



Australian Government
Department of Defence
Capability Acquisition and
Sustainment Group

Reliability Programmes – how **THEY** can help **YOU!**

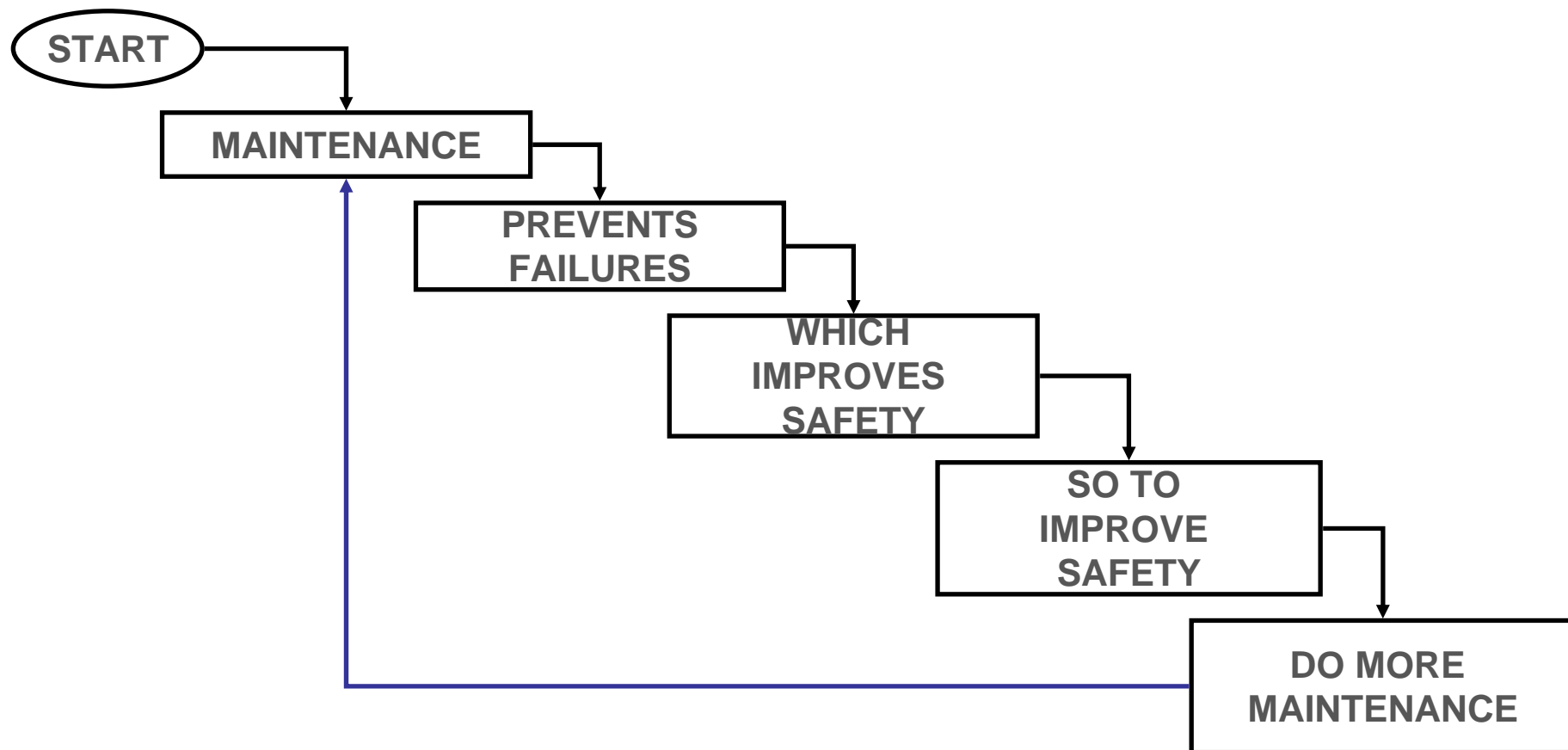
SQNLDR Paul Martinovich – ASD RAM Centre of Expertise

Continuing Airworthiness Conference
Defence Plaza Melbourne
16 November 2016

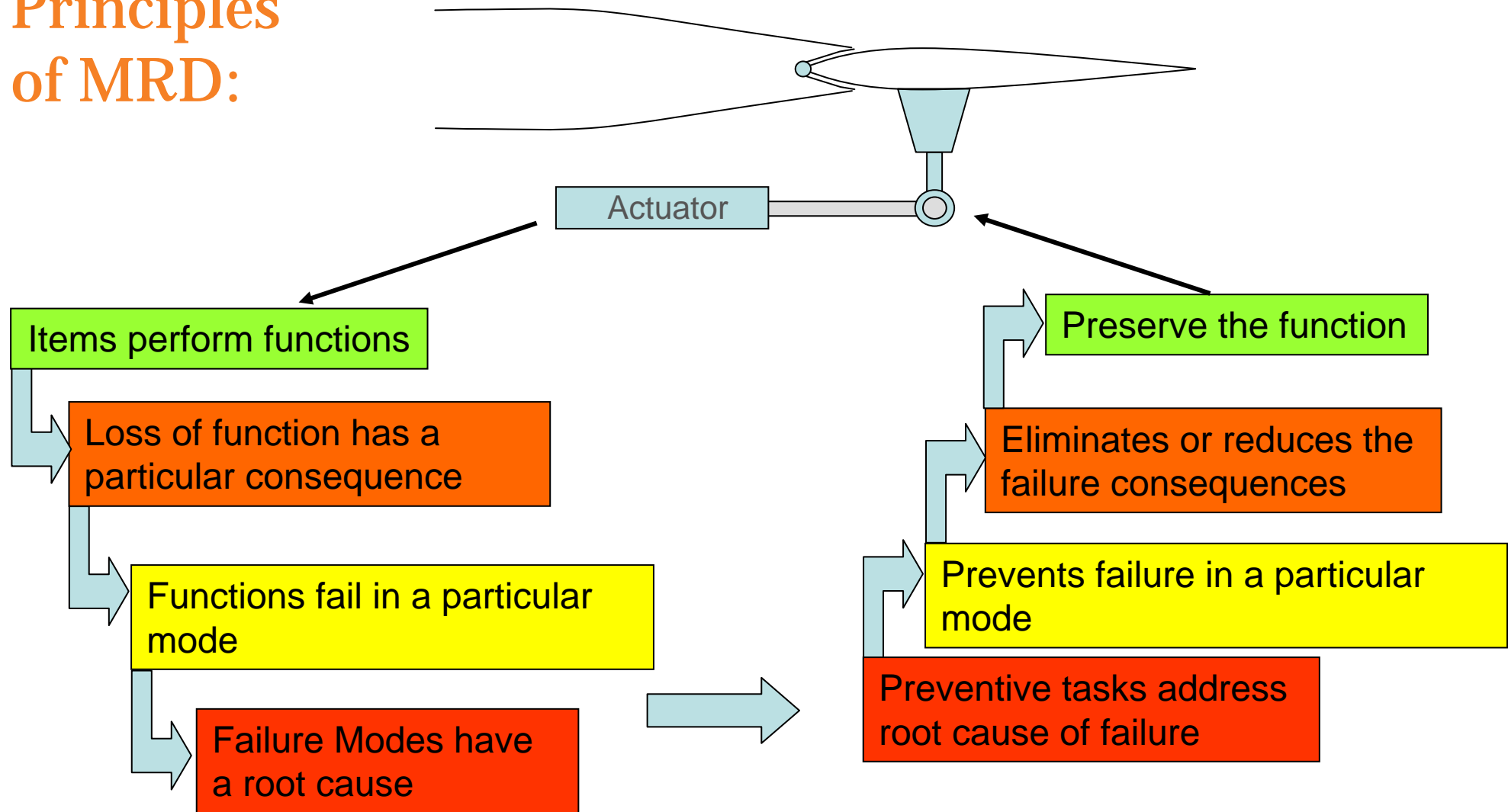
Outline

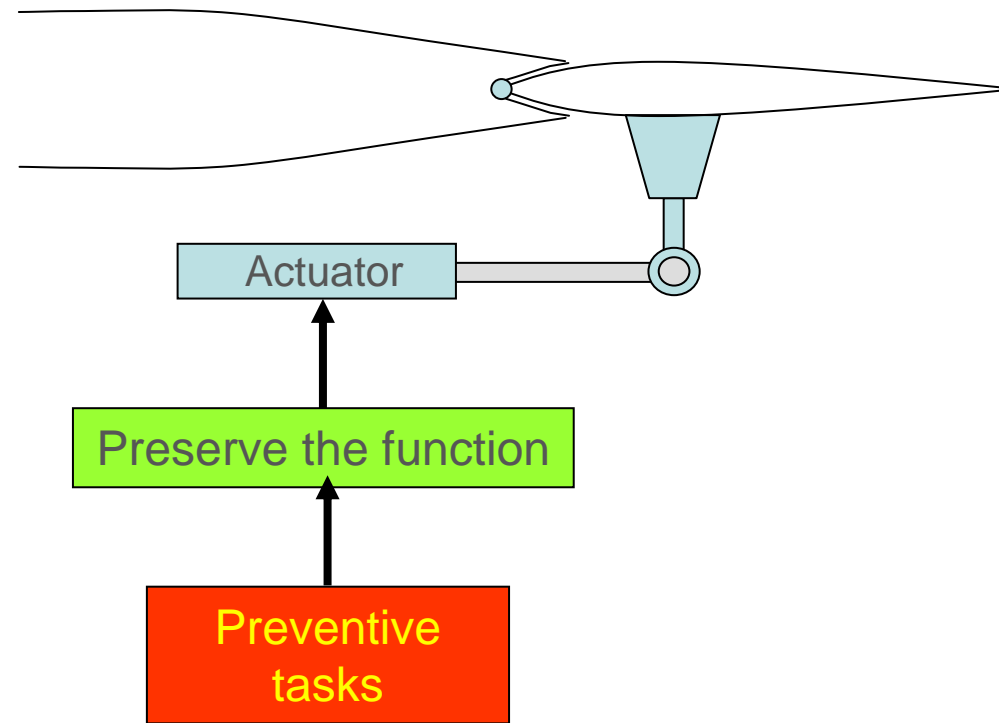
- Why we perform maintenance - a quick refresher.
- DASR – AMP and Reliability Programmes.
- Why would we want to implement another Plan?
- Components of a Reliability Plan.
- Perceived challenges in implementation...
- How we can help you!

Old Maintenance Thought Process

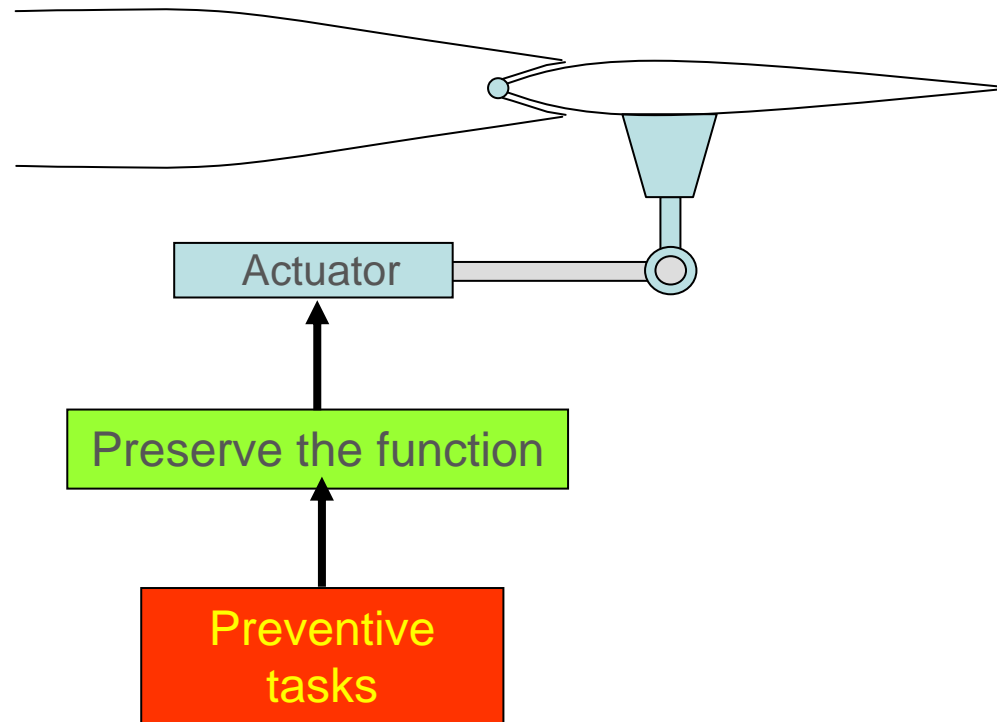


Principles of MRD:





**DO THE RIGHT TASK
AT THE RIGHT TIME
FOR THE RIGHT REASONS**



- Is the Task applicable?
- Is the Task effective at the current interval?
- Will the Task be effective at a modified interval?

Is the Task doing its job?



Can the in-service time be extended?

Defence Aviation Safety Regulations (DASR)

- **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) ...

Defence Aviation Safety Regulations (DASR)

- **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 taking 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 why (do we need 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

A Process...

PLAN

Maintenance preparation:

- Planning of maintenance tasks
- Scheduling of activities
- Assigning and obtaining resources

DO

Maintenance support planning:

- Maintenance support definition
- Maintenance task identification
- Maintenance task analysis
- Maintenance support resources

Maintenance conduct:

- Performance of maintenance
- Recording results
- Special safety and environmental procedures

ACT

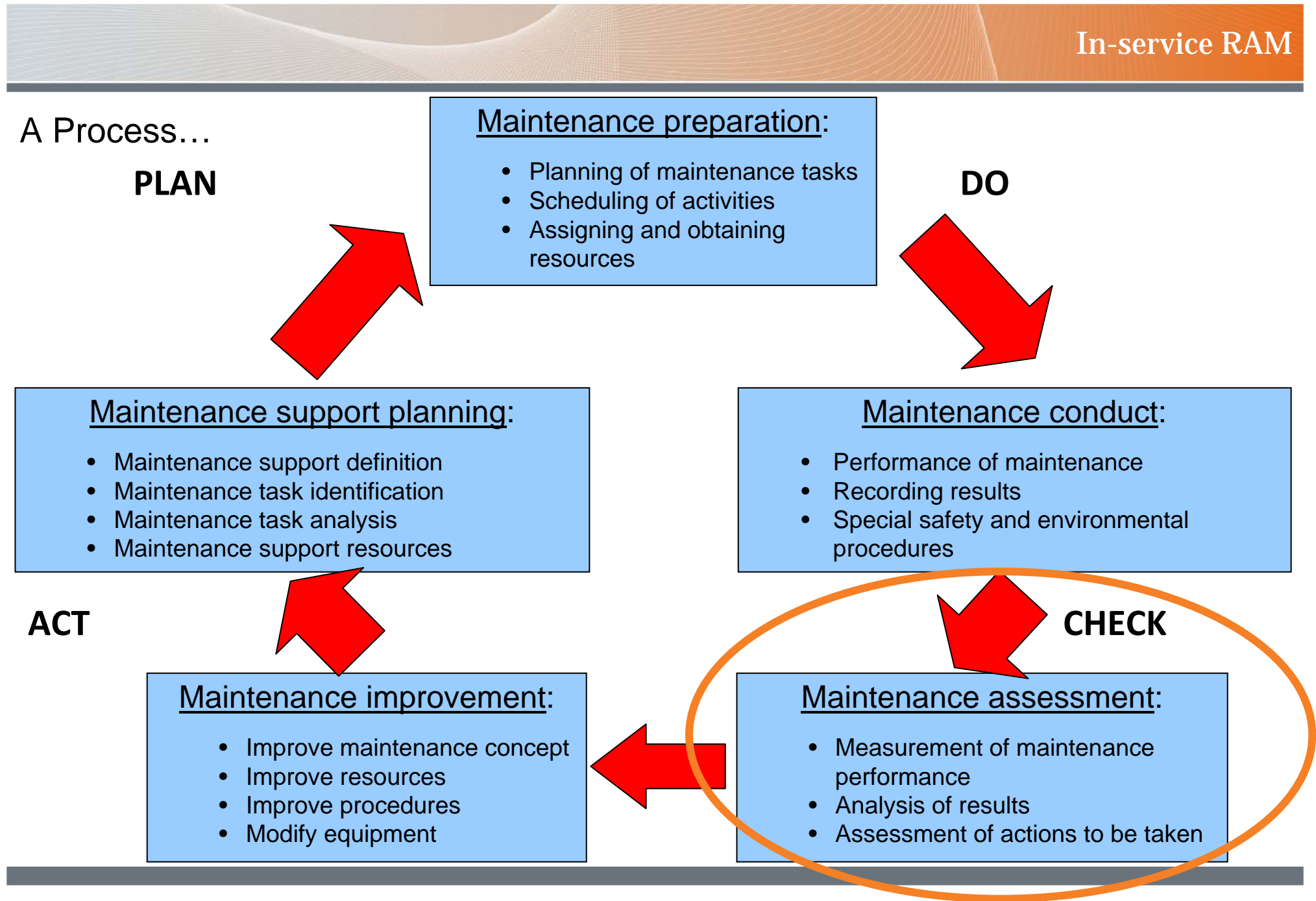
Maintenance improvement:

- Improve maintenance concept
- Improve resources
- Improve procedures
- Modify equipment

CHECK

Maintenance assessment:

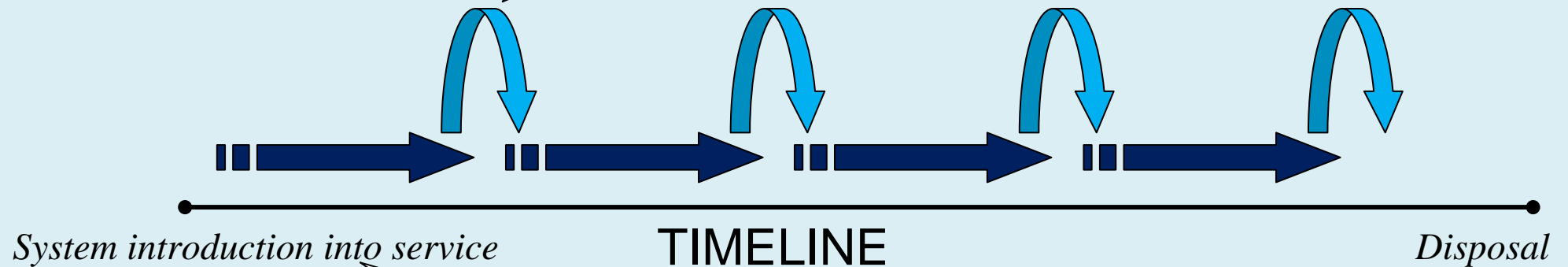
- Measurement of maintenance performance
- Analysis of results
- Assessment of actions to be taken



Check - The RAM Assessment Process

In-service data collection and analysis:

- **System performance monitoring**
- **Investigation and redesign of system**
- **Redesign of support system**



Acquisition

- Verification of acquisition specifications
- Establishment of system performance benchmarks

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.

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,

Effective Reliability Programming

- Consideration should be given to monitoring of:
 - All safety critical items
 - All mission essential items
 - Items that exceed a project specific cost threshold:
 - Non-repairable/limited repairable item with long-lead times.
 - Repairable items with long turn around times.
 - Task intervals that have their origin in MSG/RCM logic.
- Data sources, collection and analysis methods should also be specified.
- Further Reading: Para 6.5 of App. 1 to AMC M.A.302 contains a list of items that should be stated. The Defence RAM Manual also contains a template for In-Service RAM Program.

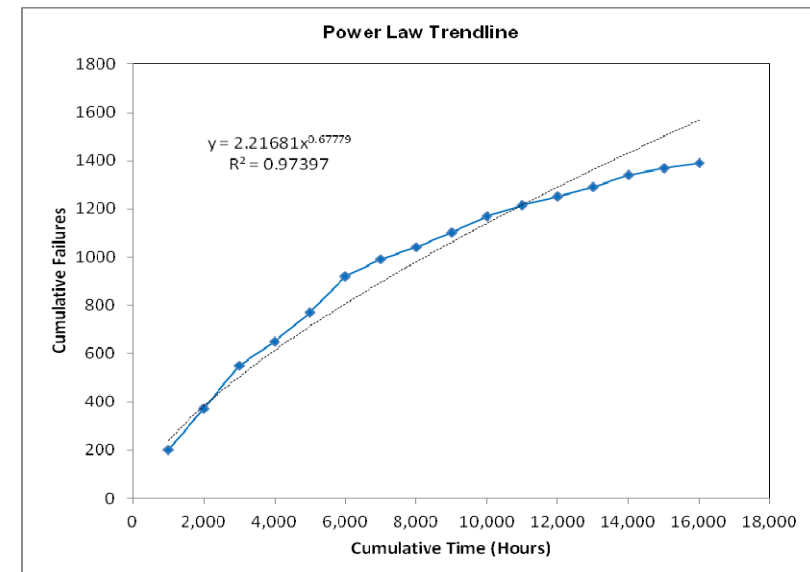
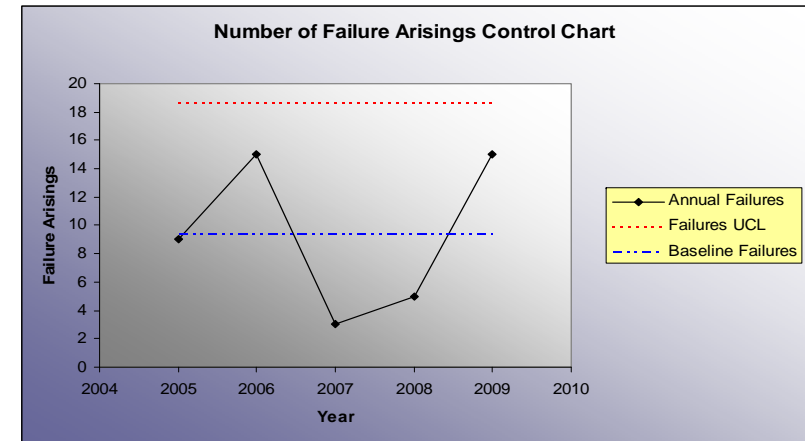
Elements of a Reliability Program

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

- **Objectives?** – regulatory compliance, 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?** – multiple sources
- **Display of Information?** – how we will we display what we are monitoring
- **Examination, analysis & interpretation of info.?** – skills, training, software
- **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

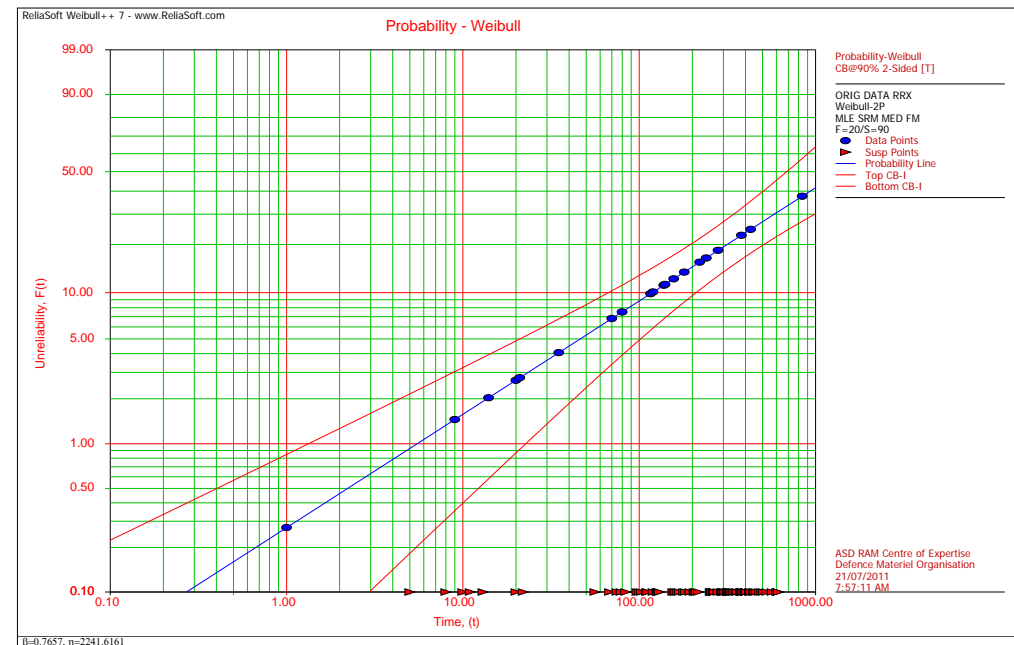
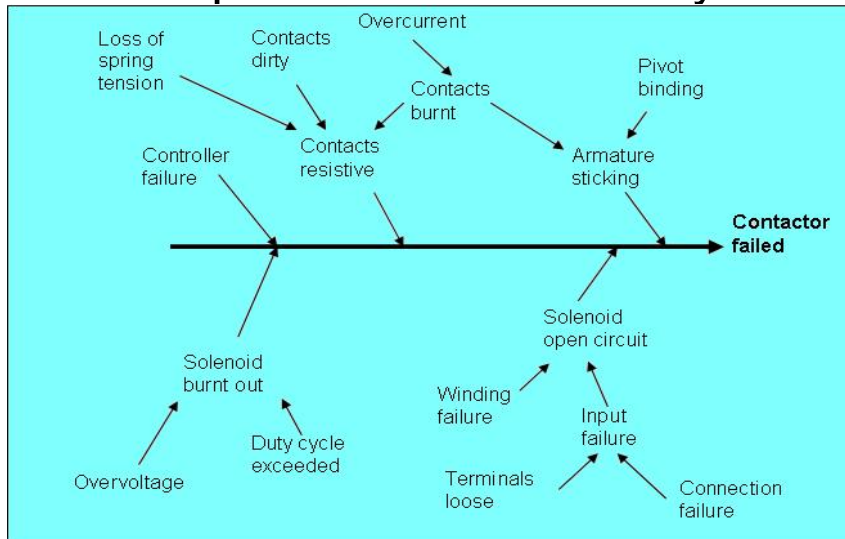
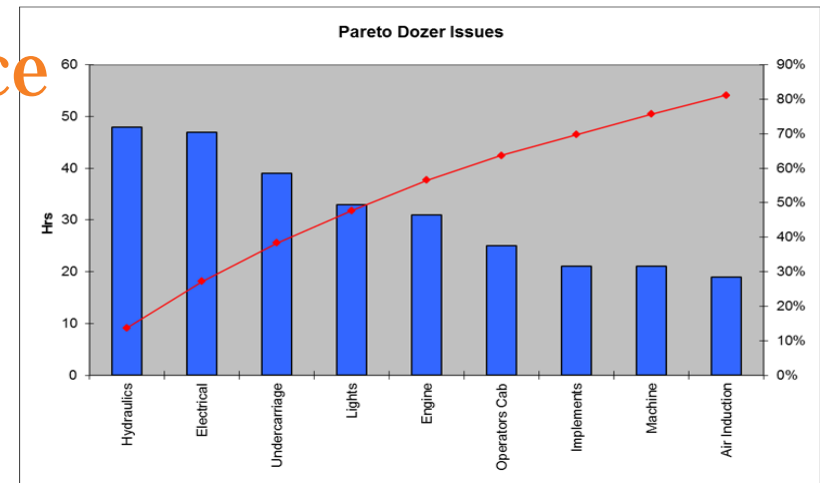
System Performance Monitoring

- Key Performance Indicator (KPI)
- Exception 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 Frequency
- Root Cause Analysis
 - Finding what makes them bad
- Component life data analysis



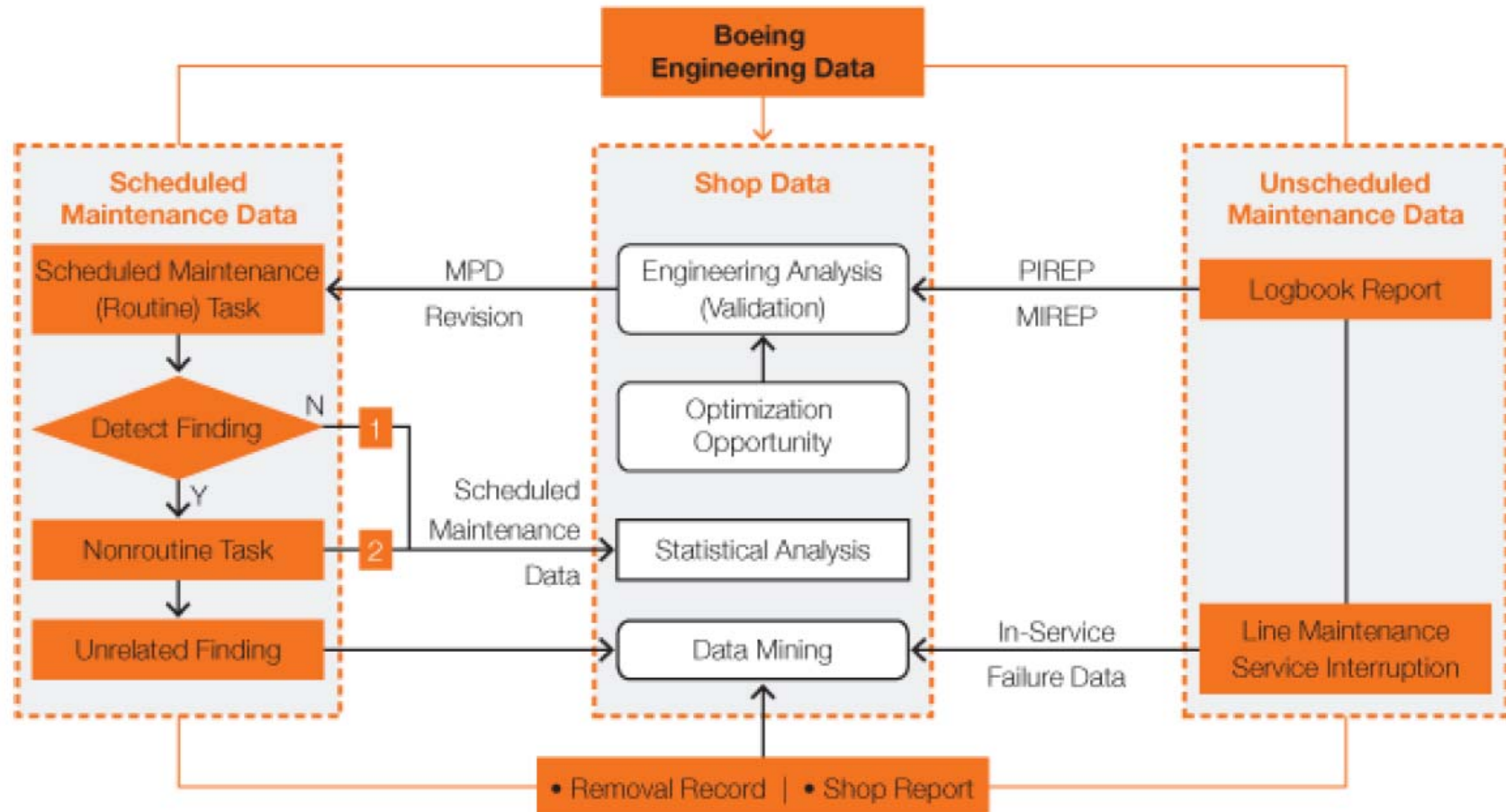
What you can achieve through implementation..

- Ensure that your CAMO is monitoring the effectiveness of the maintenance program against the stated objectives (against M.A.302).
- Transformational outcomes compared with transactional outcomes.
- Informed answers to the following questions:
 - Does the delivered capability meet requirements?
 - Does an item/fleet need to be replaced, modified or upgraded?
 - What is our expected/realised failure rate (and sparing requirements)?
- Retained levels of safety, increased levels of capability at reduced cost!

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 descalated
- An analysis of B777 tasks occurring at 7500hrs:
 - 68% of tasks were escalated
 - 26% remained the same
 - 6% were descalated
 - one task was deleted

Example from Industry: Boeing's SASMO

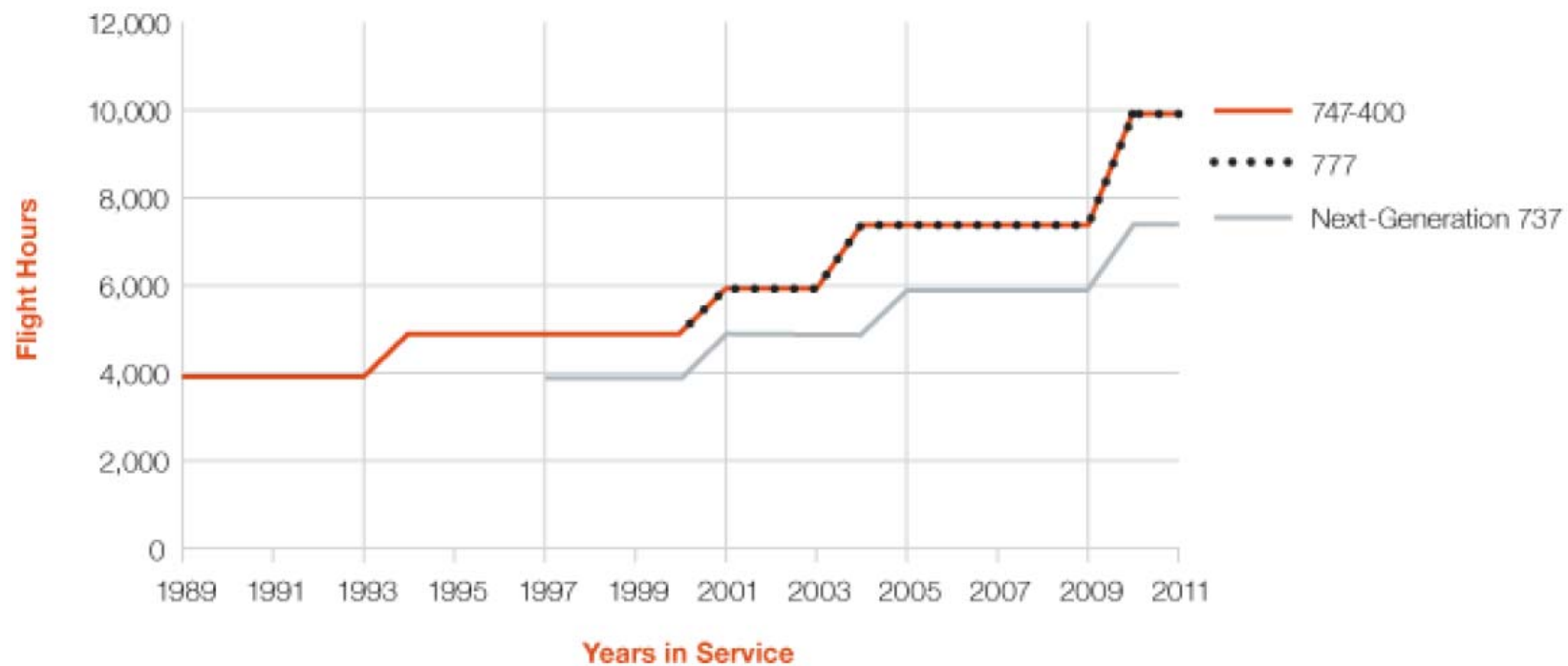


Legend: MPD: Maintenance Planning Document
 PIREP: Pilot Logbook
 MIREP: Maintenance Logbook

1 Clean Check
 2 Defect

Example from Industry: Boeing

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



Example from Defence Aviation: AMPRT P-3C

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.

Perceived Challenges in Implementation

- Business as usual ...
- Co-operative arrangements.
- Trusting (and preferably owning) the process.
- Incentivizing existing contractual arrangements.
- Initial investment (in training and software) is not cheap.
- Measuring our business = meeting the commander's intent.

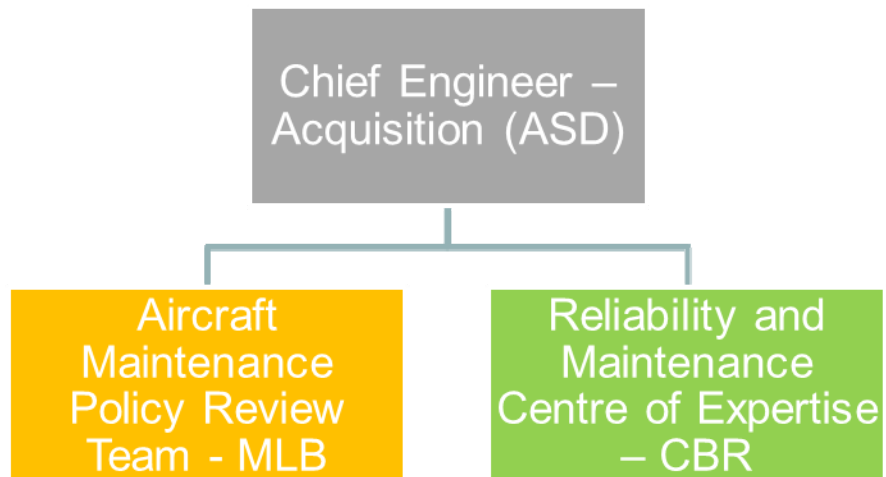
How we can help you!

- Organisational Restructuring
- Training
- Support
- Policy Sponsorship

Aerospace RAM

Former Situation (pre DASR)

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



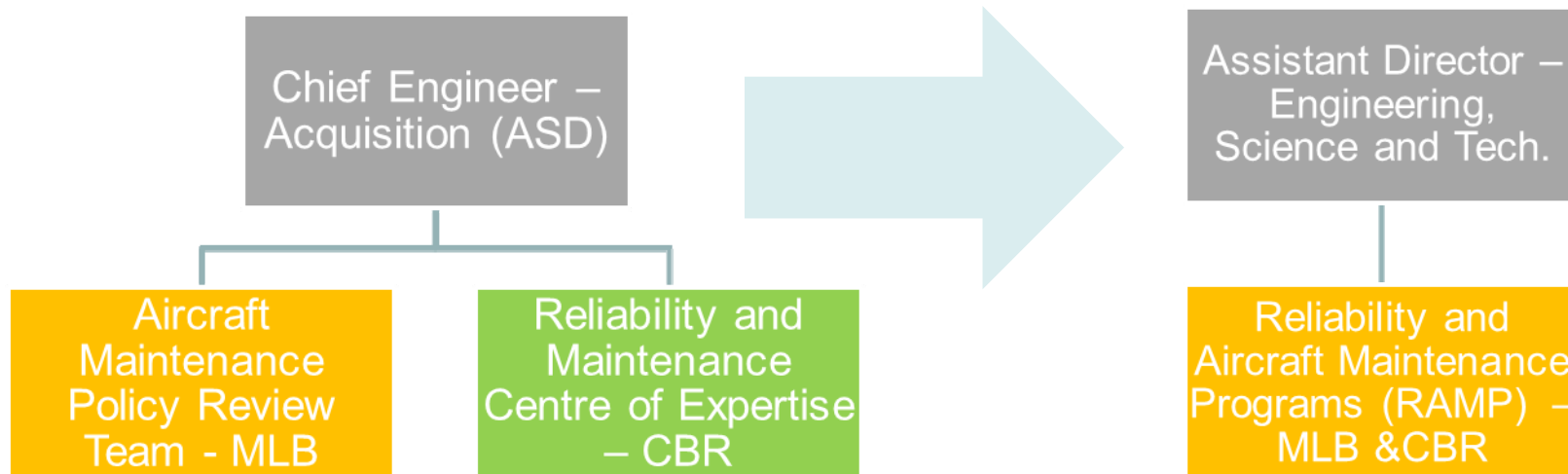
Aerospace RAM

Former Situation

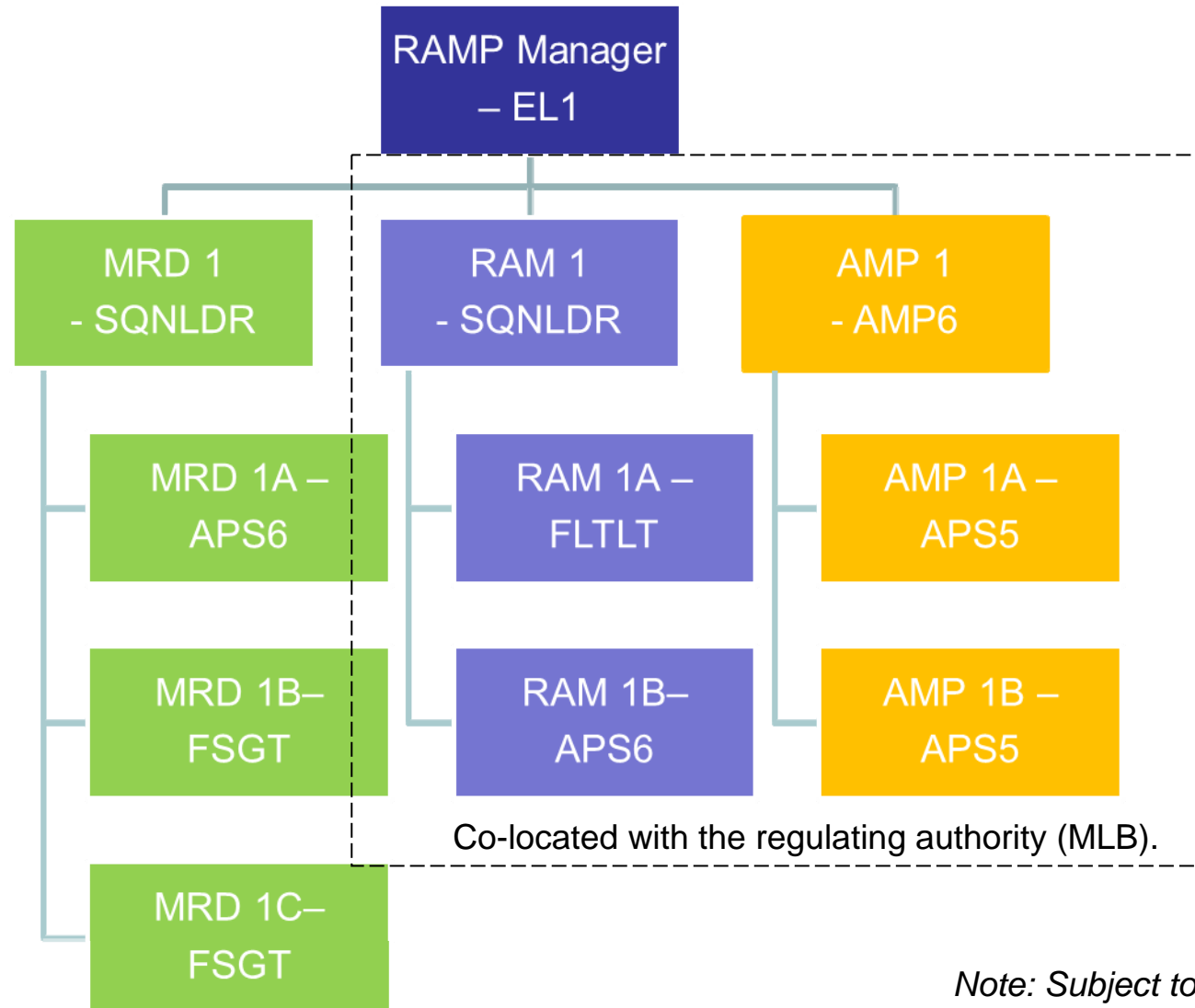
- Support the implementation of RAM across the capability life cycle (including RAM Programs); and conduct Maintenance Policy Reviews.
- Policy – Defence Logistics Manual Series (DEFLOGMAN)

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; and (Likely) Delegate of the Safety Authority
- Policy – Defence Logistics Manual Series (DEFLOGMAN) and Defence Aviation Safety Regulations (DASR)



The RAMP Team – WEF Jan 17



Note: Subject to Final Approval.

Defence Reliability Management Course (DEFRELMAN)

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 all Defence personnel (there is a cost for contractors)

Dates for 2017 (nominate via CAMPUS)

- 07-11 Mar 16 – Melbourne (Defence Plaza)
- 22-25 May 16 – Sydney (Victoria Barracks)
- Other – nominate via EOI

Other forms of assistance.....

- Reliability and Aircraft Maintenance Program - RAMP Team!



WHAT WE DO HAVE ARE A VERY
PARTICULAR SET OF SKILLS...

- AAP7001.038 MRD Manual and ADO RAM Manual

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 support 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.