TRADOC

Army Capabilities Integration Center

In Coordination with the Combined Arms Support Command (CASCOM)

Logistics Supportability Chapter for the Capability Development Document/Capability Production Document (CDD/CPD) Writer's Guide

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Materiel System Logistics Supportability Requirements Development Guidance

Purpose: To provide guidance on developing materiel system logistics supportability requirements within Capability Development Documents (CDD) and Capability Production Documents (CPD).

Scope: This guide is applicable to all TRADOC proponent centers and schools and non-TRADOC proponents having an MOA/MOU with TRADOC to conduct capability development activities. Instances of the use of "TRADOC proponents" in this document will also pertain to these non-TRADOC proponents that work under TRADOC guidelines for capability developments.

Summary: Comprehensive logistics supportability planning for materiel systems is an investment to insure our Soldiers receive warfighting capabilities that are reliable, survivable, maintainable, sustainable and affordable. This guide was developed to assist the TRADOC capability development community in defining and developing logistics supportability requirements for combat systems and equipment. The guide uses the Integrated Logistics Support (ILS) elements as a tool to lead the development of system logistics supportability capabilities. The guide also includes other critical system attributes for Reliability, Availability, and Maintainability (RAM), Condition Based Maintenance, Network Centric Logistics, and Life Cycle Sustainment Metrics. Developing logistics supportability requirements within capability documents promotes Army goals for reducing total ownership cost and the logistics footprint; meeting operational and system readiness objectives at minimal life cycle costs; designing systems to personnel limitations and constraints; and improving logistics standardization and interoperability. While many organizations have a role in determining logistics supportability, the TRADOC capability development community is responsible for initially defining and documenting logistics supportability attributes within our warfighting systems.

Source Documents:

- CJCSM 3170.01C Operation of the Joint Capabilities Integration and Development System
- CJCSM 3170.01F Joint Capabilities Integration and Development System
- AR 700-127 Integrated Logistics Support
- DA Pam 700-56 Logistics Supportability Planning and Procedures in Army Acquisition
- AR 711-7 Supply Chain Management (SCM)
- AR 70-1 Army Acquisition Policy
- AR 25-1 Army Knowledge Management and Information Technology
- AR 750-1 Army Materiel Maintenance Policy

1. Logistics Supportability Assessment and Documentation. The ten ILS elements (Maintenance Planning; Manpower and Personnel; Supply Support; Support Equipment; Technical Data; Training and Training Support; Computer Resources Support; Facilities; Packaging, Handling, Storage and Transportability (PHST); and

Design Interface) serve as a baseline to develop and document logistics supportability requirements for the materiel system. As applicable, the capability developer shall address each element when developing the Capability Development Document (CDD) and the Capability Production Document (CPD). Documenting materiel system logistics supportability requirements early in the developmental process is essential to assure the system's associated support structure is communicated to the materiel developer. DA Pamphlet 700-56, Logistics Supportability Planning and Procedures in Army Acquisition, provides detailed information on system supportability planning and should be used as a companion reference. The supportability elements cited below serve as a guide for developing logistics supportability requirements. Following each supportability element is a sample paragraph that may be used within the CDD or CPD.

Since many new systems are initially supported by Contractor Logistics Support (CLS) or Interim Contractor Support (ICS), the sample paragraphs should be modified to reflect requirements for systems supported through CLS or ICS, military logistics structure or a hybrid support structure, such as combined CLS/ICS and military logistics support. The author also needs to make a distinction between CLS/ICS support requirements and military logistics support requirements especially when a transition will occur from CLS/ICS to military logistics.

Maintenance Planning: Maintenance planning is the process conducted to evolve and establish maintenance concepts and support requirements for the life of the system. It encompasses levels of repair, repair times, maintenance procedures/ techniques, support equipment needs, and contractor or government responsibilities. It defines the actions and support necessary to ensure that the system attains specified system readiness objectives with minimum Life Cycle Cost (LCC). Areas to be addressed include the maintenance concept, Level of Repair Analysis (LORA), Provisioning Plan, Supportability Test and Evaluation Program, Performance Based Logistics (PBL) or Performance Based Agreements (PBA) Requirements, and Contractor Logistics Support (CLS).

Example Maintenance Planning Paragraphs:

a. ***The maintenance concept: The maintenance concept for the "weapon system" Family of Vehicles (FoV) will be accordance with (IAW) policy outlined in AR 750-1. The system(s) will be supported by the Army's two level maintenance system, Field and Sustainment maintenance. Field level maintenance is primarily repair and return to user tasks that consist of on/near-system repair, replacement of components (primarily LRU and LRM), adjustment, alignment, service, and diagnose fault/failure. Those tasks may consist of: major assemblies repair [examples: splitting pack (Engine/Transmission/generator) and/or turbo, generator, injector/fuel pump, etc replacement]; LRUs may be repaired through the replacement/adjustment of subassemblies/components but is primarily replacement of Line Replaceable Modules (LRM). Sustainment maintenance consists of off-system repair and return-to-supply tasks: those tasks required to return components, subassemblies, and/or end item systems***

to a national standard. Maintenance will be accomplished in IAW the Standard Army Maintenance System. The maintenance plan will be developed by the "weapon system" Program Manager (PM).

When CLS or ICS is the initial source of system support, we recommend using the paragraph below for the capability document. When military logistics support will be used from the on-set of system fielding, there is no requirement for this paragraph.

b. ***Contractor Logistics Support (CLS) is the initial source of support for the "weapon system" FoV. Anticipate CLS will transition to military maintenance no later than _____ years after the First Unit Equipped Date (FUED). The PM will develop a transition plan as part of the system Supportability Strategy (SS). Planning for transition from CLS to organic support is essential to continuous sustainment of the fielded systems. The content of the transition plan must include:***

(1) Logistics functions included in the CLS.
(2) The length of time CLS will be required.
(3) Procedures for possible extension of the CLS.
(4) Funding requirements.
(5) Control structure for CLS.
(6) A checklist of actions to be completed before transition can take place.
(7) Milestone dates for major actions leading up to transition date.
(8) Tracking and reporting procedures for transition.
(9) Contract data on maintenance actions, repair parts consumption, and other data beneficial to establishing organic support.

c. ***Level of Repair Analysis (LORA): A LORA will be conducted as part of the Logistics Management Information (LMI) collection process. As part of the post deployment evaluation, the LORA will be rerun no earlier than 1 year and no later than 3 years from the First Unit Equipped (FUE) date using reliability data collected by material developers from fielded equipment. The LORA will be rerun every 5 years throughout the system's life cycle. Military Standard (MIL STD) Technical Manual (TM) Maintenance Allocation Charts (MAC) will be updated to reflect any changes in the LORA outcome. The PM will resource this effort throughout the system life cycle.***

d. ***Provisioning Plan. Contract performance specifications must include provisions to provide National Stock Number (NSN) data for spares to the Government. The PM will fully provision for and resource sufficient spares to ensure each unit fielded the "weapon system" maintains a ___% Operational Readiness (OR) rate (deployed or CONUS based).***

e. ***Supportability Test & Evaluation Program. All "weapon system" FoV will undergo a logistics demonstration to verify operator and***

maintenance tasks, capture projected annual maintenance man-hour data, and form the basis for developing the Basis of Issue Feeder Data (BOIPFD) and Manpower Requirements Criteria (MARC) data. Contractor validated and Government verified Technical Manuals (TM) produced IAW MIL STD 40051 are required for the logistics demonstration. These requirements will be identified within the system(s) Test and Evaluation Master Plan (TEMP).

Where Performance Based Logistics (PBL) (through the use of Performance Based Agreement (PBA)) is determined to be feasible by the PM as the Total Life Cycle System Manager(TLCSM), the capability developer will insert the paragraph below so system data collection is conducted to facilitate transition to military logistics support.

f. ***Performance Based Logistics (PBL) and Performance Based Agreements (PBA) Requirements. PBL is a system support strategy that delineates outcome performance goals of weapon systems, ensures that logistics support responsibilities are formally assigned, and provides metrics-based performance incentives for attaining these goals. The PBA is a signed agreement that details the performance goals and clearly assigns their responsibility for a particular weapon system according to its PBL strategy. The CLS or ICS contract must include provisions for maintenance data collection to include: maintenance performance data, maintenance task frequency for both field and sustainment level tasks, man-hour data for task performance duration, repair part usage, demand stockage, and all other repair part provisioning information. The contractor will use a Logistics Information Systems (LIS), formerly known as Standard Army Management Information Systems (STAMIS)) reporting format or a format that is readily convertible to the LIS. This information will be consolidated and reported to the Government Program/Product Manager(PM) on a monthly basis for the duration of the CLS or ICS contract. Logistics Demonstration data will be used in conjunction with the CLS collected field data to facilitate transition to military maintenance. All other PBL or PBA requirements and metric analysis will be developed and managed by the PM.***

Manpower and Personnel: Manpower and personnel include the identification and provisioning for military and civilian personnel with the skills and grade levels needed to operate, maintain, and support a system over its life in both peacetime and wartime. Materiel Developers typically do not acquire personnel. The materiel developer should, however, work with force management organizations to ensure that the proper positions are available within the required modified table of organization and equipment (MTOE) and tables of distribution and allowances (TDA) of the organization or recommend changes to the MTOE and TDA. Areas to be addressed are force structure implications, TDA or MTOE impacts, personnel required and available to operate, maintain, sustain, and provide training for the system, identification of current or the need for new MOS requirements, and Human Factors implications.

Example Manpower and Personnel Paragraphs:

a. ***Current vs. New Military MOS Requirements. No new operator or maintainer MOS requirements are anticipated/required for the "weapon system" FoV. Total required manpower to operate and maintain the "weapon system" will be reflected in the Manpower Estimate Report (MER) prepared for acquisition milestone approvals. Logistics Management Information (LMI) and the logistics demonstration will provide preliminary data to indicate if new or revised MOS requirements or additional Army Skill Identifiers (ASI) are needed. The PM will fully support and resource a focused Army Materiel Systems Analysis Activity (AMSAA) Sample Data Collection (SDC) program for the lifecycle of the program.***

b. ***Force Structure Implications: There are no anticipated changes to existing force structures as a result of "weapon system" fielding. Field performance and data collection will influence future decisions on the need for force structure changes prior to conversion to military maintenance.***

c. ***Table of Organization and Equipment (TO&E) /Modified TO&E (MTO&E) changes: All changes to TO&E or MTO&E tables of authorization as a result of "weapon system" system fielding will be documented IAW Army Regulation 71–32.***

d. ***Supply, Ammunition, POL Support Requirements: Use of existing supply support for these commodities is expected and preferred. Any unique or non-standard "weapon system" system requirements will be identified by the contractor.***

e. ***Human Factors Engineering. The contractor shall evaluate the initial vehicles provided to assess capability to maximize system and human performance and combat effectiveness, and identify any shortfalls and implement appropriate resolutions. The contractor shall utilize MIL-HDBK-46855 as a guide for managing the HFE program.***

Supply Support: Supply support is all the management actions, procedures, and techniques used to determine requirements to acquire, catalog, receive, store, transfer, issue and dispose of secondary items. This encompasses provisioning for initial support and all end-to-end replenishment supply support and supply pipeline plans and activities. Supply support must be distribution based rather than inventory based and proactive rather than reactive. Areas to be addressed are the level of supply support, supply support IAW Two Level Maintenance policy, initial requirements for CLS or ICS, identification of potential long lead-time items and vendor supplied items, and requirements for interservice supply support agreements or HNS agreements.

Example Supply Support Paragraph:

a. ***Supply Support: The "weapon system" FoV will be supported using the current logistics and maintenance structure established for Army equipment using the Army Two Level Maintenance System with repair parts available through the established supply system. As applicable, CLS will also be used to support the Authorized Stockage List (ASL) and field replenishment requirements until military standard supply levels are built. This is estimated to occur no later than the end of the first multi-year production contract. Parts data and demand history will be documented by the CLS program to ensure proper spare stockage and distribution plans are in place prior to transfer to military maintenance support.***

Support Equipment: Support equipment is all the management actions, procedures, and techniques used to determine requirements for and acquire the fixed and mobile equipment needed to support the operations and maintenance of a system. This includes materiel handling equipment (MHE); tools; test, measurement, and diagnostic equipment (TMDE); calibration equipment; prognostics/imbedded diagnostics; and automated test equipment (ATE). In addition, this element includes all plans and activities required to operate, maintain, and support all system support equipment.

Areas to be addressed or evaluated:

1. Procedures used to identify requirements for support equipment
2. Procedures for maximizing selection of standard tools, TMDE, support equipment and ASIOE, to include vehicles, generators, and trailers
3. TMDE requirements
4. Calibration requirements for the system and its support equipment
5. MHE/CHE requirements
6. Environmental and storage requirements needed for TMDE, ATE, and TPS
7. Recovery and Evacuation equipment requirements
8. Specialized or standard Shelters
9. Vehicle and / or Trailer requirements
10. Generator and Power Generation requirements
11. Standard or Unique Support requirements

12. Identify Commercial off the Shelf (COTS) or Government off the Shelf (GOTS) Applications

Example Support Equipment Paragraphs:

a. ***Test, Measurement, and Diagnostic Equipment (TMDE) Requirements: No new or unique TMDE support equipment at field or sustainment level of maintenance shall be introduced without coordination and approval by the PM for TMDE and the Combined Arms Support Command (CASCOM).***

b. ***Calibration requirements: All calibration requirements, procedures, schedules will be identified in operator and maintainer technical manuals.***

c. ***Materiel Handling Equipment (MHE) or Container Handling Equipment (CHE) requirements: MHE/CHE is not anticipated to employ the "weapon system" FoV. Operating and maintenance procedures requiring the use of MHE/CHE will be identified in the technical manuals.***

d. ***Specialized or Standard Shelters: All requirements for specialized or standard shelters must be reviewed as part of the transportability analysis. If applicable, additional analysis will be conducted by the PM for design interface requirements.***

e. ***Vehicle Recovery*** (When Applicable):

(1) Vehicle recovery will be conducted by vehicle to vehicle and by organic recovery equipment within the unit the "weapon system" system is assigned. Self-recovery with existing military standard tow-bar (of adequate capacity) is required. Each "weapon system" system will be equipped with front and rear trailer air couplings that controls brakes of existing military trailers and can connect to the braking system of towed vehicle in like-vehicle recovery scenarios. Specialized instructions/ procedures (e.g. identify transfer gear-case shift mode, specify pre-condition requirements, disconnect front or rear propeller shafts to preclude damage) will be identified in operating instructions.

(2) The "weapon system" systems will be flat tow and lift and tow capable using current military standard wreckers. The systems will undergo testing to validate flat and lift and tow capability (or mitigating circumstances for movement with one or more disabled wheel assemblies) and will include front and rear lift and tow testing. The appropriate operator, maintainer and recovery TMs will identify unique procedures and designate specified maximum speeds in both self-recovery and lift-tow scenarios.

(3) The "weapon system" may require an evacuation asset that is capable of up-righting, lifting, towing, and transporting a "weapon

system" system that has been catastrophically damaged or whose level of damage exceeds the recovery capability of current inventory wreckers or by "like vehicle recovery". The evacuation asset must meet the threshold or objective survivability Key Performance Parameter (KPP) requirements outlined in this document. This capability will provide "weapon system" operators and recovery Soldiers the ability to effectively and safely conduct evacuation operations when those requirements exceed capabilities currently authorized within the assigned unit.

g. ***Standard or Unique Support requirements (When Applicable). Specialized MHE required to perform maintenance tasks such as armor removal for planned or un-planned maintenance shall be provided by the OEM. Specialized MHE will be tested, safety certified and documented in technical manuals prior to fielding.***

<u>Technical Data</u>: Technical data are all the management actions, procedures, and techniques needed to determine requirements for and to acquire recorded system information, technical manuals and technical drawings associated with the system, its operation, maintenance, and support. Although computer programs and related software are not considered technical data, any documentation for computer programs and software support is considered technical data. Areas to be addressed include requirements for publications, evaluation criteria for validation and verification of publications, Technical Manuals (TM) for Operators and Maintainers, and provisions for the technical data package.

Example Technical Data Paragraphs:

a. ***Technical Manuals (TM). TMs for Operators and Maintainers will be produced to MIL STD and undergo a contractor validation and Government verification process to ensure accuracy and completeness. Electronic Technical Manuals (ETM) and Interactive Electronic Technical Manuals (IETM)shall be programmed for production. COTS digital manuals for operators and maintainers (used prior to the issuance of validated and verified MIL STD TMs), will undergo a Government verification review prior to issue. Operator, field and sustainment levels of maintenance will be called out in the Maintenance Allocation Chart (MAC) found in the Field and Sustainment Maintenance Technical Manuals (TMs).***

b. ***Technical Data Package: The technical data package for each "weapon system" variant will be procured by the Government to accommodate cost effective material change, configuration control, re-procurement, and parts commonality requirements.***

<u>Training and Training Support</u>: Training and training support consists of the processes, procedures, and techniques to identify requirements for and to acquire programs of instruction, training facilities, and training systems/devices needed to train/qualify military and civilian personnel to operate and maintain a system

proficiently. This includes institutional training, on-the-job training, new equipment training, sustainment training, and individual/crew training.

<u>Areas to be addressed or evaluated</u>:

1. Describe how training and training device requirements will be met and who is responsible for meeting those requirements
2. Identify long-term training facilities programming requirements
3. Identify institutional training requirements for operators and maintainers
4. Establish preliminary New Equipment Training (NET) Plan
5. Identify requirements for collective training
6. Identify requirements for Training Aids, Devices, Simulators and Simulations (TADSS)
7. Identify requirements/provisions for TADSS CLS

Example Training and Training Support Paragraphs:

a. ***"weapon system" FoV Training. Operator and maintainer training must be designed to support and sustain the required levels of training readiness for the "weapon system" crew by leveraging existing institutional and unit training profiles with the addition of tailored "weapon system" simulation, embedded and New Equipment Training (NET). Training will be assessed through exercises and operational assessments. Existing military training facilities will be modernized to reflect the "weapon system" unique characteristics and requirements. For new systems in which courseware does not exist, new courseware shall be provided in electronic format that is compliant with the latest version of the DOD Standard Content Object Reference Model (SCORM). Standard operating Services' training processes shall be followed to determine training requirements. These requirements along with the design solution shall be documented in Training Planning Process Methodology (TRPPM) or equivalent Joint Program Document as determined by Joint Services agreements. The training concept will employ a cost-effective solution consisting of blended capabilities using both dedicated and on-the-job training. Final determination of training requirements will be reflected in the TRPPM (or equivalent program document).***

b. ***Training Structure. All "weapon system" FoV-related training and task development shall be reflected in appropriate training plans and incorporated into the existing institutional and organizational training structures. Individual, unit and maintenance training support manuals, training literature, publications, and other training products will be reviewed and updated to reflect new technologies and operational requirements inherent in the "weapon system". It is expected that a complete training package to include the required quantity of training products in accordance with the TRADOC fielding plan, shall be available to support all phases of "weapon system" operational testing and New Equipment Training (NET).***

c. ***Training Support. All initiatives will be adequately planned, programmed, and resourced to ensure training capability is available to support system fielding. All unit training support manuals, training literature, publications, and other training products shall be developed concurrently with the "weapon system" FoV and be delivered in time for Operational Testing. A complete training package to include the required quantity of training products in accordance with the TRADOC fielding plan shall be available to support all phases of "weapon system" training.***

d. ***New Equipment Training (NET). NET is required during system fielding. NET shall be provided to receiving units at the time of, or prior to when each unit receives the "weapon system". The "weapon system" fielding plan will include a training package that resources all leader training, ammunition, range, logistical, and technical resources for each "weapon system" fielded. The NET program of instruction (POI) will be included in the TSP and be validated during train-up for the technical/operational evaluation window. The new equipment training team (NETT) will conduct initial training of individual and collective tasks. Unit personnel will receive training necessary in the skills and tasks required to accomplish the unit's mission. The NET will train the unit in operation and employment of the system, operator and unit maintenance, and operations. During NET, key personnel will also receive instruction and training to prepare them to execute, integrate, sequence, and apply the "weapon system" training resources in an effective and efficient manner to sustain a trained status within the unit. A complete Training Support Package (TSP) with all necessary training materials (POI, lesson plans, slides, handouts, practical exercises, examinations, CD-ROM, operator videotapes, etc.) will be left with the unit to use as a basis for sustainment training. The System Training Support Package should use Interactive Multimedia Instruction (Level III) (Objective), and be designed for multipurpose use in support of institutional training, new equipment training (NET), and unit sustainment training.***

e. ***Institutional Training (IT). Institutional training shall include all tasks related to safe operation and mission critical repairs to the "weapon system" FoV. It shall be part of all active and reserve operator and maintainer courses or provided as functional course(s). "weapon system" operation, capabilities and Doctrine, Tactics & Techniques (DTT) shall be provided to crew personnel with specific skill sets as identified by the operating Services. This training may be provided in-house, Web-delivered, or by contractor.***

f. ***Unit (Sustainment) Training. Unit sustainment training shall be conducted IAW operating Service's training strategies such as Army's Training and Evaluation Program (ARTEP) Mission Training Plan (MTP) and the Combined Arms Training Strategy (CATS). Units shall leverage "weapon system" Training Support Packages (TSP) and related materials***

provided through the Material Developer to conduct Sustainment training and maintain training readiness.

g. ***"weapon system" FoV Simulators. Full mission "weapon system" operator/maintainer simulators shall be provided to support operator/maintainer training at training sites and unit locations. These simulators will be a realistic replication of the "weapon system". This includes interior configurations, line of sight, and size requirements. The simulators shall include realistic interactive equipment and simulation features that replicate all of the essential functions of an actual "weapon system" including electrical and electronic control systems and BIT/BITE messages. The "weapon system" simulators shall be a state of the art blend of real and facsimile equipment that provides for realistic training of all functions and tasks required on a "weapon system".***

<u>Computer Resources Support</u>: Computer resources support consists of the management actions, procedures, and techniques used to determine requirements for and to acquire hardware, middleware, firmware, software, documentation and support supplies required to support and upgrade computer resources used in operation and maintenance of the system. This includes fixed and mobile facilities required for computer resources support.

<u>Areas to be addressed or evaluated</u>:

1. Computer Resources Management Plan
    a. Determining computer resource requirements for Operation and Maintenance
    b. Assess suitability of existing computer resources
    c. Comparison of existing computer resources to requirements stated in the requirements document/system specification
2. Identify Post production software support requirements

Example Computer Resources Support Paragraph: ***Computer Resources Software shall be compatible with existing tactical maintenance and diagnostic systems such as the Maintenance Service Device (MSD) and other similar devices in the Army inventory. This will reduce the need for procurement of new maintenance devices. At this time, it is envisioned that there will be no impact on computer resources.***

<u>Facilities</u>: Facilities are all the management actions, procedures, and techniques used to determine requirements for and to acquire the permanent and semi permanent real property assets needed to support operation, maintenance and storage of a system and its support equipment. This element includes new and modified facilities, special environmental conditions, and utilities required. Areas to be addressed are common or special facility requirements, adequacy of existing facilities, existing facility modifications, construction requirements and timeline, MCA funding requirements, and special security requirements for storage and use of classified end items, components, and manuals.

Example Facilities Paragraph: ***Existing maintenance facilities must be reviewed to determine their applicability to the "weapon system" maintenance concept. Pre-positioning of add on kits for the "weapon system" will be addressed along with environmental concerns stemming from long periods of storage. The PM will conduct an assessment of live fire training range requirements associated with the "weapon system" weapons payload (universal weapons mount or remote weapons station) to determine if the "weapon system" requires new or modified range capabilities.***

Packaging , Handling , Storage and Transportability: Packaging, handling, storage, and transportation (PHS&T) includes the resources, facilities, processes, procedures, design considerations, and methods needed to ensure that all system equipment and support items are preserved, packaged, stored, handled, and transported quickly, safely, and effectively.

Areas to be addressed or evaluated:

1. Describe any unique transportation and transportability responsibilities and requirements
2. Describe anticipated PHS&T modes and constraints
   a. Strategic
   b. Operational
   c. Tactical
3. Identify special care required during PHS&T such as removal of sensitive components or hazardous material requirements
4. Identify transportability test requirements
5. Other Special Handling Requirements
6. Blocking, Bracing and Tie-down Requirements
7. Specific requirements should be addressed as applicable: Land, Maritime, Air Transport, Parachute Drop (Airborne / SOF), Low Altitude Parachute Extraction System (LAPES), Shelf and Service Life, and hot/cold environments.

Example Packaging, Handling, Storage and Transportability Paragraphs:

a. ***Storage and Preservation: An Equipment Preservation Data Sheet will be developed for each vehicle configuration.***

b. ***Containerization Requirements: As applicable, the contractor shall identify the need for Long Life Reusable Containers (LLRC) and alternate reusable container(s) for each item requiring retrograde shipment. Under direction from the Government, the contractor shall submit a proposal to develop each LLRC. Each LLRC proposal shall include development cost, validation, estimate of life cycle cost, analysis of data from the Container Design Retrieval Service (CDRS), and the cost to develop a Technical Data Package (TDP). The Government shall evaluate each LLRC proposal. If***

approved, the contractor shall develop a new LLRC as directed by the Government.

c. ***Transportation Modes Analysis: The PM shall provide vehicle transport characteristic data to Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA). SDDCTEA will use the data to prepare updates to their modal transportability guidance pamphlets. The PM shall provide data on all "weapon system" variants and configurations, covering all shipment modes. Following the start of production, changes that affect system weight, center of gravity, size, or lifting and tie down, location or capacity, shall be identified using this same method and respective updates provided.***

d. ***Hazardous Materials Requirements: The contractor shall provide a Material Safety Data Sheet (MSDS) for each hazardous material item, without an NSN, procured under this contract. Content of MSDS shall be in accordance with Occupational Safety and Health Act (OSHA) 1910.1200(g) and annotated onto the contractor MSDS format.***

e. ***Other Special Handling Requirements: Packaging strategy for "weapon system" variants new and unique itemsis "best commercial practices".***

<u>Design Interface</u>: Design interface reflects the relationship of the various supportability parameters to other system design parameters. These parameters include human factors, system safety, energy management, standardization, interoperability, survivability, vulnerability, reliability, maintainability, environmental compliance, and affordability. Areas to be addressed include safety and health issues for use and maintenance, Built in Test (BIT) Built In Test Equipment (BITE) requirements, system diagnostics and prognostics requirements, and impacts from other supportability requirements.

Example Design Interface Paragraphs:

a. ***Safety & Health Issues for Use and Maintenance: The materiel developer shall develop and implement a Soldier Survivability program to ensure that all Soldier survivability concerns, including reducing system-induced detect ability, reducing fratricide, preventing attack, reducing potential threat-induced damage, reducing system induced soldier injury, and reducing system induced soldier fatigue, are met and verified by analyses, simulation, testing, and evaluation. The materiel developer shall develop and implement a safety program for the "weapon system" that is integrated with the concurrent engineering process used to develop, mature and support the system. The program shall address each variant/configuration within the family of "weapon systems" vehicles. The materiel developer shall use MIL-STD-882 in determining whether safety engineering objectives are met. As a minimum, the materiel developer shall do the following:***

(1) Identify hazards associated with the system by conducting safety analyses and hazard evaluations. Analyses shall include both operational and maintenance aspects of each variant/configuration within the "weapon system" FoVs/systems.

(2) Eliminate or reduce significant hazards by appropriate design or materiel selection. If hazards to personnel are not avoidable or eliminated, take steps to control or minimize those hazards.

b. ***Built in Test (BIT)/ Built In Test Equipment (BITE) Requirements: To the greatest extent possible and within rapid fielding constraints, the contractor shall embed and integrate BIT / BITE / diagnostic capability and make available on the common data / information interchange network. Maintenance concepts shall include optimum use of accurate on-board diagnostic capability to include BIT or BITE. The BIT / BITE / diagnostic capability shall apply to all electronic, electro-optic, electro-mechanical, electro-hydraulic, and electro-pneumatic systems as applicable. The contractor shall fully document and support embedded systems and software. The software shall not contain proprietary restrictions. The DA Test, Measurement and Diagnostic Equipment (TMDE) Preferred Items List (PIL) will be used as the preferred acquisition guideline for procurement or reprocurement of Army TMDE. The TMDE PIL objectives and policy are defined in AR 750-43. The level of BIT / BITE / diagnostic capability shall be IAW the "weapon system" specifications and strive to achieve 99% accuracy.***

c. ***Standardization and Interoperability (S&I). The "weapon system" FOV/systems will provide configuration updates to meet new mission and safety requirements and will incorporate design improvements found necessary during operation. All affected parts will be reviewed for S&I impact.***

2. <u>Condition Based Maintenance Plus (CBM+):</u> The Combat Developer must determine whether CBM+ is a required capability for the system or platform. Example text is provided below in subparagraphs e and f.

a. The intent of Army CBM program, using CBM+ enablers, is to reduce maintenance down time, increase operational readiness, and reduce life-cycle operating costs. AR 750-1 defines CBM+ as a set of maintenance processes and capabilities derived primarily from real-time assessment of the weapon system condition obtained from embedded sensors, external tests, and measurements using portable equipment.

b. The intent of incorporating CBM+ into materiel systems is to project the condition of the components and use this data to determine the cumulative effect on the availability of the overall end item.

c. The decision to employ CBM+ on a weapons system starts with understanding the application of Reliability Centered Maintenance (RCM). According to the DoD Instruction (DoDI 4151.22), RCM is a logical, structured process used to determine the optimal failure management strategies for any system based on system reliability characteristics and the intended operating context. RCM defines what must be done to a system to achieve the desired levels of safety, reliability, environmental soundness, and operational readiness, at best cost. RCM is to be applied continuously throughout the life cycle of any system.

d. CBM Tasks. Tasks derived from RCM methodology to monitor operating equipment to identify impending failure are called condition monitoring tasks. When those tasks are automated, using sensors in and on the platform, to detect the signals of an impending out of tolerance condition that will lead to failure, the result is called CBM. When this process is aided by technology, it is called CBM+. Through CBM+, data is collected from the weapons system, end item, component, etc. and diagnostic algorithms (based on fleet operating history and environmental factors) are applied to assess the status and prompt the maintenance process to start proactive intervention to halt the impact of a failure cycle.

Areas to be addressed or evaluated:

1. Platform hardware and software requirements.
2. Platform interfaces to include command and control (C2) requirements.
3. Analysis and decision support requirements.
4. Maintenance management information system requirements.
5. Data warehouse requirements.
6. System health management in a common logistics operating environment for weapon system platforms
7. Human factors in the ability to use the automated outputs of CBM+ e.g. man-machine interface, complexity of the graphical user interfaces (GUI) etc.

e. CBM+ is a "net-centric" maintenance concept. It supports net-centric warfare concepts by enabling near real-time visibility of platform operating status and improving mission reliability. CBM+ relies on the movement of platform data to the right places through built-in standard business processes. An expanded Net Ready Key Performance Parameter (KPP) is required to enable the platform to operate in the common logistics operating environment (CLOE) of the enterprise. Machinery Information Management Open Systems Alliance (MIMOSA) is the approved standard for the migration of CBM+ data from the platform to the Logistics Information Warehouse. An expanded narrative for the Net-Ready KPP portion of CDD and CPD that must be included for CBM+ is stated below:

"A CBM+ compliant platform must monitor it's health and self-diagnose to preclude system deterioration. It must also be able to automatically produce, consume, exchange, and propagate sustainment-focused information in near real-time using the existing/emerging military logistics and C2 information and communications systems available at fielding. The platform must provide tactical commanders with a current/near real-time, accurate, and complete picture of its combat power. At the same time,

information must flow to the logistics providers so they can proactively plan and execute complementary actions to sustain the combat power levels required by the commander. A CBM+ compliant platform must integrate with the Army Integrated Logistics Architecture (AILA)." The AILA is described in paragraph 2g below. The Army repository of the AILA is at the CASCOM web site: **http://www.cascom.army.mil/esd/lac/lac.htm**.

f. In addition to the Net-Ready KPP portion of the CDD or CPD, each document should address the integration of Net-Centric Logistics. Below are example paragraphs that will enable Net-Centric Logistics and CBM+ for the proposed materiel system:

(1) ***Net-Centric Logistics: The "weapon system platform" shall be capable of supporting net-centric logistics in a common logistics operating environment. The "weapon system platform" shall be designed and developed in accordance with the Joint Technical Architecture – Army (JTA-A)[1] and the AILA to fully support net-centric logistics and operate in a common logistics operating environment. The Machinery Information Management Open Systems Alliance (MIMOSA) is the approved standard for the migration of CBM+ data from the platform to the Logistics Information Warehouse.***

(2) ***Condition Based Maintenance Plus (CBM+): CBM+ capabilities will be designed and incorporated into the "weapon system platform" to support a net-centric common logistics operating environment. Threshold (T) CBM+ capabilities will use embedded diagnostics and prognostics to provide a sensor-based, self-monitoring, self-reporting, both on and off, platform. Objective (O) CBM+ capabilities will provide a fully sensor-based, self-monitoring, self-reporting, both on and off, platform. The "weapon system platform" will make full use of embedded diagnostics and prognostics and will be fully capable of platform self-diagnostics for system health management in a common logistics operating environment.***

g. The Army's logistics architecture is known as the AILA. Information on the AILA and how it fits within the CLOE can be obtained at the web site (https://lss.lta.army.mil/ako_pwd/ml/cloe/Architectures.htm). The AILA is an integrated, capabilities-based architecture that supports the Army G-4's Warfighter Mission Areas and Business Mission Areas. The AILA is compliant with the Department of Defense Architecture Framework (DODAF) and focuses on current and future concepts, their associated concepts of operations (CONOPS), Service Concepts, Army doctrine and transformation of the total force versus a force structure or system focused development. The architecture is composed of: Operational Views (OV's) validated by TRADOC, Tehnical Standards Views (TVs) published by HQDA, CIO/G-6 in DISRonline (DoD Information Technology Standards Registry Online),

[1] As defined in AR 25-1, 15 JUL 05, the JTA-A is a complete set of rules derived from the Joint Technical Architecture (JTA) that prescribe standards for Army information technology systems and enable interoperability among joint systems.

and ASA (ALT) approved Systems and Services Views (SVs). The AILA supports Army modularity, execution of the Joint Capabilities Integration and Development System (JCIDS) process, portfolio management, capability and gap/need analysis, standards identification, and DOTMLPF analysis. The AILA provides the framework for implementing net-centric warfare principles in the logistics domain.

(To access the AILA website - AKO log-in required http://www.cascom.army.mil/esd/lac/lac.htm then click on "Validated AILA 1.3, choose and click on the desired views: AV-1, OV-1, OV-4, OV-5, and/or OV-6c etc. Systems and Technical views are available at the AILA web site.)

3. Common Logistics Operating Environment (CLOE): The Common Logistics Operating Environment sets common data standards, specifications, and protocols necessary for an integrated platform, information, and command, control and communications (C3) technologies for use in the Objective Force logistics sustainment. It fuses information, logistics processes and platform/Soldier embedded sensor-based technologies to support the tactical, operational and strategic sustainment levels in a joint operating environment. The CLOE initiative aims to synchronize logistics concepts, organizations, and processes, as well as the latest generation of technologies, into a single operational and technical architecture for the force structure of the future. The CLOE is fully described within the "PM and Logistician's Guide to the Net-centric CLOE" at the LIA web site: https://lss.lta.army.mil/ako_pwd/ml/cloe/splash.htm.

The "weapon system platform" platform must be sustained in a Net-Centric military common logistics operating environment (CLOE). The platform must provide tactical commanders with a current/near real-time, accurate, and complete picture of combat power and it must provide the logistics providers with timely, accurate, and complete information they need to plan and execute logistic support operations. The platform must be capable of self-diagnosing system health and sustainment needs and interacting with a networked sustainment infrastructure. The platform must be able to automatically produce, consume, and propagate sustainment-focused data in near-real time from "Foxhole to Factory" using existing and/or emerging military logistics and command and control (C2) information systems available at fielding. The platform's logistics architecture must comply with the Army Integrated Logistics Architecture. Embedded diagnostics and prognostics employed on the platform must interface with the system's battle command system and provide the information needed to auto-populate the Logistics Situation Report (LOGSITREP), Call for Support, and other messages. The embedded diagnostics, prognostics and equipment / system health management and TMDE employed on the platform must provide accurate fault diagnosis for component replacement. (Threshold)

The "weapon system platform" platform must be sustained fully in a Net-Centric military common logistics operating environment (CLOE). The platform must fully provide tactical commanders with a current/near real-

time, accurate, and complete picture of combat power and it must fully provide the logistics providers with timely, accurate, and complete information they need to plan and execute logistic support operations. The platform must be capable of fully self-diagnosing system health and sustainment needs and interacting with a networked sustainment infrastructure. The platform must be able to fully and automatically produce, consume, and propagate sustainment-focused data in near-real time from "Foxhole to factory" using existing and/or emerging military logistics and C2 information systems available at fielding. The platform's logistics architecture must fully comply with the Army Integrated Logistics Architecture. Embedded diagnostics and prognostics employed on the platform must fully interface with the system's battle command system and provide the information needed to auto-populate the LOGSITREP, Call for Support, and other messages. The embedded diagnostics, prognostics and equipment / system health management and TMDE employed on the platform must provide accurate first time fault diagnosis for component replacement. (Objective)

The critical elements of information to be sent off the platform include:

Overall Platform Status (operational status)
- ***Equipment health status***
- ***Mission-critical faults (requiring immediate attention)***
- ***Predicted faults expected to occur within current mission time horizon***
- ***Other faults requiring attention at next logistics event***

Consumption Status
- ***Fuel Status***
- ***Platform Ammunition Inventory (by type of round (armor piercing, high explosive, etc))***
- ***Equipment Health***
  - ***System Status***
  - ***Critical Faults***
  - ***Predicted Faults***

Inventory of other consumables (rations, water, etc)
- ***Rations***
- ***Water***

Crew Status

Diagnostic Status
- ***Actual***
- ***Predicted***

Rationale: Net-Ready KPP (NR-KPP) is required by CJCSM 6212.01D, 8 March 2006. As part of the NR-KPP, the system's platform must be capable of providing tactical commanders with a current/near real-time,

accurate, and complete picture of combat power and provide logistics providers with timely, accurate, and complete information they need to plan and execute logistic support operations. The platform must be capable of self-diagnosing system health and sustainment needs and interacting with a networked sustainment infrastructure. Designing the system's platform to be sustained in a Net-Centric military common logistics operating environment (CLOE) supports the DOD and Army military supply chain integration and management process and enables the DOD logistics system to provide focused logistics support to the field. Use of embedded sensors to conduct diagnostics and/or prognostics enables condition based maintenance plus (CBM+).

4. Life Cycle Sustainment (LCS) Metrics: In July 2006, the Joint Requirements Oversight Council (JROC) established a mandatory warfighter Materiel Availability Key Performance Parameter (KPP) and further identified Materiel Reliability and Ownership Cost as Key System Attributes (KSA) and an additional metric for Mean Down Time for all Acquisition Category (ACAT) I acquisition programs, select ACAT II, as well as all major legacy programs currently included in the Defense Readiness Reporting System (DRRS). A March 10 2007 DUSD (L&MR) policy memorandum, SAB, further defined and clarified the four LCS Metrics (the sustainment KPP and KSAs) to include reporting requirements and the need for PMOs to also address fourteen (14) LCS 'Enablers' (see paragraph 5 – Life Cycle Sustainment Outcomes Memo). Goals for materiel readiness outcomes should be established early in the concept decision process, refined throughout the design development phase, and then carried through as program baseline goals until system retirement. These requirements were integrated into the Chairman of the Joint Chiefs of Staff Manual (CJCSM) 3170.01C/F in May 2007. All CDDs and CPDs meeting the aforementioned criteria will be evaluated using the Life Cycle Sustainment Metrics criteria as part of the overall system supportability assessment. For guidance on documents that were approved under the previous versions of this CJCSI 3170.01, refer to enclosure B of CJCSI 3170.01F (Joint Capabilities Integration And Development System), 1 May 07. This publication will be electronically updated to reflect emerging guidance on sustainment metrics to include the sustainment KPP and the associated KSAs along with the LCS Enablers.

5. Reliability, Availability, and Maintainability (RAM): Capabilities Documents must articulate requirements that are operational, measurable and achievable. These requirements include descriptions for key equipment performance criteria such as system reliability, maintainability, and supportability that directly correlate to a system's logistics footprint, enhance combat operations, and reduce total ownership cost. The "Procedural Guide For Development Of Operationally Based Reliability, Availability, and Maintainability Requirements" provides a process for the TRADOC RAM engineer to develop and specify RAM requirements in operational metrics that focus on unit mission success and the full spectrum of logistics support. Capability developers should coordinate with TRADOC RAM engineers for assistance on the development of system RAM characteristics. A copy of the Procedural Guide is attached to the electronic copy of this guidance. The Life Cycle Sustainment Metrics policy cited above will effect how we develop system RAM characteristics. As

additional guidance evolves, this publication will be electronically updated with specific guidance on system RAM development.

Example RAM Paragraphs:

a. ***Materiel Availability Key Performance Parameter (KPP). The Material Availability [expressed in terms of Operational Availability (Ao)] the "weapon system" shall achieve is an Operational Availability (Ao) of 95% (T) and 98% (O) (measured at battalion level with an average Administrative and Logistics Downtime (ALDT) of 40 hours for all failures). Rationale: The "weapon system" characteristics allow it to assimilate into maneuver and support brigades, operate over greater distances, and enable increased tactical dispersion thereby enhancing a brigade's ability to conduct rapid offensive maneuver. These tactical and operational distances demand superior reliability & availability which enhance force protection and survivability as well as reducing demands for supplies and personnel. Supporting enablers include component commonality, embedded diagnostic & prognostic systems, and rapid component replacement.***

Determining Operational Availability (Ao) - The percentage of time the "weapon system" is available for combat/missions, measured continuously against the total available time of each 72 hour mission. Ao applies to System Aborts only and is expressed as:

Ao = (Total time - Downtime)/Total Time or = [(N x T) – DT]/(N x T)

Where:
N = number of a system variants within a Battalion
T = time can be constrained as that time across each mission or measured across an operation with multiple missions; in this case as a KPP, time is time across a mission pulse.
DT = total unscheduled downtime for System Aborts across that number of variants

b. ***Materiel Reliability. The "weapon system" shall achieve a Mean Miles Between System Abort (MMBSA) of 6170 miles (T) 11,700 miles (O). MMBSA is platform specific and does not include Government Furnished Equipment (GFE). Increment II (2016) Threshold is 11700, and Objective is 15150 MMBSA. Rationale: Reliability is the probability that the "weapon system" will perform its intended mission functions under stated conditions for a specified period of time or distance. The "weapon system" must be able to operate at extended ranges, for long periods of time without mission failure. Given the changing global environment and the prolonged operations within which the joint force is engaged, reliability is as much a driver of survivability as it is sustainment and lifecycle cost.***

For this Key System Attribute (KSA) an "operational mission failure" is defined as a critical failure event rendering a system incapable of continuing its mission, thereby deadlining the system and requiring immediate (maintenance) action to return the system to an operational status. Increment II levels support logistics footprint reductions as well as operations and support cost goals.

c. ***Maintainability (Field Level). The "weapon system" shall have a Field Level Maintenance Ratio of 0.005 (T) 0.0036 (O) maintenance man-hours per operating mile (MMH/OM). The maintenance ratio includes scheduled, preventive, unscheduled and condition based maintenance. Rationale: The "weapon system" must be easily maintained and able to be repaired in a timely manner with minimal crew or maintenance personnel. The "weapon system" should have the ability to be retained in, or restored to, a specified condition when maintenance is performed by personnel having specified skill levels IAW with the 2-level maintenance system. Field Level Maintenance is defined as repair and return to user tasks that are normally performed on or near the platform.***

The maintenance ratio has a direct correlation to a unit's maintenance footprint.

d. ***Maintenance Ratio: The maintenance man-hour burden per operating mile of the "weapon system" is a system reliability and maintainability efficiency metric. Maintenance Ratio calculations include the following: (1) Preventive Maintenance Checks (other than automated checks executed as part of the systems health monitor system); (2) lubrication; (3) cleaning; (4) alignment/adjustment/repair of sub assemblies; (5) diagnostics and fault isolation (6) remove and replace tasks for Line Replaceable Units (LRU), Line Replaceable Modules (LRM) and components/assemblies; (7) Verification of corrective action; (8) installation of kits; and (9) the time expended referencing supporting technical publications to complete identified tasks.***

e. ***Maintainability (Sustainment Level): The "weapon system" shall achieve a Sustainment Level Maintenance Ratio of <0.0010 (T) <0.0009 (O) maintenance man-hours per operating mile (MMH/OM). Rationale: Sustainment maintenance is characterized as repair and return to the supply system. The focus is on repairing components, assemblies, modules and end items in support of the supply system at echelons above the brigade. The intent is to perform commodity-oriented repairs on supported items returning them to a national standard thus providing consistent and measurable levels of reliability. This attribute, when compared to current systems, ensures that the sustainment footprint (which includes depot repair) is not increased by the "weapon system" when fielded.***

It is an expectation that the sustainment/depot logistic footprint will naturally be decreased as a result of higher component reliability. The Sustainment MR normally is a calculation based on industry best practices on like/similar items.

f. ***Platform Re-Generation (PRG): Rapid repair of the "weapon system" at field level is critical to increasing unit effectiveness by quickly returning equipment to fully mission capable status. The ease of maintenance reduces complexity of tasks thereby enhancing enduring reliability and increasing operational availability. To achieve this "pit stop" capability the "weapon system" shall achieve a Mean Time to Repair (MTTR) of 0.5 hrs (T) and <0.5 hrs (O) hrs for all field level repairs/tasks. Rationale: Reduces maintenance force structure, achieves ease of maintenance through critical design considerations and supports the "platforms" overarching maintainability and availability requirements. MTTR is measured as "hood up to hood down" repair time which includes isolation of failure, time spent referencing technical manuals, repair / remove & replace as well as verification. MTTR is measured in clock-hours for two Soldier's simultaneous efforts.***

g. ***Platform Re-Generation - Maximum (PRG-M): To enhance operator and maintainer effectiveness and provide reasonable allocation of maintenance the "weapon system" shall achieve a Maximum Time To Repair (MaxTTR) for an operator of 0.5 hrs (T) and <0.5 hrs (O) and a MaxTTR for the mechanic of 2.5 hrs (T) and 1.5 hrs (O). Rationale: Unit Maintenance Collection Points and similar activities are relics of cold war philosophy that are unnecessary force protection risks which rapidly inhibit the momentum of a unit. The MaxTTR optimizes the operator without adversely effecting mission, training or creating unreasonable expectations of the operator. It ensures that complex tasks are designed is such a manner as to allow quick in-stride/fix-forward repairs for both the operator and mechanic. It reduces maintenance force structure, achieves ease of maintenance through critical design considerations and supports the "platforms" overarching maintainability and availability requirements. Additionally it provides an achievable governor on time spent completing major platform repairs (i.e. engine, transmission, axle***

replacements) by mechanics. MaxTTR is measured as "hood up to hood down" repair time which includes isolation of failure, time spent referencing technical manuals, repair / remove & replace as well as verification. MTTR is measured in clock-hours for two Soldier's simultaneous efforts.

6. Staffing Requirement: System proponent capability developers will staff the system CDD and CPD to the ILS Division, Materiel Systems Directorate (MSD), Combined Arms Support Command (CASCOM) during initial worldwide staffing, prior to submitting the documents for ARCIC validation. The email address is leeecascomfuturesmsd@conus.army.mil.

7. Where to go for system logistics supportability and ILS assistance: The ILS Division, MSD, CASCOM is a capability development activity solely dedicated to system supportability assessment and analysis. The ILS Division will assist the proponent system combat developer on this assessment and should be part of the proponent's ICDT, IPT, and supportability IPT. The ILS Division can be reached by emailing requests for information or assistance to leeecascomfuturesmsd@conus.army.mil.

RAM

Procedural

Guide

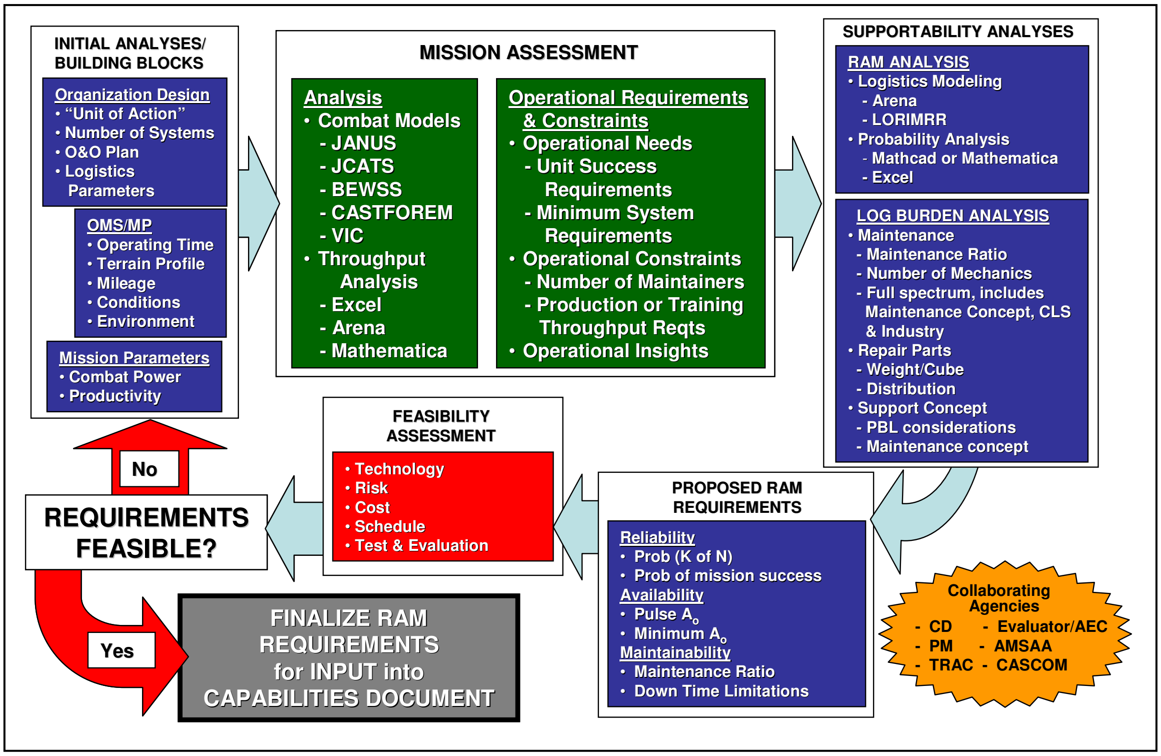
PROCEDURAL GUIDE
FOR DEVELOPMENT OF OPERATIONALLY BASED
RELIABILITY, AVAILABILITY, AND MAINTAINABILITY
REQUIREMENTS

1. Capabilities Documents (Initial Capabilities Documents (ICD), Capability Development Document (CDD), Capability Production Document (CPD)) articulate operational requirements that are operational, measurable and achievable. These requirements include descriptions for key equipment performance criteria such as system reliability, maintainability, and supportability that directly correlate to a system's logistics footprint, enhance combat operations, and reduce total ownership cost. This guide provides a process for the TRADOC Reliability, Availability, and Maintainability (RAM) Engineer to develop and specify RAM requirements in operational metrics that focus on unit mission success and the full spectrum of logistics support.

2. In the past, reliability requirements were stated as probability statements (e.g., 90% probability that a system completes a mission or specified time period without a System Abort) or as Mean Time, Miles, or Rounds Between System Abort or Essential Function Failure. Maintainability requirements were generally stated as Mean Time to Repair (MTTR), Maintenance Ratio (MR) of "X.XX" Maintenance Man-Hours/Operating Hour (MMH/OH), and/or Maximum Time To Repair (MaxTTR). Mean Times, Rounds, Hours Between Failure are no longer acceptable terms for expressing operational reliability requirements and MTTR is no longer an acceptable term for expressing operational maintainability requirements because they are not operationally based terms. Instead these terms are test metrics corresponding to conditions which may or may not be reflective of the operational conditions. This procedural guide provides a process by which RAM may be presented in operational terms based on mission and logistics constraints. The development of test metrics specifically tailored to the system design will be preformed in support of other acquisition documentation. MR and MaxTTR are viable terms provided they focus on operationally based maintenance constraints, force design limitations, or concepts of operation.

3. The TRADOC RAM Engineers, in support of the system proponent will, as part of the capabilities development process, develop operationally focused RAM requirements. The RAM requirements will be analytically based and address the full spectrum of attributes that impact mission success and logistics effectiveness (e.g., reliability, maintainability, maintenance force structure, employment concepts, re-supply distribution, etc.). A thorough analysis should identify the attributes that will drive unit mission success and logistics support reductions as well as provide operationally based analytical underpinning for RAM requirements. The Development Process that will be employed to develop operationally based RAM requirements that reflect the operational concept for the proposed system follows:

RAM Requirements Development Process



This process encompasses five major stages as depicted in the figure above. The Initial Analysis/Building Blocks provide the foundation for RAM requirements generation. It defines the unit and mission to be accomplished, measures/criteria for unit mission success and the conditions to which the system will be exposed when employed by the unit. The Mission Assessment determines the potential operational system requirements necessary for the unit to achieve mission success based on combat modeling, production/throughput simulation, or other analysis. The Supportability Analyses determine the appropriate operational RAM requirements that will satisfy combat mission requirements, logistics constraints, and/or operational concepts based on usage rates from the OMS/MP, envisioned force design and support concepts. The Proposed RAM Requirements provide the benchmarks that will be collaboratively evaluated for feasibility. The Feasibility Assessment evaluates the proposed RAM requirements with respect to technical achievability, testability, and risk given the program's cost and schedule constraints. These five stages will culminate in RAM Requirements that will be included in Capabilities Documents. Subsequent paragraphs will address each specific stage contained in this process.

a. **Initial Analyses/Building Blocks**. RAM requirements must focus on successfully meeting combat mission requirements, logistics constraints, and/or operational concepts at both the unit and system level. These requirements must be founded in the early RAM analyses and should be derived based on the following building blocks:

- Unit force design(s) (number of systems, maintenance personnel allocations, logistics support structure, etc.)
- Operational concepts
- Emerging or existing support structure and concepts

- TRADOC approved scenarios
- Proponent-developed wartime and/or peacetime usage rates outlined in the Operational Mode Summary/Mission Profile (OMS/MP)
- Unit mission success parameters.

Determination of potential RAM requirements must be operationally based and satisfy the proponent's needs based on the concept of operations, envisioned support concept, and threat environment. Furthermore, system proponents must identify mission and logistics constraints/goals that must be met to successfully accomplishment the unit's mission or the system's operational requirement. Mission effectiveness and logistics footprint constraints/goals may be generated from a number of sources to include results of war-gaming models/simulations, previous studies, logistics initiatives, spare parts cube/weight limitations, distribution constraints, changes in maintenance concepts, Performance Based Logistics (PBL) initiatives, or maintenance force structure limitations. Examples of typical mission effectiveness constraints/goals include but are not limited to the following:

- The ratio of number of enemy systems killed to the number of friendly systems lost
- The percentage of systems killed in a opposing force during a prescribed mission pulse
- For productivity type systems, the number of units of output that must be accomplished during a specified period of time
- For training systems, the number of students or personnel throughput required over a specified period of time.

Proponent mission requirements and logistics constraints/goals should be addressed to underpin the RAM requirements. These constraints identify threshold capabilities necessary to achieve mission success in the eyes of the proponent while focusing RAM threshold requirements on critical operational parameters.

b. **Mission Assessment**. This assessment addresses the specific mission requirements the system/equipment needs to accomplish during the unit's assigned mission or mission sets. It further defines the operational parameters the system/equipment must achieve for the unit to successfully accomplish its assigned mission(s). The RAM Requirements Development Process must be supported by operational analysis that presents a solid case that RAM characteristics are contributors to the system's ability to meet operational mission requirements, full spectrum logistics constraints (small unit, Modular Brigade, Division, Corps, Contractor Logistics Support (CLS), and/or industry levels), planned support concepts, and operational concepts. This process starts with mission modeling, simulation, and/or analysis (Excel, MathCad, Arena, or other analytical tools) that help identify minimum levels of acceptable performance at the unit or system level. For combat systems, this may require output or insights from combat models or simulation. For production or training systems, this may require insights from throughput modeling or analyses. Typical models used in combat gaming or force-on-force operations include but are not limited to:

- Janus
- Joint Conflict and Tactical Simulation (JCATS)
- Combined Arms and Support Task Force Evaluation Model (CASTFOREM)
- Vector In Commander (VIC)
- One Semi Automated Force (OneSAF)

Annex A provides a brief description and Point of Contact (POC) for models and analytical tools. These models are used by TRADOC Analysis Center (TRAC), the TRADOC RAM Engineers supporting the proponent schools and centers, and AMSAA to evaluate proposed combat systems using Human-In-The-Loop (HITL) or "closed form" force-on-force simulation. Output or insights from these models may help focus on the minimum number of systems required to conduct or continue combat operations given the theater and threat portrayed in the TRADOC approved scenario.

Similarly, for systems that are not combat oriented (production or training systems), the TRADOC RAM Engineer may conduct analysis using Excel, MathCad, Arena, or other analytical tools to determine the minimum number of systems/equipment items necessary to meet operational or training demands given specified periods of operation outlined in the OMS/MP. Throughput analysis may be based on number of personnel that need to be trained in a specified period of time (daily, monthly, or annually) or the required number of product units to be processed in a given time period (e.g., gallons of water purified per day, gallons of fuel pumped per hour, number of meals served per week, number of items washed in 24 hours, or number of tons handled per 12 hour shift). These demands focus the RAM requirements on critical operational requirements that must be accomplished to insure mission success.

These analyses form the foundation of the Mission Assessment and establish critical operational parameters necessary for mission success. The critical operational parameters also help determine the system's essential functions that are described in the Failure Definition and Scoring Criteria (FDSC) and used to evaluate RAM requirements during testing. These critical operational parameters provide the underpinning for operational RAM requirements that will be developed and evaluated in the Supportability Analyses.

c. **Supportability Analyses**. Supportability analyses determine the appropriate operational RAM requirements that meet combat mission requirements, logistics constraints, and/or operational concepts based on usage rates from the OMS/MP, force designs, and envisioned support concepts. The Supportability Analyses consists of two distinct analytical processes (RAM and Logistics Burden Analyses). These analyses may be conducted sequentially or concurrently depending on the complexity of the system under evaluation. Furthermore, the process may be iterative in nature as multiple solutions could be derived forcing the analyst to determine the optimal solution set. Each of the blocks under Supportability Analyses are addressed individually.

1) RAM Analysis. The RAM Analysis examines the traditional triad of reliability, availability, and maintainability attributes that would be necessary to meet the operational demands placed on the proposed system given the envisioned force design. For example, the proponent requires 5 out of 6 systems to remain operational throughout a mission pulse. The RAM Analysis would examine what level of reliability and availability would be required to consistently maintain a minimum of 5 systems in an operational status during the mission pulse. An alternative would be to determine the probability that a single system would have to operate without a critical failure in order for 5 of 6 to have an "acceptable" probability of operating without a critical failure during the mission pulse (assuming maintenance was not permitted until

the end of the mission pulse). To determine appropriate RAM metrics, the following modeling, simulation, and analytical tools may be employed:

- Logistical/Operational Readiness Impacts of Maintainability and Reliability (LORIMRR) to assess number of systems operational during a mission pulse based on operational usage rates and various logistics constraints (maintainers, spares, repair time, etc.)
- Stochastic simulation (e.g., ARENA) to evaluate the impact of system reliability on production throughput, maintenance demands, and/or logistics footprint
- Analytical software tools (e.g., Excel, Mathcad, or Mathematica) to evaluate probability of completing a mission without a critical failure for one or multiple systems.

Applying these simulation and analytical tools may lead to multiple sets of acceptable results. Sensitivity analyses should be incorporated into the overall analysis to fully comprehend the operational impacts that RAM may have on parameters that determine mission success. Sensitivity analysis should provide the threshold that produces the optimal level necessary to meet operational mission requirements, logistics footprint reductions, maintenance constraints, and/or other operational concepts. Simulation models/tools employed during RAM requirements development should also be made available for use during post-test evaluation by ATEC. Annex B provides a POC listing of Futures Center's RAM Engineers that provide the expertise to conduct RAM analysis.

2) <u>Logistics Burden Analysis</u>. RAM requirements must also be evaluated with respect to the full spectrum logistics burden. This includes evaluation of proposed maintenance assets necessary to conduct all scheduled and unscheduled maintenance; availability of spare parts based on force design constraints for Class IX hauling capacity, on-board sparing provisions, distribution methods to transport spares to failed vehicles, and time delays for delivering parts; recovery assets (if required); crew repair capabilities; daily productive man-hours for maintainers; and/or life cycle costs of spares. To accomplish this type of analysis, it is critical to collaborate with CASCOM to fully understand the logistics concept envisioned for the system (e.g., Contractor Logistics Support (CLS), Performance Based Logistics (PBL) considerations, and organic support requirements) and AMSAA to capitalize on analysis conducted to evaluate Class IX spare parts weight, cube, and cost. The following modeling, simulation, and analytical tools should be employed to evaluate logistics impacts:

- Logistical/Operational Readiness Impacts of Maintainability and Reliability (LORIMRR) to assess maintainer assets, Administrative and Logistics Delay Times (ALDT), and reliability estimates based on operational usage rates
- Stochastic simulation (e.g., ARENA) to evaluate the impact of system reliability and availability on production throughput, maintenance demands, operational tempo, and/or logistics footprint constraints
- Analytical software tools (e.g., Excel, Mathcad, or Mathematica) to evaluate maintainer workload
- AMSAA models such as Optimum Stock Requirements Analysis Program (OSRAP) and SESAME Life Cycle Costs (SESLCC) to estimate weight, cube, and costs for anticipated Class IX parts.

The results of the logistics impact analysis may require an adjustment to the proposed RAM requirements metrics or highlight the need for another RAM metric to fully address the proponent's operational demands. Once again, applying these simulation and analytical tools may lead to multiple sets of acceptable results. Sensitivity analyses should be incorporated into the overall analysis to fully comprehend the impacts that RAM requirements may have on full spectrum logistics considerations. Sensitivity analysis should provide the threshold that produces the optimal level necessary to meet operational mission requirements, logistics footprint considerations, maintenance constraints, and/or other operational factors.

d. **Proposed RAM Requirements.** The completion of the Supportability Analyses coupled with the Mission Assessment should provide a set of proposed RAM requirements that meet mission needs, address logistics constraints, and satisfy operational demands. These requirements must be expressed in operational terms to align with other requirements stated in Capabilities Documents. Examples of operationally focused RAM requirements include, but are not limited to, the following:

- K of N systems must remain operational throughout a mission pulse
- 90% probability that K of N systems operate failure free over a mission pulse
- 90% probability that the system completes a mission pulse successfully without requiring maintenance support
- System will have a 90% Average Operational Availability (A_o) for a 72 hour mission pulse and all subsequent mission pulses for up to 90 days
- Systems within a Combined Arms Battalion (CAB) will have a Pulse Availability that does not breach a 90% minimum threshold level during a mission pulse
- The Brigade organic maintenance assets must support all scheduled and unscheduled maintenance requirements for the system
- Crew must perform 80% of all unscheduled maintenance using on-board tools
- System will have a Field and Sustainment Maintenance Ratio not to exceed 0.1 Maintenance Man-Hours/Operating Hour
- System must not exceed a MaxTTR of 30 minutes for all crew repairs.

e. **Feasibility**. In order to address the full spectrum of key logistics requirements, RAM requirements development must be accomplished in concert with analyses conducted by the proponent, Program Manager (PM), AMSAA, ATEC, TRAC, RAND, and/or CASCOM. It is imperative that inter-agency collaboration be exploited during the development process in order to establish a more defendable set of RAM requirements. This collaboration will help address the feasibility of the proposed requirements with respect to technology, risk, cost, schedule, and test and evaluation considerations. The PM, CASCOM, TRAC, RAND, and AMSAA will be able to help assess what level of reliability and maintainability technology can support. The PM and AMSAA can address the risk involved in achieving the proposed RAM requirements given the program's anticipated funding and schedule constraints. ATEC can provide risks associated with testing the requirements based on test schedules, estimated test costs, and available test assets.

This collaborative assessment is crucial since it will determine if the proposed RAM requirements are technically achievable given program cost and schedule constraints. If the proposed requirements are deemed "unachievable" then it may be necessary to review the mission assessment, OMS/MP, and/or the proposed force design to determine mitigation measures. The RAM and Logistics Burden analyses will also require refinement to evaluate impacts of the proposed mitigation measures. The result will be a new set of RAM requirements that meet mission needs, address logistics constraints, satisfy operational demands, and are technically achievable.

f. **Final RAM Requirements**. The Supportability Analyses coupled with the Feasibility Assessment will culminate in optimal RAM requirements that meet combat mission requirements, logistics constraints, and/or operational demands. The resultant RAM requirements must be expressed in operational terms that support other operational requirements stated in the Capabilities Document. Annex C provides an example of RAM requirements developed under this process.

4. The RAM Requirements Development Process produces operationally focused RAM requirements with supporting rationale that will be included in the appropriate Capabilities Documents. Ultimately, this process, through a holistic consideration of all the operational requirements and variables, will help the TRADOC RAM Engineer determine the optimal RAM requirements that directly correlate to the logistics force structure and align with the concept of operations for the proposed system.

Annex A
Modeling, Simulation, and Analysis Tools

1. Arena. Arena is a stochastic modeling software used to analyzing complex, medium to large-scale projects involving highly sensitive changes related to supply chain, manufacturing, processes, logistics, distribution, warehousing, and service systems. Arena supports weibel, exponential, beta, erlang, continuous, discrete, gamma, johnson, lognormal, normal, poisson, triangular, and uniform distributions. The following website provides additional modeling specifics and an information request form for Arena: www.arenasimulation.com/
POCs are Mr. Jeff Higgins, Lee Field office or Mr. Paul Hornback, Knox Field Office
Email addresses: jeff.higgins@us.army.mil or paul.hornback@knox.army.mil
Phone: Mr. Higgins, Comm 804-734-0493 or DSN 687-0493
Mr. Hornback, Comm 502-624-3648 or DSN 464-3648

2. Joint Conflict and Tactical Simulation (JCATS). JCATS is a multi-sided, interactive, entity-level conflict simulation utilized by government organizations (military and site security organizations, for example) as a tool for training, analysis, planning and mission rehearsal. The simulation is primarily focused at command and control or unit synchronization issues. It offers an excellent opportunity for exercising tactics, techniques and procedures for units of almost any type. JCATS simulates realistic operations in urban and rural environments through use of detailed buildings, natural terrain features and road models. The following website provides additional modeling specifics and an information request form for JCATS:
www.benning.army.mil/SimCntr/JCATS.htm
POC is MAJ Everett Johnson, Soldier Battle Lab Ft Benning, GA
Email addresses: JohnsonE2@benning.army.mil
Phone: Comm 706-545-5903 or DSN 835-5903

3. Janus. Janus is an interactive model that accurately models friendly and enemy combat forces down to weapon systems level. Janus accounts for night and weather conditions and can include output for after action reviews. Warfighters have used it to train for and analyze conventional and low intensity conflicts. The following website provides additional modeling specifics and an information request form for JCATS: www.trac.army.mil
POC is Mr. Chad Mullis, TRAC-WSMR
Email addresses: chad.mulis@us.army.mil
Phone: Comm 505-678-4115 or DSN 258-4115

4. Combined Arms and Support Task Force Evaluation Model (CASTFOREM).
CASTFOREM is used to evaluate weapon systems and unit tactics, brigade and below. It simulates intense battle conditions at battalion and brigade level. It models a range of operations to include: Ammunition Resupply; Aviation, Close Combat; Combat Service Support; C3, Countermobility; Logistics, Engineering; Mine Warfare; Fire Support; Intelligence & Electronic Warfare; Mobility; Survivability; and Air Defense. The following website provides additional modeling specifics and an information request form for CASTFOREM: www.trac.army.mil
POC is Mr. Tom Loncarich, TRAC-WSMR
Email address: loncarit@trac.wsmr.army.mil

Phone: Comm 505-678-2538 or DSN 258-2538

5. Logistical/Operational Readiness Impacts of Maintainability and Reliability (LORIMRR). LORIMRR is an analytical methodology that integrates logistical and readiness considerations with system reliability and maintainability (RAM) requirements. It provides a method for assessing the impacts of RAM on maintenance force structure and system operational readiness for units consisting of a single system.
POC is Mr. Gary Pryor, Leonard Wood Field office or Mr. Al Lara, Bliss Field Office.
Email addresses: gary.pryor@us.army.mil or al.lara@us.army.mil
Phone: Mr. Pryor, Comm 573-329-8711
Mr. Lara, Comm 915-568-2161, DSN 978-2161

6. Mathcad. Mathcad is an industry standard for applying mathematics and incorporates features allowing the user to calculate, graph, and communicate technical ideas. Mathcad incorporates technology allowing the user to work with mathematical expressions using standard math notation - but with the added ability to recalculate, view, present, and publish with ease, even to the Web.
POC is Mr. Terry DeWitt
Email address: terry.dewitt@knox.army.mil,
Phone: Comm 502-624-8132 or DSN 464-8132.

7. Mathematica. Mathematica seamlessly integrates a numeric and symbolic computational engine, graphics system, programming language, documentation system, and advanced connectivity to other applications. Allows the user to handle complex symbolic calculations that often involve hundreds of thousands or millions of terms; Load, analyze, and visualize data; solve equations, differential equations, and minimization problems numerically or symbolically; and conduct numerical modeling and simulations ranging from simple control systems to complex biological systems.
POC is Dr. Michael Cushing, AMSAA
Email address: cushing@amsaa.army.mil
Phone: Comm 410-278-4739 or DSN 298-4739.

8. Optimum Stock Requirements Analysis Program (OSRAP). OSRAP is a computer model used to calculate stock levels required to meet a performance objective. It is used to determine multi-echelon stock lists that meet an optimum "cost" solution while meeting desired performance goals. "Cost" can refer to least weight, volume, or dollar amount. The performance can be either operational availability (Ao) at the retail level or supply availability at the wholesale level. Operational availability is the fraction of deployed end items that can complete their intended mission. Supply availability is the fraction of requisitions that are filled from stock on hand. The model was developed by AMSAA and was intended to be only used for Class IX war reserve computations. After expanding the model to incorporate Classes of Supply I, II, IIIP, IIIB, and IV, other applications for the model have developed.
POC is Vicki Evering, AMSAA
Email address: charlotte.evering@us.army.mil
Phone: Comm 410-278-4980 or DSN 298-4980

9. Vector In Commander (VIC). VIC is the Army's principal Corps-level simulation. While traditionally developed to study Army issues, VIC represents a variety of joint operations. The VIC model is a variable resolution, two-sided, deterministic, discrete event simulation. It portrays non-linear warfare in a combined arms environment representing land and air forces at the U.S. Army Corps level with a commensurate enemy force in a mid-intensity battle. The following website provides additional modeling specifics and an information request form for VIC: www.trac.army.mil

POCs are Mr. Mike Hannon, TRAC-LVN or Mr. Rick Cunningham, TRAC-LVN
Email addresses: Michael.J.Hannon@us.army.mil or Rick.cunningham@us.army.mil
Phones: Mr. Mike Hannon, Comm 913-684-9255 or DSN 552-9255
Mr. Rick Cunningham, Comm 913-684-9230 or DSN 552-9230

Annex B
Points of Contact - Futures Center
Reliability, Availability and Maintainability (RAM) Engineering Division

Location	Name	Position	Email Address	Phone Number
Futures Center Fort Monroe, VA	Michael Menard	Deputy Chief	michael.d.menard@us.army.mil	DSN 680-3602 Comm 757-788-3602
Fort Knox Field Office	Terry DeWitt	Senior Regional Engineer	terry.dewitt@knox.army.mil	DSN 464-8132 Comm 502-624-8132
Fort Bliss Field Office	Al Lara	Senior Regional Engineer	Alfredo.Lara@emh10.bliss.army.mil	DSN 978-2161 Comm 915-568-2161
Fort Knox Field Office	Paul Hornback	RAM Engineer	paul.hornback@knox.army.mil	DSN 464-3648 Comm 502-624-3648
Fort Benning Field Office	Jess Gilmer	RAM Engineer	jess.gilmer@us.army.mil	DSN 835-7865 Comm 706-545-7865
Fort Benning Field Office	Austin Hardin	RAM Engineer	austin.hardin@us.army.mil	DSN 835-9080 Comm 706-545-9080
Fort Eustis Field Office	Michael Menard	RAM Engineer	michael.d.menard@us.army.mil	DSN 826-4752 Comm 757-878-4752
Fort Lee Field Office	Jeff Higgins	RAM Engineer	jeff.higgins@us.army.mil	DSN 687-0493 Comm 804-734-0493
Fort Lee Field Office	David Henkel	RAM Engineer	david.henkel@us.army.mil	DSN 687-0484 Comm 804-734-0484
Fort Rucker Field Office	Billy Sandel	RAM Engineer	sandelb@rucker.army.mil	DSN 558-1414 Comm 334-255-1414
Fort Bliss Field Office	Tony De Anda	RAM Engineer	Antonio.DeAnda@emh10.bliss.army.mil	DSN 978-0270 Comm 915-568-0270
Fort Gordon Field Office	Gene Workman	RAM Engineer	gene.workman@us.army.mil	DSN 780-4250 Comm 706-791-4250
Fort Huachuca Field Office	Tom Morehouse	RAM Engineer	tom.p.morehouse@us.army.mil	DSN 821-0848 Comm 520-533-0848
Fort Leonard Wood Field Office	Gary Pryor	RAM Engineer	gary.pryor@us.army.mil	DSN 676-7345 Comm 573-563-7345
Fort Leonard Wood Field Office	Larry Fincher	RAM Engineer	larry.fincher@us.army.mil	DSN 676-8712 Comm 573-329-8712
Fort Sill Office	George Devine	RAM Engineer	devineg@sill.army.mil	DSN 639-5401 Comm 580-442-5401

Annex C
RAM Requirements Development Process - Example

Objective Crew-Served Weapon (OCSW) - Analysis Procedures

1. Acquired and reviewed initial analyses/building blocks to become familiar with the proposed system. This included: Initial Capabilities Document (ICD), working draft Capability Development Document (CDD), information regarding Basis of Issue (BOI) and maintenance concept, System Supportability Strategy documentation (or Supportability Strategy documentation for functionally similar systems or subsystem, e.g., Objective Individual Combat Weapon (OICW), which provided pertinent information), OMS/MP, and other related documentation deemed necessary.

2. Developed an Analysis Plan. Coordinated with agencies involved in providing support so that they can determine our expectations of them and plan for requested support. **NOTE**: This coordination needs to be done as early as possible; the agencies providing support (e.g., AMSAA, CASCOM) require advanced notice and will not operate in crisis mode to meet abbreviated time line constraints. Coordination with the following agencies was accomplished:

a. DCD (combat developer) and TSM – to obtain User input.
b. AMSAA, TRAC, and the Soldier Battle Lab, i.e., agencies having simulation capability – to provide modeling support. **NOTE**: Modeling support usually requires funding, which may make the desired modeling support unfeasible.
c. AMSAA – to obtain a Repair Parts Weight/Cube Assessment.
d. CASCOM – to acquire support in determining applicable maintainers. **NOTE**: This info may be available in a draft System Supportability Strategy.
e. PM Office for the system – to obtain a technical feasibility analysis/assessment of the proposed RAM requirements; they were also the POC for the System Supportability Strategy.
f. AEC – to obtain a testability assessment of the proposed requirements.

Lesson Learned --
Development of a Analysis Plan Outline (vice a detailed Plan) is highly recommended. Putting together a Plan Outline will provide just enough direction and focus to decide which analysis events are necessary and which can be postponed or deleted, while also providing a summary of events that can be used to keep management personnel informed of the analysis approach and progress.
If necessary, a detailed Analysis Plan can be developed, however, a Plan of this type requires considerable forethought and time and there are often circumstances that will alter which supporting analyses are accomplished, how much support is provided, etc. Complications such as this can make the effort of developing a detailed plan not worth the while. On top of all this, requests to develop RAM requirements often provide too little time to accomplish both full planning and completion of all aspects of a detailed Analysis Plan.

3. Established, to the level necessary, failure definitions for the system.

4. Coordinated with AMSAA for the Repair Parts Weight/Cube Assessment. Items considered/needed in preparation for this assessment included the following.

   a. Determined the tactical TOE unit(s) for which the repair parts assessment was accomplished; it was also necessary to determine the system's BOI for input to the assessment. **NOTE**: The maintenance concept may determine whether or not a repair parts assessment is necessary. For example, if the Supportability Strategy describes a system life cycle of Contractor Logistics Support using regional support centers for repair, there should be no repair parts required at the field level for Army maintenance support.
   b. Before the assessment was formally executed, AMSAA required emerging reliability requirements (to avoid conducting an analysis based on assumptions, then re-conducting the analysis based on emerging requirements).
   c. Determination of the level of detail for the weight/cube analysis. For example, a small, low density system may not require a full blown assessment; rather, an abbreviated SME type assessment by knowledgeable personnel from AMSAA, based on the logistical impact they perceive for the system being considered, may be sufficient.

5. Performed *Maintainer MOS Assessment*. Coordinated with CASCOM (e.g., DCD - Ordnance) and the applicable PM to determine the applicable field level maintainers (MOS) that will support the system. Since the formal list of maintenance tasks, and thus the final determination of maintainer MOS(s)) are developed through the System Supportability Strategy, the MOSs CASCOM provided were an estimate. Alternatively, this info could have been derived by examining predecessor/similar system information, i.e., examine information in the Army Manpower Requirements Criteria (MARC) Data Base (AMMDB) to determine which MOSs repaired/maintained the predecessor system.

6. Conducted *Mission Assessment*.

   a. Examined use of combat modeling, specifically, CASTFOREM modeling performed by TRAC. This assessment approach was not accomplished because of a backlog of pre-programmed work (at TRAC) and an identified lack of suitable gaming scenarios to simulate OCSW usage.
   b. In lieu of combat modeling, convened an IPT to perform an operational assessment of the minimum number of systems needed to complete the missions and operations described in the OMS/MP. IPT members were the OMS/MP POC, combat developer project officer, and appropriate OCSW SMEs.

7. Conducted *Maintenance Personnel Availability Assessment*. Several detailed steps were necessary to complete this assessment.

   a. Identified representative TOE unit(s) to use as a basis for the maintenance personnel availability assessment (e.g., a BCT).
   b. Determined equipment in the TOE unit(s) displaced/replaced by the OCSW.
   c. Determined the annual direct production maintenance man-hours allocated for repair of displaced/replaced equipment for each applicable maintainer MOS that supports the displaced system.

d. Identify the total quantity of TOE maintainers (having MOSs appropriate to support the new system) in the representative TOE unit(s).
e. Determine the annual direct production maintenance man-hours that each applicable maintainer MOS can provide.
f. Determine the total maintenance burden (in direct production annual maintenance man-hours), by MOS, for the new system. Comparison of these needed man-hour values with the available values determined in the previous steps will indicate the adequacy of the available maintenance personnel. A negative value indicates that there is a man-hour deficit and a positive value represents a surplus. A significant deficit can necessitate increasing the number of maintainers (usually not desirable); if this is the case, alternative maintenance concepts should be examined.

8. Performed the *RAM Subanalysis*. Here, again, several detailed steps were necessary.
   a. Conducted a probabilistic "K out of N" reliability evaluation of the mission assessment results determined in paragraph 6. Emerging results from this set of calculations were provided to the PM office to ensure that the emerging values were within the realm of technical feasibility.
   b. Conducted an operational availability (A_o) evaluation to assess the impact of reliability on A_o. Two cases were considered.
      - Case 1 - Impact of reliability on A_o evaluated during combat operations, i.e., over two 96-hour battle scenarios as described in the OMS/MP.
      - Case 2 - Impact of reliability on A_o evaluated on an annualized basis (included both combat operations and stand-down time to assess the average A_o.)

   Multiple maintenance support concepts were evaluated for each case to assess the level of reliability needed to attain an A_o of .90 commensurate with category I combat units. Computation of A_o was performed using the Logistical/Operational Readiness Impacts of Maintainability & Reliability Requirements (LORIMRR) analysis tool (developed by the TRADOC Futures Center RAM Engineering Branch).
   c. Coordinated with combat developer POC(s) to select a "final" reliability requirement for the OCSW (weapon subsystem + target acquisition/fire control). This selection was based on results from the "K out of N" reliability evaluation and the maintenance support impacts on A_o. Verified (using LORIMRR) that the selected value would enable a .90 A_o to be attained.
   d. Determined maintainability requirements.
   - Maintenance ratio was calculated by dividing the total of all of the maintenance man-hour allocations for equipment items the OCSW replaces by the annual usage projected in the OMS/MP.
   - Since the OCSW is a subsystem on some of the FCS platforms, the FCS maximum time to repair requirement for operator level maintenance was also applicable as an OCSW requirement.
   f. Established durability requirement for OCSW ground mount assembly using data for the tripod assembly for current heavy machine guns the OCSW will replace/displace.
   g. Developed a maintenance ratio requirement for the OCSW ground mount assembly, based on the current tripod assembly.

h. Conducted reliability analysis of both tactical and training munitions. The probability of completing a 3-round burst was the driving factor in determining the individual round requirement.

9. AMSAA's OCSW Repair Parts Weight/Cube Impact Assessment. Provided the proposed reliability requirements, by subsystem, to AMSAA for use is conducting the Repair Parts Weight/Cube Impact Assessment.

10. *OCSW RAM Requirements Feasibility Assessment*. Coordinated with the PM for a final assessment of reliability requirement technical feasibility and with the AEC Reliability Evaluator to assess requirement testability.