Australian Government
Department of Defence
Capability Acquisition and Sustainment Group

The Evolution of RAMP within the Air Domain....

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Outline

- Back in the beginning….
- DASR M.A.302 Aircraft Maintenance Programme.
- What a Reliability Plan is; and what it should include.
- Perceived Challenges in implementing Reliability Plans in DASR Ph#2.
- Reformation of the RAMP Team.
- Training Opportunities.

Back in the beginning.... (late 1970s)

- **RAAF Analytical Maintenance Programme (RAMP) est. 1976**

  Objective: Develop a new system for the definition and review of aircraft maintenance requirements

  – P-3B Orion selected to test the validity and efficiency of the developed maintenance analysis procedures (with revised maintenance requirements inserted in 1977).

  – Result was improved aircraft availability of at least 10% and significant reduction in fleet maintenance man-hours (order of 10,000s of hours)

Back in the beginning.... (late 1970s)

- **Formal implementation of RAMP System – August 1978 with:**
  - AAP7001.038-1 RAAF Aircraft Maintenance Philosophy
  - AAP7001.038-2 Maintenance Analysis Procedures (based on MSG-2)
- **FAA Advisory Circular AC 120-17A Maintenance Control by Reliability Methods released March 1978**
  - Purpose: Provide information on the application of reliability control methods as an integral part of an approved AMP.
  - The operator should develop a document describing the application of reliability control methods – titled the Reliability Program Document.

MEA and MRD through the Decades

- **1990s - TAREG introduced a requirement for MEA Plan (3.5.3)**
  - Each applicant for the issue of an EAC applicable to this regulation shall establish a maintenance engineering analysis (MEA) system to validate the instructions for continuing airworthiness (ICA) of the aircraft and aircraft equipment. The MEA System shall include a Plan.
- **2000s – TAREG amended the requirement (3.5.15)**
  - Each applicant for the issue of an EAC with applicability under this regulation must establish procedures to: (7) collect and analyse data used to validate the ICA that identify maintenance requirements essential to the airworthiness of aircraft and CIs.
- **2010 – Release of HASD Directive requiring documented MRD Strategies**

The New World – DASR Release, 30 Sep 2016

- **Extract from M.A. 302 Aircraft Maintenance Programme (AMP)**

  a) Maintenance of each aircraft shall be organised in accordance with an AMP.

  b) An organisation responsible for producing and amending an AMP in accordance with DASR M.A. 302 shall also be responsible for sending the AMP to the NMAA. The AMP and any subsequent amendments shall be approved by the NMAA

  c) The AMP shall establish compliance with:
     1. Instructions issued by the NMAA
     2. Instructions for continuing airworthiness issued by any organisation recognised by the NMAA
     3. Additional or alternative instructions once approved in accordance with paragraph (b) …

The New World – DASR Release, 30 Sep 2016

- **Extract from M.A. 302 Aircraft Maintenance Programme (AMP)**

d) The AMP shall contain details, including frequency, of all maintenance to be carried out, including any specific tasks linked to the type and specificity of operations.

e) The AMP shall include a reliability programme, unless otherwise specified by the NMAA.

f) The AMP shall be subject to periodic reviews and amended accordingly where necessary. These reviews shall ensure that the AMP continues to be valid in light of the operating experience and instructions from the NMAA, whilst talking into account new and/or modified maintenance instructions promulgated by the MTC and MSTC holders and any other organisation that publishes such data in accordance with DASR 21.

but what about the ESIP/PSIP……

- **AMC M.A.302(d) Aircraft Maintenance Programme compliance**

  Airworthiness Limitations (including safe life limit or safety by inspection program parameter for aircraft structure and dynamic components as defined in the weapon system ASIMP, critical inspection requirements or retirement times of propulsion system critical parts as defined in GM 21.A.41, CMRs or other Airworthiness Limitations) are **outside the scope of the reliability program and cannot be modified without engagement of an approved design organisation and NMAA approval.**

So what am I doing here!

Why plan.....

'In the absence of a plan, people run around trying to do the right thing.'

Win in a Complex World
U.S. Army's future Operating Concept

General D.G. Perkins
CG U.S. Army TRADOC

.... not another plan!

- The primary purpose of a reliability program is to provide statistical information which could be used for adapting and improving the operators aircraft maintenance program (Marusic, 2007).

- Improving/optimising the maintenance program …. ?

Doing the right task, at the right time for the right reasons!

- But what does this provide?

  - Safety – Ensures the inherent levels of the aircraft's airworthiness.

  - Capability - Increases the aircraft's availability and reliability.

  - Cost – Reductions in materiel, labour and the likelihood of human error.

The Importance of a Reliability Programme …

- **Refer to AMC M.A. 302 (f) AMP – Reliability Programmes**
  - Reliability programmes should be developed for AMP based upon MSG/RCM logic or those that include CM components or that do not contain overhaul time periods for all significant system components.
  - The purpose of a reliability programme is to ensure that the AMP are effective and their periodicity is adequate
  - The reliability programme may result in the escalation or deletion of a maintenance tasks, as well as the de-escalation or addition of a maintenance task.
  - A reliability programme provides an appropriate means of monitoring the effectiveness of a maintenance programme.

- **…. but what about the DEFLOGMAN – In-service RAM!**
  - During the in-service phase the focus of RAM activities is the measurement and analysis of materiel performance against the RAM capability requirements utilising data collected from in-service activities

Elements of a Reliability Program

6.5 of Appendix 1 to AMC M.A. 302 AMP

- **Objectives**? – regulatory compliance, safety, capability, cost
- **Scope**? – what is the scope of the program (what items are in/out)
- **Terminology**? – are we all singing from the same song sheet
- **Performance Standards**? – what are we going to measure (against item)
- **Information sources and collection**? – there are multiple sources!
- **Display of Information**? – how we will we display what we are monitoring
- **Examination, analysis & interpretation of info.**? – skills, training, SW
- **Corrective Actions**? – what will you do about it & how will you do it
- **Presentation of Information to the NMAA**? routine reporting, escalations
- **Evaluation and Review**? – time period and criteria to be considered
- **Pooling Arrangements**? – access to other operators data e.g. USN, data exchanges etc

Effective Reliability Programming

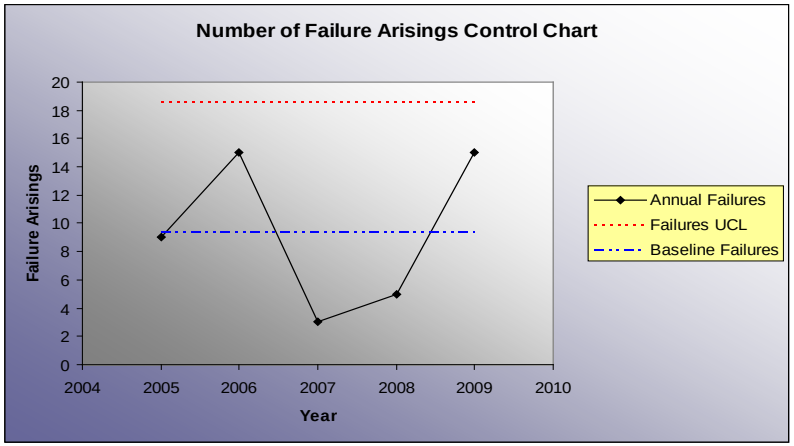
- RAM Monitoring is achieved by:
  - Determining the items in the system to be monitored
  - Determining the metrics to be used for each item
  - Setting performance standards

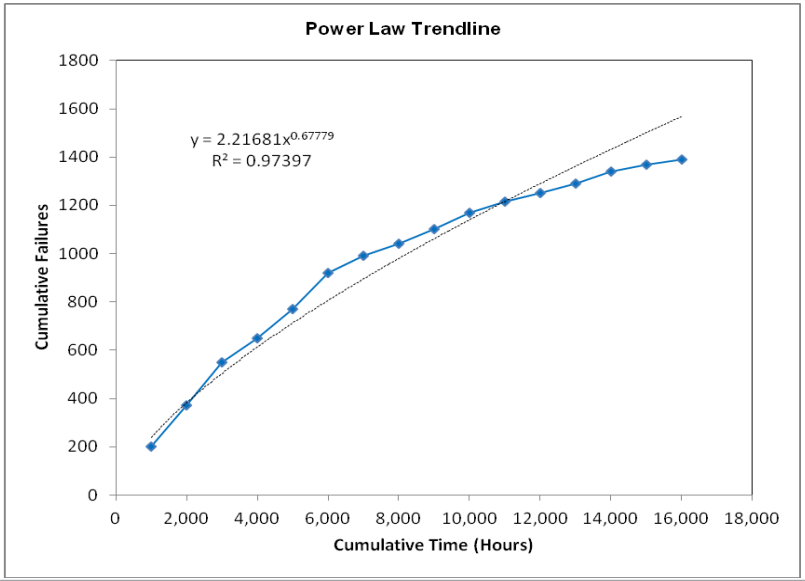
- Typical Reliability Metrics Include:
  - Corrective maintenance removal rates
  - System and component failure rates
  - Repair times; and Admin and Logistic delay times of item failure

- Performance Monitoring may also include condition monitoring,

Examples of System Performance Monitoring

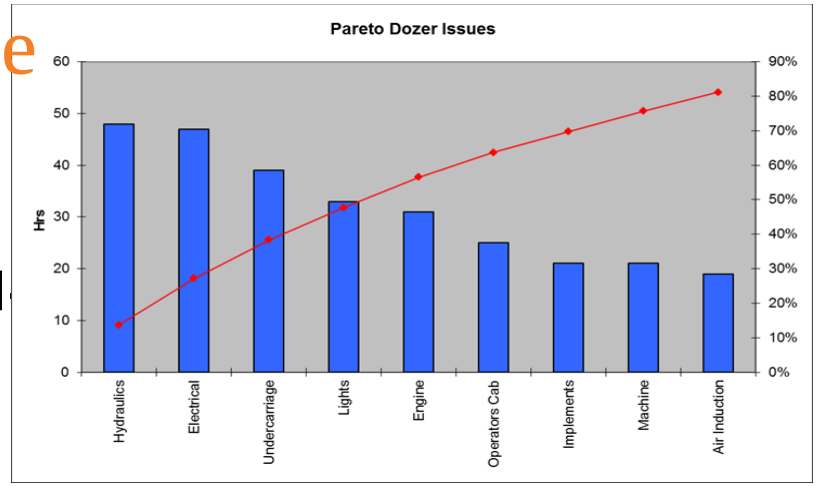
- Key Performance Indicator (KPI) – especially in an age of Performance Based Contracts.
- Exception/occurrence reporting
- Trending:
  - Moving average
  - Power Law models
  - General Renewal Process model.

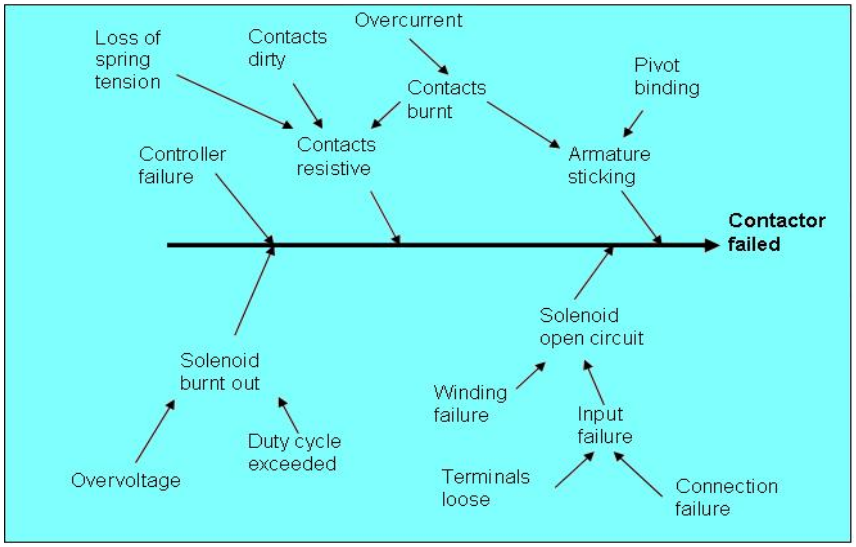


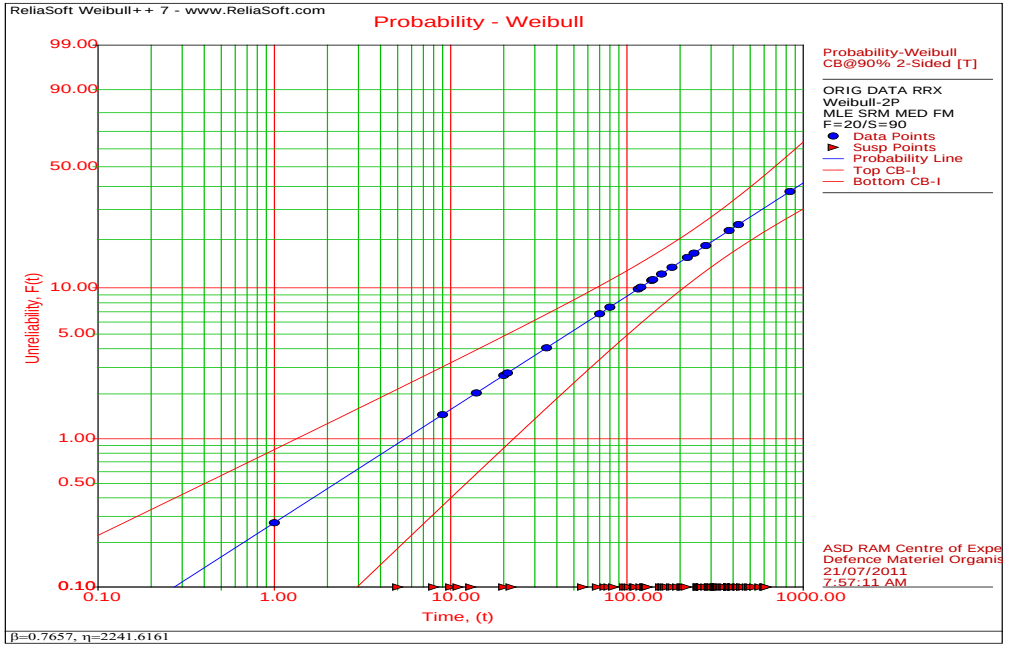


Investigating System Performance

- Pareto analysis
  - Finding the bad actors.
  - May use compound criteria eg Cost x Freq
- Root Cause Analysis
  - Finding what makes them bad
- Component life data analysis







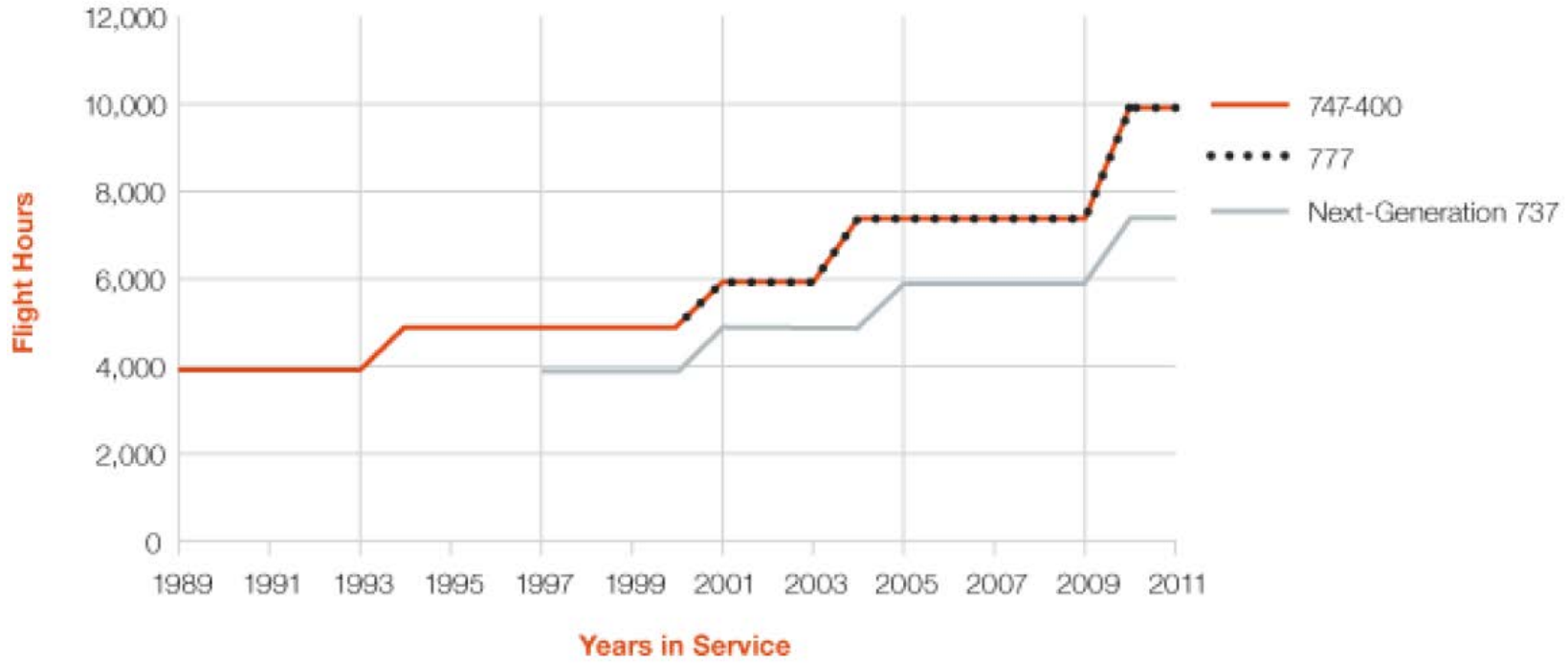
Example from Industry: Boeing

- Next generation B737 was the first model to implement the statistical analysis process (SASMO)
  - Analysis of tasks occurring at 4000 flight hours:
    - 80% of scheduled maintenance tasks were escalated
    - 10% remained at the current interval
    - 10% were de-escalated
- An analysis of B777 tasks occurring at 7500hrs:
    - 68% of tasks were escalated
    - 26% remained the same
    - 6% were de-escalated
    - one task was deleted

Source: Aero, Q3 2011

Example from Industry: Boeing

- Optimisations of Typical Hangar Scheduled Maintenance Intervals Since Entry Intro Service.



Source: Aero, Q3 2011

Example from Defence Aviation: P-3C Maintenance Policy Review

The value of the projected maintenance optimisation:

- Reduction in the numbers of routine services in the period up to the Planned Withdrawal Date:

Servicing	Projected Reduction
R1	60
R2	20
R3	0
S31	15

- Generated personnel efficiencies:
  - ~20,000 person-days made available for other DLM
  - ~1,350 person-days made available for other OLM
- Related material savings - consumables & TA item usage.

Example from Defence Aviation: PC-9/A Maintenance Policy Review

The value of the projected maintenance optimisation:

- Extension of the R1 and R2 usage based intervals to accommodate high utilisation.
- Identification of a discretionary calendar backstop in the event of low utilisation.
- Streamlined and standardised servicing tasks.

Resulted in increased availability and increased likelihood of the aircraft reaching the revised planned withdrawal date (PWD) e.g. an additional 800+AFHRS achieved at 2FTS in the first year.

Perceived Challenges in Implementation ….

- Business as usual …
- Trusting the process.
- Co-operative and Contractual arrangements.
- Initial investment (in training and software) is not cheap.

Measuring our business = meeting the commander's intent.

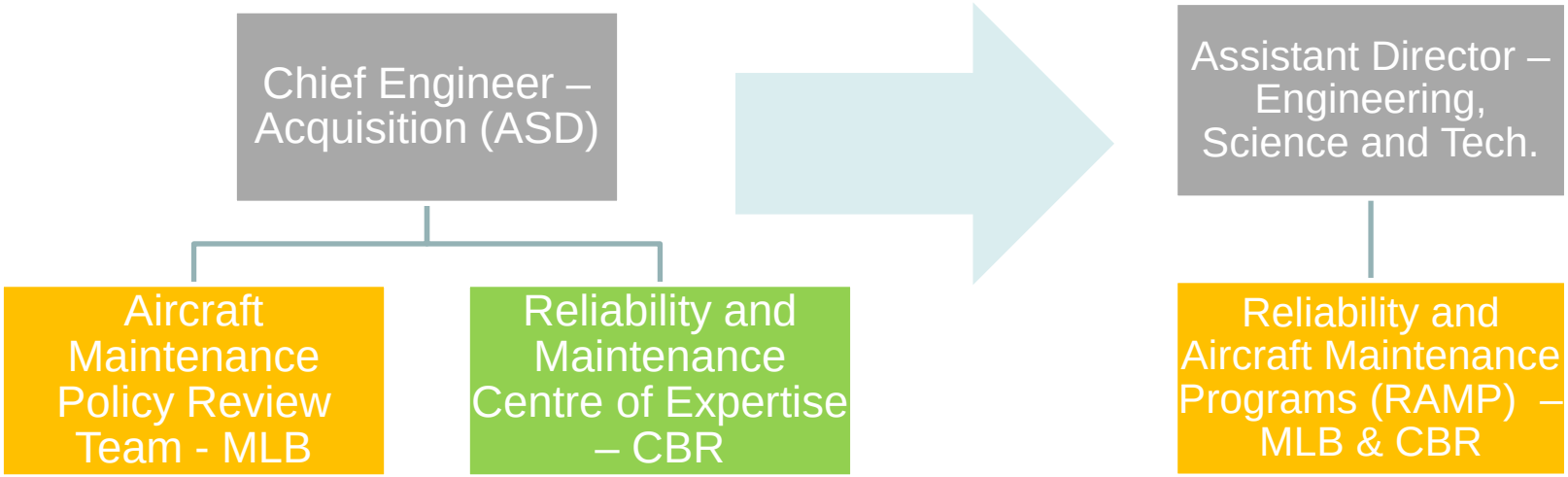
Reformation of RAMP

Former Situation

- Support the implementation of RAM across the capability life cycle (including RAM Programs); and conduct Maintenance Policy Reviews.
- Policy – Defence Logistics Manual Series (DEFLOGMAN)

Current & Future Situation (WEF Jan 17)

- Support the implementation of RAM across the capability life cycle (including RAM Programs); and conduct Maintenance Policy Reviews (reducing).
- MoA between CASG and DASA
- Policy – Defence Logistics Manual Series (DEFLOGMAN) and Defence Aviation Safety Regulations (DASR)



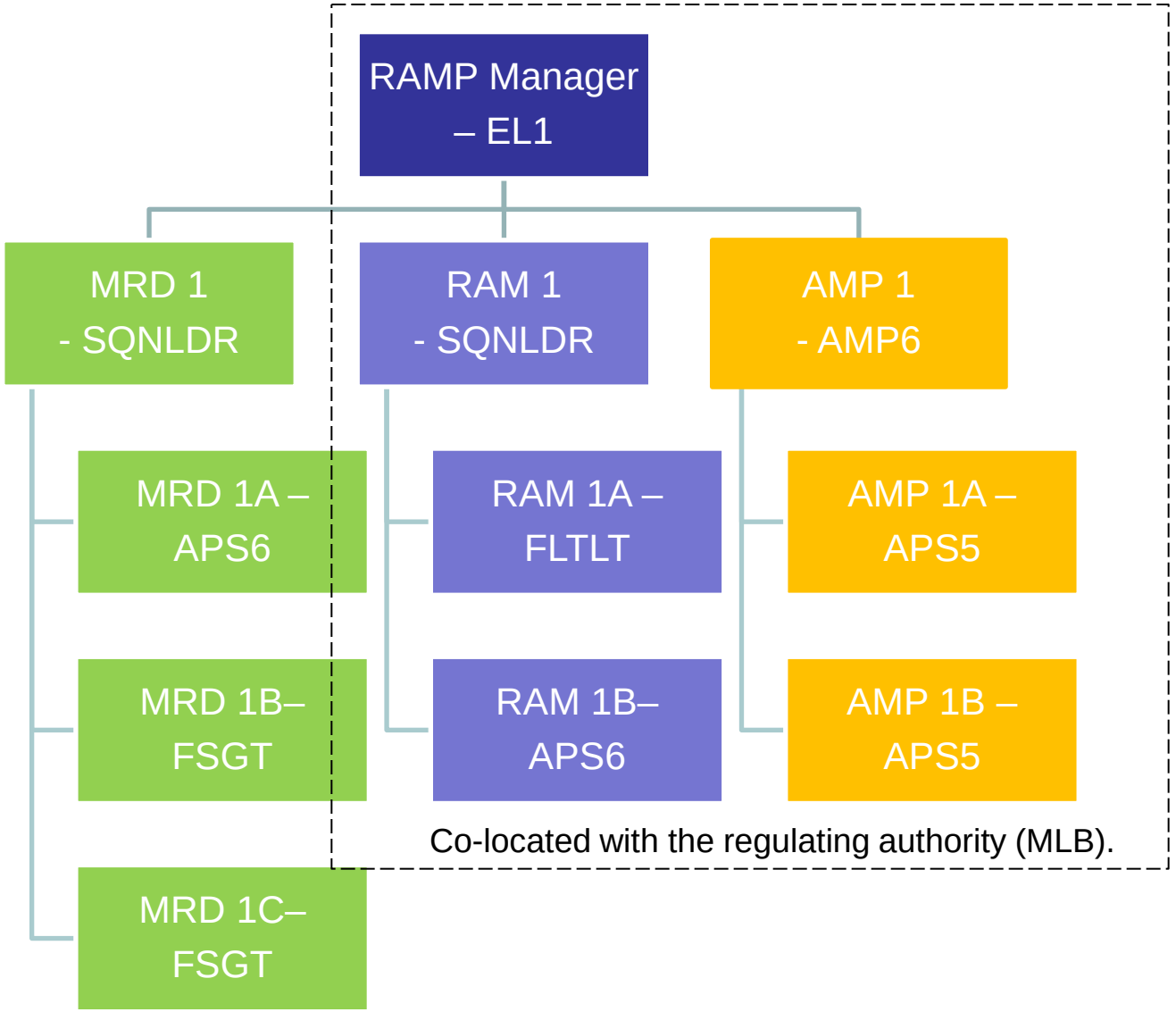
The Reliability and Aircraft Maintenance Program Team

We don’t have all the answers…

BUT WHAT WE DO HAVE ARE A VERY PARTICULAR SET OF SKILLS…

Sponsors: AAP7001.038 MRD Manual and ADO RAM Manual

The RAMP Team – WEF Jan 17



Defence Reliability Management Course

A consumer focused RAM course relevant to engineers in all phases of the Capability Life Cycle. Course covers basic RAM engineering tools which can be applied to improve capability and reduce lifecycle costs.

Comprises two modules as follows:

- Module 1 – 1.5 days – RAM Management Fundamentals (RELMANFUN)
- Module 2 – 3.5 days – RAM Data Analysis

Cost: Free for Defence Personnel ($400 for Defence Contractors)

Dates for 2017 (nominate via CAMPUS)

- 22-25 May 17 – Sydney (Victoria Barracks)
- 21-25 Aug 17 – Adelaide (RAAF Base Edinburgh)
- 9-13 Oct 17 – Canberra (Brindabella Park)

Defence Postgraduate Reliability Training

UMD-Monash - M.Eng (Reliability Engineering)

- Annual Eight Week Residential Program in Melbourne (at conclusion, student can be awarded a Graduate Diploma in Reliability Engineering)
- Students who complete an additional six courses remotely from UMD eligible for the M.Eng (Reliability Engineering)
- Program sponsored by CASG-Professionalisation

ADFA-UNSW - M.System Engineering (Reliability Engineering)

- Four courses dedicated to Reliability Engineering
- Four other courses required to be awarded the M.
- Partnership exists between UCLA and ADFA

Final RAMblings

- Defence requires capability at acceptable cost and level of safety, which is driven by failure.
- RAM engineering is the process of characterising failures with the aim of ensuring safety, optimising capability and cost objectives
- Every AMP is to be supported by an in-service Reliability Programme, that seeks to preserve the inherent levels of safety (DASR M.A. 302).
- There are many techniques available to assess failure data – it is a skill that requires investment in training and software applications!
- RAMP Team exists to provide training and specialist skills to optimise Defence Aviation.

And I'll leave you with this...

Often, operators maintain reliability programs only to formally satisfy regulatory requirements without a real desire to deeply investigate negative trends and take efficient corrective measures.

One of the reasons for such a situation is that operators do not understand the philosophy of statistical process control. Instead, they concentrate on solving daily, case by case, problems trying to cure symptoms without dealing systematically with problem causes. Reliability program does not react to single events; it discovers system problems and trends that trigger many events. Such problems have a great impact on flight safety and/or economics of an operator

(Marusic et al, 2007)

References:

Edwards, D. (2013) *Aligning Maintenance and Operational Goals*, IATA Maintenance Cost Conference, 10-13 Sep 13.

Marusic, Z. Galovic, B. Pita O. (2007) Optimising Maintenance Reliability Program for Small Fleets, Transport-2007 Vol XXII, 22:3, 174-177

McLoughlin, B. (2011) *Improving Maintenance Programs through Statistical Analysis*, Aero Q3 2011, Boeing.

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