Reliability and Maintainability (R&M) Engineering Update

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Office of the Deputy Assistant Secretary of Defense for Systems Engineering

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Purpose/Outline

PURPOSE

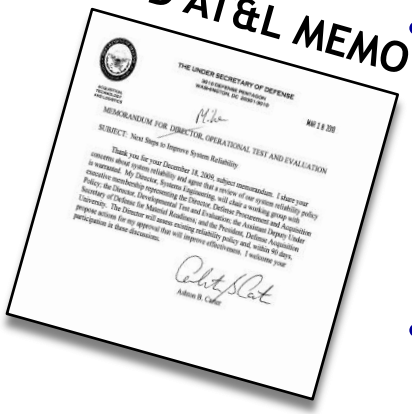
- **Provide an update of DoD R&M Engineering Activities**

OUTLINE

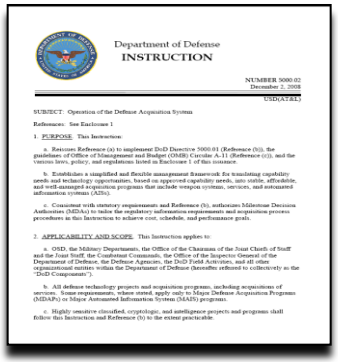
- **Policy**
- **Guidance and Standardization**
- **Annual Report**
- **Workforce Development**

Policy
Reliability Analysis, Planning, Tracking and Reporting

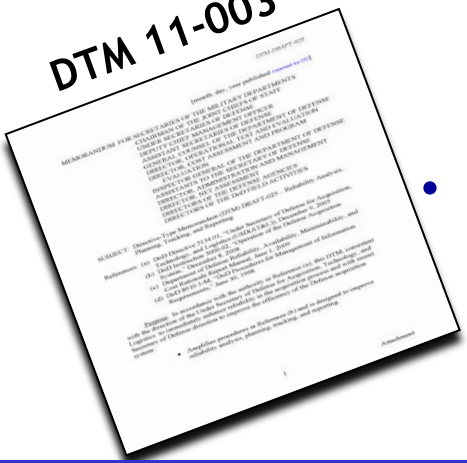
USD AT&L MEMO



DoDI 5000.02



DTM 11-003



- **Impetus for Reliability Policy**
  - Directed by Dr. Carter in response to memo from DOT&E
  - DASD(SE) to assess existing reliability policy and propose actions to improve effectiveness
- **DoD Acquisition Policy (DoDI 5000.02)**
  - Does not adequately or uniformly consider R&M engineering activities throughout the acquisition process
  - Fails to capture R&M planning in new or existing acquisition artifacts to inform acquisition decision making
- **DTM 11-003 (Approved 21 Mar 2011)**
  - Amplifies current DoDI 5000.02 by requiring PMs to perform reliability activities
  - Institutionalizes planning and reporting timed to key acquisition activities

http://www.dtic.mil/whs/directives/corres/pdf/DTM-11-003.pdf

Policy
DTM 11-003 Overview

- **Engineering activities (The Acquisition Strategy (AS) to describe tasks and processes to be stated in the RFP)**
  - R&M Allocations, block diagrams and predictions
  - Failure definitions and scoring criteria
  - Failure Mode, Effects and Criticality Analysis (FMECA)
  - Built-in Test (BIT) and maintainability demonstrations
  - Reliability Growth testing at system/subsystem level
  - Failure Reporting, Analysis and Corrective Action System (FRACAS)
- **Preliminary RAM-C Report in support of Milestone (MS) A and updated for MS B & C**
  - Provides early (Pre-MS A) reliability, availability, maintainability and ownership cost feasibility assessments of alternative concepts
    - Includes early formulation of maintenance & support concepts
  - Provides an audit trail that documents and supports JCIDS thresholds
  - Ensures correct balance between the sustainment metrics (Availability-KPP, Materiel Reliability-KSA, and Ownership Cost-KSA)
  - Provides early risk reduction by ensuring requirements are realistic and correct
- **AS and SEP to specify how the JCIDS sustainment thresholds have been translated into R&M design requirements for use in contract specifications**

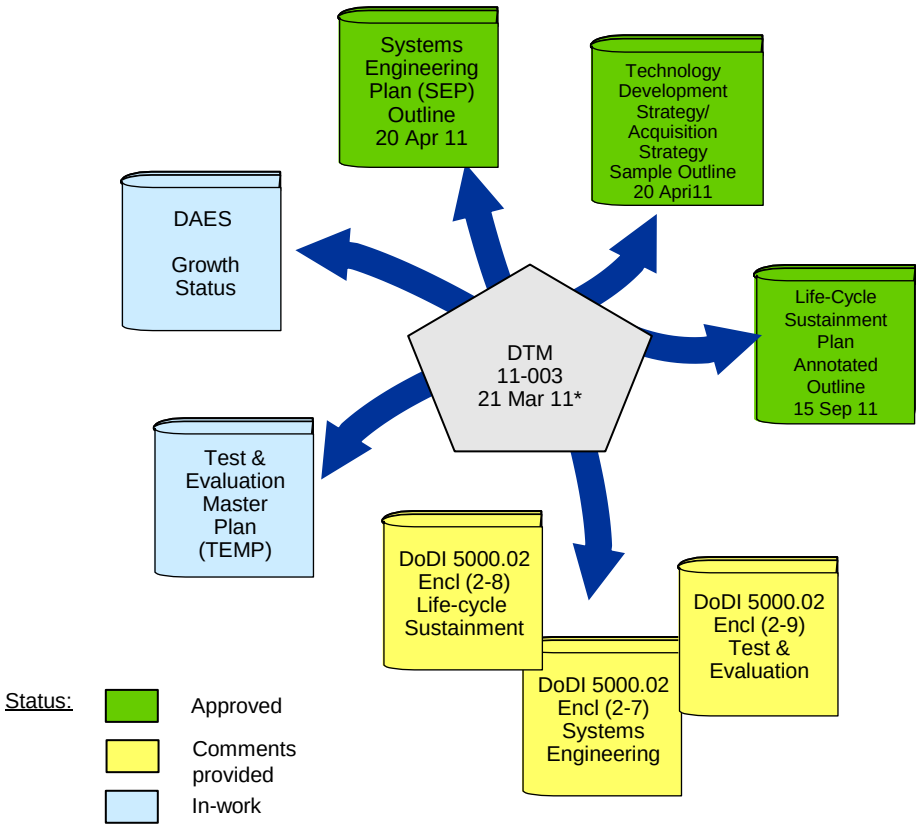
Policy
DTM 11-003 Overview

- **Reliability Growth Strategy**
  - Documents system-level reliability growth curves in the SEP beginning at MS A and updated in the Test & Evaluation Master Plan (TEMP) beginning at MS B
  - Establishes intermediate goals for reliability growth curves that will be tracked through fully integrated system-level test and evaluation events until the threshold is achieved
  - Requires MS C PMs and Operational Test Agencies to assess reliability growth required to achieve the reliability threshold during Initial Operational Test and Evaluation
- **Tracking and Monitoring**
  - Requires PMs to report status of reliability objectives and/or thresholds as part of the formal system engineering review process
  - Incorporates Reliability Growth Curves into the Defense Acquisition Executive Summary (DAES) review process

Policy
Relationship to DoD Documents

- **Integrating DTM-required engineering activities into DoD Policy**
  - Approved Outlines
    - Systems Engineering Plan
    - Technology Development Strategy and Acquisition Strategy
    - Life Cycle Sustainment Plan
  - Comments provided
    - DoDI 5000.02, Encl 2-9 (T&E)
    - DoDI 5000.02, Encl 2-7 (SE)
    - DoDI 5000.02, Encl 2-8 (LCS)
  - In-Work
    - TEMP – DDT&E evaluating format
    - DAES Growth Status

DTM Relationship to DoD Policy Documents



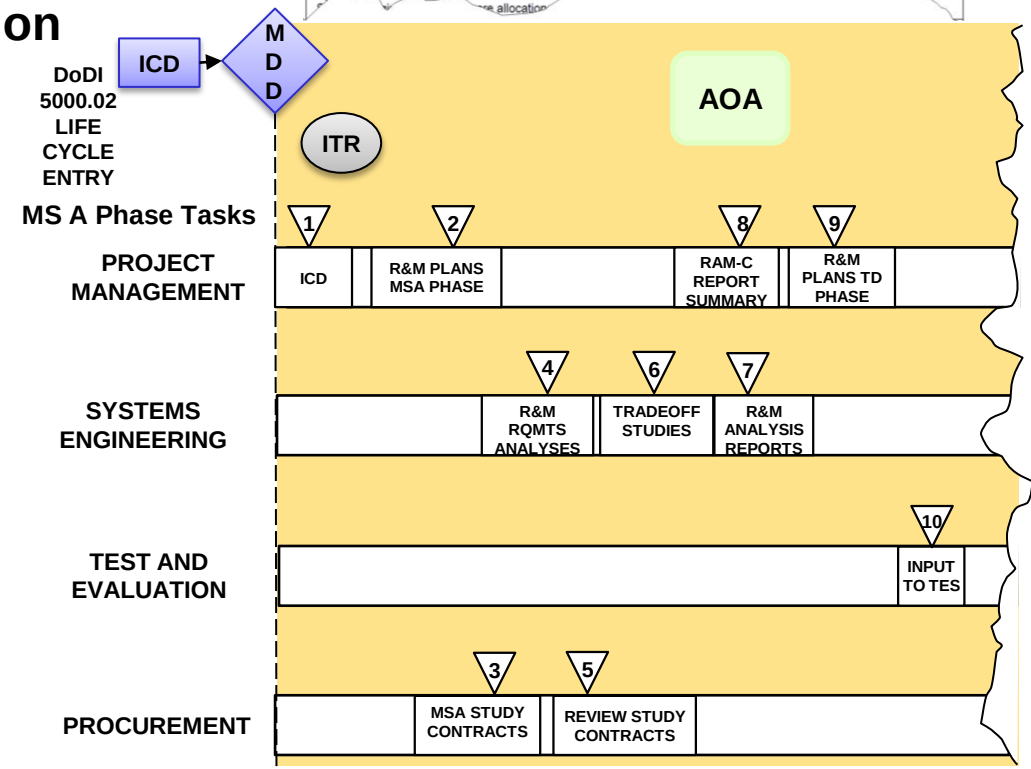
* Extended to 31 Dec 2012

Guidance and Standardization

- **Defense Acquisition Guidance (DAG)**
  - **(Phase 1) DAG Chapter 4, paragraph 4.4.15 updated for "fact of life" changes**
  - **(Phase 2) Participating in DAG Ch 4 Rewrite as primary R&M Section Author**
- **Lower Level Guidance**
  - **Developing R&M engineering guidance by phase and by program functional areas**
    - **MSA, TD, EMD phases completed**
    - **P&D and O&S phases in-work**
    - **Contracting Language completed**

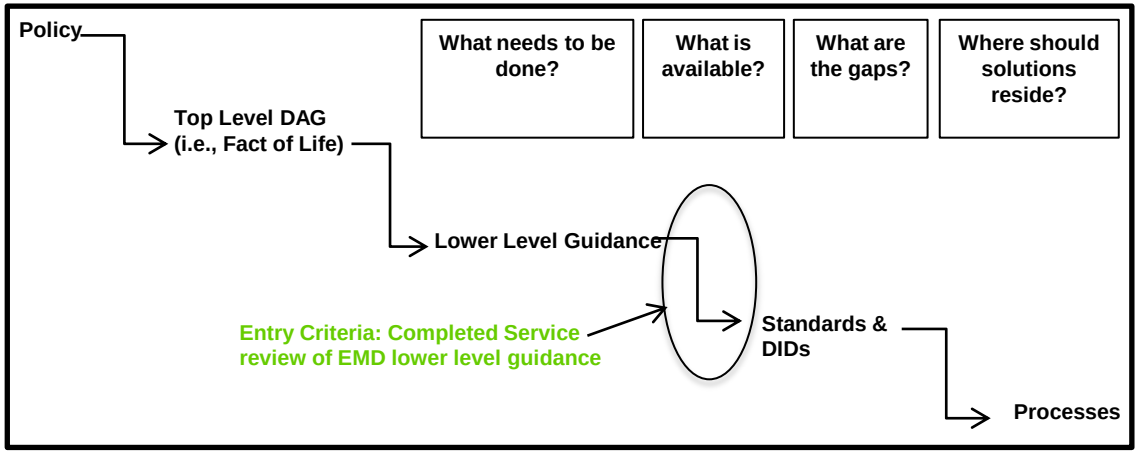
Table 1. DTM 11-003 Required R&M Engineering Activities by Functional Area

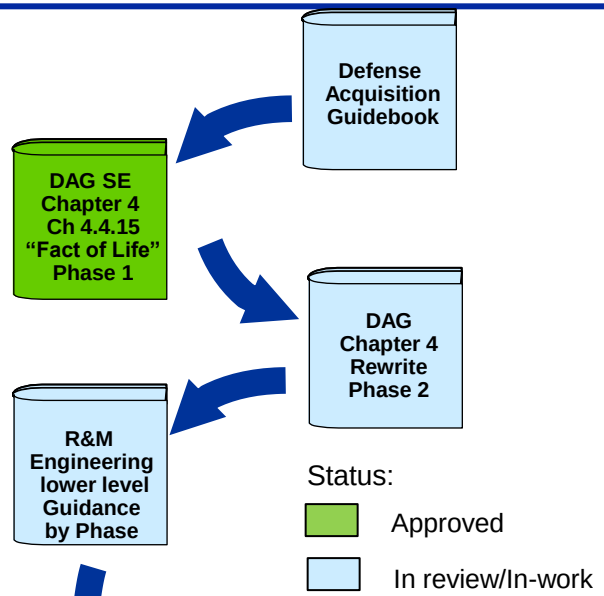
Functional Area	DTM 11-003-Required R&M Engineering Activities	MSA	TD	E&MD	P&D	O&S
Project Management	Formulate a comprehensive R&M program using appropriate reliability growth strategy	•	•	•	•	•
Project Management	Integrate R&M Engineering Program in Systems Engineering Plan (SEP) including a system reliability growth curve	•	•	•		
Project Management	Prepare/Update RAM-C Report and attach to the SEP	•	•	•		
Project Management	Report reliability status during formal design review process and technical reviews (SRR, PDR, CDR, etc.)	•	•	•		
Project Management	Prepare reliability growth assessment of the likelihood of meeting the CDD threshold by IOT&E			•		
Project Management	Evaluate reliability growth and report status in DAES reviews until the thresh[illegible]achieved			•		
[illegible]	[illegible] allocation					

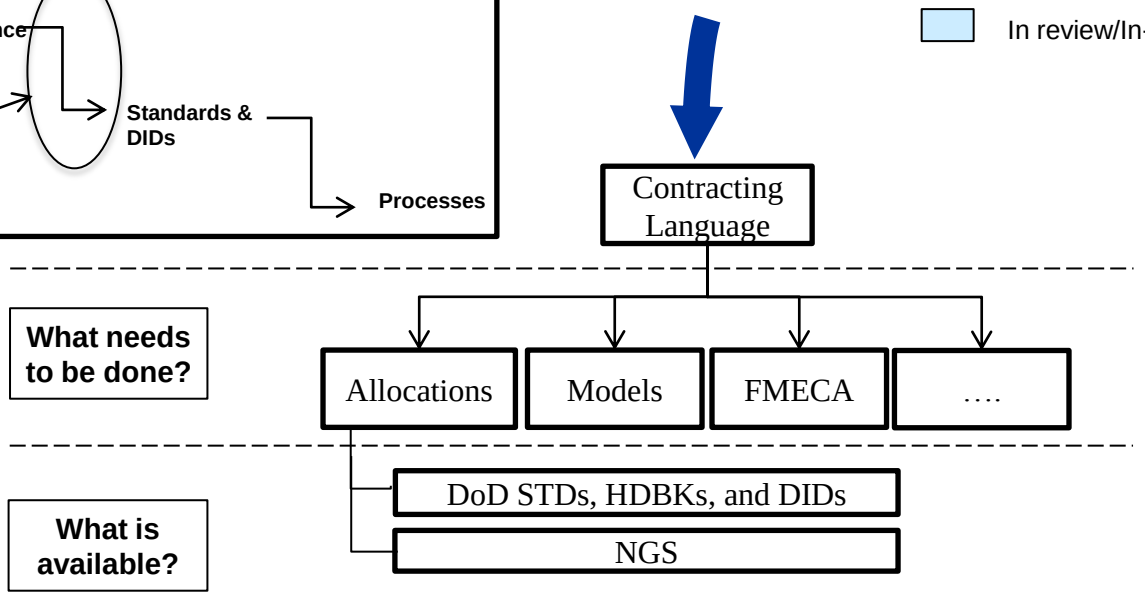


Guidance and Standardization

- **R&M Standards working group**
  - Priority will be given to standards that directly relate to R&M engineering activities required by the DTM
    - Contracting language will define the standardization activity to contract for R&M







Annual Report
1.3 Reliability and Maintainability

BACKGROUND:

WSARA Requirement:

101(b)(1) PLANS.—The service acquisition executive of each military department and each Defense Agency with responsibility for a major defense acquisition program shall develop and implement plans to ensure the military department or Defense Agency concerned has provided appropriate resources for each of the following:

(B) Development planning and systems engineering organizations with adequate numbers of trained personnel in order to—

(ii) include a robust program for improving reliability, availability, maintainability, and sustainability as an integral part of design and development within the systems engineering master plan for each major defense acquisition program;

Lack of Workforce Capacity from last Annual Report

- **All Services reported a lack of capacity in the area of R&M Engineering Workforce.**
- **However, there was no indication of actionable steps to address R&M Engineering capacity and capability going forward.**
- **The lack of actionable steps can be attributed to the timing of the DTM 11-003 which was signed on March 21, 2011, leaving only 6 months in FY11 for Services to implement the policy.**

Annual Report
Differences in R&M Reporting Requirement

CHANGE (in RED):

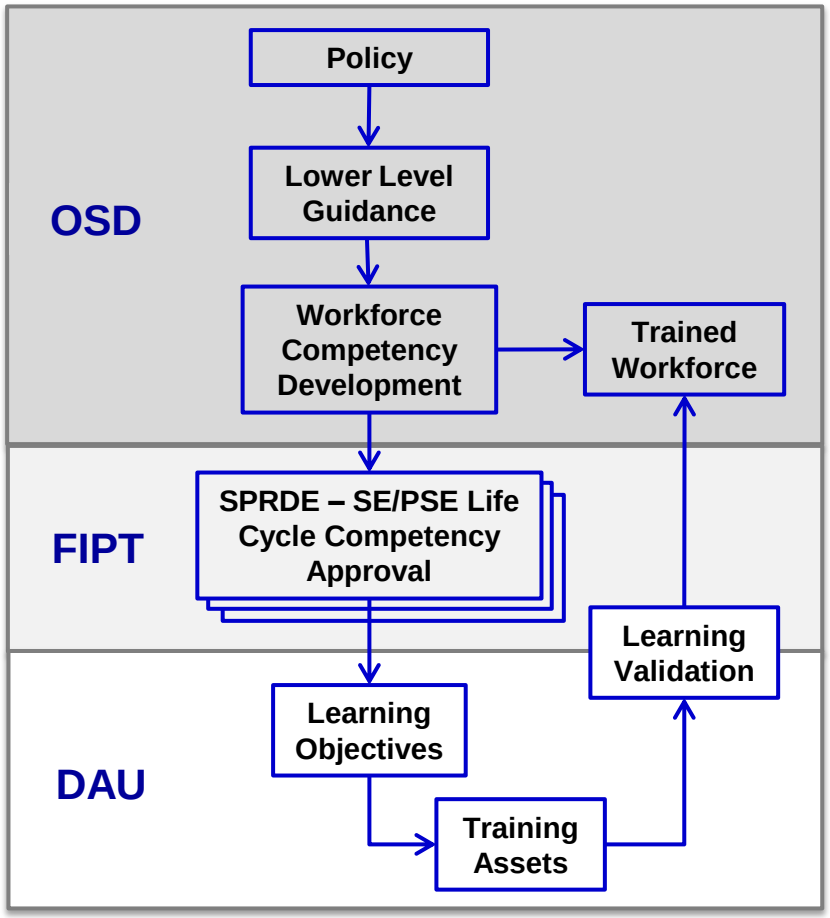
Provide evidence of your FY12 progress and discuss FY13 plans to address the statutory requirements to develop and implement plans to ensure your service has provided appropriate resources for development planning and systems engineering organizations with adequate numbers of trained personnel in order to satisfy the WSARA requirement below. *Describe the current/planned process for determining the available and required numbers of trained personnel, conducting a gap analysis comparing the available and required numbers of trained personnel, and developing service strategies to address identified gaps.*

"(ii) include a robust program for improving reliability, availability, maintainability, and sustainability as an integral part of design and development within the systems engineering plan for each major defense acquisition program;" *- Pub. L. 111-23, title I, Sec. 102(b)(1)(B)(ii)*

Why:

DTM 11-003 was signed March 21, 2011 which did not leave the Services enough time in FY11 to address their R&M Engineering Workforce in detail. With another year (FY12) to implement DTM 11-003, the Services should be in an adequate position to describe their *process* for assessing their workforce going forward.

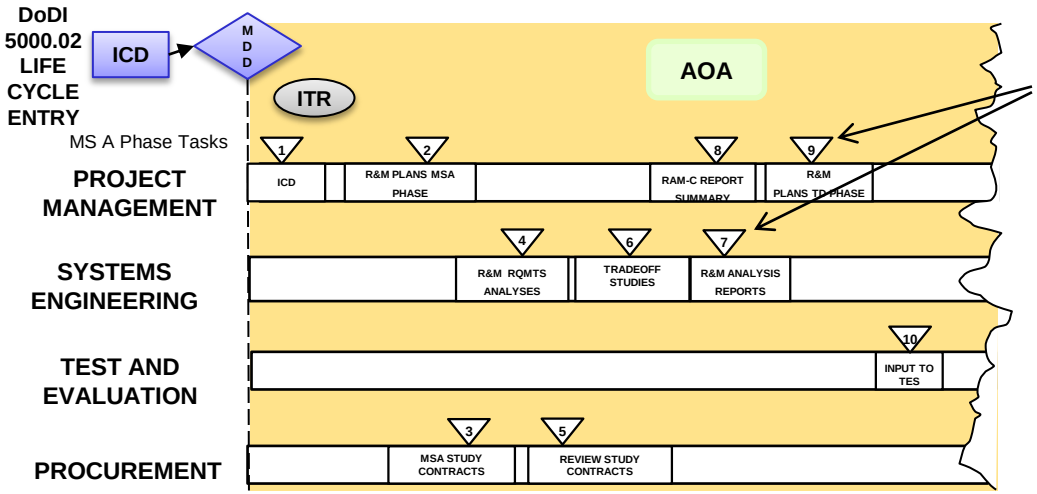
Workforce Development
Training Development Approach

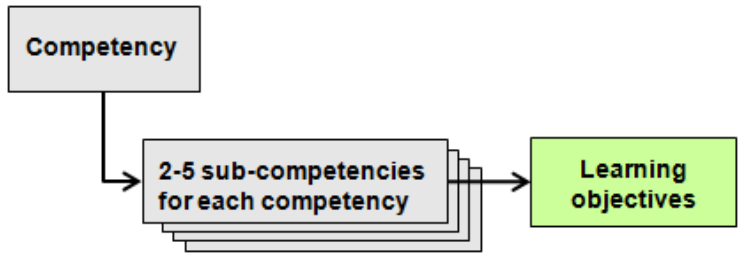


- **Goal: Adequate numbers of trained R&M Engineering Personnel**
- **OSD defines:**
  - **Policy**
  - **Lower level guidance**
  - **Workforce competencies**
- **SE Functional IPT (FIPT) reviews and validates workforce competency set**
- **Informational meetings with other FIPT functional leads (PM, Contracts, T&E, Logistics, BCEFM)**
- **DAU provides training material aligned to approved competency set to meet workforce needs**

R&M Workforce Development illustrates training development key products and process owners.

Workforce Development
R&M Competencies





- **Competencies are focused by program functional areas and span the acquisition life cycle**
- **Developing competencies, sub-competencies, and supporting standard skills for basic, intermediate, and advanced career levels to support learning architecture development**
- **Mapping sub-competencies to DAU courseware learning objectives**
- **Opportunities exist to partner with Services and academia to identify core R&M engineering training requirements.**

The R&M competency structure spans the acquisition life cycle and will address all levels of proficiency.

Workforce Development
Competency Association Process

... Using the DAU MODEL

R&M Lower Level Guidance

Competency Topic

Competencies

Sub-competencies

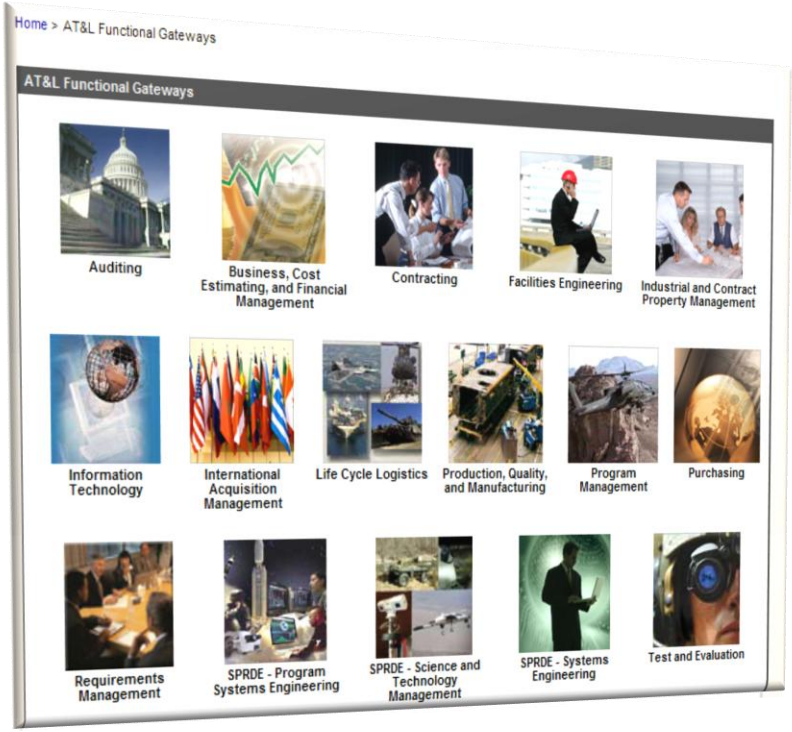
Skills

Functional Area (e.g. SPRDE)

Courses

Modules

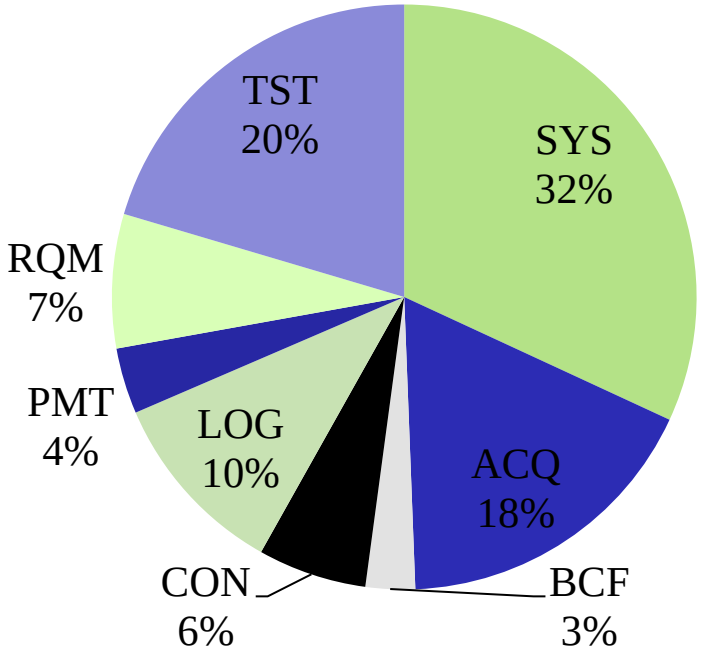
Terminal Learning Objectives (TLO)
- Enabling Learning Objectives (ELO)



- R&M draws from multiple subject areas from DAU
- A comprehensive review must be conducted to assess whether R&M lower level guidance tasks are fully covered

Workforce Development
Learning Objectives

TLOs/ELOs by DAU Subject Area



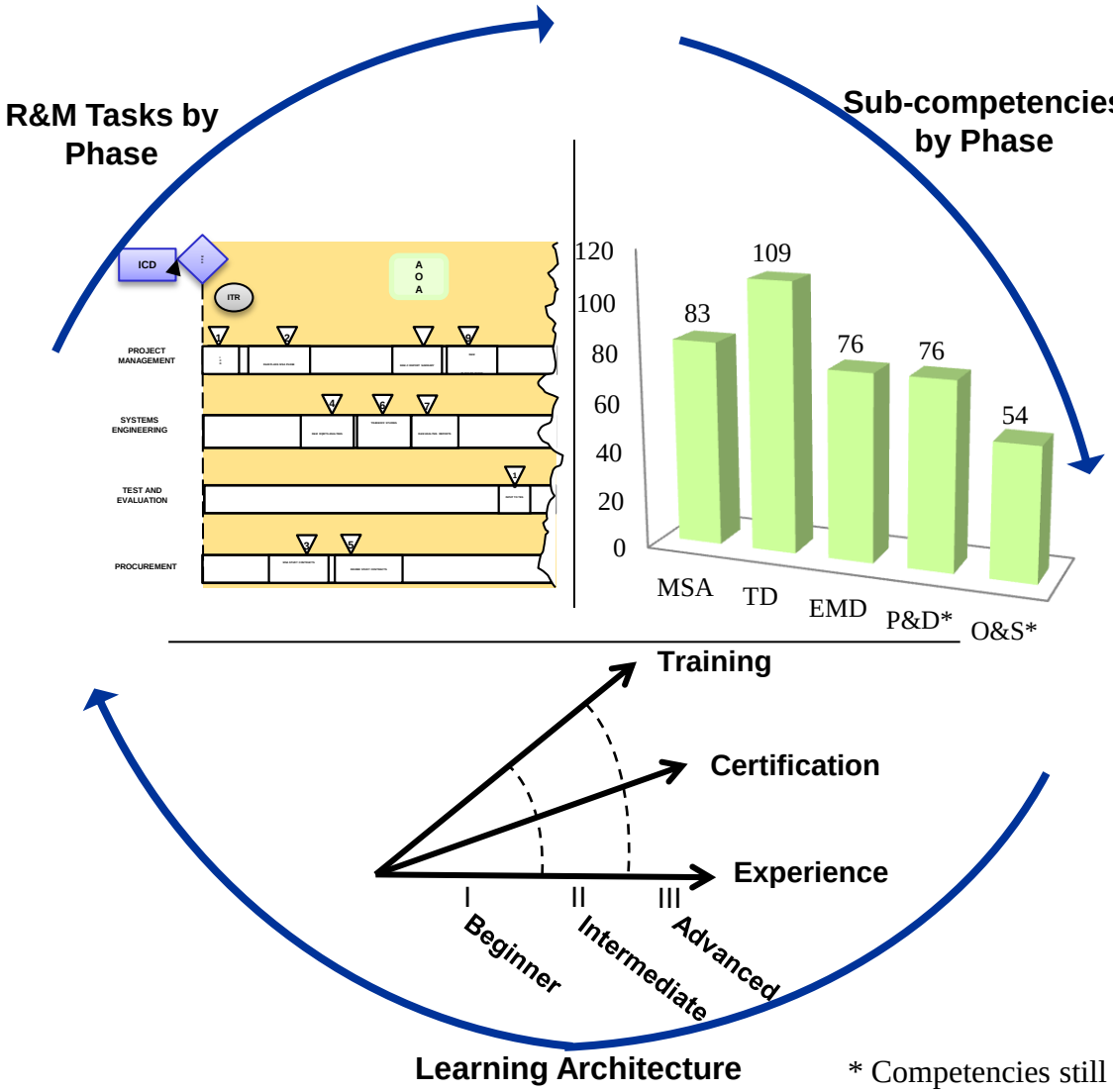
- Reviewed 35 DAU courses*
- 1,646 TLOs/ELOs grouped by functional area

[* Still awaiting TLOs/ELOs for several designated courses]

- **The lower level R&M guidance functional areas span multiple DAU subject areas, not just SPRDE**
- **Based on initial associations, we must consider non-DAU sources to cover the full range of R&M Engineering competencies**

To fully cover all R&M competencies, we must develop a learning architecture to leverage DAU, Service, and Academia resources.

Workforce Development
R&M Future Learning Architecture



- **DoD R&M competency structure requires a comprehensive learning architecture**
- **OSD with support from DAU and Services is defining the approach**
- **Sources for R&M training:**
  - **DAU**
  - **Services**
  - **Academia**
- **Learning architecture will support capability and career growth for the DoD R&M Workforce**

* Competencies still being refined

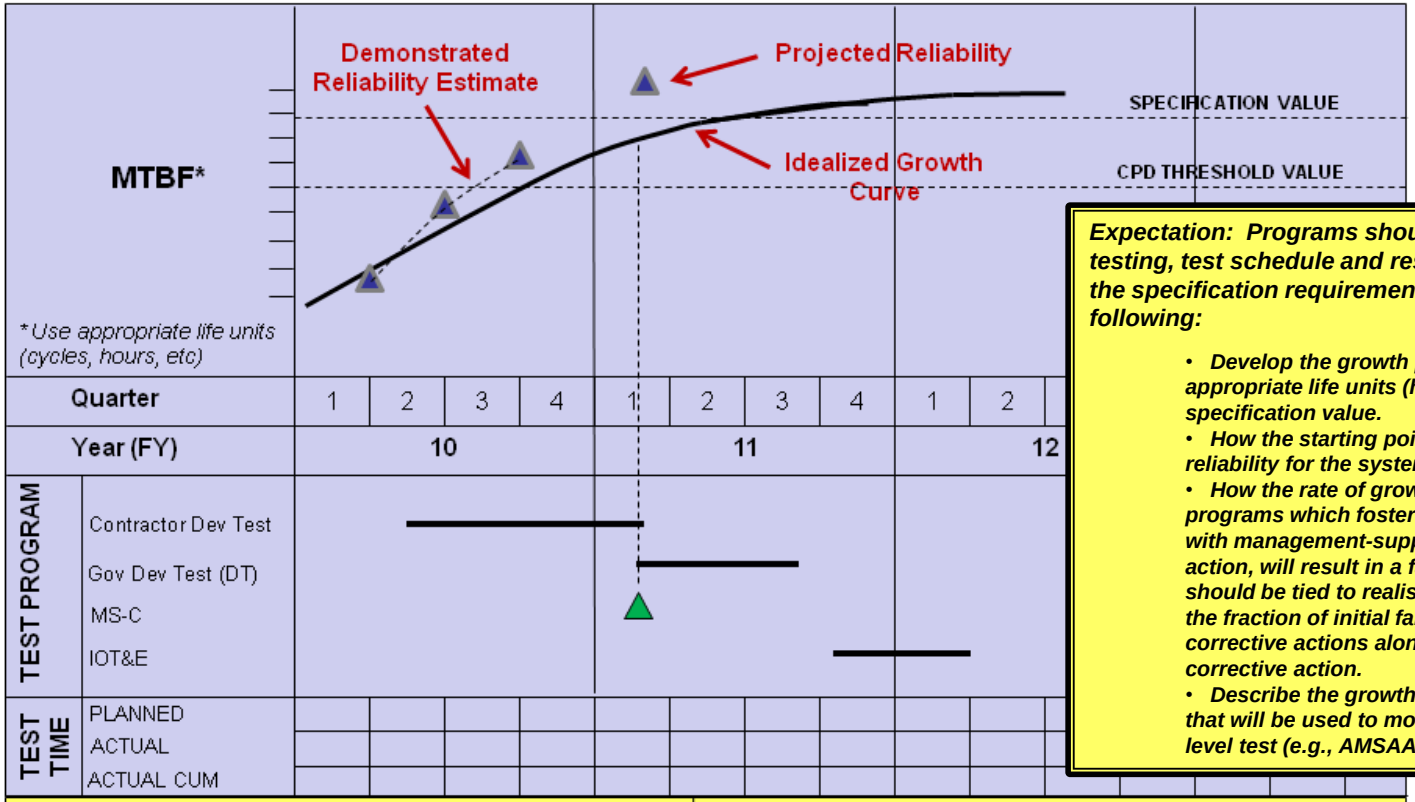
Summary

- **Developing lower level guidance**
  - MSA, TD, and EMD phases complete
  - Preparing to release P&D and O&S phases to R&M Service Leads
- **Associations are being examined between R&M competencies and DAU courseware learning objectives**
  - Initial gap analysis and results are being reviewed
- **Working with Service Leads and DAU to develop and refine preliminary R&M Workforce Strategy**

Additional References

Reliability Growth Reporting in the Systems Engineering Plan

Document the Reliability Growth Curve beginning at MS A, updated at each successive milestone, …



Expectation: Programs should understand the amount of testing, test schedule and resources available for achieving the specification requirement. Programs should consider the following:

- ***Develop the growth planning curve as a function of appropriate life units (hours, cycles, etc,) to grow to the specification value.***
- ***How the starting point that represents the initial value of reliability for the system was determined.***
- ***How the rate of growth was determined. Rigorous test programs which foster the discovery of failures, coupled with management-supported analysis and timely corrective action, will result in a faster growth rate. The rate of growth should be tied to realistic management metrics governing the fraction of initial failure rate to be addressed by corrective actions along with the effectiveness of the corrective action.***
- ***Describe the growth tracking and projection methodology that will be used to monitor reliability growth during system-level test (e.g., AMSAA-Crowe Extended, AMPM).***

System:

Date:

Remarks:

1. Demonstrated Reliability Estimate – Statistical estimate of reliability based on test data.
2. Projected Reliability – Assessment of reliability based on test data and engineering assessment of corrective action effectiveness.

Reliability Engineering Design and Test Activities

Describe planning and timing to generate R&M artifacts.

R&M Engineering Activity	Planning and Timing
R&M Allocations	
R&M Block Diagrams	
R&M Predictions	
Failure Definitions and Scoring Criteria	
Failure Mode, Effects, and Criticality Analysis (FMECA)	
Maintainability and Built-in Test Demonstrations	
Reliability Growth Testing at the System and Subsystem Level	
Failure Reporting , Analysis, and Corrective Action System (FRACAS)	

Table 4.6-2 R&M Activity Planning and Timing (mandated) (sample)

•Expectation: Programs should understand that the content of the R&M artifacts need to be consistent with the level of design knowledge that makes up each technical baseline.

- ***R&M Allocations – R&M requirements assigned to individual items to attain desired system level performance. Preliminary allocations are expected by SFR with final allocations completed by PDR.***
- ***R&M Block Diagrams – The R&M block diagrams and math models prepared to reflect the equipment/system configuration. Preliminary block diagrams are expected by SFR with the final completed by PDR.***
- ***R&M Predictions – The R&M predictions provide an evaluation of the proposed design or for comparison of alternative designs. Preliminary predictions are expected by PDR with the final by CDR.***

•Failure Definition and Scoring Criteria – Failure definitions and scoring criteria to make assessments of R&M contract requirements.

- ***FMECA – Analyses performed to assess the severity of the effects of component/subsystem failures on system performance. Preliminary analyses are expected by PDR with the final by CDR.***
- ***Maintainability and Built-In Test – Assessment of the quantitative and qualitative maintainability and Built-In test characteristics of the design.***
- ***Reliability Growth Testing at the System and Subsystem Level – Reliability testing of development systems to identify failure modes, which if uncorrected could cause the equipment to exhibit unacceptable levels of reliability performance during operational usage.***
- ***FRACAS – Engineering activity during development, production, and sustainment to provide management visibility and control for R&M improvement of hardware and associated software by timely and disciplined***

Workforce Development
Tabulated Associations Example

	ACQ 101		6	TLO		
			53		ELO	ELO
Number of Associations			Example: Task 1 – Review ICD for R&M Objectives	**Apply current acquisition policy and best practices to make sound acquisition management decisions**	Given an Initial Capabilities Document (ICD) and a summary Analysis of Alternatives, (AoA), select an appropriate concept, from the perspective of the system developer, to meet the user's need	Given an Capability Development Document (CDD) and a summary Analysis of Alternatives (AoA), select an appropriate concept, from the perspective of the system developer, to meet the user's need
	MSA Phase					
	Competency		*Evaluate the program Initial Capabilities Document (ICD) to determine adequacy of R&M requirements and definitions.*			
1		Sub-competency	Understand the content, structure, and purpose of an Initial Capabilities Document (ICD).		1	
1		Sub-competency	Understand why R&M is an important component of an Initial Capabilities Document (ICD).		1	
2		Sub-competency	Evaluate the operational requirements and definitions established by the Initial Capabilities Document (ICD) to refine the program's mission and environmental profiles, performance envelope, operational sequence, maintenance plan, sustainment Key Performance Parameters (KPPs), and R&M capabilities.		1	
0		Sub-competency	Understand R&M definitions to develop a uniform quantitative basis to be used as a common denominator for all program study efforts.			