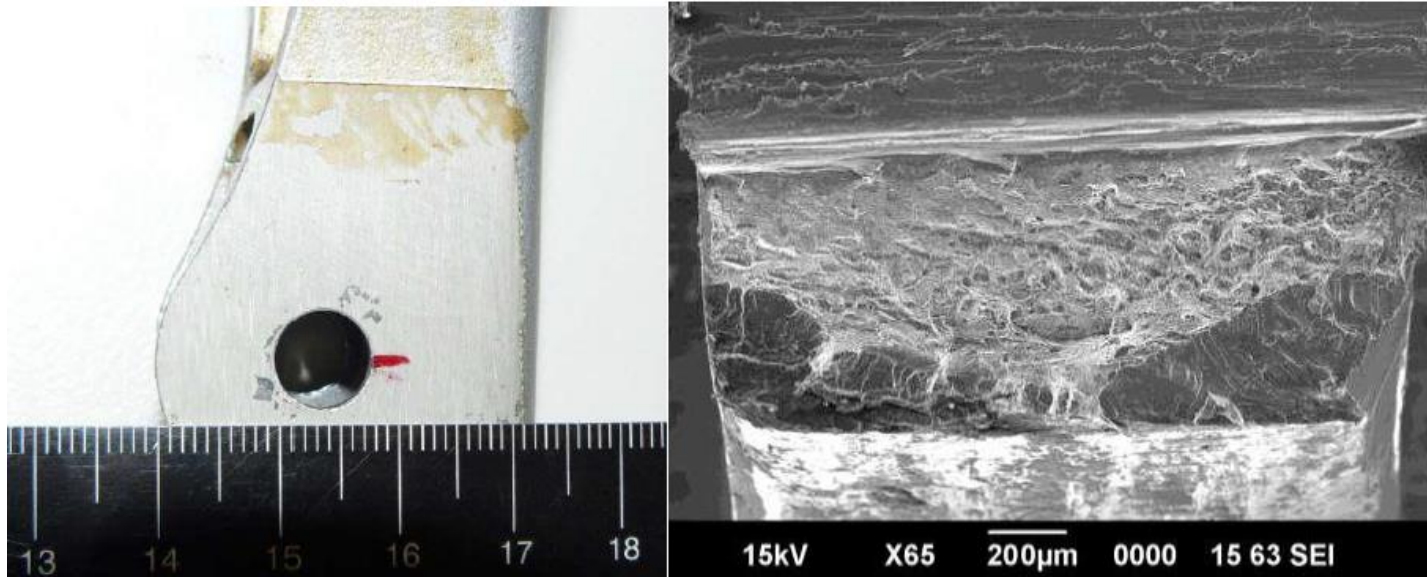
Teardown – Notable Findings – Aileron Nose Rib 1

- 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.



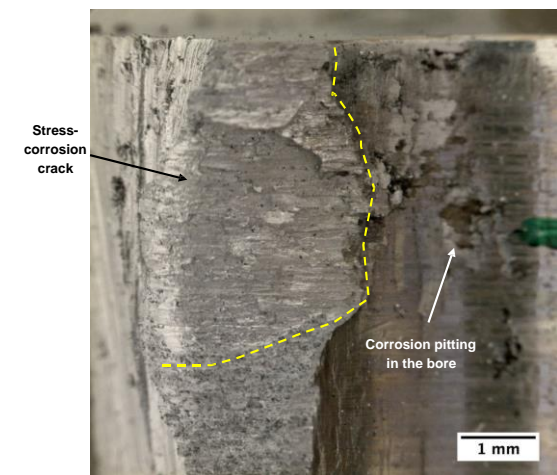
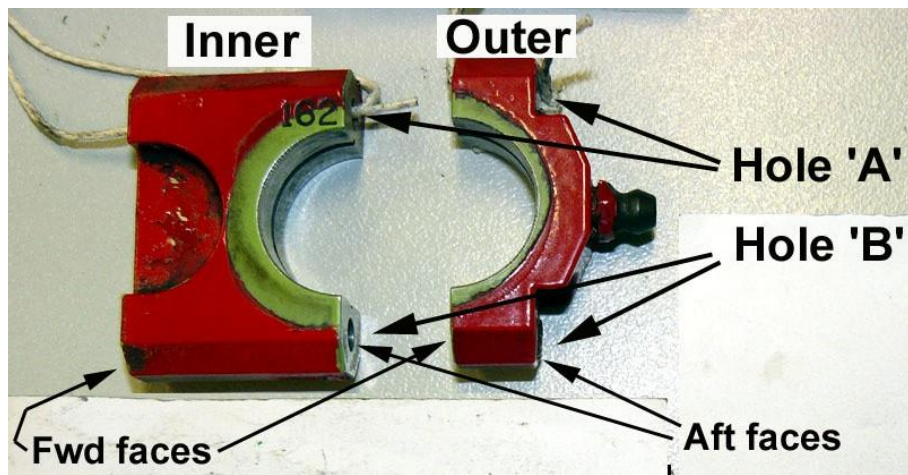
Teardown – Notable Findings – MLG Folding Strut Lever

- 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 processes.

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

HRI	Risk Level
1-3	HIGH
4-6	MEDIUM
7-10	LOW
11-16	NEGLIGIBLE

- 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

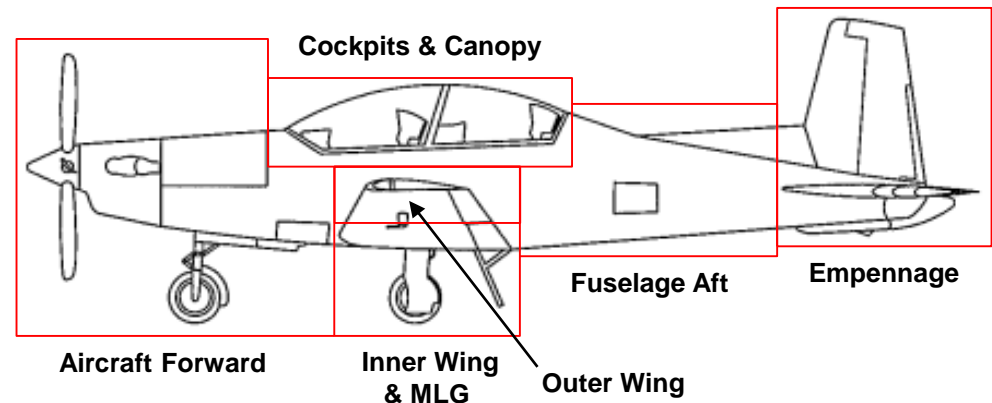
		HAZARD SEVERITY			
PROBABILITY		Minor	Major	Hazardous	Catastrophic
	Probable	7	4	2	1
	Remote	11	8	5	3
	Extremely Remote	14	12	9	6
	Extremely Improbable	16	15	13	10

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



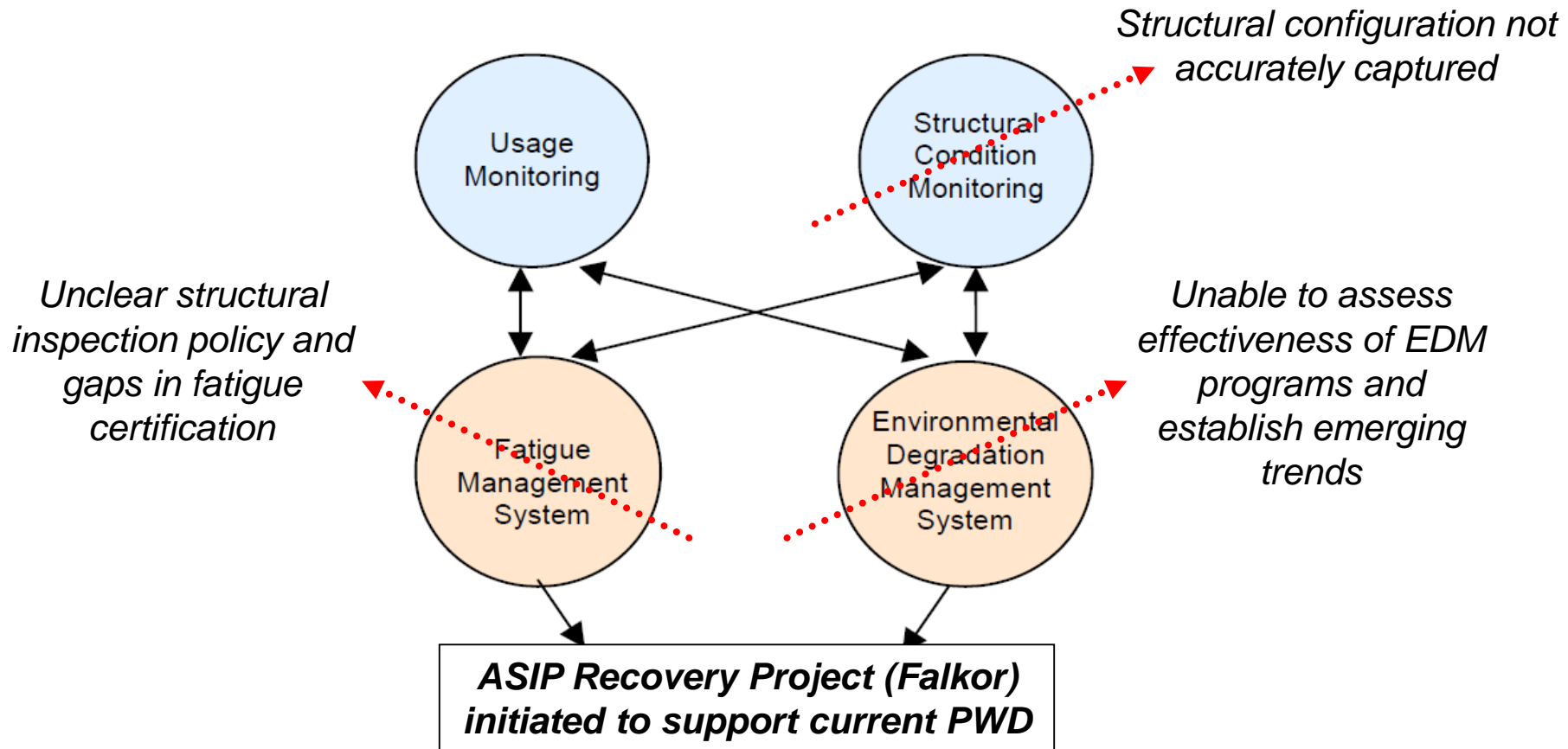
Ageing Aircraft Systems Audit (AASysA) – Outcome

- 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.

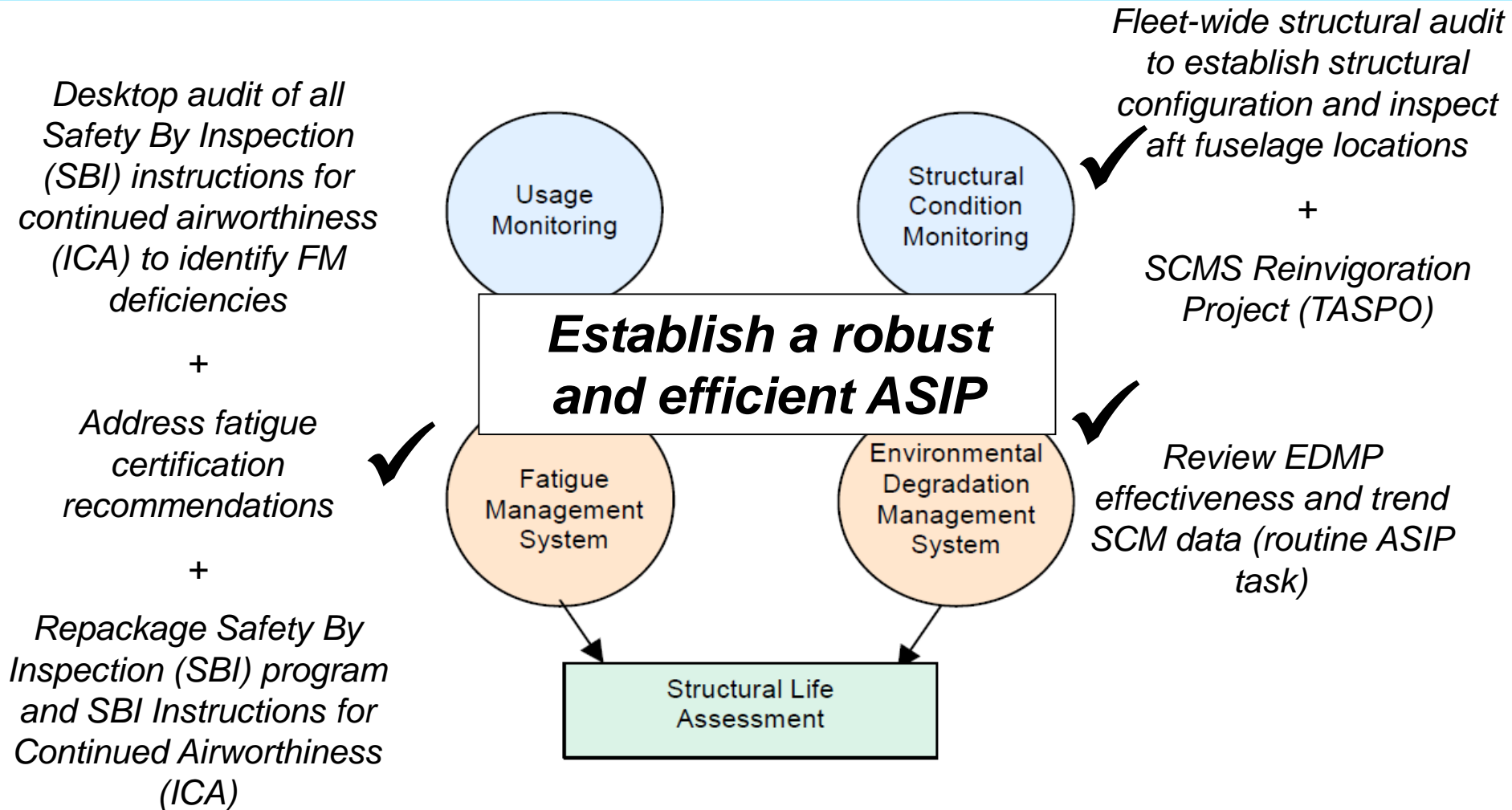


PROJECT FALKOR ASIP RECOVERY

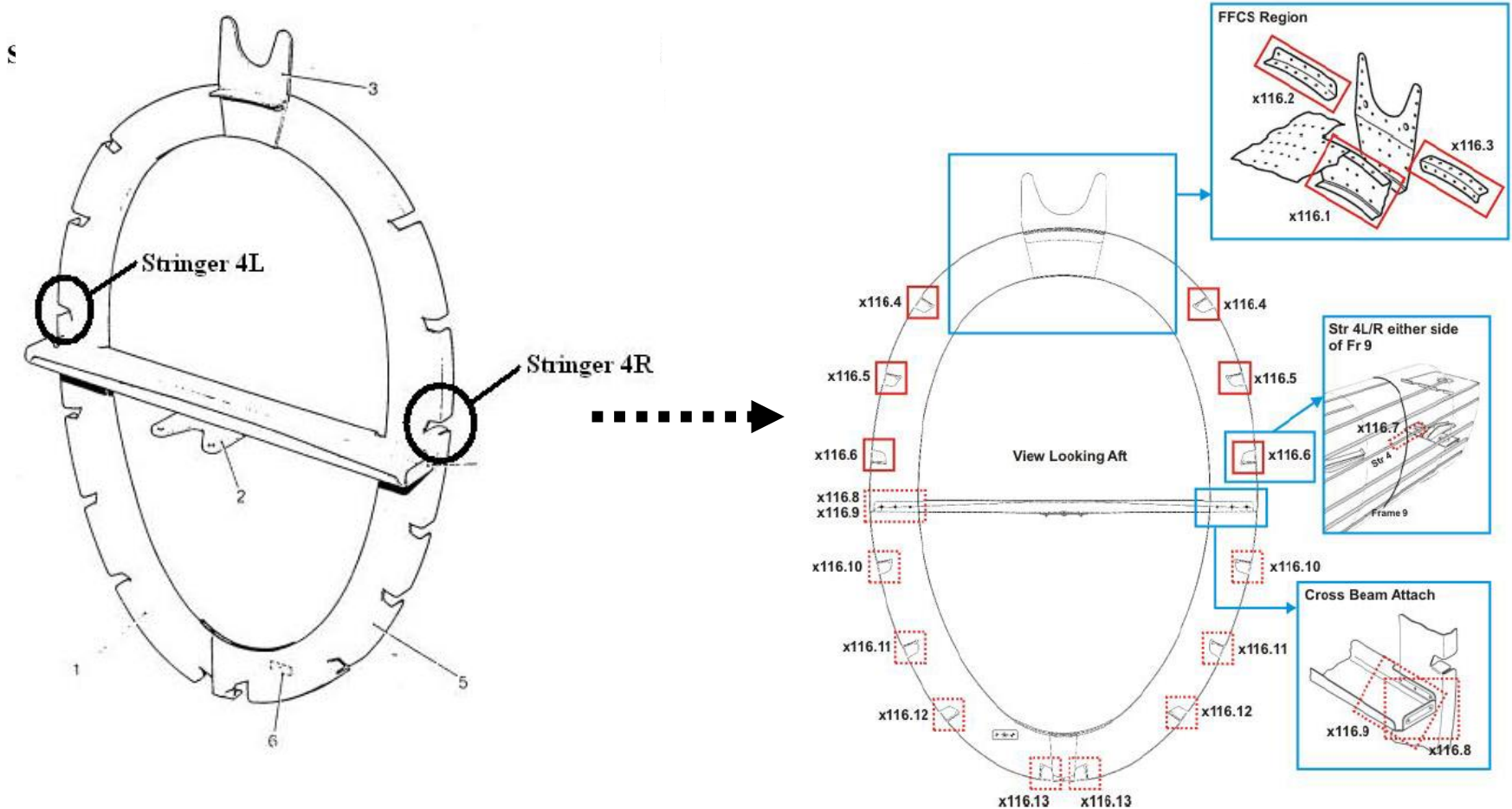
Project Falkor – ASIP Deficiencies



Project Falkor – Rectification Activities



Project Falkor – Consolidation of ASIMP Volume 2 Locations

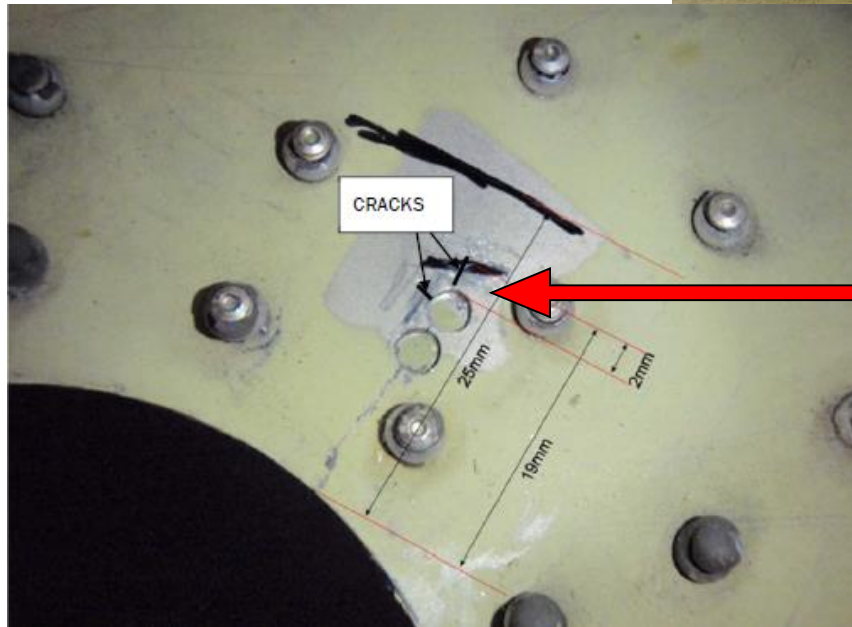
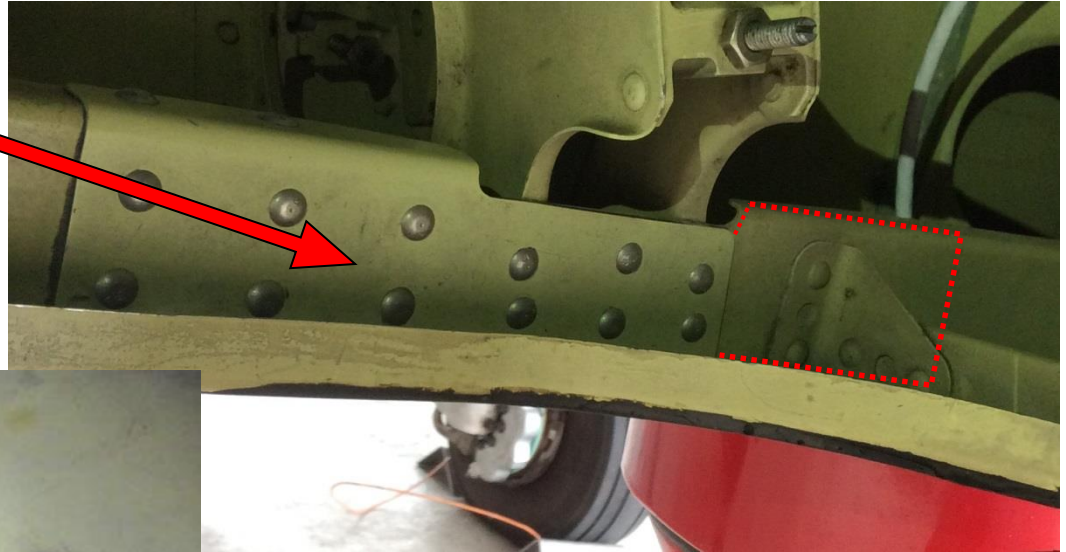


Project Falkor – Physical Audit

- 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

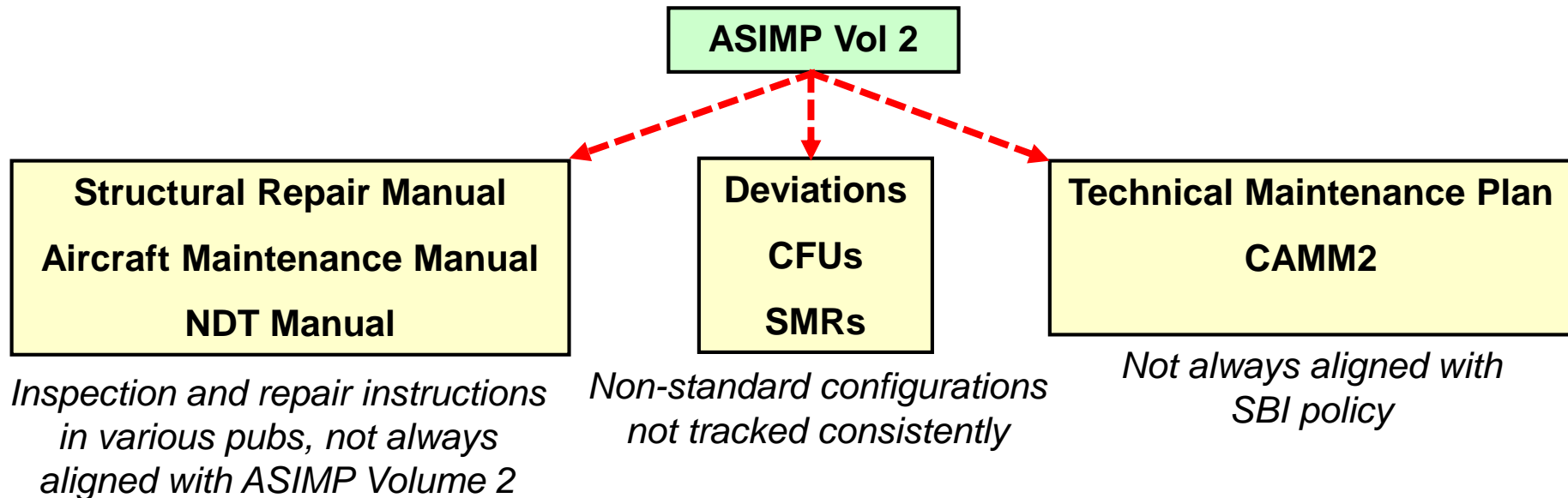
Non-standard repair at Frame 4A
versus repair authorised by SBI policy



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.



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.



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