Manufacturing Readiness Assessments

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“DOD faces problems in manufacturing weapon systems -- systems cost far more and take much longer to build than estimated. Billions of dollars in cost growth occur as programs transition from development to production, and unit-cost increases are common after production begins. Several factors contribute to these problems including inattention to manufacturing during planning and design, poor supplier management, and a deficit in manufacturing knowledge among the acquisition workforce. Essentially, programs did not identify and resolve manufacturing risks early in development, but carried risks into production where they emerged as significant problems.”
SEC. 812. MANAGEMENT OF MANUFACTURING RISK IN MAJOR DEFENSE ACQUISITION PROGRAMS.

(a) GUIDANCE REQUIRED.—Not later than 180 days after the date of the enactment of this Act, the Secretary of Defense shall issue comprehensive guidance on the management of manufacturing risk in major defense acquisition programs.

(b) ELEMENTS.—The guidance issued under subsection (a) shall, at a minimum—

(1) require the use of manufacturing readiness levels as a basis for measuring, assessing, reporting, and communicating manufacturing readiness and risk on major defense acquisition programs throughout the Department of Defense;

(2) provide guidance on the definition of manufacturing readiness levels and how manufacturing readiness levels should be used to assess manufacturing risk and readiness in major defense acquisition programs;

(3) specify manufacturing readiness levels that should be achieved at key milestones and decision points for major defense acquisition programs;

(4) identify tools and models that may be used to assess, manage, and reduce risks that are identified in the course of manufacturing readiness assessments for major defense acquisition programs; and

(5) require appropriate consideration of the manufacturing readiness and manufacturing readiness processes of potential contractors and subcontractors as a part of the source selection.”
Definitions and Policy
Manufacturability

- The characteristics considered in the design cycle that focus on process capabilities, machine or facility flexibility, and the overall ability to consistently produce at the required level of cost and quality. Associated activities may include some or all of the following:
  - Design for commonality and standardization—uses fewer parts
  - Design for environmental and safety compliance
  - Design for multi-use and dual-use applications
  - Design for modularity and plug compatible interface/integration
  - Design for flexibility/adaptability or use “robust design”
  - Utilize reliable processes and materials
  - Utilize monolithic and determinant assembly
  - Design for manufacturing and assembly
  - Achieve production yield
Producibility

• The relative ease of producing an item that meets engineering, quality and affordability requirements. Associated activities may include some of the following:
  – Design for specific process capability and control parameters
  – Perform material characterization analysis
  – Perform variable reduction analysis, e.g., Taguchi and design of experiments
  – Develop critical materials and processes before selecting product design
  – Utilize modeling and simulation for product and process design tradeoffs
  – Design and development of closed-loop process control on critical items
10. **MANUFACTURING AND PRODUCIBILITY.** The Program Manager will ensure manufacturing and producibility risks are identified and managed throughout the program’s life cycle. Beginning in the Materiel Solution Analysis Phase, manufacturing readiness and risk will be assessed and documented in the SEP. By the end of the Technology Maturation and Risk Reduction Phase, manufacturing processes will be assessed and demonstrated to the extent needed to verify that risk has been reduced to an acceptable level. During the Engineering and Manufacturing Development Phase, program managers will assess the maturity of critical manufacturing processes to ensure they are affordable and executable. Prior to a production decision, the Program Manager will ensure manufacturing and producibility risks are acceptable, supplier qualifications are completed, and any applicable manufacturing processes are or will be under statistical process control.
Manufacturing Readiness Levels
Challenges of Assessing MR

- Perceived as using limited resources and taking too much time
  - Myth: properly using resources and time upfront prevents need for expending increasing amount of resources and time later to correct issues
- May find unwanted new or hidden issues in the program
  - Fact: While these issues may be unwelcome discovery, finding them early helps avoid surprises later on when impacts are likely to be much greater
- Cost money, as do the solutions to the new issues found
  - Fact: Spending money upfront to find and fix issues will prevent having to spend a lot more money fixing program issues later
- You can overcome these challenges by:
  - Educating both government and contractors about the assessment process
  - Knowing and having good relationship with Procurement Contracting Officer
  - Building a well-rounded MRA Team to assess manufacturing readiness
  - Understanding value of assessment far outweighs any upfront perceived challenges
Manufacturing Readiness Levels
-- MSA Phase --

• MRL 1: Basic Manufacturing Implications Identified
  – Focus on addressing manufacturing shortfalls and opportunities needed to achieve program objectives
  – Basic research begins in form of studies

• MRL 2: Manufacturing Concepts Identified
  – Characterized by describing application of new manufacturing concepts
  – Translates basic research into solutions for broadly defined military needs
  – Includes identification, paper studies & analysis of material/process approaches
  – Understanding of manufacturing feasibility and risk is emerging

• MRL 3: Manufacturing Proof of Concept Developed
  – Begins validation of manufacturing concepts through experiments
  – Typical of technologies in Applied Research and Advanced Development
  – Materials/processes characterized for manufacturability and availability but further evaluation and demonstration required
  – Experimental h/w models developed in lab may possess limited functionality
MRL 4: Capability to produce technology in laboratory environment

- Acts as exit criterion for Materiel Solution Analysis (MSA) Phase
- Matured technologies to at least TRL 4, indicating readiness for Technology Maturation and Risk Reduction Phase
- Identified required investments, such as manufacturing technology development
- Developed processes to ensure manufacturability, producibility, and quality in place and sufficient to produce technology demonstrators
- Identified manufacturing risks for building prototypes and mitigation plans
- Established target cost objectives
- Identified manufacturing cost drivers
- Completed producibility assessments of design concepts
- Identified key design performance parameters
- Identified any special tooling, facilities, material handling and skills required
Manufacturing Readiness Levels
-- TMRR Phase --

- MRL 5: Capability to produce prototype components in a production relevant environment
  - Technologies should have matured to at least TRL 5
  - Assessed industrial base to identify potential manufacturing sources
  - Refined manufacturing strategy and integrated with risk management plan
  - Identified enabling/critical technologies and components
  - Demonstrated prototype materials, tooling, test equipment and personnel skills on components in a production relevant environment
  - Still developing manufacturing processes and procedures
  - Initiated manufacturing technology development efforts
  - Continuing assessment of producibility of key technologies and components
  - Constructed cost model to assess projected manufacturing cost
An environment with some shop floor production realism present (such as facilities, personnel, tooling, processes, materials etc.). There should be minimum reliance on laboratory resources during this phase. Demonstration in a production relevant environment implies that contractor(s) must demonstrate their ability to meet the cost, schedule, and performance requirements of the EMD Phase based on their production of prototypes. The demonstration must provide the program with confidence that these targets will be achieved, but does not require a production line. Furthermore, there must be an indication of how the contractor(s) intend to achieve the requirements in a production representative and pilot environments.
Manufacturing Readiness Levels  
-- TMRR Phase --

- MRL 6: Capability to produce a prototype system or subsystem in a production relevant environment  
  - Signals readiness for M/S B to initiate acquisition program by entering into EMD  
  - Typically denotes readiness for acceptance of preliminary system design  
  - Developed initial manufacturing approach  
  - Defined and characterized majority of manufacturing processes, but still significant engineering and/or design changes in the system itself  
  - Completed preliminary design and producibility assessments and trade studies of key technologies and components  
  - Demonstrated prototype manufacturing processes and technologies, materials, tooling, test equipment and personnel skills in production relevant environment  
  - Performed cost, yield and rate analyses to assess prototype data compare to target objectives  
  - Established risk reduction to achieve cost req’ts or establish a new baseline  
  - Conducted design trades w/ producibility considerations shaping development plans  
  - Completed Industrial Capabilities Assessment (ICA) for Milestone B  
  - Identified long-lead and key supply chain elements
• MRL 7: Capability to produce systems, subsystems, or components in a production representative environment
  – Level of manufacturing readiness typical for mid-point of EMD
  – System detailed design activity nearing completion
  – Approved material specs -- materials available for pilot line build schedule
  – Demonstrated manufacturing processes and procedures in a production representative environment
  – Completed detailed producibility trade studies with producibility enhancements and risk assessments underway
  – Updated cost model with detailed designs rolled up to system level, and tracked against allocated targets
  – Prioritized unit cost reduction efforts
  – Updated yield and rate analyses with production representative data
  – Assessed supply chain and supplier quality assurance
  – Established long-lead procurement plans
  – Developed manufacturing plans and quality targets
  – Initiated production tooling and test equipment design and development
Production Representative Environment

An environment that has as much production realism as possible, considering the maturity of the design. Production personnel, equipment, processes, and materials that will be present on the pilot line should be used whenever possible. The work instructions and tooling should be of high quality, and the only changes anticipated on these items are associated with design changes downstream that address performance or production rate issues. There should be no reliance on a laboratory environment or personnel.
• **MRL 8: Pilot line capability demonstrated; Ready to begin Low Rate Initial Production**
  – Signals manufacturing readiness for M/C decision and entry into LRIP
  – Complete detailed system design and stable to enter low rate production
  – All materials, manpower, tooling, test equipment and facilities are proven on pilot line and are available to meet the planned low rate production schedule
  – Manufacturing and quality processes and procedures have been proven in a pilot line environment and are under control and ready for low rate production
  – Known producibility risks pose no significant challenges for low rate production
  – Updated cost model and yield and rate analyses with pilot line results
  – Completed supplier qualification testing and first article inspection
  – Completed Industrial Capabilities Assessment for Milestone C showing that the supply chain is established to support LRIP
Pilot Line Environment

An environment that incorporates all of the key production realism elements (equipment, personnel skill levels, facilities, materials, components, work instructions, processes, tooling, temperature, cleanliness, lighting etc.) required to manufacture production configuration items, subsystems or systems that meet design requirements in low rate production. To the maximum extent practical, the pilot line should utilize full rate production processes.
Manufacturing Readiness Levels

-- PD Phase --

- MRL 9: Low rate production demonstrated; Capability in place to begin Full Rate Production
  - System, component or item has been previously produced, is in production, or has successfully achieved low rate initial production
  - Matured technologies to TRL 9
  - Ready to enter Full Rate Production (FRP)
  - Met all systems engineering/design requirements with minimal system changes
  - Major system design features are stable and proven in test and evaluation
  - Ensured materials, parts, manpower, tooling, test equipment and facilities available to meet planned rate production schedules
  - Manufacturing process capability in a low rate production environment is at an appropriate quality level to meet design key characteristic tolerances
  - Continuing production risk monitoring
  - Met LRIP cost targets and analyzed learning curves with actual data
  - Developed cost model for FRP environment, reflecting impact of continuous improvement
MRL 10: Full Rate Production demonstrated and lean production practices in place

- Engineering/design changes are few and generally limited to quality and cost improvements
- System, components or items are in full rate production and meet all engineering, performance, quality and reliability requirements
- Manufacturing process capability is at the appropriate quality level
- All materials, tooling, inspection and test equipment, facilities and manpower are in place and have met full rate production requirements
- Rate production unit costs meet goals
- Funding is sufficient for production at required rates
- Lean practices well established with continuous process improvements ongoing
Successful manufacturing has many dimensions. MRL threads have been defined to organize these dimensions into nine manufacturing risk areas.
MRL Threads and Sub-Threads

- **Technology and the Industrial Base**: Requires an analysis of the capability of the national technology and industrial base to support the design, development, production, operation, uninterrupted maintenance support of the system and eventual disposal (environmental impacts)
  - Sub-threads include industrial base issues and manufacturing technology development
- **Design**: Requires an understanding of the maturity and stability of the evolving system design and any related impact on manufacturing readiness
  - Sub-threads include producibility and maturity
- **Cost and Funding**: Requires analysis of funding adequacy to hit target manufacturing maturity levels. Examines risk associated with reaching manufacturing cost targets
  - Sub-threads include production cost knowledge (cost modeling), cost analysis, and manufacturing investment budget
- **Materials**: Requires an analysis of the risks associated with materials (including basic/raw materials, components, semi-finished parts, and subassemblies)
  - Sub-threads include maturity, availability, supply chain management, and special handling (i.e. GFP, shelf life, security, hazardous materials, storage environment, etc.)
MRL Threads and Sub-Threads

• Process Capability and Control: Requires an analysis of the risks that the manufacturing processes are able to reflect the design intent (repeatability and affordability) of key characteristics
  – Sub-threads include modeling and simulation (product and process), manufacturing process maturity, and process yields and rates

• Quality Management: Requires an analysis of the risks and management efforts to control quality, and foster continuous improvement
  – Sub-threads include supplier quality

• Manufacturing Workforce (Engineering/Production): Requires assessment of required skills, availability, and required number of personnel to support manufacturing effort

• Facilities: Requires an analysis of the capabilities and capacity of key manufacturing facilities (prime, subcontractor, supplier, vendor, and maintenance/repair)

• Manufacturing Management: Requires analysis of orchestration of all elements needed to translate design into integrated, fielded system (meeting program goals for affordability and availability)
  – Sub-threads include manufacturing planning and scheduling, materials planning, and tooling/special test and inspection equipment
Manufacturing Readiness Assessment Process
Process for Conducting MRAs

1. Determine Initial Assessment Scope
2. Determine Assessment Taxonomy and Schedule
3. Form and Orient Assessment Team
4. Orient Contractors Being Assessed
5. Request Contractors to Perform Self Assessment
6. Set Agenda for Site Visits
7. Conduct Assessment
8. Prepare the Report
Determine Initial Assessment Scope

• Government program office establishes initial scope and schedule for assessment in conjunction with prime contractor

• Scope of assessment and associated MRL target will vary as function of stage of life cycle and specific program requirements
  – At Milestone C, prime contractor associated with system-level PRR
  – Manufacturing maturity expectations different for low rate production item (e.g., satellite) as compared to high rate production (e.g., ammunition, radios)

• For example, with an assessment of the JLTV pilot production line, emphasis placed on understanding what production capability and capacity are needed to meet objectives in cost, schedule (e.g., low rate production rates) and performance
  – What manufacturing and/or production processes are cost drivers?
  – Anticipate whether any problem with full rate production processes
Determine Assessment Taxonomy and Schedule

- Encompasses what will be assessed, where assessments will take place, and who will lead assessment
- **What will be assessed** -- Subject Critical Technology Elements and significant areas of WBS or BOM to following questions. “Yes” responses imply MRA may be needed for that element as a function of risk
  - **Materials**: Are there materials which have not been demonstrated in similar products or manufacturing processes?
  - **Cost**: Is this item a driver that significantly impacts life-cycle cost (development, unit, or operations and support costs)? Is the technology new with high cost uncertainty?
  - **Design**: Is the item design novel or does it contain nonstandard dimensions or tolerances or arrangements?
  - **Manufacturing Process**: Will the item require the use of manufacturing technology, processes, inspection, or capabilities that are unproven in the current environment?
  - **Quality**: Does the item have historical/anticipated yield or quality issues?
  - **Schedule**: Does this item have lead time issues or does it significantly impact schedule?
  - **Facilities**: Does this item require a new manufacturing facility or scale up of existing facilities (i.e., new capability or capacity)?
  - **Supply Chain Management**: Does the item have anticipated or historical sub-tier supplier problems (e.g., cost, quality, delivery)?
  - **Industrial Base**: Does the item have an industrial base footprint with critical shortfalls or is this a critical item manufactured by a sole or foreign source?
Determine Assessment Taxonomy and Schedule (cont)

- **Who will be assessed?** -- On-site evaluations are typically reserved for locations where one or more of the following apply:
  - Highest percentage of manufacturing cost is incurred
  - Final assembly and test is conducted
  - Most sensitive manufacturing tasks are accomplished
  - Materials, components or subsystems that are the least technologically mature are produced or availability issues exist
  - Known significant problems or risks (low yields, high costs, immature manufacturing processes, etc.) exist

- **Who will lead assessment?** -- Typically government program office leads assessments at prime contractor(s). Prime contractor(s) leads assessments for its suppliers

- Major acquisition programs may require multiple site visits over period of months and involve a larger team, not all of whom will go to every site
Form and Orient Assessment Team

- Members should be experienced/knowledgeable in areas of manufacturing engineering; Industrial base and supply chain; Quality; Design/Systems Engineering; Production
- Team should identify potential manufacturing constraints, risks, and capability of technology and industrial base to execute manufacturing efforts
- Experience/knowledge important to tailor reviews to program-specific circumstances
- Technology/process SMEs may be required to identify issues not expected to be uncovered by general manufacturing, industrial base, quality, and production experts
- DoD staff organizations may participate as well, if assessment is being performed on an acquisition program approaching a milestone decision
  - Adds credibility to the assessment
  - Enables alternative views from others who may have a different perspective
  - Provides opportunity to obtain opinions from SMEs not normally available to program
  - Promotes cross-flow of information well beyond program office
- Consider contacting DCMA to gather info on contractor’s performance
  - Consider including DCMA personnel in on-site evaluation teams if they are available
- Set expectations for team members early in the process – schedule, reporting, standards of conduct, personal preparation, clearances, observations, etc.
Orient Contractors Being Assessed

• May involve including contractor personnel in planning meetings
• Providing contractor with orientation package that includes:
  – MRL definitions and threads
  – Directions to additional materials on http://www.dodmrl.com/
  – Self-assessment questions
  – Indication of technologies/processes of special interest that need to be in self assessment
  – Questions the assessment team will use
  – Strawman agenda for the assessment visit
  – Evidence to be provided at onsite visit (e.g., process maps, proposed manufacturing plan, process capability data, yield data, technology development plans, risk reduction plans, value stream analysis, etc.)
  – High-interest areas where shop floor visits and/or discussions with contractor experts desired
  – Expectations of resources, time, etc. required for the assessment
• Make arrangements for assessment team meeting room where private discussions can be held and team members can record their observations
• Make arrangements for assessment team members to bring computers into facility to facilitate capture of their observations in electronic format
Request Contractors Perform Self Assessment

• Ask contractor(s) to conduct self-assessment to address following basic questions:
  – What is the current MRL for each of the key technologies being developed and each key manufacturing process being used?
  – If currently funded activities continue as planned, what MRL will be achieved for each key technology or process by the end of this acquisition phase or program? What activities and schedules are required to achieve this MRL?
• Contractor should be prepared to brief results to assessment team when it is on-site
• For companies that provide key components or subassemblies and for which a site visit is not feasible, the contractor’s written self-assessment should be analyzed by the assessment team
Set Agenda for Site Visits

- Provides more detailed understanding than can be gained from briefings/documents
- Take maximum advantage of discussions with contractor experts and first-hand observations of status of shop floor activities
  - Strike balance between time spent in briefing rooms and time spent making observations and having discussions with individuals and small groups of contractor’s personnel
- Typical agenda for a review may contain the following elements:
  1. Contractor welcome, review of agenda, assessment schedule, and orientation to the facility
  2. Introduction of assessment team and contractor personnel
  3. Briefing to contractor describing objectives and expectations for the on-site visit
  4. Contractor overview and discussion of the results of their self-assessment
  5. Shop-floor visits to key areas by individuals or small groups
  6. One-on-one or small group discussions between assessment team members and contractor subject matter experts focused on key areas
  7. Private meeting of assessment team to record and discuss observations
  8. Out-briefing by assessment team to contractor
Conduct the MRA
--- Review the Self-Assessment ---

- Initiate focused dialog at component, test, and/or assembly process based on complexity, location, personnel availability, etc.

- Assign specific technologies, assemblies, subsystems or processes to individuals or sub teams

- Review self assessment and examine targeted components, subsystem and system-level test and assembly processes with respect to MRL threads

- Use threads to guide examination of sources, e.g., process maps, work instructions, and factory tours to assign MRL to technology, component, or subsystem

- Use knowledge-based questions derived from MRL definitions/threads to guide assessment process and determine the MRL of specific elements
  - Questions are to be tailored to program and incorporated into tools that store MRL data for self-assessment
  - Questions and tools can be found at http://www.dodmrl.com/
### MRL Criteria Matrix

--- Technology and Industrial Base ---

<table>
<thead>
<tr>
<th>Acquisition Phase</th>
<th>Engineering &amp; Mfg Development (EMD)</th>
<th>Low-Rate Initial Production (LRIP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Reviews</td>
<td>CDR</td>
<td>PRR/SVR</td>
</tr>
<tr>
<td>Thread</td>
<td>Sub-Thread</td>
<td>MRL 7</td>
</tr>
<tr>
<td>Technology Maturity</td>
<td>Should be assessed at TRL 7</td>
<td>Should be assessed at TRL 7.</td>
</tr>
<tr>
<td>A.1 - Industrial base</td>
<td>Industrial capability to support production has been analyzed. Sole/single/foreign sources stability and obsolescence issues are assessed/monitored. Developing potential alternate sources as necessary.</td>
<td>Industrial base capability assessment for MS C has been completed. Industrial capability is in place to support LRIP. Sources are available, multi-sourcing where cost-effective or necessary to mitigate risk.</td>
</tr>
<tr>
<td>A.2 - Manufacturing Technology Development</td>
<td>Manufacturing technology efforts continuing. Required manufacturing technology development solutions demonstrated in a production representative environment.</td>
<td>Primary manufacturing technology efforts concluding, and some improvement efforts continuing. Required manufacturing technology solutions validated on a pilot line.</td>
</tr>
</tbody>
</table>
Conduct the MRA
-- Conduct Assessment --

- Ensure well-defined hierarchy among elements being assessed
  - Start at system level and flow down to lowest component forming smallest unit for exam
  - Includes test and assembly steps contained in subsystem or component fabrication
    - Printed Wiring Board (PWB) has several assembly and testing steps during fabrication
    - PWB then included in subsystem buildup in avionics box requiring next higher level assembly and test
- Threads serve as completeness check to alert team of need to examine other areas
- Ensure level of detail analysis matches component or subsystem complexity
- Seek existing, objective documentation that supports assessment results in key areas
- In determining manufacturing readiness, key emphasis is on manufacturing risk
  - Use MRL Matrix to structure review and establish target criteria for each thread/sub-thread
  - If target criteria are not met, use risk matrix approach in “DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition” to characterize risks
  - Assess number and severity of risks to determine manufacturing readiness of component or subsystem
- Include actions necessary to bring readiness up to target level in time to transition technology or support milestone decision with manageable risk

Assessment not focused on MRL number, but to identify and mitigate risk to achieving program objectives
Conduct the MRA
-- Complete Assessment --

- Ask DCMA personnel for perspective/insight on contractor’s presentations and status
- Assign action item for contractor to provide info by specific date for key areas they were unable to provide adequate information to support assessment
- Meet at contractor’s facility to discuss observations/impressions in electronic format
- Provide out-brief to contractor highlighting strengths and risks, MRL achievements compared to targets, and action items
  - Recognize contractors’ hospitality and cooperation
- Assigning a single MRL to an entire technology or weapon system has little value
  - MRL assessments are not a simple go/no-go gauge
  - Likely MRL will vary widely from component to component and perhaps even manufacturing process by manufacturing process for specific component
  - Using ‘weakest link’ basis, technology/system would receive overall MRL that reflects element with lowest level of readiness – not accurate depiction of program
- Contain bottom-up assessment of relative manufacturing readiness at system, sub-system and component level in assessment report
Prepare Assessment Report

• May not be feasible to agree on assessment while on-site at contractor’s facility
  – Typically requires analysis to clearly define manufacturing readiness and risk status of key technologies/manufacturing processes and to put identified risks into a program context
• Final results typically documented in written report or out-brief containing following:
  1. Description of technology, component, subsystem or system which identifies elements assessed; key objectives of development effort; and discussion of current state
  2. Discussion of companies responsible for assessed elements
  3. List of team members, along with dates/locations of site visits
  4. Description of manufacturing processes for assessed elements
  5. MRL for each assessed element
  6. Areas where manufacturing readiness falls short of target MRL
     • Identify key factors
     • Describe driving issues
  7. Plans to reach target MRL
  8. Assessments of type and significance of risk to cost, schedule or performance
  9. Assessments of effectiveness of current risk mitigation plans
     • Address right issues?
     • Timely?
     • Adequately funded?
     • Probability of success?
     • Options for increased effectiveness?

• Provides basis for risk analysis/assessment associated with each manufacturing thread
• Establishes manufacturing maturity baseline -- **manufacturing maturation plan** normally delivered along with assessment report
• Provide MDA info to determine if level of manufacturing risk supports milestone approval
Manufacturing Maturation Plans
Introduction

- Identifying risk is key part of developing risk mitigation efforts -- key enabler of success
- **Risk management** includes risk planning, risk assessment, risk handling and mitigation strategies, and risk monitoring approaches
  - Risk Management Continuous Learning Management Module ([http://www.dau.mil/clc/default.aspx](http://www.dau.mil/clc/default.aspx), then register or browse CLM 017)
- Key product of MRA is Manufacturing Maturation Plan (MMP)
  - Addresses manufacturing risk and provides mitigation plan for each risk area throughout duration of program, including supplier and sub-tier supplier risk management shortfalls
  - Channel investment to attain target MRL before transition to the program’s next phase
  - Formulate and execute MMPs before the risks become severe
- Needed info to decide whether technology/system is ready to move to next phase:
  - Identification of any elements (technologies, components, assemblies, subsystems, processes, etc.) that have not reached the target MRL
  - Understanding of potential impact if element fails to mature to target level -- how difficult, time consuming, and expensive it will be to bring element up to acceptable maturity level or develop adequate work around
Manufacturing Maturation Plan

1. Title
2. Statement of the problem
   – Describe element of assessment, maturity status and how this element would be used in system
   – Show areas where MR falls short including key factors and driving issues
   – Assess type and significance of risk to cost, schedule or performance
3. Solution options
   – Benefits of using the preferred approach
   – Fall-back options and the consequences of each option
4. Maturation plan with schedule and funding breakout
5. Key activities for the preferred approach
6. Preparations for using an alternative approach
7. The latest time that an alternative approach can be chosen
8. Status of funding to execute the manufacturing plan
9. Specific actions to be taken (what will be done and by whom)
10. Prototypes or test articles to be built
11. Tests to be run
   – Describe how the test environment relates to the manufacturing environment
12. Threshold performance to be met
13. MRL to be achieved and when it will be achieved
Applying MRLs in Contractual Language
Brief Overview

- If manufacturing requirements exist, MRAs should be included in the Statement of Objectives (SOO) and in resulting SOW, so they can be a formal part of contract
- If MR is source selection discriminator, RFP should require offerors' proposal to document results of MRA against appropriate MRL definition for current phase
  - Key decision factor should not be current MRL, but risk of achieving final MRL target
  - Best approach to assess this risk is by assessing contractors understanding of steps necessary to evaluate their MRL, steps necessary to achieve required MRL (e.g., Manufacturing Maturity Plans), and risk associated with achieving those steps
- Using MRAs in source selection requires language in three key sections of RFP: Section L (Instructions to Offerors), Section M (Evaluation Criteria), and SOO
  - Sub-factor/Component (TBD)—Manufacturing Readiness Level Demonstration
  - Section M Example: This sub-factor will evaluate the adequacy of the offeror’s process and plans to achieve the target MRL as described in Manufacturing Readiness Level Deskbook
  - SOO Language : RFP should specifically describe respective intentions and roles of gov’t program office and offeror in preparation, analysis, and reviews of MRA
  - Contract SOW Language: Contractor shall conduct MRA using definitions, criteria, and processes defined in MRL Deskbook as guide. Shall develop, deliver and implement MMPs
- Implementation of MRL-based assessments may require some deliverable documentation from the contractor and, if so, should be included in the SOW
Effective Adaptation and Use of MRL Criteria
Basic Attributes for Success

- Trained SMEs involved in the assessment of manufacturing readiness based on MRL criteria – adapting criteria as well as conducting MRA
- Traceability to MRL criteria must be maintained to provide sound foundation for risk management
- Most MRL threads and sub-threads have multiple criteria to address, and while not all criteria may be feasible to assess, the entire thread or sub-thread cannot be ignored
  - Assess to what is appropriate for the given phase and unique reality of your S&T effort
  - Goal is to identify and understand risks as early as possible
- More adaptions for MRL Criteria found in Chapter 8 of MRL Deskbook
  - S&T
  - Sustainment/Maintenance, Repair & Overhaul (MRO) and Depot Activities
  - Single or Limited System Acquisition, i.e., ships, spacecraft, etc.
  - Industry, to include commercial
DODMRL.COM Tools

- MRL Deskbook – presentation is synopsis of Deskbook
- The MRL Users Guide – MS Excel-based supplement with info needed to perform MRA at any stage life-cycle -- consists of six worksheets:
  1. Instructions
  2. Displays detailed information about MRL or Product Life-cycle simply by clicking on a given cell or icon for which information is desired
  3. List of definitions for terms typically used in acquisition and MRA process
  4. List of acronyms commonly used in manufacturing and in the development and acquisition process
  5. MRL Matrix for those who wish to view/print the entire matrix on a single sheet
  6. Contains complete list of questions/criteria to be used in MRA
    - Intended to be tailored to system, subsystem, or component being assessed
    - Limited to questions focused on target MRL or one level lower, selected for item and target MRL
- Government “Ask an Expert” List and Industry POC List

http://www.dodmrl.com/
“Acceptance of MRLs has grown among some industry and DOD components. Yet, DOD has been slow to adopt a policy that would require MRLs across DOD. Concerns raised by the military services have centered on when and how the MRL assessments would be used. While a joint DOD and industry group has sought to address concerns and disseminate information on benefits, a consensus has not been reached. If adopted, DOD will need to address gaps in workforce knowledge, given the decrease in the number of staff in the production and manufacturing career fields.”