What is in an Effective RAM-C Rationale Report?

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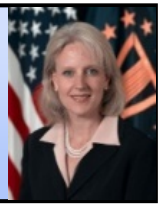
Outline

- DASD, Systems Engineering
- Reliability, Availability, Maintainability and Cost Rationale (RAM-C) Policy
- RAM-C Manual Update (Guide and Annotated Outline)
- RAM-C Process
- What's in an effective RAM-C Rationale Report
- Summary

DASD, Systems Engineering

DASD, Systems Engineering
Stephen Welby
Principal Deputy Kristen Baldwin



Major Program Support
James Thompson

Supporting USD(AT&L) Decisions with Independent Engineering Expertise

- **Engineering Assessment / Mentoring of Major Defense Programs**
- **Program Support Assessments**
- **Overarching Integrated Product Team and Defense Acquisition Board Support**
- **Systems Engineering Plans**
- **Systemic Root Cause Analysis**
- **Development Planning/Early SE**
- **Program Protection**

Engineering Enterprise
Robert Gold

Leading Systems Engineering Practice in DoD and Industry

- **Systems Engineering Policy and Guidance**
- **Technical Workforce Development**
- **Specialty Engineering (System Safety, Reliability and Maintainability, Quality, Manufacturing, Producibility, Human Systems Integration)**
- **Security, Anti-Tamper, Counterfeit Prevention**
- **Standardization**
- **Engineering Tools and Environments**

Providing technical support and systems engineering leadership and oversight to USD(AT&L) in support of planned and ongoing acquisition programs

RAM-C Rationale Report Policy

- **Joint Capabilities Integration and Development System (JCIDS) (February 12, 2015, including errata as of 12 Jun 2015)**
  - RAM-C report will document the quantitative basis for the three elements of the Sustainment Key Performance Parameter (KPP) (as well as the tradeoffs made with respect to system performance).
- **DoDI 5000.02 Operation of the Defense Acquisition System (January 7, 2015)**
  - Applicable to Major Defense Acquisition Programs (MDAP)
  - A preliminary Reliability, Availability, Maintainability and Cost Rationale (RAM-C) Report in support of the Milestone A decision.
  - Report provides a quantitative basis for reliability requirements, and improves cost estimates and program planning.
  - Attached to the SEP at Milestone A, and updated in support of the Development RFP Release Decision Point, Milestone B, and Milestone C.

JCIDS Sustainment KPP Endorsement Guide Excerpts

- **Are sources of data, information systems, and processes identified to track the Sustainment KPP and its supporting Key System Attributes (KSAs) across the life cycle?**
- **Availability KPP**
  - Is there evidence of a comprehensive analysis of the system and its planned use, including the planned operating environment, operating tempo, reliability alternatives, maintenance approaches, and supply chain solutions leading to the determination of the materiel availability value? Are the analysis assumptions documented?
  - Are specific definitions provided for failures, mission-critical systems, and criteria for counting assets as “up” or “down”? Are the failure rate values supported by analysis?
  - Is the administrative and logistics downtime associated with failures addressed (e.g. - recovery time, diagnostics time, movement of maintenance teams to the work site, etc.)?

JCIDS Sustainment KPP Endorsement Guide Excerpts

- **Reliability KSA (Mission and Logistics Reliability)**
  - Has the reliability metric been established at the system level? Is it traceable to the original capability requirements, or other performance agreement?
  - Does the analysis clearly provide criteria for defining relevant failure?
  - Does the analysis clearly define how time intervals will be measured?
  - Does the analysis identify sources of baseline reliability data and any models being used? Is the proposed value consistent with comparable systems? Are sources of data and processes to track reliability across the life cycle identified?
  - Is the reliability value consistent with the intended operational use of the system (i.e., the CONOPs)?
  - Is the reliability value consistent with the sustainment approach as presented in the operational availability metric?

JCIDS Sustainment KPP Endorsement Guide Excerpts

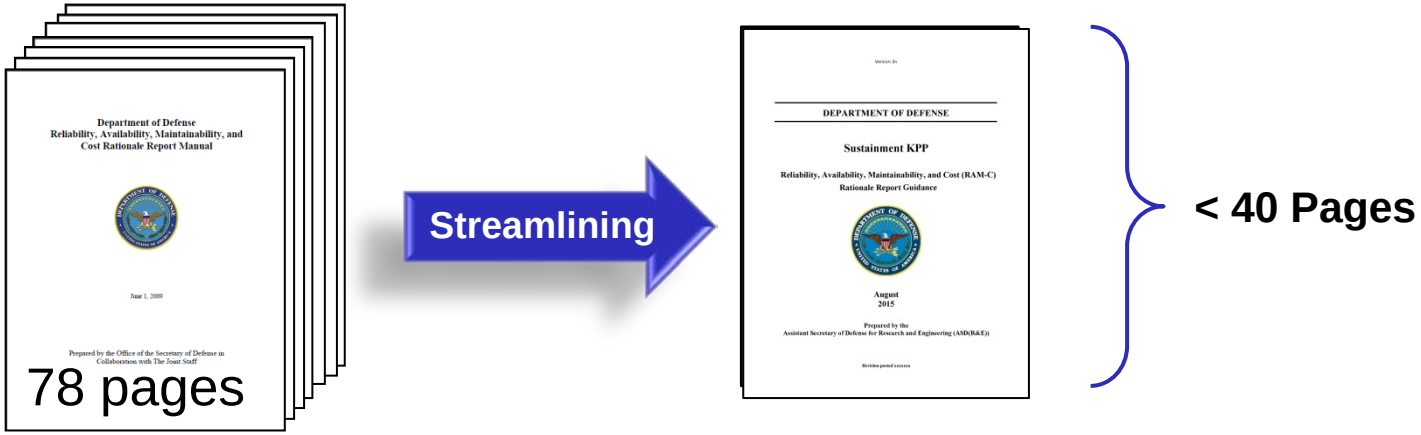
- **Operations and Support (O&S) Cost KSA**
  - Has the O&S cost goal been defined for the system?
  - Does the analysis utilize the CAPE O&S cost element structure?
  - Is the cost model consistent with the assumptions and conditions being used for materiel availability and reliability?
  - Is the cost metric traceable to the original capability requirements, or agreement with the warfighter?
  - Is the O&S Cost KSA data consistent with the capability solution's life cycle cost estimate (LCCE), Cost Analysis Requirements Data (CARD) and/or the CAPE independent cost estimate (ICE) if available for comparison?

RAM-C Manual Update

- **Program Office Feedback—Observations from interviewing authors of selected RAM-C Reports:**
  - Unclear who should conduct a RAM-C analysis (R&M engineering, logistics, and cost personnel should be fully engaged in a team structure)
  - Difficult to obtain defined requirements and mission profiles
  - Iterative process may overlook needed changes to the sustainment metrics
  - Unclear how to obtain good cost estimates or how they are developed to support the RAM-C analysis
  - Unclear how to define and calculate the sustainment metrics
  - Level of expertise varies greatly with limited training available for the development of a RAM-C
  - Often involved too late in process and not clear how to perform sensitivity analysis or perform optimization

RAM-C Manual Update

Conduct a RAM-C Analysis using the Outline and attach the Report to the SEP



- **Streamline the "Manual" into a Guide and Annotated Outline format**
  - Focus content on validity, feasibility, and proper balance of requirements
  - Delete examples and redundant information
  - Provides direction (Includes expectations in the Outline)

RAM-C Guide (with Annotated Outline)

RAM-C Rationale Report Guide

Table of Contents

Contents of Annotated Outline

1. Executive Summary
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   - 1.2. Summary
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   - 2.1. Purpose
   - 2.2. Changes
   - 2.3. Preparers
3. Program Information
   - 3.1. Sustainment Parameters
   - 3.2. OMS/MP
   - 3.3. Maintenance Concept Planning Factors
4. Validation
   - 4.1. Operational Availability (A_O)
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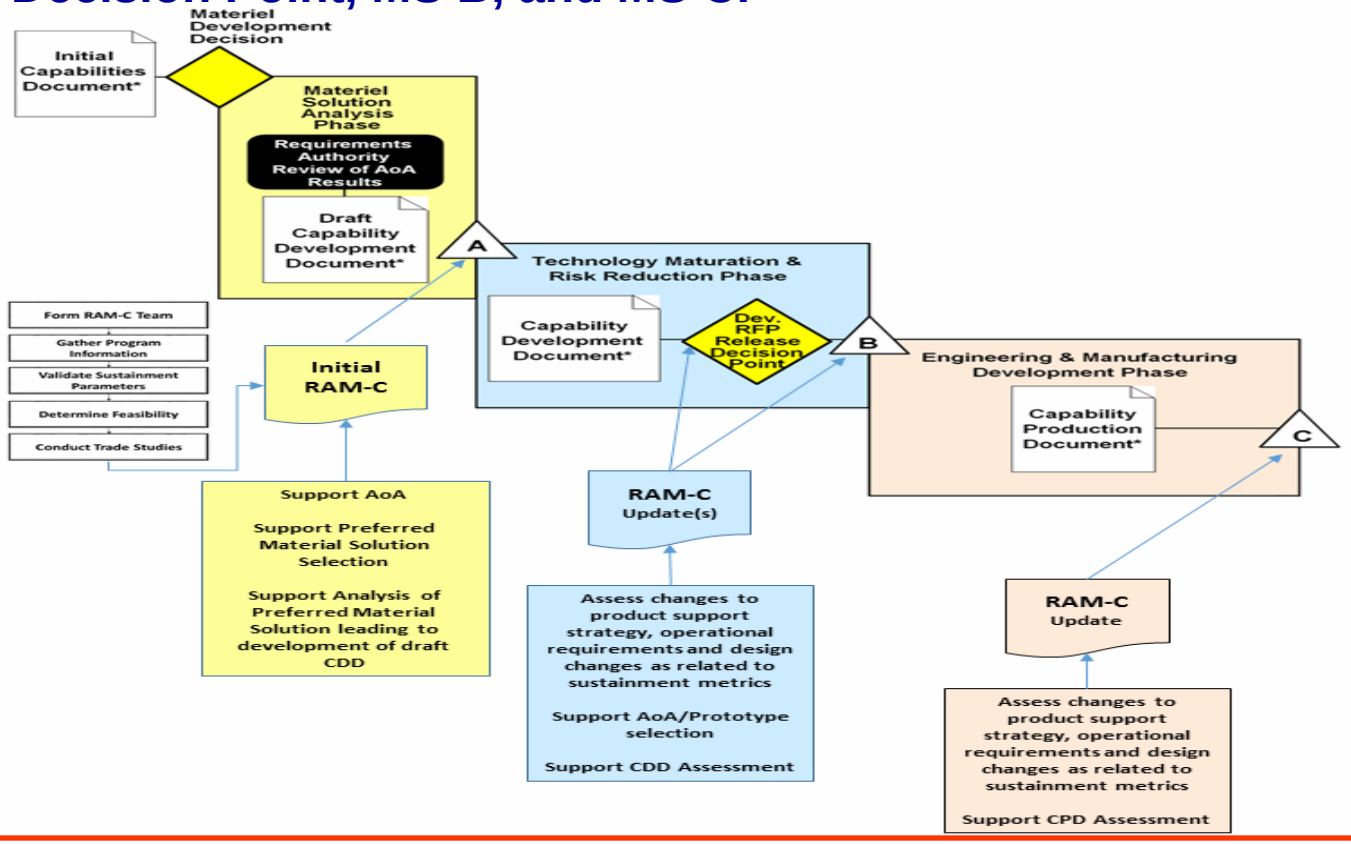
5. Feasibility
   - 5.1. Composite System Model
   - 5.2. R&M Feasibility
   - 5.3. O&S Cost Feasibility
   - 5.4. A_O and A_M Feasibility
   - 5.5. Feasibility Summary
6. Trade Studies
7. Summary

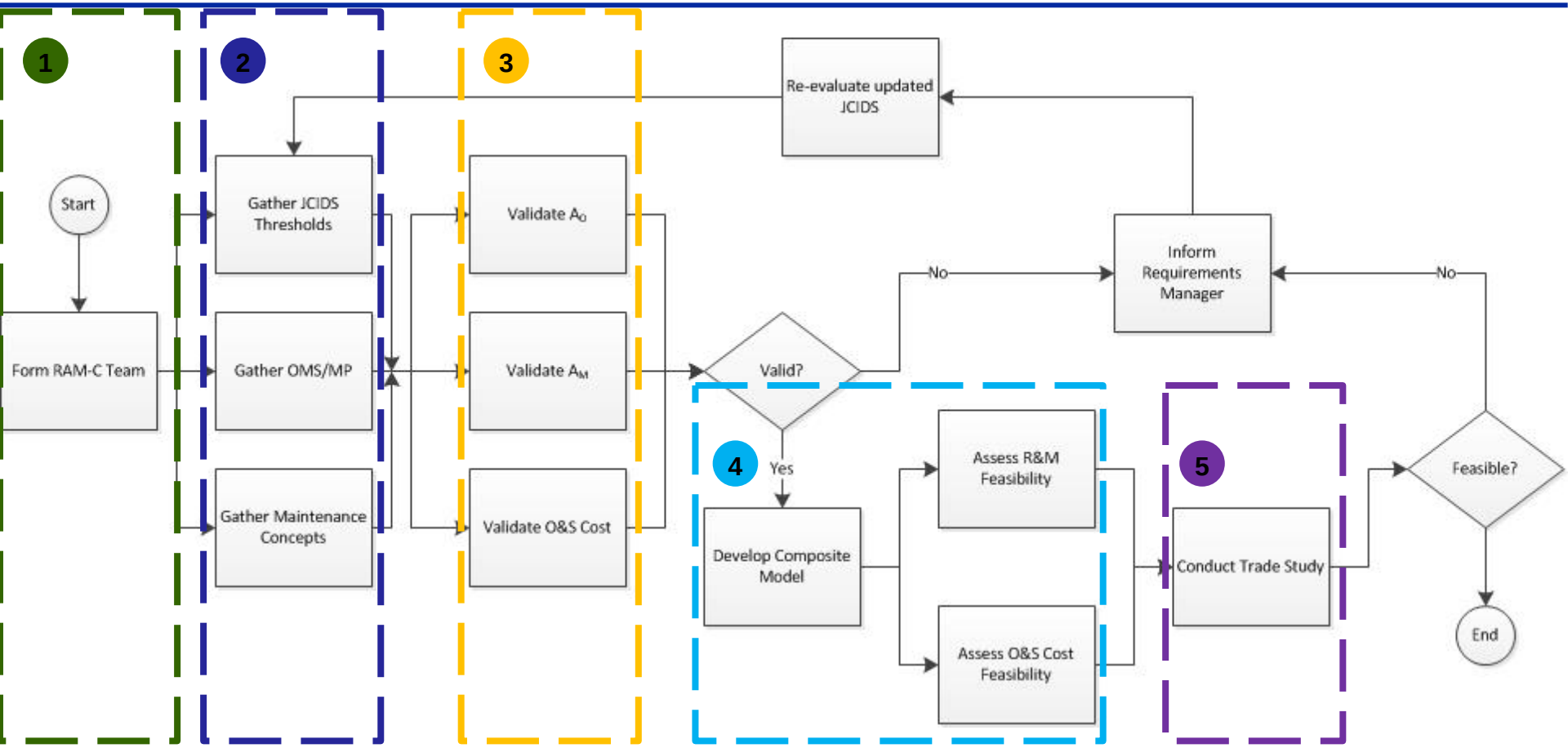
Annex A – Acronyms
Annex B – Documentation, References, and Tools
Annex C – Composite Model Details

RAM-C Process by Phase

- **Program Office conducts RAM-C analysis in parallel with development of the Capability Development Document (CDD) and Capability Production Document (CPD).**
- **Initial submittal supports Milestone (MS) A, updated for Development RFP Decision Point, MS B, and MS C.**



Iterative RAM-C Process



1. Form RAM-C Team
2. Gather Program Information
3. Validate Sustainment Parameters
4. Determine Feasibility
5. Conduct Trade Studies

Attributes of An Effective RAM-C Rationale Report

- **JCIDS sustainment parameters are validated and feasible and meet the requirements of the JCIDS endorsement guide.**
- **Program Office R&M Engineer, Product Support Specialist, and Cost Analyst are involved.**
- **Sustainment KPP/KSA/APAs support the OMS/MP, CONOPS, and maintenance concept.**
- **The R&M metrics and Cost KSAs support the Ao and Am KPPs ("the math works") and are consistent with mission and sustainment needs indicating that the parameters are valid.**
- **Model of the composite system is developed and based on comparison data and current state of the art, and feasibility is determined.**
- **A trade analysis is conducted to illustrate trade space between reliability and maintainability metrics within the feasible region showing the relationship of these metrics with Ao and O&S costs.**

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Annex B – Documentation, References, and Tools
Annex C – Composite Model Details

Model of the Composite System

	Reliability[1]		Maintainability		Total Downtime (MDT)	O&S Costs (3.0)
Subsystem (2-Digit WUC)	**Mission Reliability (MFHBA)**	**Logistics Reliability (MFHBF)**	**Maintenance Burden (MMH/FH)**	**Corrective Maintenance (MTTR)**		
11 Airframes						
12 Furnishings						
13 Landing Gear						
14 Flight Control/Lift System						
15 Hydraulic Propellers						
22 Engine						
List Remaining subsystems						
Assessed System[2]						
JCIDS Threshold						
Legacy System[3]						

Notes

1. Use appropriate life units (hours, miles, cycles, etc)
2. Highlight any cell in red if the assessed system value does not meet the JCIDS Threshold
3. If applicable, enter legacy system data for each sustainment parameter

Table C-1 Composite Model Details (Sample aviation WUC)

Relationship Between R&M and Ao

JCIDS CDD:
Ao KPP = 0.90
MTBF KSA = 170 Hrs

Assumptions:

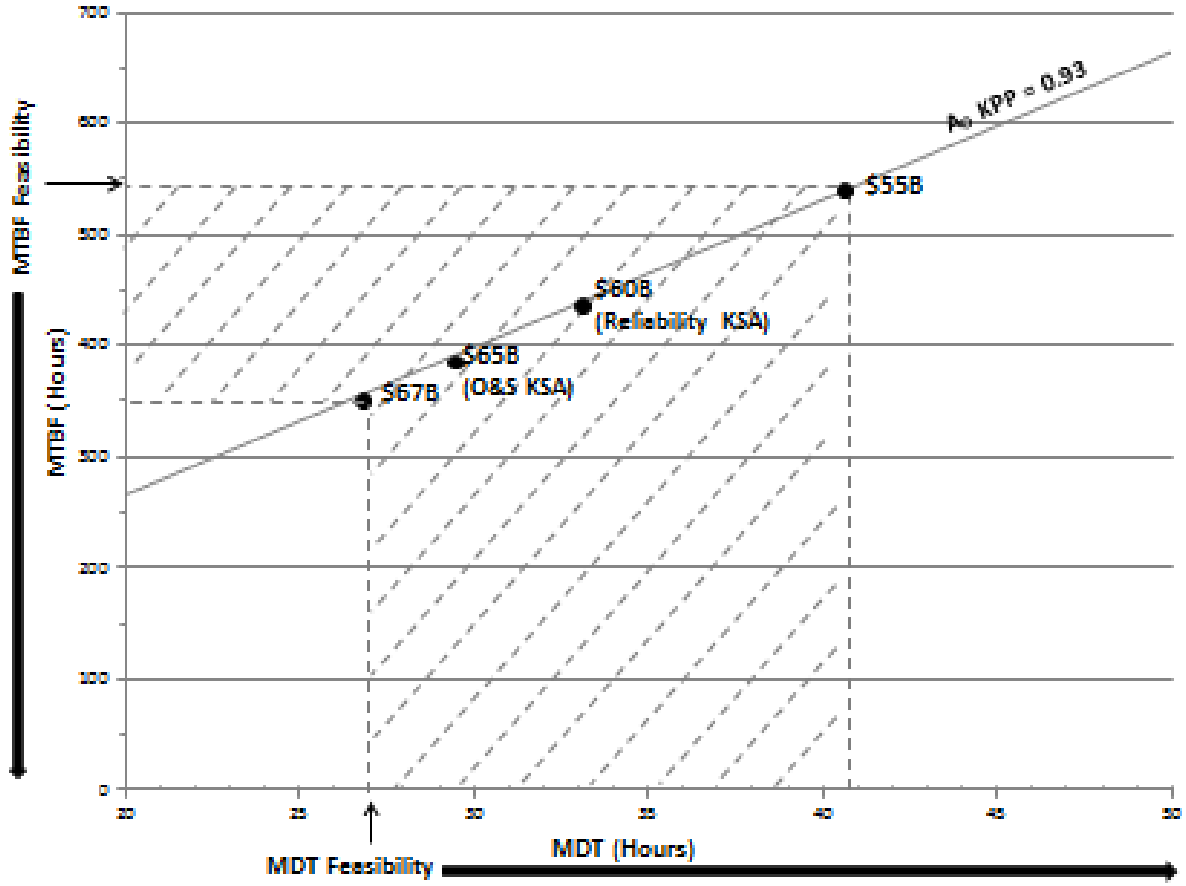
- MTBF feasibility based on state of the art ≤180 hrs.
- MTBF feasibility based on O&S cost ≥ 115 hrs.
- MDT feasibility ≥ 14 hours.
- MDT includes MTTR APA = 2 hours.

Legend
Below Ao KPP
Supports Ao KPP
Above Ao KPP

	MDT										
MTBF	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
115	0.89	0.88	0.88	0.87	0.86	0.86	0.85	0.85	0.84	0.83	0.83
120	0.90	0.89	0.88	0.88	0.87	0.86	0.86	0.85	0.85	0.84	0.83
125	0.90	0.89	0.89	0.88	0.87	0.87	0.86	0.86	0.85	0.84	0.84
130	0.90	0.90	0.89	0.88	0.88	0.87	0.87	0.86	0.86	0.85	0.84
135	0.91	0.90	0.89	0.89	0.88	0.88	0.87	0.87	0.86	0.85	0.85
140	0.91	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.86	0.86	0.85
145	0.91	0.91	0.90	0.90	0.89	0.88	0.88	0.87	0.87	0.86	0.86
150	0.91	0.91	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87	0.86
155	0.92	0.91	0.91	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87
160	0.92	0.91	0.91	0.90	0.90	0.89	0.89	0.88	0.88	0.87	0.87
165	0.92	0.92	0.91	0.91	0.90	0.90	0.89	0.89	0.88	0.88	0.87
170	0.92	0.92	0.91	0.91	0.90	0.90	0.89	0.89	0.89	0.88	0.88
175	0.93	0.92	0.92	0.91	0.91	0.90	0.90	0.89	0.89	0.88	0.88
180	0.93	0.92	0.92	0.91	0.91	0.90	0.90	0.90	0.89	0.89	0.88

Notional Data

Model Established to Conduct Sensitivity Analyses



- Graphically illustrates the range of R&M parameters (MDT includes MTTR) that will satisfy Ao and O&S Cost
- Trade space is bounded by MDT feasibility (lower bound) and reliability feasibility (upper bound)

This along with the Composite Model is "essentially" the RAM-C analysis.

Summary Thoughts

- Conducted early enough to influence sustainment related decisions. Provides a history of those decisions. Not an afterthought, but a driver of program decisions.
- Shows collaboration with requirements developers where issues arise during the analysis
- Uses the best information available at the time the RAM-C is written with an understanding of the accuracy of the information based on the program acquisition phase.
- Verifies that the definitions of failure for each Sustainment KPPs/KSAs/APAs are included in the CDD/CPD
- Demonstrates comprehensive analysis of the best information available. Analysis techniques used are appropriate to the information available and acquisition phase. (Analogy, parametric, engineering, M&S)
- Demonstrates an understanding of the options available within the trade space created within the feasible region and shows how the program used this to make better program sustainment decisions.

For Additional Information

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Systems Engineering: Critical to Defense Acquisition










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