

ORGANIZATIONAL MISSION ASSURANCE STANDARD

Reliability, Maintainability, Availability, and Dependability Program

***SET*TM**

Revision: 2

Release: 03-30-2011

Effective: 03-30-2011

Copyright *SET*TM as an unpublished work. All rights reserved.

STANDARD

OBJECTIVE

This Standard defines *SET*'s approach for implementing a Reliability, Maintainability, Availability and Dependability (RMAD) Program. Through the interpretation and implementation of this Standard, *SET* will tailor RMAD Programs to achieve all pertinent mission assurance requirements which are commensurate with the unit-value/criticality of its products. At the time this Standard was written, *SET* did not develop any very-high or ultra-high unit-value products.

Note: Guidance for product unit-value/criticality determination is found in Figure 1.

APPLICABILITY

This Standard applies to all present and future *SET* sites/facilities, programs/projects, business lines/services, functional organizations/working groups, and employees/subcontractors, regardless of whether an RMAD Program has been contractually imposed.

TABLE OF CONTENTS

1. INTRODUCTION	1
1.1 Scope.....	1
1.2 Purpose.....	1
2. REFERENCES	3
2.1 Normative References.....	3
2.2 Relationship to Other Corporate Standards	4
3. TERMINOLOGY	5
3.1 Terms and Definitions.....	5
3.2 Acronyms.....	10
4. GENERAL REQUIREMENTS	12
5. DETAILED REQUIREMENTS.....	14
5.1 Assign Responsibility and Authority for Meeting Mission Assurance Requirements and Objectives.....	14
5.2 Define and Flow Down RMAD Requirements.....	14
5.2.1 Identify RMAD Requirements Which Are Already Met	14
5.2.2 Identify Opposing Requirements.....	14
5.2.3 Define System Failure Criteria.....	14
5.3 RMAD Program Planning in the Systems Engineering Life Cycle.....	15
5.3.1 RMAD Program Plan	17
5.3.2 Subcontractor and Supplier RMAD Management	18
5.3.3 RMAD Working Group.....	19
5.3.4 Functional Diagram Modeling (FDM).....	20
5.3.5 System Reliability Modeling.....	21
5.3.6 Component Reliability Predictions.....	22
5.3.7 Product Failure Mode, Effects and Criticality Analysis (FMECA)	23
5.3.8 Sneak Circuit Analysis (SCA).....	24
5.3.9 Design Concern Analysis	25
5.3.10 Finite Element Analysis.....	26
5.3.11 Worst Case Analysis.....	28
5.3.12 Environmental Event / Survivability Analysis	29
5.3.13 Anomaly Detection and Response Analysis.....	30
5.3.14 Maintainability Predictions.....	31
5.3.15 Operational Dependability and Availability Modeling.....	32
5.3.16 Software Component Reliability Predictions.....	34
5.3.17 Process Failure Mode, Effects and Criticality Analysis (FMECA).....	35
5.3.18 Similarity and Allocations Analysis	36
5.3.19 Stress and Damage Simulation Analysis	37
5.3.20 Reliability Development/Growth Testing (RD/GT).....	38
5.3.21 Reliability, Maintainability, and Availability Demonstration Testing	39
5.3.22 Reliability Life Testing.....	40
5.3.23 Ongoing Reliability Testing.....	41
5.4 Coordinate the RMAD Processes with Other Systems Engineering Processes.....	42
5.4.1 Oversee Subcontractor’s RMAD Activities	42
5.4.2 Establish, Utilize, and Maintain a Project RMAD Database System.....	42
5.5 Apply Engineering and Evaluation Methods to Identify System and Process Deficiencies	43
5.5.1 Define the System Failure Criteria and Identify Failure Modes	43

5.5.2 Assess Maturity of Key Input Data, Constraints, Ground Rules, and Analytical Assumptions	44
5.6 Risk Assessment and Control	45
5.6.1 Integrate RMAD Process with Program-wide Risk Management Process	45
5.6.2 Perform Structured Reviews.....	46
5.7 Verify RMAD Requirements Are Met	71

Figures

Figure 1. SET Product Unit-Value/Criticality Categorization.....	2
Figure 2. Product Life Cycle RMAD Program Implementation (Notional).....	13
Figure 3. Applicability of RMAD Program Planning in Product Life Cycle.....	17
Figure 4. Applicability of Subcontractor and Supplier Mission Assurance Management in Product Life Cycle.....	18
Figure 5. Applicability of MAWG in Product Life Cycle.....	19
Figure 6. Applicability of FDM Process in Product Life Cycle.....	20
Figure 7. Applicability of System Reliability Modeling in Product Life Cycle.....	21
Figure 8. Applicability of Component Reliability Predictions in Product Life Cycle.....	22
Figure 9. Applicability of Product FMECA Process in Product Life Cycle.....	23
Figure 10. Applicability of SCA Process in Product Life Cycle.....	24
Figure 11. Applicability of DCA Process in Product Life Cycle.....	25
Figure 12. Applicability of Finite Element Analysis Process in Product Life Cycle.....	27
Figure 13. Applicability of WCA Process in Product Life Cycle.....	28
Figure 14. Applicability of Environmental Event / Survivability Analysis in Product Life Cycle.....	29
Figure 15. Applicability of ADR Analysis in Product Life Cycle.....	30
Figure 16. Applicability of Maintainability Predictions in Product Life Cycle.....	31
Figure 17. Applicability of Operational Dependability and Availability Modeling in Product Life Cycle.....	33
Figure 18. Applicability of Software Component Reliability Predictions in Product Life Cycle.....	34
Figure 19. Applicability of Product FMECA in Product Life Cycle.....	35
Figure 20. Applicability of Similarity and Allocations Analysis Process in Product Life Cycle.....	36
Figure 21. Applicability of Stress and Damage Simulation Analysis Process in Product Life Cycle.....	37
Figure 22. Applicability of RD/GT Process in Product Life Cycle.....	38
Figure 23. Applicability of Reliability, Maintainability, and Availability Demonstration Testing Process in Product Life Cycle.....	39
Figure 24. Applicability of Reliability Life Testing Process in Product Life Cycle.....	40
Figure 25. Applicability of Ongoing Reliability Testing Process in Product Life Cycle.....	41

Tables

Table 1. AIAA S-102 Failure Severity Classification Criteria.....	15
Table 2. Failure Mode Severity and Probability of Occurrence Category Definitions	44
Table 3. Key Input Data, Constraints, Ground Rules, and Analytical Assumptions Maturity Ratings....	45
Table 4. Sample Systems Engineering Artifacts.....	47
Table 5. RMAD Program Artifact Evaluation Criteria.....	50

Note: The terms and acronyms used in this Standard are defined in Section 3.

1. Introduction

This Standard establishes the general requirements for a Space Environment Technologies (*SET*) Reliability, Maintainability, Availability and Dependability (RMAD) Program.

1.1 Scope

This Standard applies to all present and future *SET* sites/facilities, programs/projects, business lines/services, functional organizations/working groups, and employees/subcontractors, regardless of whether an RMAD Program been contractually imposed.

1.2 Purpose

SET's RMAD Programs are authorized in accordance with this Standard, with responsibility and authority to

- 1) Ensure all reliability, maintainability, availability, and dependability risks are balanced within the project's objectives, constraints, and budget,
- 2) Evaluate potential failure modes across the product life cycle, as applicable, and
- 3) Quantify the inherent and operational reliability of the product.

The implementation of an RMAD Program to evaluate potential failure modes during the design, manufacture, assembly, testing, transportation, and operational phases of all high unit-value products, will be required either by contract or by this Standard. If the planning for an RMAD Program does not address all of the pertinent requirements called out in the contract or this Standard, then the Lead Reliability Engineer (LRE) will provide documented evidence that verifies only negligible or non-credible failure modes are associated with the requirements not addressed.

Through the interpretation and implementation of this Standard, *SET* will define and implement RMAD Programs that are commensurate with the unit-value/criticality and product life cycle of the products they are applied to. Figure 1 provides *SET's* product unit-value/criticality categorization.

Figure 1. SET Product Unit-Value/Criticality Categorization.

<u>Ultra-High Unit-Value / Criticality Products</u>	<u>Very-High Unit-Value Criticality / Products</u>	<u>High Unit-Value / Criticality Products</u>	<u>Medium Unit-Value / Criticality Products</u>	<u>Low Unit-Value / Criticality Products</u>
<ul style="list-style-type: none"> • Defense satellites • Launch vehicles • Long-range missiles • Nuclear weapons • Nuclear power plants 	<ul style="list-style-type: none"> • Commercial / communications satellites • Fossil fuel / hydro-electric power plants • Oil tankers • Off shore oil rigs • Water filtration plants • Short-range missiles/rockets • Passenger aircraft / helicopters • Military aircraft / helicopters • Military drones / unmanned vehicles • Naval vessels • Passenger trains / buses • Cruise liners • Safety-critical hardware / software components • Satellite ground control stations 	<ul style="list-style-type: none"> • Science satellites • Cargo ships • Mobil / mechanized weapons • Freight trains • Amusement park rides • Elevators / escalators • Small private aircraft / helicopters • Automobiles / trucks / motorcycles • Mission-critical hardware / software components • Construction / demolition / excavation equipment • Satellite communications relay stations 	<ul style="list-style-type: none"> • Industrial electronics • Personal computers / peripherals • Industrial computers / peripherals • Farm equip • Medical / laboratory equip • Factory machinery • Handheld construction / demolition / excavation equip • Communications / utility equip • Explosive devices • Test / monitoring hardware/software components • Computer operating system software • Prototype systems / components 	<ul style="list-style-type: none"> • Motorized / manual hand tools • Fire arms • Consumer electronics • Household appliances • Batteries • Battery operated toys • Infant/ children toys • Computer application program software