**Army Regulation 702–19**

**Product Assurance**

# Reliability, Availability, and Maintainability

**Headquarters**
**Department of the Army**
**Washington, DC**
**12 February 2020**

**UNCLASSIFIED**

# *SUMMARY of CHANGE*

AR 702–19
Reliability, Availability, and Maintainability

This mandated revision, dated 12 February 2020—

- Incorporates Army Directive 2018–15 (chap 1 section II paras and throughout).

- Incorporates Section 2443, Title 10, United States Code (para 2–1).

**Headquarters**
**Department of the Army**
**Washington, DC**
**12 February 2020**

# *Army Regulation 702–19

**Effective 12 February 2020**

**Product Assurance**

## Reliability, Availability, and Maintainability

By Order of the Secretary of the Army:

JAMES C. MCCONVILLE
*General, United States Army*
*Chief of Staff*

Official:

KATHLEEN S. MILLER
*Administrative Assistant*
*to the Secretary of the Army*

**History.** This publication is a mandated revision. The portions affected by this mandated revision are listed in the summary of change.

**Summary.** This regulation prescribes Department of the Army policy and responsibilities for the reliability, availability, and maintainability of its materiel. This policy implements key provisions of the DODD 5000.01 and DODI 5000.02.

**Applicability.** This regulation applies to the Regular Army, the Army National Guard/Army National Guard of the United States, and the U.S. Army Reserve, unless otherwise stated.

**Proponent and exception authority.** The proponent of this regulation is the Assistant Secretary of the Army (Acquisition, Logistics and Technology). The proponent has the authority to approve exceptions or waivers to this regulation that are consistent with controlling law and regulations. The proponent may delegate this approval authority, in writing, to a division chief within the proponent agency or its direct reporting unit or field operating agency, in the grade of colonel or the civilian equivalent. Activities may request a waiver to this regulation by providing justification that includes a full analysis of the expected benefits and must include formal review by the activity's senior legal officer. All waiver requests will be endorsed by the commander or senior leader of the requesting activity and forwarded through their higher headquarters to the proponent. Refer to AR 25–30 for specific guidance.

**Army internal control process.** This regulation contains internal control provisions in accordance with AR 11–2 and identifies key internal controls that must be evaluated (see appendix B).

**Supplementation.** Supplementation of this regulation and establishment of command and local forms are prohibited without the prior approval of the Assistant Secretary of the Army (Acquisition, Logistics and Technology) (SAAL–ZL), 103 Army Pentagon, Washington, DC 20310–0103.

**Suggested improvements.** Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publication and Blank Forms) directly to the Assistant Secretary of the Army (Acquisition, Logistics and Technology) (SAAL–ZL), 103 Army Pentagon, Washington, DC 20310–0103.

**Distribution.** This publication is available in electronic media only and is intended for the Regular Army, Army National Guard/Army National Guard of the United States, and the U.S. Army Reserve.

**Contents** (Listed by paragraph and page number)



*This regulation supersedes AR 702–19, dated 22 May 2018.



UNCLASSIFIED

**Contents—Continued**

# Chapter 1
# Introduction

## Section I

## General

### 1–1. Purpose
This regulation sets forth policies for planning and managing Army materiel systems' reliability, availability, and maintainability (RAM) during development, procurement, deployment, and sustainment. It applies to all combat or mission essential developmental, non-developmental, commercial items adapted for military use, and product improved hardware and software systems. Materiel systems also include, but are not limited to, stand-alone or embedded automatic data processing equipment hardware and software; support and ancillary equipment comprising the total materiel system; and multi-Service materiel systems when the Army is lead Service.

### 1–2. References and forms
See appendix A.

### 1–3. Explanation of abbreviations and terms
See the glossary.

### 1–4. Responsibilities
Responsibilities are listed in section II of this chapter.

### 1–5. Records management (recordkeeping) requirements
The records management requirement for all record numbers, associated forms, and reports required by this regulation are addressed in the Army Records Retention Schedule–Army (RRS–A). Detailed information for all related record numbers, forms, and reports are located in ARIMS/RRS–A at https://www.arims.army.mil. If any record numbers, forms, and reports are not current, addressed, and/or published correctly in ARIMS/RRS–A, see DA Pam 25–403 for guidance.

### 1–6. Concepts and coordination
All users of this regulation are encouraged to be flexible in developing and executing RAM programs. RAM programs will be tailored to the individual needs of each system and are expected to vary in scope and complexity between major and non-major systems and between developmental and non-developmental, commercial-based systems. Materiel developers should pursue system and program alternatives that are cost-effective in achieving reliable and maintainable materiel systems.

*a. Logistics.* System RAM characteristics can be significantly altered by changes in operational, environmental, or logistic support concepts. Throughout a system's life cycle, organizations concerned with the RAM of a system and its components must closely coordinate with organizations responsible for its operation and logistic support. This coordination should ensure that system RAM characteristics, requirements, and allocations (such as hardware, software, personnel, and support system) are mutually compatible with logistic concepts. Maintenance concepts, spare and repair parts provisioning, and allocation of maintenance resources must support the system readiness objective. The RAM program must interface with logistic support planning and execution to ensure that each complements the other. The interface will enhance the achievement of an affordable and supportable system. Procedures will be established to ensure that RAM data are compatible with logistics support analysis requirements contained in AR 700–127. This will include documenting a product/system's logistics product data in accordance with Government Electronics Information Technology Association (GEIA)-STD–0007, to facilitate integration with the logistics product data store and the conduct of subsequent analyses needed to conduct post-fielding segments and modifications based on field experience.

*b. Personnel and training functions.* System RAM characteristics are interrelated with human performance requirements and the development and use of trained personnel. Throughout the life cycle, coordination among the warfighter, logistics planning, personnel, and training agencies is required. This planning will be accomplished to ensure compatibility between quantitative and qualitative personnel resources and materiel readiness requirements.

*c. Defense Standardization Program.* Developing and procuring commands and activities will participate in the Defense Standardization Program. Applicable military specifications, standards, handbooks, and standardization studies will

be used to improve interchangeability, reliability, and maintainability of military equipment, supplies, and their associated product data.

*d. Test, measurement, and diagnostic equipment.* Use of test measurement and diagnostic equipment (TMDE) and built-in test equipment (BITE) for hardware systems diagnosis and built in test (BIT) for software system diagnosis will be considered during design and development. TMDE requirements will be coordinated with the Executive Director, TMDE Activity. This will ensure maximum use of items available to the Army. Weapon system developers and managers requiring TMDE will submit acquisition requests to the Program Executive Officer Combat Support and Combat Service Support, Product Director TMDE (SFAE–CSS–JC–TM) Building 3651, Army TACMS Drive, Redstone Arsenal, AL 35898–5400 (see AR 750–43).

## Section II

## Responsibilities

### 1–7. Chief of Staff, Army

CSA, through the Commander, U.S. Army Test and Evaluation Command (ATEC), for assigned user tests, will—

*a.* Serve as the Army's independent evaluator.

*b.* Perform continuous evaluation of system RAM characteristics throughout developmental and operational testing (OT).

*c.* Manage and conduct developmental and operational testing to enable RAM evaluation.

*d.* Review and comment on documents pertinent to RAM test and evaluation (T&E) such as the Test and Evaluation Plan (TEMP).

*e.* Design the overarching RAM T&E program to evaluate system RAM capabilities against approved RAM requirements as documented in the Joint Capabilities Integration and Development System (JCIDS) documents; Reliability, Availability, and Maintainability Cost Rationale (RAM–C) report, critical operational issues and criteria, and contract specifications.

*f.* Maintain a common system RAM database for developmental and operational testing.

*g.* Provide a member to the RAM working group.

*h.* Support the development of a system-level reliability growth program.

*i.* Serve as the chair for the impact assessment committee in the event of a system reliability growth plan threshold breach and provide findings to the Assistant Secretary of the Army (Acquisition, Logistics and Technology) (ASA (AL&T)).

*j.* Review and provide disposition of the RAM–C reports.

*k.* Support and assist with post fielding sustainment reviews and independent logistics assessments, as needed.

*l.* Support and assist with RAM assessments before major decision reviews.

*m.* Assist the capability developer in establishing testable RAM requirements consistent with system operational and support concepts, Army doctrine, organization, and force structure.

### 1–8. Assistant Secretary of the Army (Acquisition, Logistics and Technology)

ASA (AL&T) will—

*a.* Have primary responsibility for the overall RAM program pertaining to materiel.

*b.* Develop, issue, and maintain Army policies on RAM planning and execution in acquisition programs.

*c.* Supervise the major RAM program elements to—

(1) Ensure that operationally focused, achievable, affordable, and testable RAM requirements are included in the requirements documentation.

(2) Ensure that planning under the provisions of AR 70–1 and AR 73–1 include a RAM program and its funding.

(3) Ensure that the RAM program is executed in accordance with the approved plan.

(4) Promote the development, improvement, and application of RAM technology and design practices.

(5) Ensure that RAM is evaluated in product improvement programs.

(6) Ensure that RAM requirements fully consider integrated product support, performance based logistics, and system readiness objectives.

*d.* Ensure that system operational RAM characteristics are reviewed during the Department of the Army (DA) decision-making process.

*e.* Ensure compatibility between the integrated product support program (AR 700–127) and the RAM program.

*f.* Provide policy guidance on the provision of logistics support data to capability development and materiel development organizations for use in developing and validating RAM requirements for new materiel systems.

*g.* Ensure continued data collection and assessment of RAM performance for deployed systems.

*h.* Assist in Army staff evaluation of proposed changes to operational systems' RAM characteristics in product improvement programs.

*i.* Review the logistics-related RAM requirements for adequacy.

*j.* Provide a member for RAM working groups and RAM scoring and assessment conferences, as required.

*k.* Program, product, and project managers will—

(1) Help the capability developer establish RAM requirements consistent with system operational and support concepts, current technology, Army doctrine, organization and force structure, analysis of alternatives (AoA), and expected war losses.

(2) Generate the materiel availability ($A_M$) component of the availability key performance parameter (KPP) and operations and support (O&S) cost key system attribute (KSA) for inclusion into the requirements documentation and RAM–C report.

(3) Lead development and updates of the RAM–C report in conjunction with the capability developer and ATEC.

(4) Assist the capability developer in selecting the support concept, with corresponding RAM requirements and document in the Life-Cycle Sustainment Plan.

(5) Validate the technical feasibility and affordability of proposed RAM requirements. The feasibility assessment will include government furnished equipment, commercial-off-the-shelf (COTS) items, and non-developmental items (NDIs) at the system level requirements. These assessments will be conducted as part of the RAM–C report compilation.

(6) Establish and maintain integrated controls to ensure achievement of RAM requirements and compliance with this regulation. This includes the development of the RAM program.

(7) Identify and implement RAM engineering, design, manufacture, test, and management practices sufficient to ensure delivery of reliable and maintainable systems and equipment.

(8) Represent established RAM requirements with appropriate specification values and thresholds in contracts. These requirements will be coordinated with the ATEC and capability developer. The specification values will be translated from the operational RAM requirements.

(9) Execute the reliability program.

(10) Assess critical elements of RAM throughout the life cycle to detect trends indicating degraded system performance, degraded operational readiness, or increased life-cycle costs and propose or take corrective action based on the assessment.

(11) Ensure that RAM will be a primary objective in contractor and Government system level testing. All plans for testing and assessing RAM performance will be coordinated with and provided to ATEC.

(12) Maintain a RAM database for materiel under their responsibility throughout the life cycle.

(13) Develop and execute the plan for attaining required reliability requirements, to include reliability growth planning curves (RGPC) developed in coordination with ATEC.

(14) Conduct developmental test (DT) on assigned items of materiel to assess RAM and to provide the RAM DT portion of the TEMP.

(15) Conduct RAM assessments in support of decision/technical and post fielding reviews.

(16) Provide necessary manpower and funding during development of missiles/munitions/ammunition to optimize the design and minimize future ammunition stockpile reliability program testing.

(17) Document life limiting components identified as a result of reliability testing and/or predictive technology prior to fielding.

(18) Provide manpower resources and training to support RAM program development and execution.

(19) Provide RAM support to science & technology programs.

(20) Track implementation of corrective actions associated with reliability failures and provides periodic updates to the ATEC and the capability developer.

(21) Support RAM effort for materiel release.

(22) Establish and chair the RAM working group.

(23) Ensure RAM requirements align with AR 385–10, Military Standard (MIL–STD) 882, and AR 70–62.

### 1–9. Chief Information Officer, G–6

CIO, G–6 will implement the RAM-related policies set forth, to include—

*a.* Maintaining a central activity or office for the proper statement and justification of RAM characteristics in materiel requirements documents.

*b.* Establishing and maintaining controls to ensure effective coordination of RAM program functions and compliance with this regulation.

*c.* Establishing RAM requirements, operational mode summary/mission profile (OMS/MP), and failure definition and scoring criteria (FDSC) with the materiel developer’s assistance.

*d.* Providing input to the materiel developer for inclusion into the RAM–C report.

*e.* Developing and executing the RAM program for all Army acquisition programs within their mission area.

*f.* Monitoring materiel development and assessing how well the system has met RAM requirements, as demonstrated during DT and OT.

*g.* Coordinating with materiel developers and applicable test and evaluation organizations to assist with the review and exchange of RAM data needed to develop requirements for emerging systems.

### 1–10. Deputy Chief of Staff, G–2

DCS, G–2 will implement the RAM-related policies set forth, to include—

*a.* Maintaining a central activity or office for the proper statement and justification of RAM characteristics in materiel requirements documents.

*b.* Establishing and maintaining controls to ensure effective coordination of RAM program functions and compliance with this regulation.

*c.* Establishing RAM requirements, OMS/MP, and FDSC with the materiel developer's assistance.

*d.* Providing input to the materiel developer for inclusion into the RAM–C report.

*e.* Developing and executing the RAM program for all Army acquisition programs within their mission area.

*f.* Monitoring materiel development and assessing how well the system has met RAM requirements, as demonstrated during DT and OT.

*g.* Coordinating with materiel developers and applicable test and evaluation organizations to assist with the review and exchange of RAM data needed to develop requirements for emerging systems.

### 1–11. Deputy Chief of Staff, G–3/5/7

DCS, G–3/5/7 will include RAM (as appropriate) in all Army requirements development and review processes.

### 1–12. The Surgeon General

TSG, through the U.S. Army Medical Command, will implement the RAM-related policies set forth in their respective areas of interest, to include—

*a.* Maintaining a central activity or office for the proper statement and justification of RAM characteristics in materiel requirements documents.

*b.* Establishing and maintaining controls to ensure effective coordination of RAM program functions and compliance with this regulation.

*c.* Establishing RAM requirements, OMS/MP, and FDSC with the materiel developer's assistance.

*d.* Providing input to the materiel developer for inclusion into the RAM–C report.

*e.* Developing and executing the RAM program for all Army acquisition programs within their mission area.

*f.* Monitoring materiel development and assessing how well the system has met RAM requirements, as demonstrated during DT and OT.

*g.* Coordinating with materiel developers and applicable test and evaluation organizations to assist with the review and exchange of RAM data needed to develop requirements for emerging systems.

### 1–13. Chief of Engineers

CoE will implement the RAM-related policies set forth, to include—

*a.* Maintaining a central activity or office for the proper statement and justification of RAM characteristics in materiel requirements documents.

*b.* Establishing and maintaining controls to ensure effective coordination of RAM program functions and compliance with this regulation.

*c.* Establishing RAM requirements, OMS/MP, and FDSC with the materiel developer's assistance.

*d.* Providing input to the materiel developer for inclusion into the RAM–C report.

*e.* Developing and executing the RAM program for all Army acquisition programs within their mission area.

*f.* Monitoring materiel development and assessing how well the system has met RAM requirements, as demonstrated during DT and OT.

*g.* Coordinating with materiel developers and applicable test and evaluation organizations to assist with the review and exchange of RAM data needed to develop requirements for emerging systems.

### 1–14. Commanding General, U.S. Army Futures Command

CG, AFC, will—

*a.* Through the Director, Futures and Concepts Center—

(1) Lead the RAM Engineering Program with direct support on-site at the Capability Development Integration Directorate and general support (GS) to Training and Doctrine Command (TRADOC) capability developers (such as GS on-site to TRADOC capability managers at the CoEs, and other TRADOC organizations).

(2) Represent the user in developing and establishing RAM rationale and requirements for inclusion in capability documents and the RAM–C report. Represent the user in generating the operational unit availability (AO) component of the availability KPP, reliability KSA, and maintainability KSA or other RAM attribute documented within requirements documents in accordance with JCIDS . Ensure RAM requirements are operationally relevant and testable. Coordinate with ASA (AL&T) (Program Executive Office proponent) to ensure requirements are achievable and affordable. Ensure requirements are developed with early and continued collaboration with the RAM community, particularly ASA (AL&T), the materiel developer, and ATEC.

(3) Maintain a central activity or office for the proper statement and justification of RAM characteristics in materiel requirements documents.

(4) Develop and maintain awareness of current progress in RAM methodology as applied to capability developments.

(5) Provide RAM training for capability developers.

(6) Participate in, and provide user perspective to, RAM activities that may be outside the scope of normal program acquisition, such as testing and evaluating new technologies, product improvements, and network integration.

(7) Ensure capability development documents (CDDs) include reliability and maintainability as KSAs for acquisition category (ACAT) I and TRADOC designated ACAT II and ACAT III programs.

*b.* Through the commanders and directors of all capability development activities—

(1) Establish and document the basis of RAM requirements, system and system-of-system concept of employment (CONEMP), and FDSC, in coordination with the materiel developer and ATEC.

(2) Provide input to the materiel developer for inclusion into the RAM–C report.

(3) Establish the support concept with materiel developer assistance.

(4) Monitor materiel development, track achievement of RAM requirements, and support any impact assessment.

(5) Coordinate with materiel developers and ATEC to assist with the review and exchange of RAM data needed to develop requirements for emerging systems.

(6) Provide a member to the RAM working group.

*c.* Through the Director, Combat Capabilities Development Center (CCDC) Data and Analysis Center—

(1) Support the ATEC, program, project, or product managers (PMs), and the other CDDCs and AFC elements with early engineering reviews, to include using the reliability scorecard, to determine if the subject system is on a path to achieve the early engineering, manufacturing, and development (EMD) phase reliability threshold, established by the RAM working group, as well as the system operational-reliability requirements.

(2) Serve as a lead for the Army's Center for Reliability Growth.

(3) Perform RAM analyses in support of Headquarters, Department of the Army; Headquarters, Army Materiel Command (AMC); materiel developers; AFC elements; and ATEC.

*d.* Through the Commander, CCDC—

(1) In support of the PM and capability developers, help establish RAM requirements that are consistent with system operational-and-support concepts, current technology, Army doctrine, organization and force structure, AoAs, and expected war losses.

(2) Characterize the reliability and maintainability attributes, provide operations-and-support cost data for alternative materiel solutions—with capability developer assistance—and document in the RAM–C report.

(3) Help to generate the $A_M$ component of the availability KPP and O&S cost KSA, to include with the requirements documentation and RAM–C report.

(4) Help to develop and update the RAM–C report, with the materiel and capability developer.

(5) Help the capability developer select the support concept, with corresponding RAM requirements.

(6) Validate the technical feasibility and affordability of RAM requirements proposed for items that are within the command's development responsibilities. The feasibility assessment will include Government-furnished equipment, COTS items, and NDI system-level requirements. These assessments will be conducted as part of the RAM–C rationale report compilation.

(7) Establish and maintain integrated controls to ensure achievement of RAM requirements and compliance with this regulation. This includes developing the RAM program.

(8) Identify and implement RAM engineering, design, manufacture, test, and management practices sufficient to ensure delivery of reliable and maintainable systems and equipment.

(9) Help the materiel developer represent RAM requirements, with appropriate specification values and thresholds in contracts. These requirements will be coordinated with the ATEC and capability developer. The specification values will be consistent with, and provide for the achievement of, RAM requirements.

(10) Execute the RAM program during sustainment for all Army programs within their mission area.

(11) Assess critical elements of RAM throughout the life cycle to detect trends indicating degraded system performance, degraded operational readiness, or increased life-cycle costs; propose, or take, corrective action based on the assessment.

(12) Ensure that RAM will be a primary objective in contractor and Government system-level testing. All plans for testing and assessing RAM performance will be coordinated with, and provided to, ATEC.

(13) Maintain a RAM database for materiel under their responsibility throughout the life cycle.

(14) Present the plan for attaining required reliability requirements, to include RGPCs developed in coordination with ATEC, at program reviews.

(15) Conduct DT on assigned items of materiel to assess RAM.

(16) Conduct RAM assessments on assigned items of materiel before major decision reviews.

(17) Develop and execute the Army Ammunition Stockpile Reliability Program.

(18) Document life-limiting components identified through reliability testing and/or use of predictive technology, prior to fielding.

(19) Provide manpower resources and training to support RAM program development and execution.

(20) Provide RAM support to science and technology programs.

(21) Track the implementation of corrective actions associated with reliability failures, and provide periodic updates to the PM, ATEC, and the capability developer.

(22) Prepare RAM statement for materiel release (see AR 700–142).

### 1–15. Commanding General, U.S. Army Materiel Command

The CG, AMC will—

*a.* Demonstrate advanced technologies that lead to new and improved RAM, and that ease technology transition and integration into current capabilities, after items have transitioned to sustainment.

*b.* Through the commanders of life cycle management commands—

(1) Plan for maintenance and other logistics support compatible with specified RAM design requirements.

(2) Ensure RAM characteristics are maintained or improved during product improvement of materiel.

(3) Issue RAM data on fielded systems to interested Army activities.

(4) Coordinate with the involved Army commands, Army service component commands, and/or direct reporting units for on-site monitoring of deployed materiel.

(5) Assist the capability developer in selecting the support concept, with corresponding RAM requirements.

(6) Work with the U.S. Army CCDC elements, Software Engineering Centers, and PMs in identifying product improvement opportunities associated with life limiting components and high replacement items.

(7) Review and provide disposition of the RAM–C report.

### 1–16. Commanding General, U.S. Army Training and Doctrine Command

The CG, TRADOC will—

*a.* Support the implementation of the RAM Engineering Program outlined in paragraph 1–14 on AFC-responsible systems, by providing subject matter expertise, document review, and development when requested by AFC.

*b.* Support the implementation of the RAM Engineering Program outlined in paragraph 1–14 on TRADOC-responsible systems by accepting and receiving user representative RAM Engineering General Support from the AFC RAM Engineering team.

*c.* Through commanders and directors of all capability development activities—

(1) Establish and document the system and system-of-system CONEMP in coordination with AFC.

(2) Ensure CDDs include reliability and maintainability as KSAs for ACAT I and TRADOC-designated ACAT II and ACAT III programs.

(3) Assist the AFC with the development and documentation of the basis of RAM requirements, and FDSC.

(4) Establish the support concept with materiel developer assistance.

(5) Monitor materiel development, track achievement of RAM requirements, and support any impact assessment.

(6) Coordinate with materiel developers and ATEC to assist with the review and exchange of RAM data needed to develop requirements for emerging systems.

(7) Provide a member to the RAM working group.

## Chapter 2
## Reliability, Availability, Maintainability Policy

### 2–1. Management

*a.* Materiel developers are responsible for establishing system life-cycle RAM programs that maximize operational readiness and assure mission accomplishment while minimizing maintenance manpower cost, and logistic support cost. The Army CCDCs and life-cycle management commands support the materiel developers in the establishment of the RAM programs. RAM programs will include a mix of RAM engineering and accounting activities that achieve a balance between life-cycle costs and system effectiveness and readiness. RAM management applies to all ACAT programs where the capability developer has determined reliability, availability, and/or maintainability to be an attribute of operational importance. That is, reliability, availability, and/or maintainability requirements exist. The RAM program designed by the materiel developer will—

(1) Ensure that materiel systems provided to the Army:

*(a)* Are operationally ready for use when needed.

*(b)* Will successfully perform their assigned functions.

*(c)* Can be operated, maintained, and sustained within the scope of logistic concepts and policies with skills and training expected to be available to the Army.

(2) Ensure that the RAM program contributes to reducing life-cycle costs, while maintaining or increasing overall effectiveness and suitability.

(3) Ensure that RAM requirements for systems developed, procured, or improved meet the capability developer's requirements.

(4) Ensure that the system's integrated developmental and operational test program will enable the ATEC to assess the system's RAM characteristics.

(5) Analyze RAM trade space against the operational concepts and in coordination with the capability developer.

(6) Ensure that the independent evaluator(s) and capability developer(s) are involved throughout the materiel acquisition process. The PM will establish a RAM working group to include the capability developer and independent evaluator as soon as practical after the materiel development decision.

(7) Ensure that the materiel solution addresses the impact of hardware, software, firmware, operator/maintainer skills, and environment on RAM performance.

*b.* RAM planning, programming, and resource allocation will be provided throughout the life cycle of each system. Under 10 USC 2443—

(1) Clearly defined and measurable reliability and maintainability specifications will be included in the solicitation for and terms of contracts for design of weapon systems.

(2) Clearly defined and measurable RAM engineering activities will be included in the solicitation for and terms of contracts for design of weapon systems. RAM engineering activities will focus on design, manufacture, test, and management practices that will result in delivery of reliable and maintainable items to the operational forces. Acquisition and program plans will stress early investment in RAM engineering tasks.

(3) Contracts may include provisions for the payment of incentive fees to the contractor based on achievement of design specification requirements for reliability and maintainability of weapon systems under the contract, or the imposition of penalties to be paid by the contractor to the Government for failure to achieve such design specification requirements. Information about such fees or penalties will be included in the solicitation for any covered contract that includes such fees or penalties.

(4) Determinations of contractor's performance on reliability and maintainability, and evaluation of payment of incentives or imposition of fees, will be based on reliability and maintainability data collected during the program. Such data collection and associated evaluation metrics will be described in detail in the contract. To the maximum extent practicable, such data will be shared with appropriate contractor and government organizations. RAM accounting will provide information essential to acquisition, operation, and support management to include properly defined data for estimating operational effectiveness and operations and support costs.

(5) If the materiel developer determines that engineering activities and design specifications for reliability or maintainability should not be a requirement in a contract or solicitation for such a contract, the materiel developer will document in writing the justification for the decision. The decision will also be documented in the program acquisition strategy.

*c.* Materiel developers, with support from the capability developer and the ATEC, will prepare a preliminary reliability, availability, maintainability, and cost rationale (RAM–C) report in support of the milestone A decision for all ACAT I and designated ACAT II and ACAT III programs requiring quantitative RAM attributes, as required by DODI 5000.02 (see para 4–4, below). The RAM–C report provides a quantitative basis for reliability requirements and improves cost estimates and program planning. The report will be attached to the systems engineering plan submitted at milestone A and updated

in support of milestones B and C. Programs that enter the acquisition system after milestone A will prepare and submit a RAM–C as soon as practicable but not later than the next pro-gram milestone. Programs that enter the acquisition system in sustainment will be assessed by the capability developer, materiel developer, the ATEC, and the U.S. Army Materiel Command to determine the necessity of the RAM–C report for successful sustainment planning.

### 2–2. Reliability, availability, and maintainability emphasis during source selection

Sustainment factors, including reliability and maintainability will be identified in the source selection plan as a technical evaluation subfactor in making a source selection. When operations and support costs can be accurately estimated and evaluated, these costs will be considered during the source selection decision. Whenever RAM and logistics are evaluated the source selection board should include a reliability engineer, reliability evaluator, or reliability manager for all major defense acquisition programs.

### 2–3. Reliability, availability, and maintainability engineering and design

*a.* The RAM program will provide a clear understanding of RAM requirements along with appropriate translation into contractual specifications that are logically traceable to user-defined requirements.

*b.* RAM engineering activities will be tailored to each system acquisition program by the materiel developer. Essential RAM tasks and tests will be identified, together with the RAM requirements and program schedules, to ensure delivery of reliable and maintainable systems and equipment. Critical RAM tasks will be summarized in the systems engineering plan and tests that contribute to RAM assessment and evaluation will be described in the TEMP.

*c.* Early design maturity will be the objective of each system acquisition program. Component and subsystem level RAM testing will be planned and funded early in the development phase with prioritization based on those areas where the potential return on investment (in terms of system level RAM) is assessed to be the greatest. Such RAM testing will be conducted well before the components are incorporated into system prototypes and system level RAM testing begins. Testing will be planned, funded, and conducted on all acquisitions, unless shown not to be appropriate or of no benefit. Sufficient test items (components and systems) will be funded throughout the system acquisition to support this component testing effort. This early work will serve as a basis for a well-founded estimate of the system's initial reliability at the beginning of the reliability growth program. Programs that enter the acquisition system after development will coordinate with the capability developer and the ATEC to determine the extent of test and demonstration required for program evaluation.

*d.* The RAM program is an integral part of the systems engineering process and must include design for reliability/design for maintainability. It should identify specific design activities required that minimize the risk(s) of not achieving the system's RAM requirements. Hardware, software, operator, training, mission profile, maintenance, manufacturing variation and errors, and technical manuals are the minimal set of risk areas that must be addressed and be documented in the program's System Engineering Plan. The design activities planned and conducted should include:

(1) Reliability and maintainability allocations, block diagrams and predictions.

(2) Refining the FDSC.

(3) Estimation of operational and environmental life-cycle loads.

(4) Engineering or physics-based models in order to identify potential failure mechanisms and the resulting failure modes.

(5) Failure Mode, Effects and Criticality Analysis.

(6) Maintainability and BIT/BITE analysis and demonstrations.

(7) Reliability testing including growth at the system and subsystem level.

(8) Failure reporting and corrective action system.

*e.* The RAM program will include the development and implementation of a closed-loop failure-mode mitigation process to address potential failure modes from the Failure Mode Effects and Criticality Analysis/Failure Modes Effects Analysis as well as observed failure modes to reduce risk.

*f.* Highly accelerated life testing, and/or modeling and simulation must be planned and funded prior to prototype fabrication, to support the establishment of profiles for environmental stress screening (ESS). The ESS planning and profiles will be developed prior to production for all Army acquisitions that include electronic, electrical, or electromechanical hardware.

*g.* Materiel developers, with the support of the CCDCs, will emphasize management of parts, materials, and processes (PM&Ps) to ensure hardware high reliability performance in operating and non-operating environments (for ex-ample, storage) across the acquisition life cycle. The approach will address the requirements of MIL–STD–3018 and standard (SD)–19 including: supply chain disruption, counterfeit PM&P, lead-free usage, and the validation and acceptance test approaches for PM&P items. Additional design "best practices" to improve quality and reduce reliability risk to fielded hardware are provided for reference in SD–18. Program and project PM&P selection and application requirements will be

initiated in the technology development phase, become mandatory at the beginning of the engineering and manufacturing development phase, and continue thereafter.

*h.* Materiel developers with the support of the CCDCs will designate RAM engineering activities in solicitations that will establish and implement RAM programs intended to achieve RAM requirements. The materiel developer will continually assess RAM progress toward requirements achievement. Independent evaluators will conduct system evaluations to identify deficiencies and determine whether intermediate thresholds are met. Prompt management action and allocation (or reallocation) of resources to correct deficiencies will be used to concentrate engineering efforts where needed (for example, to improve mission reliability by correcting mission critical failures, or to re-duce maintenance manpower and logistic cost by correcting repetitive failures).

*i.* RAM design reviews are an integral part of system design reviews and audits; these are conducted throughout the item life cycle and acquisition process. Solicitations and contracts will contain the necessary provisions to support design reviews. Design review procedures will be tailored to specific commodity areas and life-cycle phases. The general objectives of design reviews and audits are to:

(1) Evaluate the adequacy and completeness of technical requirements.

(2) Evaluate the ability of the design of the system, or configuration item, to satisfy its technical requirements.

(3) Verify that actual performance of the system, or configuration item, met its technical requirements.

(4) Evaluate adequacy of resources (schedule, funding, and so forth) to achieve technical requirements.

(5) The CCDC Data and Analysis Center reliability scorecard is a tool available for the materiel developer to conduct an early engineering-based reliability program review.

### 2–4. Reliability growth

*a.* Reliability growth, as used in the materiel acquisition process, is an Army management tool rather than a technical tool. Reliability growth management should—

(1) Aid in allocating resources to achieve reliability requirements on schedule and within cost constraints.

(2) Establish a feasible path to demonstrate system-level reliability requirements with statistical confidence.

(3) Focus attention on achieving reliability growth by following industry best practices for Design for Reliability, identifying operationally relevant failure modes, implementing corrective actions, and verifying the effectiveness of those corrective actions.

(4) Serve as an enabler to assess the O&S cost impact of fielding the system.

*b.* The materiel developer will plan an approach to reliability growth, to include a planning model, prior to milestone A that will be applied starting in EMD, and continue through the production and deployment phase. A period of testing will be scheduled in conjunction with post milestone B to identify design, software, or manufacturing defects. Test time and resources will be scheduled to correct deficiencies and defects found during prior testing. The test-analyze-fix-test (TAFT) program will have dedicated resources (people, facilities, and test units for the necessary duration) to effectively eliminate deficiencies. The TAFT program is required to begin prior to the production phase.

*c.* Materiel developers will develop and use reliability growth plans on all ACAT I, II, and selected non-major systems. The reliability growth plans will include RGPCs. Materiel developers will include a RGPC in the System Engineering Plan, the TEMP, and the Life-Cycle Sustainment Plan at the first program milestone and all subsequent milestones. The RGPC will also be included in EMD contracts. If a single RGPC is not an adequate tool to aid in the management of system-level reliability growth, multiple RGPC may instead be used for critical subsystems with rationale for their selection.

*d.* At program reviews, materiel developers, with support from the CCDCs, will present the coordinated RGPC to provide a realistic portrayal of system reliability in relation to requirements. All updates to the RGPC will be provided to the RAM working group members.

(1) Materiel developers will incorporate initial, interim, and final reliability goals, test phases, corrective action periods and reliability thresholds into the RGPC.

(2) The RAM working group will establish a reliability threshold on the RGPC for the EMD phase of acquisition. If agreement for this value is not reached, then the default for the reliability threshold value(s) will be 70 percent of the threshold reliability requirement(s) specified in the JCIDS document. The threshold must be demonstrated with a minimum of 50 percent statistical confidence, calculated using standard confidence level procedures, unless the RAM working group jointly agrees upon a different standard.

(3) The reliability thresholds will be documented in the acquisition program baseline and TEMP no later than milestone B and will be translated into the EMD contracts/solicitations. If a program enters the acquisition system after milestone B, the reliability thresholds will be documented as soon as practicable but not later than the next milestone.

(4) The program will be expected to meet or exceed the reliability threshold value at the end of the first full-up, integrated, system-level DT event conducted within the EMD phase.

(5) In the event that the system fails to meet or exceed the early reliability threshold established by the RAM working group, ATEC will convene an in-process review to address the following:

*(a)* The PM's planning and implementation of corrective actions (CA), the projected reliability as the CA are implemented, and the programmatic impacts.

*(b)* ATEC assessment of the PM's CA plan, the system's limitations and capabilities given the current level of reliability maturity, the projected reliability, and the risk of the program not getting back on track.

*(c)* U.S. Army AFC/TRADOC will assess the utility of the system given its current and projected reliabilities.

### 2–5. Reliability, availability, and maintainability accounting and assessment

*a.* Materiel developers will conduct a RAM assessment before each programmatic and technical event to estimate the RAM levels of performance. Materiel developers will consider the appropriate amount and specificity of data necessary to detect relevant failure modes, in order to conduct root cause analysis (RCA), devise effective corrective actions, and improve system-level reliability.

(1) The collected data should reflect the loads and stresses of the anticipated operational environment consistent with the OMS/MP.

(2) Data should include observed failure modes, total test duration, number of groups/intervals within the test and the duration of each group/interval, description of testing environment/procedure, system configuration, corresponding test incident reports (TIRs), when corrective actions were implemented and any other pertinent material.

*b.* RAM assessments, including any reliability growth, will be monitored and reported throughout the acquisition process. Materiel developers will report the status of RAM objectives and/or thresholds as part of the formal design review process, during program support reviews, during systems engineering technical reviews, post-fielding reviews or any other relevant contractual reviews.

## Chapter 3
## Reliability, Availability, and Maintainability Documentation

### 3–1. Requirements documents

*a.* Development of requirements documents (such as initial capabilities document, CDD, and capability production document (CPD)) is detailed in AR 71–9. Quantitative RAM requirements will be stated in requirements documents unless not appropriate for the item.

*b.* Quantitative RAM requirements stated in requirements documents represent the operational need and capability for the system, based on currently available knowledge. Capability and materiel developers will initiate a change to the appropriate RAM requirements when new data indicates a change in the threat, need, operational capabilities, or technical capabilities.

*c.* A RAM–C report will be prepared for all ACAT I and designated ACAT II and ACAT III programs requiring quantitative RAM attributes. The report is a separate document from the requirements document. Quantitative RAM requirements, as well as any higher order effectiveness parameters, and associated cost considerations will be documented and justified in the RAM–C report. The report will be submitted with the AoA and Systems Engineering Plan. Guidance for development of the RAM–C report is found in DOD Reliability, Availability, Maintainability, and Cost Rationale Report Manual.

*d.* The RAM–C report will be reviewed for concurrence by the following organizations:

(1) The applicable U.S. Army Life Cycle Management Command.

(2) ATEC.

(3) TRADOC.

(4) The applicable U.S. Army Program Office.

(5) U.S. Army Futures Command.

*e.* When quantitative RAM requirements do not apply, a statement with rationale will be included in the System Engineering Plan, CDD, and CPD.

*f.* The RAM working group will be established before the draft RAM–C report is prepared. The materiel developer will be the lead participant in coordinating the RAM–C report. The RAM working group will assure interagency communication throughout the program life cycle.

### 3–2. Management documents

The systems operational RAM requirements (from the JCIDS document) and technical RAM capabilities will be summarized and documented in the RAM–C, TEMP, RAM program plan, and System Engineering Plan. The Critical Operational

Issues and Criteria and critical RAM issues to be addressed during DT and evaluation and operational test and evaluation (OT&E) will be included in the TEMP. The RAM program to design and produce a reliable and maintainable system will be summarized in the program management documents (see AR 70–1).

### 3–3. Technical data package

*a.* RAM characteristics for system level and critical lower level work breakdown structure elements, along with related requirements and tests, will be integrated into the technical data package. These requirements and tests will be sufficient to ensure the delivery of a product satisfying its RAM requirements.

*b.* The materiel developer will define technical RAM values and quality assurance provisions in specifications. The requirements and provisions will be developed to the lowest work breakdown structure level necessary to control the RAM characteristics of future repair part procurement and reconditioned materiel. These requirements will be consistent with those of the requirements document.

### 3–4. Test documentation

*a. Test and Evaluation Master Plan.* The TEMP will include description of key RAM requirements, test events, configurations, and reliability growth curve(s).

*b. System Evaluation Plan.* The ATEC will prepare the system evaluation plan. The evaluation methodology and criteria to be employed for evaluating the system RAM characteristics will be included in the system evaluation plan. The plan will include a data source matrix that shows the relationship between critical operational issues, evaluation measures, test events, and data sources.

*c. Test Plan.* The ATEC will prepare detailed test plans and operational test agency test plans describing all RAM test activities. The materiel developer will coordinate test planning activities with ATEC and the RAM working group for all customer or vendor tests that are intended to support a formal RAM evaluation.

*d. Test Incident Reports.* The test organization assigned responsibility to conduct tests contributing to the overall evaluation will document each test anomaly or RAM incident observed during testing in the form of a TIR. Each TIR will include, at a minimum, the nature of the failure, the associated diagnostic and corrective maintenance time, system state (on mission, standby, and so forth), and operational impact (that is, immediate action required or partially mission capable). The data contained in the TIR should be sufficiently complete and detailed such that the reliability scoring conference can score the incident in terms of severity and chargeability. The TIR must be detailed enough to use as a basis for root cause analysis and to discern differences between similar failure modes.

*e. Independent Evaluation Report.* The ATEC will perform a comprehensive evaluation of system RAM characteristics, leveraging all available data sources, as appropriate (for example, DT, OT, operational environment), to produce a report.

### 3–5. Post fielding data assessment

Processes to capture relevant RAM information and record it in field data collection systems (for example, Logistics Product Data Store) will be planned and documented in the Life-Cycle Sustainment Plan. Execution of the post fielding data collection will be arranged prior to the program's full rate production decision review.

## Chapter 4
## Reliability, Availability, and Maintainability Requirements Generation

### 4–1. Overview

*a.* The capability developer has the overall responsibility for establishing meaningful operationally based RAM requirements and properly documenting them in capability documents. Operational RAM requirements will be translated into appropriate technical parameters by the materiel developer for testing and contracting purposes. RAM requirements are generated in coordination with the materiel developer, T&E community (ATEC), and Army logisticians to ensure requirements are achievable, feasible, cost effective, testable/verifiable, and reflect the full spectrum of attributes that impact mission success and logistics effectiveness (for example, reliability, maintainability, maintenance force structure, employment concepts, re-supply distribution, and so forth). Other agencies including CCDC Data and Analysis Center, The Research Analysis Center, and Sandia National Labs may be utilized to supplement the analysis capabilities of the capability developer.

*b.* RAM is composed of three elements:

(1) The RAM requirements and their numerical values.

(2) The OMS/MP.

(3) The FDSC.

*c.* The capability developer will, as part of the capabilities development process, develop operationally focused RAM requirements. A RAM–C report will be prepared for any program which establishes a sustainment KPP. Guidance for development of the RAM–C report is available in the DOD Reliability, Availability, Maintainability, and Cost Rationale Report Manual.

*d.* Changes to the OMS/MP and FDSC that impact the numerical RAM values in the CDD/CPD must be assessed. Such changes require impact analysis and in turn require acceptance of the change by the document approval authority.

*e.* Within the bounds of the JCIDS process, the capability developer tailors the appropriateness and applicability of quantitative operational RAM requirements for each development, NDI,COTS, and modification program.

### 4–2. Operational mode summary/mission profile

*a.* The OMS/MP provides a detailed operational understanding of expected peacetime and wartime usage and requirements of the materiel system expressed in a structured and quantitative format. An OMS/MP is a time based representation of planned operations at the tasks, conditions, and standards level across the full range of military operations. The OMS/MP is a source document for many functional areas engaged in the materiel acquisition process. Users of the OMS/MP include the logisticians, testers, evaluators, capability and materiel developers, organization documenters, analysts, trainers, operational planners, and manpower resource personnel. As an integral part of the RAM requirements, the capability developer has responsibility for developing the OMS/MP and coordinating with the materiel developer and ATEC.

*b.* OMS/MPs are mandated as a basis for the RAM requirements. The development of the OMS/MP is fully described in the TRADOC Action Officer Guide for the Development of the Operational Mode Summary/Mission Profile (OMS/MP). The OMS/MP accompanies the capability document being processed for approval.

*c.* There are two forms of OMS/MPs that serve to identify both formation and system level operational environments.

(1) A formation OMS/MP provides detailed usage data for the brigade and major systems within the brigade.

(2) A system OMS/MP contains the tasks, conditions, and standards that a system must perform to enable accomplishment of the formation's mission(s). A system OMS/MP must be developed for all systems identified by the proponent as requiring RAM attributes. System OMS/MPs are approved concurrently with the approval of the associated CDD or CPD.

### 4–3. Failure definition and scoring criteria

*a.* FDSCs are mandated as part of the RAM requirements. Content and development of the FDSC is fully described in the TRADOC Guidelines for Developing Reliability Failure Definition and Scoring Criteria. As an integral part of the RAM requirements, the capability developer has responsibility for developing the FDSC and coordinating with the materiel developer and the independent evaluator, as a minimum.

*b.* The FDSC provides reliability failure definitions and functionality thresholds applied during reliability design, testing, and assessment. The FDSC is a living document that is updated as the system matures. While it supports the RAM requirements in a CDD/CPD, the focus of the FDSC is to support the T&E process. It does not accompany the CDD/CPD being processed for approval. The failure definition consists of a list of critical tasks (represented by essential functions, which are tied to key requirements in the associated CDD/CPD) and associated standards (failure criteria) which identify when and to what level each essential function are breached. The scoring criteria consist of procedural guidance on scoring.

### 4–4. Sustainment parameters

Sustainment planning upfront enables the requirements and acquisition communities to provide a system with optimal reliability, availability, and maintainability to the warfighter at an affordable cost. Sustainment attributes provide an integrated structure that balances sustainment with capability, logistics supportability, and affordability across a system's life cycle, and informs decision makers in trade-off analysis. Sustainment is applicable to all CDDs and CPDs as mandated by JCIDS for ACAT I programs and designated ACAT II and ACAT III programs by the proponent. In cases where sustainment is not appropriate to the operational context of a capability solution, appropriate justification for non-inclusion must be provided; and the CDD/CPD may include other sponsor defined sustainment metrics as KPP, KSA, or additional performance attributes.

*a. Availability key performance parameter.* Availability consists of two components: $A_M$ and $A_O$. Respectively, they provide fleet-wide availability ($A_M$) and an operational unit availability ($A_O$). $A_M$ is a measure of the percentage of the total inventory of a system operationally capable (ready for tasking) of performing an assigned mission at a given time, based on materiel condition. $A_M$ addresses the total population of end items planned for operational use, over the total life-cycle timeframe, from placement into operational service through the planned end of service life. $A_O$ is a measure of the degree to which an item is in an operable state and can be committed at the start of a mission when the mission is called for at an unknown (random) point in time.

(1) Development of the $A_M$ metric is a materiel developer responsibility.

(2) Development of the $A_O$ metric is a capability developer responsibility.

(3) $A_O$ requirements may be specified for continuous/steady-state conditions, or for short intensive usage periods, that is, "pulse $A_O$".

(4) Accurate development of availability metrics require modeling and simulation (M&S), and in particular the derivation of an operationally relevant administrative and logistics downtime parameter collaboratively between the capability and materiel developers. Since ATEC is required to use M&S to evaluate the achievement of the sustainment KPP, M&S planning with ATEC involvement must be performed during the requirements development process. Without adequate M&S support, it is not recommended that $A_O$ be specified in a capability document as a KPP/KSA.

(5) $A_M$ is not applicable to information technology (IT) programs without hardware. However, $A_O$ and reliability requirements as KPPs, KSAs, or attributes may be established for IT programs.

*b. Reliability key system attributes.* Reliability will be sufficient to support the warfighting capability requirements, within expected operating environments. Considerations of reliability must support both availability metrics. The reliability KSA is determined by the capability developer. Applied to a system, reliability is the probability that a system will perform a required function or functions under designated operating conditions for a specified period of time (or other units such as miles, cycles, rounds, and so forth). For a single use system (that is, munition), it will cover the successful performance of the required functions and may not include a specific time interval. The JCIDS manual defines "materiel reliability" as the probability the system will perform without failure over a specific interval.

(1) Reliability of the system should not be confused with the mission success rate (which includes reliability and many other factors).

(2) Reliability requirements in capability documents will normally be expressed as probabilistic requirements because they are more operational in nature. Probabilistic reliability requirements are often converted into other forms for contractual, testing, and logistics purposes. Non-probabilistic reliability requirements are used in cases such as when the reliability of previous increments or predecessor systems were not expressed probabilistically and it is beneficial to continue in the same terms; or, when necessary to reach consensus among Joint Services.

(3) Reliability requirements in capability documents will be expressed in operational terms, meaning that they encompass the inherent hardware, software, typical operators and maintainers, manuals, tools, TMDE, support equipment, and the operational, organizational, and logistical support concepts. Operational RAM quantifies the degree to which the user can rely on required system functions and the burden associated with keeping those functions at his or her disposal.

(4) Reliability requirements in capability documents will include or account for the presence of ancillary, support, or other critical non-system components which may be mandated or are necessary for use with the system.

(5) Reliability requirements should not contain references to test confidence levels or the degree to which they will be tested and evaluated.

*c. Operations and sustainment cost key system attribute.* O&S Cost metrics provide balance to the sustainment solution by ensuring that the O&S costs associated with availability and reliability are considered in making decisions. The O&S cost metric covers the planned life-cycle timeframe, consistent with the timeframe and system population identified in the $A_M$ metric. The O&S Cost KSA is determined by the materiel developer.

*d. Maintainability key system attributes.* Maintainability has a significant impact on the operational use of a system and therefore is added as a KSA when sustainment is required or identified.

(1) Even though maintainability can be defined as a probability, the commonly used definition expresses it in terms of the type and amount of maintenance time required to restore an item to a specified condition (amount of corrective maintenance time following a failure); and/or the type and amount of maintenance it takes to restore to and maintain an item in a specified condition (incorporating both preventive and corrective maintenance). Maintainability requirements include both quantitative and qualitative aspects.

(2) Quantitative requirements associated with maintainability include measures such as mean time to repair (MTTR), maximum time to repair ($M_{ax}$ TTR), and maintenance ratio.

*e. Follow-on systems.* RAM requirements for new systems which replace legacy systems should be established such that the overall impact to the user, in terms of mission success and logistics burden, are not worse than the predecessor system at the time of the legacy system's fielding, and in keeping with the user's current operational need. The intent is that RAM requirements of follow-on systems must be no worse than achieved RAM of predecessor systems; however, reliability trade-offs may be performed to reflect the addition of new capabilities, or other cases such as a one-for-many system replacement.

## 4–5. Reliability, availability, and maintainability-cost rationale report

*a.* Guidance for development of the RAM–C report is found in the DOD Reliability, Availability, Maintainability, and Cost Rationale Report Manual.

*b.* The RAM–C report is prepared by the program/product managers with input from the capability developer, Army logistician, and support from ATEC and U.S. Army Materiel Command elements, as necessary.

*c.* A preliminary RAM–C report will be prepared in support of all ACAT I and designated ACAT II and ACAT III programs requiring quantitative RAM attributes. However, without an adequate system OMS/MP, which may not be available at milestone A, there cannot be a solid foundation for defining quantitative RAM requirements. A formation level OMS/MP can be used to provide an estimate of system usage, and an initial $A_O$ requirement may be established based on readiness constraints. The preliminary RAM–C report may also address sustainment goals or shortcomings identified in the AoA or capabilities based assessment, or sustainment issues specific to the type of technology envisioned for the system. A preliminary RAM–C report will be limited in scope due to the many unknowns at this stage of program, and may articulate RAM and sustainment requirements or goals in terms of a preferred system concept, support and maintenance concept, and technology development strategy.

### 4–6. Tailoring of reliability, availability, and maintainability requirements

The capability developer first determines whether quantitative operational RAM requirements are appropriate and applicable for each development, COTS, NDI, and modification program (in other words, if quantitative operational RAM requirements will be included in the capabilities document). The RAM requirements provide the capability developer's best estimate of what is required to meet the user's operational needs but should also reflect what the materiel developer deems affordable and technically achievable within program funding, risk, and time constraints.

*a. Information systems.* IT programs without hardware procurement such as tactical command, control communications, computers, and intelligence/IT systems may have reliability and/or $A_O$ requirements established at the discretion of the capability developer. Reliability requirements for software-only programs should be probabilistic and focus on successfully completing key or critical functions of the software. IT programs containing hardware must have RAM requirements established.

*b. Non-quantitative reliability, availability, and maintainability requirements.*

(1) *Passive systems.* Passive systems are systems which do not perform an active function (that is, have no powered or mechanical systems or any significant failure modes), such as non-powered boats, bridge girders, tools, pipe sections, clothing, protective gear, and so forth. Reliability and $A_O$ are generally not applicable to passive systems; however, durability, service life, or maintainability requirements may be applicable.

(2) *Commercial off the shelf/non-developmental item.* A COTS/NDI acquisition strategy implies that the commercial marketplace supplies an item, which is sufficient to meet all the user's needs. Items supplied by the commercial marketplace have achieved a balance between reliability and cost such that while higher reliability can be obtained, it is usually not cost effective to do so. Availability, however, is highly dependent on the establishment of proper logistics support for the fielded system. The materiel developer is responsible for obtaining the necessary data to support government-provisioning analysis.

## Chapter 5
## Testing

### 5–1. Developmental testing

*a.* DT will be conducted under controlled conditions. The DT RAM emphasis will be to—

(1) Identify design deficiencies, conduct root cause analysis, and implement corrective actions.

(2) Promote and assess reliability growth.

(3) Evaluate adequacy of design for logistical support.

(4) Estimate the effect of anticipated field utilization, environmental conditions (that is, operationally-realistic loads and stresses), and representative military personnel (where possible).

(5) Determine contract compliance and resolve contractual RAM issues.

(6) Provide a basis for a clear understanding of reliability and maintainability design deficiencies.

(7) Contribute to the DT/OT RAM database.

(8) Provide estimates of RAM characteristics.

(9) Provide shelf life assessment for ammunition stockpile reliability program.

(10) Provide durability estimate of the useful life of certain types of systems (gun barrel, vehicle track, military bridging, and so forth.)

*b.* Testing for RAM at the system level will be designed and conducted to duplicate as closely as possible the OMS/MP. When the OMS/MP cannot be duplicated, procedures will be established for adjusting the analysis of test data or results to conform to the OMS/MP. Tailored environmental profiles should be developed and used for testing components and

subsystems. Environmental profiles (like those contained in Military Handbook (MIL–HDBK)–781) should be used only when sufficient environmental information is not available and cannot be generated.

### 5–2. Operational testing

*a.* OT will be designed to provide estimates of RAM characteristics against user-specified operational RAM requirements in a variety of expected operational conditions, as established by the OMS/MP. OT concentrates on characterizing the operational RAM behavior of the system employed by representative military operators under operationally-realistic conditions. OT normally will be conducted for a fixed configuration of the system under evaluation, which must be clearly documented by the developer and provided to the RAM working group prior to the conduct of OT. In support of writing the operational test agency test plan, the materiel developer will provide documentation regarding the configuration of the system that is expected to be available during the OT. If the materiel developer determines that the actual system configuration that will be available for the OT is different from the anticipated configuration, the materiel developer will provide an updated document to the RAM working group specifying the nature of any differences as soon as possible and well in advance of the OT date. Modifications to the equipment will be allowed only if the problem is of such a nature that further testing is precluded. When system modifications are approved for OT, they will be planned as block changes. OT RAM emphasis will be to:

(1) Provide a comprehensive characterization of system RAM.
(2) Identify operational RAM deficiencies (by failure mode, subsystem, function, mission, and so forth).
(3) Contribute evaluation of RAM to the overall suitability evaluation for the system.
(4) Represent, to the maximum degree possible, realistic operational conditions based on the OMS/MP.
(5) Assess the impact of any vendor corrective actions implemented prior to the OT.
(6) Update the DT/OT RAM database.

*b.* To the maximum extent feasible, operational testing for RAM will be conducted in accordance with the OMS/MP and the program's product support strategy to eliminate the need to adjust RAM estimates. When following the OMS/MP is not feasible, procedures to adjust RAM estimates will be determined by the ATEC independent RAM evaluator.

### 5–3. First article/initial production testing

Production acceptance test and first article test requirements are detailed in AR 73–1. First article/initial production test (FA/IPT) RAM emphasis will be to—

*a.* Identify initial production deficiencies, conduct root cause analysis, and implement corrective actions.
*b.* Promote and assess reliability growth.
*c.* Determine contract compliance and resolve contractual RAM issues.
*d.* Provide a basis for a clear understanding of RAM initial production deficiencies.
*e.* Contribute to the RAM database.
*f.* Provide estimates of RAM characteristics.
*g.* Test against all support/RAM issues for which waivers were granted in previous testing. Validate corrective actions for issues identified in previous testing.

### 5–4. Test planning and design

*a.* Planning for DT, OT, and FA/IPT will be coordinated in order to promote system-level reliability growth and ensure that the potential exists to leverage all data sources in the system RAM evaluation. Subject to program office resource constraints, the test length for a system reliability demonstration event will be established to balance government and producer risks and identification of design deficiencies. During the reliability demonstration event (typically the initial operational test), the planned field configuration of the system should be exercised. The system T&E program should include opportunities to involve representative military operators as early and as often as is feasible. As discussed in chapter 3 of this regulation, the ATEC independent RAM evaluator will document the system RAM evaluation approach in the system evaluation plan.

*b.* The RAM working group will be established as a forum for discussion of the database, the analytical procedures to be used in assessing the data, and for determining the demonstrated RAM values. The RAM working group should strive for a consensus of the principal spokespersons (capability developer, materiel developer, and independent evaluator).

### 5–5. Reliability, availability, and maintainability entrance criteria for test events

RAM test criteria will be defined for each phase of testing by the materiel developer and independent evaluator in coordination with the capability developer (DA Pam 73–1). Test criteria will be included in the TEMP before the initial phase of testing and will be re-coordinated during TEMP update (AR 73–1). These test criteria will be established by using RAM

requirements, reliability growth considerations, and technological assessment of the development program. No single test (or series of tests) can provide all the information upon which to base a decision; therefore, these RAM test criteria are not established as automatic pass-or-fail criteria for the system, but will measure the attainment of the RAM requirements. The test criteria will be used to assess satisfactory progress in achieving RAM requirements. Each RAM value that is a KPP in the requirements document must be addressed by a specific issue and criterion developed by the capability developer (DA Pam 73–1). RAM and trade-off validation activity will be conducted to ensure continued viability of RAM requirements prior to key design and test activities.

## Chapter 6
## Scoring, Evaluation, and Reporting

### 6–1. Scoring conferences

*a.* The objectives of scoring conferences are—

(1) To establish a RAM database.

(2) To ensure that a proper and consistent determination is made for categorizing (assigning classification and chargeability) test incidents against RAM requirements. The FDSC provides guidelines for these determinations and reflects the user's intent with regard to the operational impact of failures on the essential tasks and standards, which the system is required to perform. Deviations from the approved FDSC or OMS/MP may be considered a change to the JCIDS RAM requirements.

*b.* If no RAM requirements exist, no scoring conference is required.

*c.* Scoring conferences will be held during and immediately after DT and OT. DT scoring conferences will be chaired by the materiel developer. OT scoring conferences will be chaired by the independent evaluator.

*d.* The principal members of scoring conferences are the material developer, capability developer, and independent evaluator. Scoring conference advisory members may include the tester, Office of the Director for Operational Test and Evaluation, and others as needed. Principal membership is the same for both DT and OT.

*e.* Scoring conferences may be held in a single physical location with all scoring conference members present, or they may be conducted virtually (teleconference, video teleconference, Web-based, and so forth).

*f.* Through careful examination of TIRs and relevant supporting system data, the scoring conference members should strive for a consensus regarding the scoring and categorization of each TIR; however, consensus is not required. If consensus is not achieved by the scoring conference, the differing viewpoints will be documented in the minutes of the meeting. The ATEC system RAM evaluation will be based on the independent evaluator's final scores for each TIR for any data intended for use in operational assessments and evaluations. Materiel developers and capability developers may express dissenting opinions during their presentations at the program decision review.

*g.* The developmental tester or the operational tester (as applicable) will provide a representative to all scoring conferences. For each incident, the tester's representative will provide explanations and background information on test conditions along with resulting maintenance actions and hardware or software conditions for failure analysis.

*h.* The developmental and operational testers will provide an initial categorization of each test incident in the associated TIR. The final categorization of each TIR is the responsibility of the scoring conference.

*i.* Additional guidelines for scoring conference procedures appear in DA Pam 73–1.

### 6–2. Reliability, availability, and maintainability evaluation

*a. Demonstrated reliability, availability, and maintainability.* The calculation of a system's demonstrated reliability is based on the observed failures accumulated on all assets during testing and the operating metric (hours, miles, cycles, and so forth). Subsequent to each test event, the independent evaluator will publish results relating to demonstrated system RAM characteristics. Such information should consist of, but not be limited to:

(1) Failure mode event timeline including all test assets.

(2) Breakdown of the relative contribution of each observed failure mode to overall system unreliability, associated repair time, and approximate cost of repair (clock hours, monetary cost of repair parts).

(3) Root cause analysis for each failure mode (there may be a delay in receiving this information from the vendor).

(4) The mission impact of each failure mode.

(5) An estimate of the system-level reliability (that is, the probability of completing a mission without a system abort or operational mission failure), availability, and maintainability characteristics.

*b. Assessed reliability, availability, and maintainability.* The calculation of a system's assessed reliability is based on the observed failures accumulated on all test assets during testing and the operating metric (hours, miles, cycles, and so forth). In contrast to demonstrated reliability, the scoring conference members perform an assessment of the effectiveness

of vendor corrective actions associated with the mitigation of observed failure modes. The reliability calculation is adjusted to account for the impact of implemented and/or planned vendor corrective actions. Refer to MIL–HDBK 189 for applicable methodologies.

(1) A RAM assessment conference will be held to discuss and establish the test database, discuss the analytical procedures to be used in assessing the effectiveness of corrective actions (both implemented and planned) aimed at mitigating observed failure modes, and determine the demonstrated RAM estimates. The DT and OT databases that have been formally processed through the scoring conference, and the aggregated DT/OT data from the RAM assessment conference, will be used in assessing achievement of RAM requirements. Minutes of RAM assessment conferences will be provided to the attendees and the logistician. The logistician will be invited to the RAM assessment conference. RAM assessment conference procedures are in DA Pam 73–1.

(2) At the completion of a phase of DT, the assessment conference will be chaired by the materiel developer's representative. This conference will include the materiel developer, the capability developer, and independent evaluator. OT assessment conferences will be chaired by the independent evaluator. In each case, the conference membership will be the same as for the scoring conferences.

(3) The results of the RAM assessment conference will be evaluated and portrayed in test reports, independent evaluations, and assessments for review by, and use in, the decision process (in process review, Army Systems Acquisition Review Council, or Defense Acquisition Board).

*c. Evaluation duties.* The independent evaluator will provide a RAM evaluation of the total system that includes all mission-essential equipment within the scope of the RAM requirement. The materiel developer will provide an assessment of the ease or difficulty of developing and incorporating design changes to eliminate high priority failure modes or improve maintainability.

*d. Maintenance and logistics assessment.* The maintenance, manpower, and logistic support cost will be assessed in the light of all DT and OT to date.

(1) The DT maintainability assessment will determine the appropriate maintainability indices, and the degree of adherence to good maintainability and human factors design principles. DT maintenance evaluation also will determine whether the equipment publications, tools, and TMDE have been developed to the point that the complete system is ready for OT. The DT maintenance test and evaluation will be performed in part by military personnel. The DT maintainability assessment supplements the logistics demonstration.

(2) The OT maintenance manpower and logistic support assessment will consider the ability of using troops to maintain the system with the tools, equipment, publications, and skills available in an operational environment and in accordance with the program support strategy. OT will consider the impact on maintenance, manpower, and logistic support cost and will include a comprehensive assessment of publications, tools, TMDE, skill levels, and allocation of tasks. A typical range of troop skills and varied environmental backgrounds will be normal components of OT maintenance evaluation. The OT maintenance manpower assessment will identify the manpower cost of the system based on task loading and basis of issue. System maintainability will be assessed during OT.

## 6–3. Data collection

*a.* RAM data are required during all phases of the materiel life cycle. During DT, OT, and FA/IPT, RAM data are required to evaluate the materiel system and plan for its support. System contractor personnel may be a source of incident information, at the discretion of the tester, but will not participate in determination and compilation of RAM data in support of OT&E.

*b.* System RAM information such as test incident reports and/or instrumented data from all testing and events intended to support assessment of RAM requirements will be provided and exchanged among the capability developer, materiel developer, testers, independent evaluators, and logistician on a timely and responsive basis. Complete and detailed data collection plans, procedures, forms, and incident reporting procedures will be coordinated among the above parties at a pretest conference to ensure that all data needs are fulfilled. Corrective action summaries (including an implementation date) will be provided by the materiel developer to the same parties as actions are completed.

## 6–4. System reliability, availability, and maintainability monitoring and reporting

*a.* In accordance with the guidelines from paragraph 6–2, subsequent to each test event, the independent evaluator will publish results relating to demonstrated system RAM characteristics.

*b.* In order for the independent evaluator to analyze and publish results relating to a particular test event, the independent evaluator must participate in the planning of the event, and the independent evaluator (or representative) must be present to observe the event. Provided the aforementioned criteria are met, the independent evaluator may publish official findings relating to a test event.

*c.* Select Army programs are monitored through the Army Data Sampling Program (AR 750–1 and DA Pam 700–24) and the Ammunition Stockpile Reliability Program (AR 702–6).

### 6–5. System contractor restrictions

System contractor personnel will not attend or be directly involved as members or observers in RAM scoring/assessment conferences which address data intended to support evaluation (or assessment) of their system's operational RAM requirements. This includes all OT RAM scoring conferences, all RAM assessment conferences, and any DT RAM scoring conferences where aggregation of DT and OT data for RAM evaluation (or assessment) purpose is anticipated. Discussions with system contractor personnel may be necessary to ensure full technical understanding of test incidents. All discussions with system contractor personnel will be held separate from any scoring and assessment activities. A written record of the nature of these contractor/government discussions will be maintained by the conference chairperson.

# Appendix A

# References

## Section I

## Required Publications

**AR 70–1**
Army Acquisition Policy (Cited in para 1–8*c*(2).)

**AR 71–9**
Warfighting Capabilities Determination (Cited in para 3–1*a*.)

**AR 73–1**
Test and Evaluation Policy (Cited in para 1–8*c*(2).)

**DA Pam 73–1**
Test and Evaluation in Support of Systems Acquisition (Cited in para 5–5.)

## Section II

## Related Publications

A related publication is a source of additional information. The user does not have to read a related reference to understand this publication. Unless otherwise indicated, Army publications are available on the Army Publishing Directorate website, at https://armypubs.army.mil/. DOD publications are available at https://www.esd.whs.mil/. The U.S. Code is available at https://www.govinfo.gov/.

**AD 2018–15**
U.S. Army Futures Command Relationship with the Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology)

**AR 11–2**
Managers' Internal Control Program

**AR 25–30**
Army Publishing Program

**AR 70–62**
Airworthiness of Aircraft Systems

**AR 385–10**
The Army Safety Program

**AR 700–127**
Integrated Product Support

**AR 700–142**
Type Classification, Materiel Release, Fielding, and Transfer

**AR 702–6**
Ammunition Stockpile Reliability Program

**AR 750–1**
Army Materiel Maintenance Policy

**AR 750–43**
Army Test, Measurement, and Diagnostic Equipment

**CJCSI 5123.01H**
Charter of the Joint Requirements Oversight Council (JROC) and the Implementation of the Joint Capabilities Integration and Development System (Available at https://www.jcs.mil/.)

**DA Pam 25–403**
Guide to Recordkeeping in the Army

**DA Pam 700–24**
Sample Data Collection

**DOD Reliability, Availability, Maintainability, and Cost Rationale Report Manual**
Office of the Secretary of Defense (Available at https://www.dau.edu.)

**DODD 5000.01**
The Defense Acquisition System

**DODI 5000.02**
Operation of the Defense Acquisition System

**GEIA–STD–0007**
Logistics Product Data (Available for purchase at https://www.sae.org/standards/content/geiastd0007b/.)

**MIL–HDBK–189C**
Reliability Growth Management (Available at https://quicksearch.dla.mil/.)

**MIL–HDBK–781A**
Reliability Test Methods, Plans, and Environments for Engineering Development, Qualification, and Production (Available at https://quicksearch.dla.mil/.)

**MIL–STD–882E**
System Safety (Available at https://quicksearch.dla.mil/.)

**MIL–STD–3018**
Parts Management (Available at https://quicksearch.dla.mil/.)

**SD–18**
Parts Requirements and Application Guide (Available at https://www.navsea.navy.mil/.)

**SD–19**
Parts Management Guide (Available at https://quicksearch.dla.mil/.)

**10 USC 2302**
Middle Tier of Acquisition for Rapid Prototyping and Rapid Fielding

**10 USC 2443**
Sustainment Factors in Weapon System Design

## Section III

## Prescribed Forms

This section contains no entries.

## Section IV

## Referenced Forms

Unless otherwise indicated, DA forms are available on the Army Publishing Directorate website at https://armypubs.army.mil/.

**DA Form 11–2**
Internal Control Evaluation Certification

**DA Form 2028**
Recommended Changes to Publications and Blank Forms

## Appendix B

## Internal Control Evaluation Checklist for Reliability, Availability, and Maintainability

### B–1. Function

The function covered by this evaluation checklist is the implementation and conduct of RAM by materiel developers, capability developers, and other Army organizations identified in this policy.

### B–2. Purpose

The purpose of this evaluation checklist is to assist in evaluating RAM planning, execution, and assessment.

### B–3. Instructions

Answers must be based upon the actual testing of controls (for example, document analysis, direct observation, sampling, simulation, and/or others). Answers that indicate deficiencies must be explained and the corrective action indicated in the supporting documentation. These internal controls must be evaluated at least once every year and then certified on DA Form 11–2 (Internal Control Evaluation Certification).

### B–4. Test questions

*a.* Is RAM included in the requirements document(s)?
*b.* Is there a RAM–C report?
*c.* Is there a reliability growth plan?
*d.* Are RAM parameters included as technical evaluation subfactors in source selection plans, when appropriate?
*e.* Has a RAM working group been established?
*f.* Has design for reliability/design for maintainability been used and are the results identified during design reviews?

### B–5. Supersession

This evaluation replaces the evaluation checklist for the implementation of and conduct of RAM by materiel developers, capability developers, and other Army organizations in this policy, previously published in AR 702-19, dated 22 May 2018.

### B–6. Comments

Help make this a better review tool. Submit comments to the Office of the Deputy Assistant Secretary of the Army (Acquisition, Logistics and Technology) (SAAL–LP), 103 Army Pentagon, Washington, DC 20310–0103.

## Glossary

### Section I

### Abbreviations

**ACAT**
acquisition category

**AFC**
Army Futures Command

**AM**
fleet-wide availability

**AMC**
Army Materiel Command

**AO**
operational unit availability

**AoA**
analysis of alternatives

**AR**
Army regulation

**ARIMS**
Army Records Information Management System

**ASA (AL&T)**
Assistant Secretary of the Army (Acquisition, Logistics and Technology)

**ATEC**
Army Test and Evaluation Command

**BIT**
built in test

**BITE**
built-in test equipment

**CA**
corrective action

**CCDC**
Combat Capability Development Center

**CDD**
capability development document

**CG**
commanding general

**CIO, G–6**
Chief Information Officer, G–6

**CONEMP**
concept of employment

**COTS**
commercial-off-the-shelf

**CPD**
capability production document

**CSA**
Chief of Staff of the Army

**DA**
Department of the Army

**DCS**
Deputy Chief of Staff

**DOD**
Department of Defense

**DT**
developmental test

**EMD**
engineering, manufacturing, and development

**ESS**
environmental stress screening

**FA/IPT**
first article/initial production test

**FAT**
first article testing

**FDSC**
failure definition and scoring criteria

**GS**
general support

**IT**
information technology

**JCIDS**
Joint Capabilities Integration and Development System

**KPP**
key performance parameter

**KSA**
key system attribute

**M&S**
modeling and simulation

**Max TTR**
maximum time to repair

**MIL–HDBK**
military handbook

**MIL–STD**
military standard

**MP**
mission profile

**MTTR**
mean time to repair

**NDI**
non-developmental item

**O&S**
operations and support

**OMS**
operational mode summary

**OT**
operational test

**OT&E**
operational test and evaluation

**PM**
program, product, or project manager

**PM&P**
parts, materials, and processes

**RAM**
reliability, availability, and maintainability

**RAM–C**
reliability, availability, and maintainability cost rationale

**RCA**
root cause analysis

**RGPC**
reliability growth planning curves

**RGT**
reliability growth testing

**RRS–A**
Army Records Retention Schedule–Army

**SD**
standard

**T&E**
test and evaluation

**TAFT**
test-analyze-fix-test

**TEMP**
test and evaluation master plan

**TIR**
test incident report

**TMDE**
test measurement and diagnostic equipment

**TRADOC**
U.S. Army Training and Doctrine Command

**TSG**
The Surgeon General

## Section II

## Terms

**Administrative delay time**
Time associated with processes or tasks not directly involved in restoration or repair activities, such as processing of requests, short-term non-availability of repair facilities, or delays due to establishment of higher priorities.

**Built-in-test**
An integral capability of the mission equipment which provides an on-board, automated test capability, consisting of software or hardware (or both) components, to detect, diagnose, or isolate product (system) failures. The fault detection and, possibly, isolation capability is used for periodic or continuous monitoring of a system's operational health, and for observation and, possibly, diagnosis as a prelude to maintenance action.

**Commercial off the shelf equipment**
Systems or equipment in which the military operating environment is essentially the same as that to which the system was designed and utilized in the commercial marketplace, that is, construction, fire-fighting, power tools, and so forth, and which does not undergo any significant modification for government usage.

**Concept of employment**
The Army capability developer (such as Capabilities Development Integration Directorate, TRADOC capability manager, integrated product team, and cross-functional team) establishes the system's intended operational use in the system and system-of-systems CONEMP. The CONEMP establishes strategy- and threat-driven, concept- and evidence-based, priority-focused, and data-enabled system operational tasks, conditions, standards, future operating environment, and operational attributes to describe the system's use in Joint operations as well as Joint and Army system dependencies and interdependencies. The Army capability developer uses experimentation activities and observations (such as modeling, simulation, analysis, experimentation) to validate the CONEMP. The CONEMP drives system design, engineering, development, testing, scoring, evaluation, life-cycle, trades, and resourcing decision activities across the Future Force Modernization Enterprise.

**Confidence interval**
A confidence interval gives an estimated range of values which is likely to include an unknown population parameter, the estimated range being calculated from a given set of sample data. The width of the confidence interval gives us some idea about how uncertain we are about the unknown parameter. A very wide interval may indicate that more data should be collected before anything very definite can be said about the parameter.

**Confidence limits**
The lower and upper boundaries or values of a confidence interval; that is, the values which define the range of a confidence interval.

**Corrective action**
A documented design, process, procedure, or materials change implemented and validated to correct the cause of failure or design deficiency.

**Corrective maintenance**
All actions performed as a result of failure, to restore an item to a specified condition. Corrective maintenance can include any or all of the following steps: localization, isolation, disassembly, interchange, reassembly, alignment, and checkout.

**Developmental item**
An item of equipment or system not available in the commercial sector and developed by the department with the purpose of providing a new or improved capability in response to a stated need or deficiency.

**Downtime**
The first component is the time waiting for spare parts to arrive via the supply chain, called logistic downtime. The second component is the time to repair, which may consist of maintenance time (that is, MTTR), and in addition, any time that is spent in the queue waiting for the maintenance persons to begin working.

**Environmental stress screening**
Defined as the removal of latent part and manufacturing process defects through application of environmental stimuli prior to fielding the equipment. ESS and highly accelerated life testing will be used to ensure that reliable, available, and maintainable systems are produced and deployed that will be devoid of latent part and manufacturing process defects.

**Failure**
The event, or inoperable state, in which any item or part of an item does not, or would not, perform as previously specified.

**Failure mode and effects analysis**
A procedure by which each potential failure mode in a product (system) is analyzed to determine the results or effects thereof on the product and to classify each potential failure mode according to its severity or risk probability number.

**Failure rate**
The total number of failures within an item population, divided by the total time expended by that population, during a particular measurement interval under stated conditions.

**Failure reporting analysis and corrective action system**
A closed-loop system of data collection, analysis, and dissemination to identify and improve design and maintenance procedures.

**Fault**
Immediate cause of failure (for example, maladjustment, misalignment, defect, and so forth).

**First article testing**
Performed to validate that the vendor has the manufacturing capability, process, and facilities to produce a product in accordance with the requirements of the contract. FAT may include a test to confirm form, fit, and function in the next higher assembly or end item.

**Formation operational mode summary/mission profile**
The primary purpose of the formation OMS/MP is as a supporting document for organic system CDD and CPD development. The formation proponent develops the OMS/MP describing the detailed operational context and intended use, in both peacetime and wartime, geographical environments, and support and maintenance plan as identified in the formation's respective doctrine and concepts.

**Logistics delay time**
All non-administrative maintenance delays involved in repair actions—including transportation of the system to the repair location, time required to obtain necessary spares, and time waiting for repair personnel availability, and so forth

**Maintainability**
Maintainability is the ability of an item to be retained in, or restored to, a specified condition when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair.

**Maintenance ratio**
A measure of the total maintenance manpower burden required to maintain an item. It is expressed as the cumulative number of man-hours of maintenance expended in direct labor during a given period of the life units divided by the cumulative number of end item life units during the 'same period.

**Materiel availability**
$A_M$ is a measure of the percentage of the total inventory of a system operationally capable (ready for tasking) of performing an assigned mission at a given time, based on materiel condition. This measure can be expressed mathematically as number of operational end items/total population. The $A_M$ addresses the total population of end items planned for operational use, including those temporarily in a non-operational status once placed into service (such as for depot-level maintenance). The total life-cycle timeframe, from placement into operational service through the planned end of service life, must be included.

**Materiel reliability**
This is the total operating hours divided by the total number of failures during the total operating hours. Note that both mission reliability (for example, failures that cause mission aborts) and basic reliability (all failures requiring maintenance) must be considered separately. In general, mission reliability supports calculations of $A_O$ while basic reliability supports calculations of $A_M$.

**Materiel solution**
Correction of a deficiency, satisfaction of a capability gap, or incorporation of new technology that results in the development, acquisition, procurement, or fielding of a new item, including ships, tanks, self-propelled weapons, aircraft, and so forth, and related software, spares, repair parts, and support equipment, but excluding real property, installations, and utilities, necessary to equip, operate, maintain, and support military activities without disruption as to their application for administrative or combat purposes. In the case of family of systems or systems of systems approaches, an individual materiel solution may not fully satisfy a necessary capability gap on its own (see CJCSI 3170.01G).

**Maximum time to repair**
The maximum time required to complete a specified percentage of all maintenance actions. For example, if a system specification indicated $M_{ax}$ TTR (95 percent) =1 hour, this means that 95 percent of all maintenance actions must be completed within 1 hour.

**Mean time between failure**
A basic measure of reliability for repairable items. The average time during which all parts of the item perform within their specified limits, during a particular measurement period under stated conditions.

**Mean time to repair**
A basic measure of maintainability. The sum of corrective maintenance times divided by the total number of repairs of the item. The average time it takes to fully repair a failed system. Typically includes fault isolation, removal, and replacement of failed item(s) and checkout.

**Mission profile**
A time-phased description of the operational events and environments an item is subject to from the start to the end of a specific mission. Tasks, events, durations, operating conditions, and environmental conditions are identified for each mission phase. The mission profiles should state specific quantities of operation (that is, hours, rounds, miles, or cycles) for each mission-essential function within the mission.

**Non-developmental item**
An NDI is any previously developed item of supply used exclusively for government purposes by a Federal agency, a State or local government, or a foreign government with which the United States has a mutual defense cooperation agreement; any item described above that requires only minor modifications or modifications of the type customarily available in the commercial marketplace in order to meet the requirements of the processing department or agency.

**Operational availability**
Availability is a measure of the degree to which an item is in an operable state and can be committed at the start of a mission when the mission is called for at an unknown (random) point in time. $A_O$ considers the effects of the OMS/MP, reliability, maintainability (including preventive maintenance), and administrative and logistics delay time (also referred to as mean logistics delay time). $A_O$ can be described by the following equation: *AO = uptime/total time*.

**Operational mode summary**
Description of the mission profile, the required functions, mission cycle and the environmental/operational conditions under which the system is expected to be used. The operational mode summary identifies the relative frequency of the various missions or the percentage of the systems involved in each mission. It also expresses the percentage of time the equipment will be exposed to each type of environmental condition during its intended lifetime. The operational mode summary will not specify unscheduled downtime.

**Preventative maintenance**
All actions performed in an attempt to retain an item in specified condition by providing systematic inspection, detection, and prevention of incipient failures.

**Probabilistic requirements**
A statement of a required probability for performance, for example, reliability: probability of survival until time specified; availability: probability that item is ready when needed; and maintainability: probability that repair completed in time. The designated standard for the chance that a given event will occur.

**Reliability**
Reliability is the probability of an item to perform a required function under stated conditions for a specified period of time.

**Reliability growth testing analysis methodology**
RGT analysis monitors improvements in reliability while deficiencies are being identified and fixed. This methodology also can assess the impact of design changes and corrective actions on the reliability growth rate of the system.

**Reliability scorecard**
The CCDC Data and Analysis Center reliability scorecard examines a supplier's use of reliability best practices, as well as the supplier's planned and completed reliability tasks. The scorecard is important for tracking the achievement of reliability requirements and rating the adequacy of the overall reliability program. An early scorecard assessment may be based solely on a reliability program plan, but as time progresses, the scorecard assessment will become more accurate if information from technical interchange meetings, a reliability case, and results from early reliability tests, are included. The reliability case documents the supplier's understanding of the reliability requirements, the plan to achieve the requirements, and a regularly-updated analysis of progress towards meeting the requirements. The reliability scorecard uses eight critical areas to evaluate a given program's reliability progress: Reliability requirements and planning, training and development, reliability analysis, reliability testing, supply chain management, failure tracking and reporting, verification and validation, and reliability improvements. There are 40 separate elements among the eight categories in the CCDC Data and Analysis Center reliability scorecard. Each element within a category can be given a risk rating of high, medium, or low (red, yellow, or green) or not evaluated (gray). The scorecard weights the elements, normalizes the scores to a 100-point scale, and calculates an overall program risk score and eight category risk scores.

**Reliability, availability, and maintainability program**
Materiel developers establish system life-cycle RAM programs that maximize operational readiness and assure mission accomplishment while minimizing maintenance manpower cost, and logistic support cost. The RAM program designed by the materiel developer for his program will: ensure that materiel systems provided to the Army are operationally ready for use when needed, will successfully perform their assigned functions, and can be operated, maintained, and sustained within the scope of logistic concepts and policies with skills and training expected to be available to the Army. In short the RAM program is the materiel developer's plan and process for addressing the capability developer's RAM requirement.

**Reliability, availability, and maintainability working group**
A sub group of the T&E integrated product team and established for each Army program with RAM requirements. The RAM working group consists primarily of representatives from the materiel developer, capability developer, and the independent system evaluator. The group may be augmented by others as appropriate. The testers should attend in an advisory capacity.

**Repair time**
The time spent replacing, repairing, or adjusting all items suspected to have been the cause of the malfunction, except those subsequently shown by interim test of the system not to have been the cause.

**Root cause analysis**
Is a method of problem solving to identify the root causes of faults or problems. Focusing correction on root causes has the goal of preventing problem recurrence. The analysis is typically used as a reactive method of identifying event(s) causes, revealing problems and solving them. Analysis is done after an event has occurred. Failure-based RCA is rooted in the practice of failure analysis as employed in engineering and maintenance.

**System operational mode summary/mission profile**
A system OMS/MP is a tool to focus overall system design for both the materiel developer and system contractor communities. It is a foundational input document for the establishment of the key attributes of RAM and serves as the benchmark document for establishing test plans and procedures to assess RAM and other system capabilities.

**System readiness objectives**
A criterion for assessing the ability of a system to undertake and sustain a specified set of missions at planned peacetime and wartime utilization rates. System readiness measures take explicit account of the effects of reliability and maintainability, system design, the characteristics and performance of the support system, and the quantity and location of support resources. Examples of system readiness measures are combat sortie rate over time, peacetime mission capable rate, $A_O$, and asset ready rate.

**Testability**
A design characteristic that allows the status (operable, inoperable, or degraded) of an item to be determined, and faults within the item to be isolated in a timely and efficient manner.

**Test–analyze–fix–test**
The process of growing reliability and BIT performance, and testing the system to ensure that corrective actions are effective. Then focus becomes ensuring that the corrective actions are producible and equate to improved RAM in the produced system.

**Total time**
The total time during which the system was supposed to be up during a given calendar interval (total time = uptime + downtime).

**Uptime**
The time during which the system was capable of performing all required functions in a given calendar interval.

## Section III

## Special Abbreviations and Terms

There are no items in this section.