



**Australian Government**

**Department of Defence**

Capability Acquisition and  
Sustainment Group

# Proactive Asset Management through Maintenance Condition Data

Bob Teunisse, RAMP Team Manager



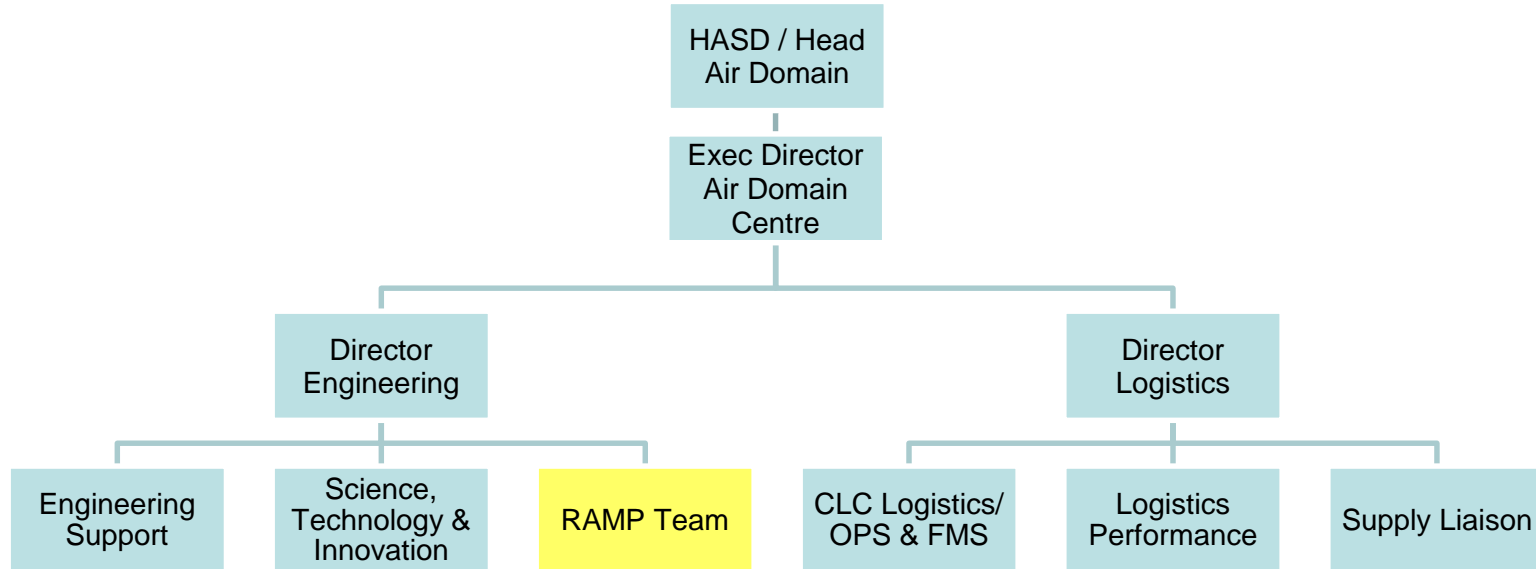
# Outline

- RAMP Team
  - Who We Are; What We Do; How We Do It
- Importance of Maintenance Condition Data (MCD)
- Current MCD Challenges
- Maintenance Data Improvement Initiatives
- Proof in the Pudding
- Final Observations

# Who We Are

## RAMP Team

The Reliability & Aircraft Maintenance Program (RAMP) Team is a team of technical specialists within the Air Domain

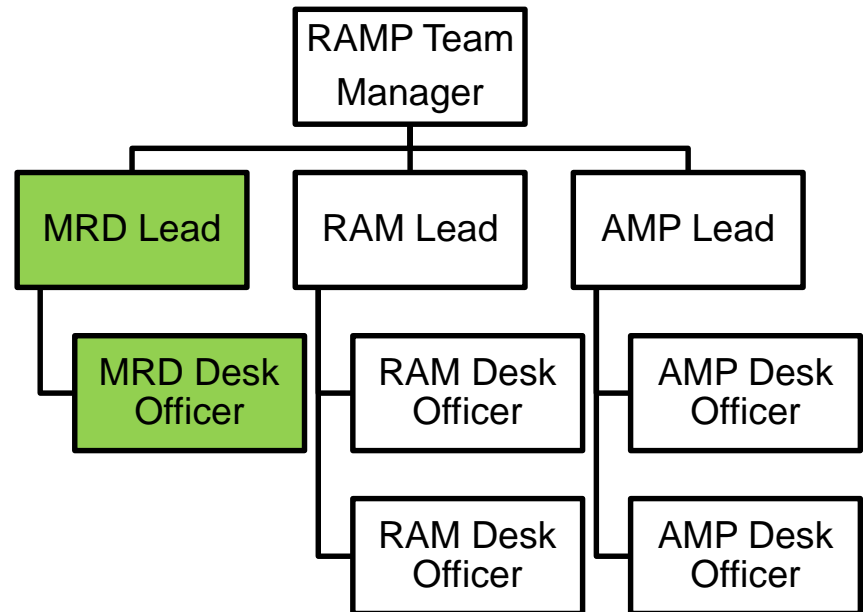


# Who We Are

## RAMP Team

Amalgamation of RAM COE, MRD COE & AMPRT

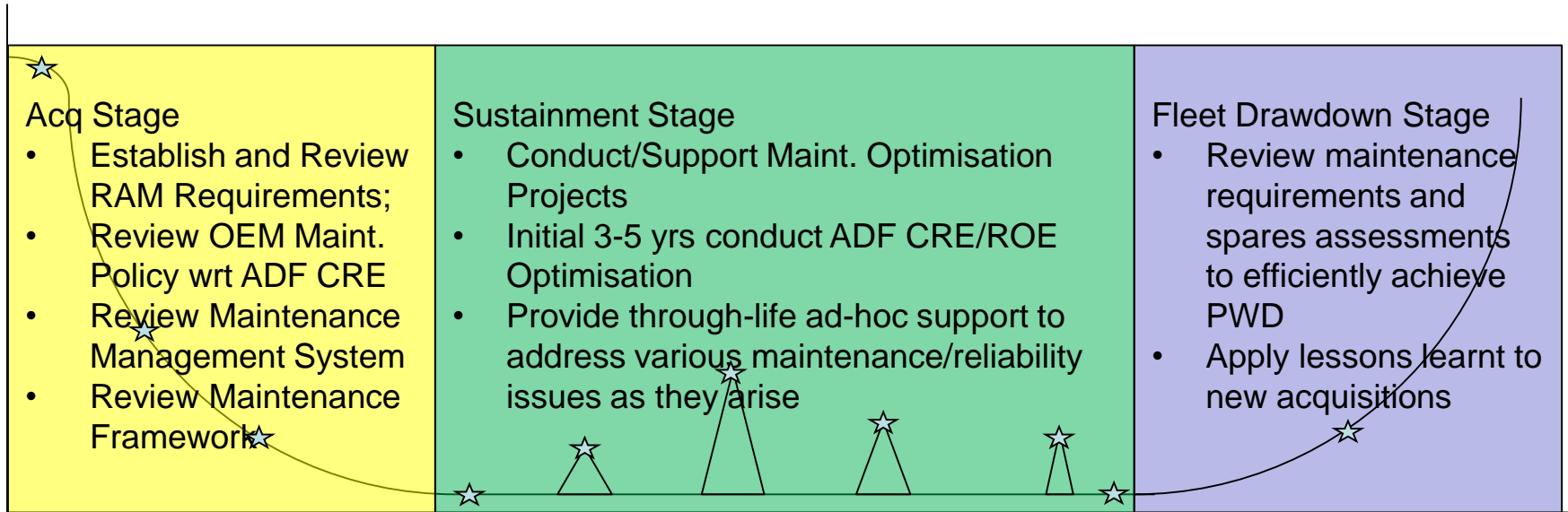
- 6 in Melbourne
- 2 in Canberra ■



# What We Do

- Assess maintenance task applicability and effectiveness.
- Conduct RAM analyses to support informed decision making across procurement, logistic and engineering activities.
- Support Defence Aviation Safety Authority wrt Aircraft Maintenance Programs (AMPs) and Reliability Programs.
- Health Check/Maturity assessment of AMPs & Reliability Programs in acquisition and sustainment.
- Publication-policy sponsorship and working group coordination.
- Practitioner and awareness training.

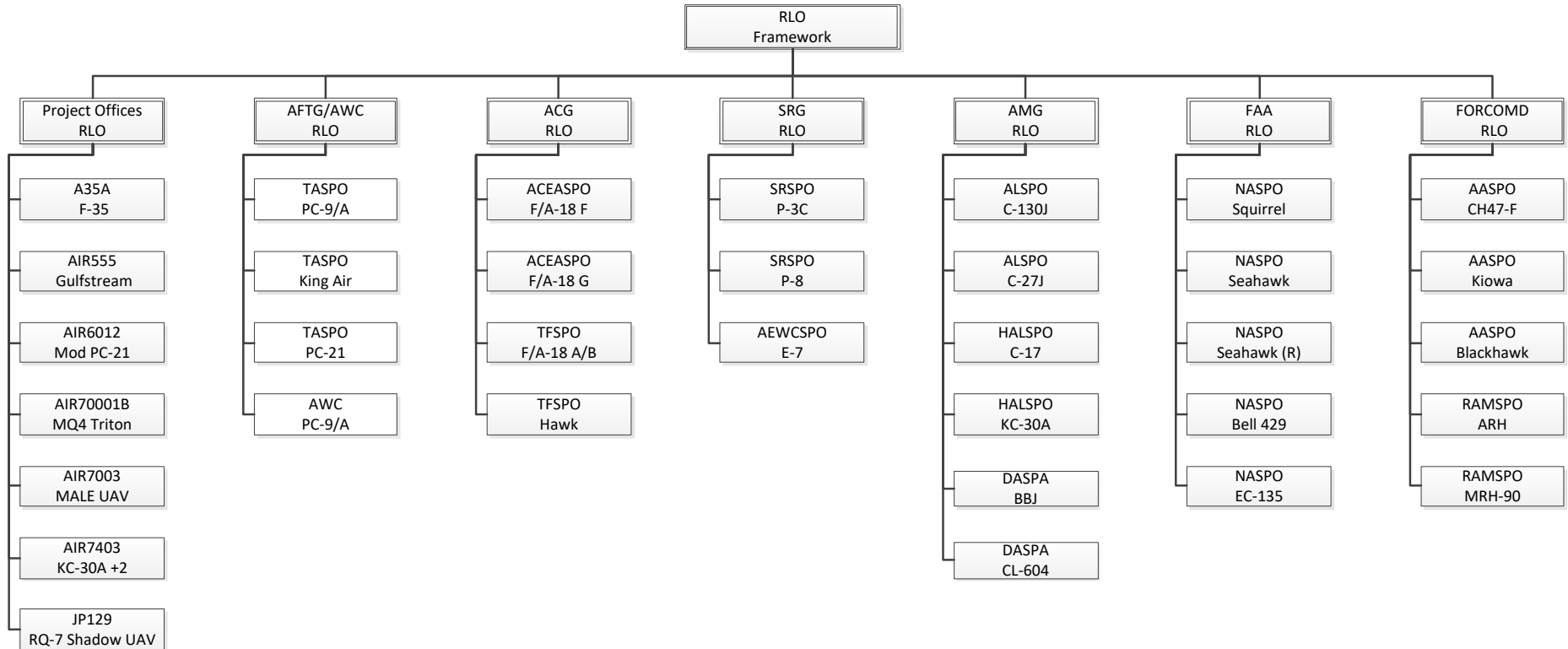
# What We Do



Capability Life Cycle



# How We Do It



# Importance of MCD

- A significant source of the cost of ownership for ADF platforms is the maintenance conducted on those platforms
- ADF platforms come with Original Engineering Manufacturer (OEM), Maintenance Policy based on many Configuration, Role & Environment (CRE) design assumptions.
  - The ADF CRE can vary from the actual OEM assumed CRE;
  - The ADF CRE can vary over time based on a variety of factors
- Collection of progressive MCD enables the degradation mode and the rate of degradation to be understood wrt ADF CRE

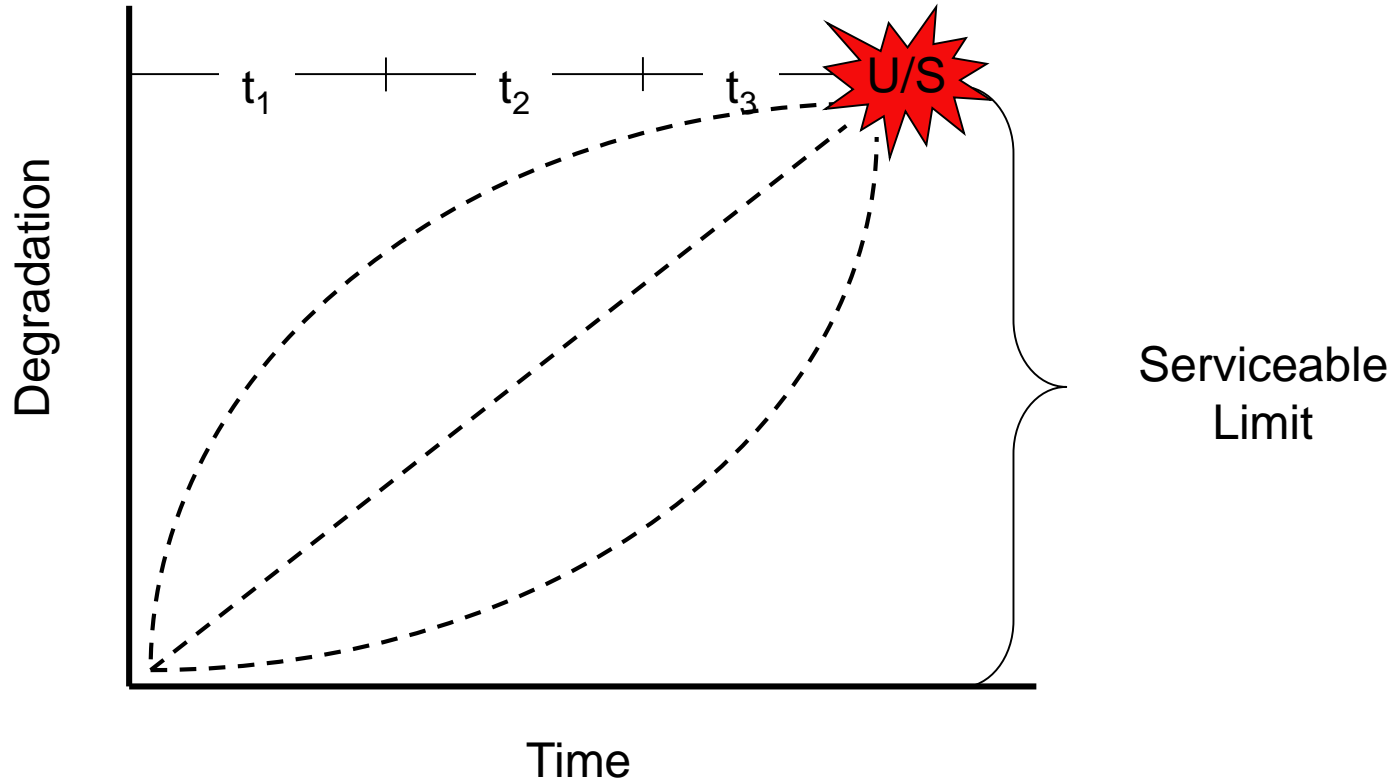


# Importance of MCD



Unserviceability

# Importance of MCD



# Importance of MCD

- MCD enables
  - platform managers to monitor and trend the severity and rate of degradation of their assets based on their CRE;
  - the assessment of the effectiveness of maintenance tasks and allows servicing intervals to be optimised
    - Maximise inherent reliability & confidence
    - Minimise maintenance impost/maintenance induced damage
- MCD ensures we do the right maintenance, at the right time, for the right reasons, which will
  - Ensure Safety
  - Optimise Cost of Ownership
  - Maximise Asset Availability

# Current MCD Challenges

- No requirement to **record** and monitor the 'condition' of components prior to being U/S
  - Failure Reporting is 'digital' (eg. Item is Serviceable or U/S)
  - Limits ability to tailor Maintenance Policy to CRE & realise inherent reliability
- Paper-based MCD has limitations
  - Storage/Access
  - Inability to interrogate; filter; trend; etc
- Failure data lack relevant details
  - Failure mode; dimensions; corrective actions; etc
  - Maintainers often lack context of the importance of MCD

# Current MCD Challenges

## Examples of Poor MCD

| Unserviceability   | Comment   |
|--|---|
| RH aileron trim tab to be replaced                                   | No mode of failure or external symptoms of failure      |
| Port outboard leading edge drop down access panel cracked as marked. | Requires access to maintenance venue/aircraft.          |
| Corrosion inside of nose wheel well lip.                             | Lacks details about the degree and type of degradation. |
| LH Aft Stubbie Cooler Appears to be Missing                          | Use of colloquialisms                                   |

## Examples of Good MCD

| Unserviceability  | Comment   |
|---|---|
| With ground power applied #3 eng flight idle stop fails to disengage.                                 | Clearly identifies the context and the problem.                       |
| Pilot side windshield has delamination evident at the LH bottom edge approx 2" wide and "5" vertical. | Clearly identifies the area of concern and the extent of degradation. |
| Flt stn aircon unable to get temp below 19 degrees Celsius in auto or manual.                         | Clearly identifies the functional failure.                            |
| Wing flap control handle friction lock slips at 26lbs force.  | Provides quantitative measurements of degradation.                    |



# Maintenance Data Improvement Initiatives

## Aim:

- To improve the acquisition of MCD at the 'coalface'

## Initiatives to Include:

- Engage Maintainers
- Reviewing/Filtering MCD
- Collection of Electronic MCD
- Collection of Progressive MCD Degradation

# Maintenance Data Improvement Initiatives

## Engage Maintainers

- Maintainers **know** Maintenance & **know** their Assets
- Continuation Training Briefs
  - Intent is to *inform* Maintainers *what* data/information is required
  - Provides context wrt *WHY* MCD is important
  - Provides assurance that MCD is *NEED* to:
    - ensure safety
    - optimise the cost of ownership/availability
  - Feedback to Maintainers is essential!
- Seek Maintainer Knowledge
  - an ideal way to get information that cannot be recorded in maintenance records

# Maintenance Data Improvement Initiatives

## **Review/Filter data at Maintenance Facility**

- Improve data quality
- Clarify vague descriptions
- May require dedicated personnel with MCD training

## **Electronic MCD**

- Essential to trend, filter, interrogate
- Transfer paper-base maintenance records to electronic database
  - Progressive vs Shock & Awe
- May require dedicated personnel



# Maintenance Data Improvement Initiatives

## **Collection of Progressive MCD Degradation**

- Utilised on RAAF PC-9/A Maintenance Policy Review Project
- Identified Candidate Preventative Maintenance Tasks
- Provide Brief to Maintainers
- Utilised Alpha-Numeric Condition Codes & Comments
  - Alpha Character specified Mode of Degradation
  - Numeric Character specified Degree of Degradation
- Condition Codes entered into MCD database by single data manager at the completion of each servicing.

# Maintenance Data Improvement Initiatives

| <b>Condition Codes</b> |   |
|------------------------|---|
| <b>Code</b>            | <b>Description</b>                                |
| B                      | Bent or Distorted                                 |
| C                      | Corrosion   |
| CN                     | Contamination                                     |
| CR                     | Cracking  |
| D                      | Damage  |
| DL                     | Delaminating or Debonding                         |
| E                      | Erosion   |
| H                      | Overheating                                       |
| L                      | Leaking   |
| LB                     | Lubrication                                       |
| M                      | Free Movement                                     |
| R                      | Replenishment                                     |
| S                      | Security  |
| T                      | Check Test  |
| V                      | Visibility/Clarity (Transparencies)               |
| W                      | Wear  |
| X                      | Calibration                                       |
| Z                      | General Conditioning (General surveillance tasks) |

| <b>Severity Rating Values</b> |  |
|-------------------------------|--|
| <b>Rating</b>                 | <b>Description</b>   |
| 0                             | No detectable degradation or variation from a specified dimension, parameter or standard.  |
| 1                             | First signs of degradation or variation from a specified dimension, parameter or standard evident but within acceptable limits.              |
| 2                             | Degradation or variation from a specified dimension, parameter or standard has progressed to a 50% point but still within acceptable limits. |
| 3                             | Degradation or variation from a specified dimension, parameter or standard has progressed to a 75% point but still within acceptable limits. |
| 4                             | Degradation or variation from a specified dimension, parameter or standard is outside acceptable limits and requires rectification.          |

# Maintenance Data Improvement Initiatives

## Example of PC-9/A Maintenance Card

AAP 7212.007-6-2-1 Aircraft Tail No: A23-031 SNOW: 4SQNXU1102493 Sheet No: OF 10 Sect 3 Chap 1

| US | LCN/ALC<br>NUMERICALURE<br>WAC IC PC CH     | TASK<br>CODE | FRR No | OPERATION DETAIL                                  | C<br>E<br>R<br>T | UNSERVICABILITY AND TRANSFER DETAILS |     | IND<br>and<br>DTG | CERTIFICATION<br>1. TRADESPERSON<br>2. DTG<br>3. SUPERVISOR<br>4. DDB? |
|----|---|--------------|--------|---|------------------|--------------------------------------|-----|-------------------|--|
|    |   |              |        |   |                  | IMIC<br>No                           | HRS |                   |  |
| 1  | A1000/00<br>8000 PEDAL IN FRONT<br>G130 S S | AK07FAA      | M      | 1 EXAMINE PEDAL AND<br>BRAKE MECHANISM.           | P                | FRR - 20, 20                         | 0.5 | /                 | 1. [Signature]<br>2. [Signature]<br>3. [Signature]<br>4. [Signature]   |
| 2  |   |              |        | 2 LUBRICATE IAN<br>AAP 7212.007-2<br>CH 12-20-67. | T                |                                      | 0.5 | /                 | 1. [Signature]<br>2. [Signature]<br>3. [Signature]<br>4. [Signature]   |
| 3  | A1000/00<br>8000 PEDAL IN REAR<br>G140 S S  | AK07FAA      | M      | 1 EXAMINE PEDAL AND<br>BRAKE MECHANISM.           | P                | FRR - M1, 20                         | 0.5 | /                 | 1. [Signature]<br>2. [Signature]<br>3. [Signature]<br>4. [Signature]   |
| 4  |   |              |        | 2 LUBRICATE IAN                                   | T                |                                      |     | /                 | 1. [Signature]<br>2. [Signature]<br>3. [Signature]<br>4. [Signature]   |

*(rule through diagonally if all discrepancies found)*

# Maintenance Data Improvement Initiatives

Enables Trending for a given aircraft across successive servicings

| Servicing - R2 |           |    |        |  |                |        |           |                |        |           |  |
|----------------|-----------|----|--------|--|----------------|--------|-----------|----------------|--------|-----------|--|
| Work Card No   | LCN       | US | Sub No | Operation Detail   | Condition Code | Rating | Date      | Condition Code | Rating | Date      |  |
| 020:01         | AZZAE06   | 4  | 1      | Examine  | C, Z           | 0, 0   | 28-Aug-12 | C, Z           | 0      | 21-Aug-14 |  |
| 020:01         | AZZAE06   | 5  | 2      | Examine left hand upper longeron   | C, Z           | 0, 0   | 28-Aug-12 | C, Z           | 0      | 21-Aug-14 |  |
| 020:01         | AZZAE06   | 6  | 3      | Examine left hand lower longeron   | C, Z           | 0, 0   | 28-Aug-12 | C, Z           | 0      | 21-Aug-14 |  |
| 020:01         | AZZAE06   | 7  | 4      | Examine right hand upper longeron  | C, Z           | 0, 0   | 28-Aug-12 | C, Z           | 0      | 21-Aug-14 |  |
| 020:01         | AZZAE06   | 8  | 5      | Examine right hand lower longeron  | C, Z           | 0, 0   | 28-Aug-12 | C, Z           | 0      | 21-Aug-14 |  |
| 020:01         | AZZAE08   | 9  | 1      | Examine  | C, Z           | 0, 0   | 28-Aug-12 | C, Z           | 0      | 21-Aug-14 |  |
| 020:02         | AZZAE     | 2  | 2      | Examine rudder & elevator cables, pulleys & operating mechanisms                       | C, Z           | 0, 0   | 28-Aug-12 | C, Z           | 0      | 22-Aug-14 |  |
| 021:01         | AZZAO00   | 1  | 1      | Examine external portion of work area  |                |        | 28-Aug-12 | Z, CN          | 1      | 21-Aug-14 |  |
| 021:01         | AZZAO00   | 2  | 2      | Examine internal portion of work area, particularly the flanges of the FWD spar        |                |        | 28-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 021:01         | AZZAO02   | 3  | 1      | Examine external portion of work area  |                |        | 28-Aug-12 | Z, CN          | 1      | 21-Aug-14 |  |
| 021:01         | AZZAO02   | 4  | 2      | Examine internal portion of work area, particularly the flanges of the FWD spar        |                |        | 28-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 021:02         | AZZAO02AA | 1  | 1      | Examine, particularly for distortion of the trailing edge                              | B, Z           | 0, 0   | 29-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 021:02         | AZZAO04AA | 3  | 1      | Examine  | B, Z           | 0, 0   | 29-Aug-12 | Z              | 0      | 21-Aug-14 |  |
| 021:02         | AZZAO04AA | 4  | 2      | Examine lower operating lever  | C, Z           | 0, 0   | 29-Aug-12 | Z, CR, C       | 1      | 21-Aug-14 |  |
| 021:02         | AZZAO04   | 6  | 1      | Examine, particularly for the LH & RH stringers & the main spar to fuselage attachment | Z              | 0      | 30-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 023:01         | AZZAG04   | 1  | 1      | Examine  | Z              | 0      | 28-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 023:01         | AZZAG04   | 2  | 2      | Examine left hand upper longeron   | C, Z           | 0, 0   | 29-Aug-12 | C, Z           | 0      | 22-Aug-14 |  |
| 023:01         | AZZAG04   | 3  | 3      | Examine left hand lower longeron   | C, Z           | 0, 0   | 29-Aug-12 | C, Z           | 0      | 22-Aug-14 |  |
| 023:01         | AZZAG04   | 4  | 4      | Examine right hand upper longeron  | C, Z           | 0, 0   | 29-Aug-12 | C, Z           | 0      | 22-Aug-14 |  |
| 023:01         | AZZAG04   | 5  | 5      | Examine right hand lower longeron  | C, Z           | 0, 0   | 29-Aug-12 | C, Z           | 0      | 27-Aug-14 |  |
| 023:01         | AZZAG04   | 6  | 1      | Inspect flight control system for free play IAW AAP 7212.007-2 CH 27-00-01             | M              | 1      | 29-Aug-12 | M              | 2      | 01-Oct-14 |  |
| 023:01         | AZZAG04   | 7  | 2      | Examine control column & interconnect rod  | M              | 1      | 29-Aug-12 | Z              | 1      | 01-Oct-14 |  |
| 023:01         | AZZAG04   | 8  | 3      | Examine rudder cables & pulleys  | C, Z           | 0, 0   | 28-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 023:02         | A1UBS     | 2  | 1      | Examine pedal & brake mechanism  | Z              | 0      | 29-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 023:02         | A1UBU     | 4  | 1      | Examine pedal & brake mechanism  | Z              | 0      | 29-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 023:02         | A1UBU     | 5  | 2      | Examine NWS control mechanism from front rudder pedals to firewall                     | S, Z           | 0, 0   | 29-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 023:02         | A1UCQ     | 7  | 1      | Examine linkage point  | Z              | 0      | 28-Aug-12 | Z              | 0      | 25-Aug-14 |  |
| 023:02         | A1UCQ     | 8  | 2      | UBS IAW AAP 72112.007-2 CH 12 20 00  | LR             | 0      | 28-Aug-12 | LR             | 0      | 25-Aug-14 |  |

# Maintenance Data Improvement Initiatives

Enables Trending for a given maintenance task across the fleet

|              | Work Card No | LCN      | US | Sub No | Operation Detail   | A23-061 (1)    |        |            |  | A23-064 (1)    |        |            |  |
|--------------|--------------|----------|----|--------|--|----------------|--------|------------|--|----------------|--------|------------|--|
|              |              |          |    |        |  | Condition Code | Rating | Date       | US, Transfer Details & Corrective Action | Condition Code | Rating | Date       | US, Transfer Details & Corrective Action |
| RT SERVICING | 002:01       | A00      | 1  | 1      | Examine  | D              | 1      | 29/05/2012 |  |                |        |            |  |
|              | 002:01       | AZZAA06  | 4  | 3      | Examine air inlet particularly the 1st stage blade root for FOD                  | Z              | 0      | 29/05/2012 |  | Z              | 0      | 04/09/2012 |  |
|              | 002:01       | A1SAK34  | 7  | 2      | Examine  | Z              | 0      | 29/05/2012 |  | Z              | 1      | 04/09/2012 |  |
|              | 002:02       | A1SAK48  | 2  | 2      | Inspect IAW AAP 7113.022-2   | Z              | 0      | 29/05/2012 |  | Z              | 0      | 04/09/2012 |  |
|              | 003:01       | A1UJK00  | 3  | 3      | Clean IAW AAP 7212.007-2 CH 28-20-06   | CN             | 1      | 29/05/2012 |  | CN             | 1      | 04/09/2012 |  |
|              | 003:01       | A1UBS    | 5  | 1      | Examine pedal & brake mechanism  | Z              | 0      | 30/05/2012 |  | Z              | 2      | 04/09/2012 |  |
|              | 004:01       | A1UBU    | 1  | 1      | Examine pedal & brake mechanism  | Z              | 0      | 30/05/2012 |  | Z              | 2      | 04/09/2012 |  |
|              | 004:01       | A1UFD    | 3  | 1      | Examine pedal & brake mechanism  | Z              | 0      | 30/05/2012 |  | Z              | 2      | 04/09/2012 |  |
|              | 004:01       | A1UFQ    | 5  | 1      | Examine pedal & brake mechanism  | Z              | 0      | 30/05/2012 |  | Z              | 2      | 04/09/2012 |  |
|              | 004:01       | A1UUG    | 7  | 1      | Lube IAW AAP 7212.007-2 CH 12-20-00  | LB             | 0      | 29/05/2012 |  | LB             | 0      | 04/09/2012 |  |
|              | 005:01       | AZZAC    | 1  | 1      | Look for corrosion & cracking of the actuator support & folding strut & supports | Z              | 0      | 30/05/2012 |  | Z              | 1      | 04/09/2012 |  |
|              | 005:01       | AZZAK04  | 3  | 1      | Examine work area  | Z              | 0      | 29/05/2012 |  | Z              | 0      | 04/09/2012 |  |
|              | 005:01       | AZZA02AA | 7  | 1      | Examine work area, particularly for distortion of trailing edge                  | Z              | 0      | 29/05/2012 |  | Z              | 1      | 04/09/2012 |  |

# Maintenance Data Improvement Initiatives

## Realised Benefits

- Provided invaluable data for PC-9/A Maintenance Policy Review Project
  - Electronic data enabled trending of tasks
  - Qualitative trend of the degradation to U/S
- Ability to better optimise Maintenance Policy based on RAAF usage
  - Allowed the aircraft to 'talk to us'

# Proof in the Pudding

- RAAF P-3 Maintenance Policy Review Project
  - Extended Major Routine Servicing Intervals
    - Reduced the number of Servicings to reach PWD
    - Reduced manhour/material costs
    - Created flexibility in fleet program
  - Removed Superfluous Tasks
  - Streamlined tasking
  - **Provided Additional Recommendations**
    - **Limited MCD prevented definitive Maintenance Policy changes**
    - **Estimated potential savings > \$350k**
  - **Electronic MCD is now being collected**

# Proof in the Pudding

- RAAF PC-9/A Maintenance Policy Review Project
  - Extended Major Routine Servicing Intervals
    - Reduced the number of Servicings to reach PWD
    - Reduced manhour/material costs
    - Created flexibility in fleet program
  - Removed Superfluous Tasks
  - Streamlined tasking
  - Increased Aircraft Availability
  - Identified Safety-By-Inspection promulgation inconsistencies
  - Due to Electronic MCD Degradation collected
    - Fewer recommendations requiring additional data



# Final Observations

## Engage with Maintainers

- Continuation Training Briefings
- Utilise Knowledge & Experience
- Provide Feedback

## Review/Filter MCD at the 'coalface'

- Improve quality of data to support analysis
- Can create an work impost

## Importance of Electronic MCD

- enables monitoring/trending/interrogating maintenance issues

# Final Observations

## MCD:

- Enables asset managers to monitor and trend the severity and rate of degradation of their assets based on the CRE of the asset
- Ensures we do the right maintenance, at the right time, for the right reasons
  - Ensures Safety
  - Optimises Cost of Ownership
  - Maximises Asset Availability

## All initiatives require organisational support

- Personnel
- Training
- Collection/Storage/Review process for MCD

# Questions

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