

# **Top 50 Equipment Reliability Availability & Maintenance Design Advanced Step Integration Levels**

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Equipment Reliability, Availability & Maintainability [RAM] targets of design and manufacturing must be an integral part of system engineering processes so RAM requirements will be addressed concurrently.

Systems engineering activities can be directed to designing and manufacturing reliability and maintainability into the system, but measures of RAM are not always directly meaningful or suitable as an engineering design specification.

Control of Tech Phases in Acquisition process must be accounted for in establishing the design RAM requirements and in design of the system itself. Changes in performance could be caused or prevented by the design, while other failures could be caused during other events.

RAM Design is an iterative process that will actively pursue developmental testing of design article. A good design process will help to reduce and eliminate risks to mission success at points where the costs of such efforts are at their minimum.

RAM design must not only take into account the system but also the processes used to structure the system, expected maintenance system, logistics system, and operational requirements. Compromised manufacturing can introduce flaws in the product potentially leading to equipment failure events in the field.

Availability is the function of inherent reliability and maintainability as well as system supportability and fit for production. It is essential reliability/maintainability activities to be integrated into the overall design effort, thereby avoiding duplicative effort and making the best use of the output and results Testing.

RAM considerations should be a part of all design decisions, trade-offs, and activities from the beginning of the design effort. In this respect, RAM is the same as any other design characteristic. User constraints are also design constraints. Must develop Design and Redesign for RAM so design satisfies requirements for the desired capability.

Systems engineering approaches using an interdisciplinary team ensures required performance characteristics including RAM requirements are achieved. Performance will not be met without continued focus, which an interdisciplinary team provides as each unit presents design specifications.

Must acquire availability through the combination of high reliability and high maintainability as well as the availability of adequate logistics support i.e., maintenance technicians, spares, test equipment, procedures, status updates, etc. Targeted levels of RAM are more likely to be

achieved when designers accurately anticipate and accommodate the operational scenarios and support factors applicable to the fielded system.

1. Consider RAM requirements explicitly beginning with system design
2. Examine subsystems, assemblies, subassemblies, and components to identify “knowns” and “unknowns” about each indenture level
3. Locate, assess, and mitigate risk to mission success to include failure modes and failure mechanisms
4. Avoid delaying corrective action in development and account for manufacturing
5. Minimise quality control problems in design that could cause mission failures in the field.
6. Evaluate system maintenance/support to include accessibility of components with potential to be replaced
7. Ensure completeness of built-in test equipment and presence of on-board instrumentation
8. Utilise sensors to support tasks such as maintenance planning, scheduling, configuration control & operator debrief
9. Create representative system prototype and identify composition of subsystems, assemblies, subassemblies, and components.
10. Verify RAM is achieved in representative field conditions, using developmental testing or similar activities.

### ***Top 10 Site Visit Executive Task Assign Responsible for Aircraft Depot Maintenance Workload Administration***

1. Allocate resources to include potential mobilised operations
2. Customise depot complex to meet requirements not performed by industry
3. Consolidate workloads to capitalise on similar/common capabilities
4. Distribute workloads to activity with capacity to perform
5. Establish Technical Interfaces between Services to share assignments
6. Identify components of Service plans to match resources with requirements
7. Consider commercial and in-house size/capability constraints

8. Fund Depot operations, construction & modernisation activities
9. Implement uniform cost accounting and information systems
10. Accomplish product support goals of administrative action plan

### ***Top 10 Testing Activity Types Link Weapons Systems Design/Reliability Requirements***

It is important to continue development testing of oversight of changing RAM attributes to determine if system has a satisfactory level of reliability, availability, and maintainability. The purpose of test and evaluation is learning.

Though operational assessments are conducted first, low rate initial production is normally the first opportunity for dedicated operational tests, using production representative units, operationally representative support systems including unique support systems and operationally realistic scenarios.

The final judgment will require system to satisfy user requirements with measurable improvements to mission capability and operational support in a timely manner, and meeting cost/benefit goals.

This is also the opportunity to verify that fixes from previous phases have been developed, incorporated, and correct the RAM problems without introducing new ones.

Often, there is not enough time or test units at the conclusion of normal development or during OT&E to demonstrate achievement of high reliability with confidence. As a result, all relevant RAM metrics should be exploited for possible use in the overall evaluation.

Every test should also be a reliability test. Early testing often focuses on performance every time a system is tested, reliability metrics should be collected. Early testing may not be in the stressful operational environment or under realistic conditions. However, when a failure occurs, consider that particular failure mode explicitly, whether a true component failure or a built-in test indicated system failure.

Consider every failure an opportunity for better system understanding, characterisation, and ultimately for system improvement. Early in the development process, failure mode removal is almost always easier and less costly than in later service life phases.

Development must deal with every failure mode, not just those that appear in specially designed reliability tests. For complex systems, it is possible that the demonstrated reliability at the end of the final design phase may still fall short of the RAM design specifications.

Target minimum value of initial reliability to be achieved by the end of development and mustg

be established during the pre-acquisition phase. In order to conform to the stated purpose of DoD Acquisition, the target minimum value should represent a measurable improvement to mission capability and operational support and meeting cost/benefit goals.

Purpose of testing is to provide information about the system so system achieves desired levels of RAM, and determine compliance with RAM requirements in the form of qualification or demonstration testing.

Testing should complement the design effort conducted throughout Entire Service Life of system. Potential test activities include:

#### 1. Operational Scenario Testing

Contractual qualification testing conducted to illustrate equipment capability provide within work order request characterisation to verify reliable system performance in operational scenarios.

#### 2. Accelerated Testing

The purpose of these tests is to quickly assess what happens when component/system stresses are increased, ie vibration/power stresses in either a continuous or step-wise manner.

#### 3. Time Window testing

Shorten time needed to “grow” the reliability of a part using a formal growth program or to demonstrate the level of requirement does not induce failures that would not normally occur in actual scenario.

#### 4. Correlation Testing

The reason for this requirement is to ensure that correlation between the accelerated and normal scenarios is not lost so to ensure reliability at normal conditions.

#### 5. Performance Projection testing

Must identify the operational or destruct limits of the system. Therefore, no projection of actual reliability performance can be made based solely on one measure of reliability observed.

#### 6. Reliability development/growth testing

This type of testing is primarily during production and manufacturing used to obtain failure modes on prototypes and production subsystems or systems so that corrective actions can be applied to mature system RAM.

#### 7. Time Allocation Testing

Sufficient test time, calendar time to implement fixes, test assets, and economic resources must be properly allocated to ensure an effectively conducted programme structure address integrated diagnostics capability.

#### 8. Reliability Qualification/Demonstration Testing

Fixed configuration test exclusively conducted to demonstrate compliance with RAM requirements for example, pre-production qualification tests and production qualification tests.

#### 9. Technical Evaluation testing

Similar to field stress testing or tests to ensure achievement of technical performance, supportability, durability and RAM integrate operational testing.

#### 10. Operational Testing

Equipment is subject to testing within operational scenarios according to system operational mode summary projected based on previous assessment.

### ***Top 10 Justification for Marine Corps Logistics Teams Operate Wholesale Supply & Depot Maintenance System***

#### 1. Marine Corps Position

Central Control Supply System allows for redistribution of assets to meet contingencies, identification of system-wide problems, and correction of readiness deficiencies in operational force. Depot Maintenance sites allow for control/flexibility of workloads. Operating forces can address any equipment repair requirement with better/faster service than at other sites.

#### 2. Operating Forces Logistics Capability

Operating Forces have separate logistics organisations providing for supply/maintenance support and access to supplies in event of surge. Operating forces must budget and account for funds and submit reports on combat readiness.

#### 3. Force Service Regiments

Combat service support organisation responsible for maintaining expeditionary division/wing forces. Service group provides motor transports, communications & engineering support to ensure logistics support for units.

#### 4. Automated Supply Systems

Automated Logistics are being implemented to provide forces with capability to detail supply requirements and control inventories for deployed forces. Transaction reports dictate what line

items/quantities must be assigned to unit and auto systems redistribute supplies among units subject to changing requirements.

#### 5. Maintenance capability

Group responsible for repairing most types of equipment used by supported operating units. Some of the equipment types normally repaired by the maintenance battalion must coordinate overflow workloads caused by surges from training exercises or deficits in staff/materiel availability.

#### 6. Range of Available Supplies to Operating Force

Operating forces must have access to more suppliers than are present in centrally controlled system. Operating forces are issued pre-positioned & protected source of supply "Mount Out" stock accessible for unanticipated deployments.

#### 7. Budget Construction Capability

Divisions and wings of operating forces must account for and set aside funds to procure materiel from stock funds of base supply activities. Field-level budget guidance is comprised of operating/training programmes and issue of new items. Budget requests are based on field-level instruction and usage levels on individual items so records of fund expense/record are verified.

#### 8. Readiness Reporting

Operational forces must report changes in training programmes and logistics impacting readiness must include status updates to identify deficiency trends and specific items causing equipment to not be operable. Must expedite integrated supply of items to determine full extent of materiel problems.

#### 9. Major Equipment Item Accounting

Besides providing readiness reports, status updates of principal supply support items must be recorded to determine/validate requests and fiscal information of equipment items. Requirements for items impact structure of operating forces. Initial requirements are established for authorisation and subsequent requirements are affected by unit activation plans, maintenance and phase-out of equipment in system.

#### 10. Technical Information

Technical information on operations/maintenance of equipment is essential to include instructions or stock lists to provide identification information on individual items in supply system. Service must consolidate only the information required by operational forces. Technical support entails provision of supply support items and engineering support for procurement in pursuit of standardisation goals.

## ***Top 10 Questions Evaluate Effects of Reliable Available & Maintained Equipment Changes to System Design During Acquisition Phases***

1. Can you facilitate investigation of design alternatives to meet RAM requirements and consider high reliability at conceptual stages of the design?
2. Can you provide foundation for qualitative RAM logistics considerations and provide criteria for early planning of tests to characterise design shortcomings?
3. Can you advance RAM objectives by formulating basis for operational troubleshooting and locate performance monitoring devices within the system?
4. Can you design visibility of RAM system interface features and problems to include fault sensing test equipment or test points?
5. Can you rank/identify effects on RAM of each failure mode on system performance and emphasis on identification of single-point failures developing corrective actions?
6. Can your satisfy RAM quality inspection and test requirements to determine what full-rate production problems are revealed during initial design models/fabrication?
7. Can you identify what specialised parts screening, or other special manufacturing process are required and meet RAM objectives for production quality/test criteria?
8. Can you determine how production rework and lower level rates for individual assemblies, units, etc., correlate with RAM of the production item as measured in job site acceptance tests?
9. Can you assess what impact proposed engineering/manufacturing changes have on RAM and does production model conform to specified demo capability requirements?
10. Can you put processes in place for anticipating parts phase-out situational factors so potential for other item supply line structure to support RAM system in real-world operational scenarios?