

A Critique
Of
MRA Lite as presented in the
*Early Manufacturing and Quality
Engineering Guide*

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Introduction

The OUSD issuance, *Early Manufacturing and Quality Engineering Guide*, Jul 2022, under section 3.3 *Early System Development MRA (MRA “Lite”)*, presents two approaches for identifying manufacturing maturity and risk. These are intended for early screening of system concepts and prototypes during early pre-Materiel Development Decision (pre-MDD) candidate solution set development and that could be used prior to Milestone A in Major Capability Acquisition (MCA). The first is the use of a list of questions as a tool to quickly identify areas of manufacturing risks in system concepts at all levels. The second is to perform an “MRA Lite,” using selected subthreads and combined MRL criteria to conduct a tailored Manufacturing Readiness Assessment (MRA). These approaches are confined to the Pre-MDD and early-stage Materiel Solutions Analysis (MSA) phase with the intent that a full Manufacturing Readiness Level (MRL) assessment of the system be performed later in the phase.

The *Guide* implies that the technical team can use certain initial questions to identify potential risk and determine where they should focus early manufacturing maturity assessments. This will allow the technical team to perform a “Tailored MRL assessment” by selecting applicable MRL criteria. This is not a “Tailored MRL assessment.” At best, this could be considered an “MRA Lite.”

As presented in *Appendix A* of the *Guide*, the second approach is to perform an “MRA Lite” by using certain MRL subthreads, but combines MRL maturity levels in the criteria shown. Choosing which subthreads to apply results in an MRA, but not an assessment using the MRL process.

MRA Lite in Early M & Q Engineering Guide

Section 3.3

The following is from the *Early Manufacturing & Quality Engineering Guide*, §3.3:

As a best practice during Pre-MDD or prototyping, if the program is not planning to conduct an MRA using the complete MRL assessment criteria matrix, the technical team may use a tailored assessment approach (i.e., MRA “Lite”) to identify risks early. This abbreviated version of the MRA allows the development team to focus quickly on specific critical technologies and subsystems with potential manufacturing and producibility issues based on known or perceived risks. The technical team should conduct a follow-on complete MRL assessment as information becomes available.

The idea of abbreviating an early stage manufacturing risk assessment is sound. This guide offers two methods for an “MRA Lite,” not an MRL Lite. In this section, the sample question set is below, and the other is discussed in Appendix A. This is a different approach, but both include the suggestion that a follow-on complete MRL assessment should be conducted:

MRA Lite evaluations should then lead to more rigorous and comprehensive MRL assessments of the preferred solution concept.

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Again, this is intended only for the early stages of a program versus a streamlined MRL assessment that could be conducted at any time. The recommendation to conduct a more rigorous MRL assessment of the preferred solution concept, which again, is correct.

The technical team can use certain initial questions to identify potential risk and determine where they should focus early manufacturing maturity assessments. They can then select applicable MRL criteria for a tailored assessment.

The last statement above is the point at which the use of the questions becomes misleading. An MRL assessment tailored using these questions does not reflect all the MRL criteria and does not link to the specific threads and subthreads. The questions only address 11 topics.

Following are sample questions:

- **Materials:** Does the item include new and/or unique materials that have not been demonstrated in similar products or manufacturing processes?
- **Diminishing Manufacturing Sources and Material Shortages (DMSMS):** Have the identified parts been evaluated to ensure there are at least 5 years remaining in their life cycle?
- **Cost:** Is this item a cost driver that has a significant impact on unit or life cycle cost (development, unit, or O&S costs)? Is the technology new with excessively uncertain cost?
- **Design:** Does the item design contain non-standard dimensions, geometries, or tolerances?
- **Manufacturing Process:** Will the item require use of manufacturing technology, processes, inspection, or capabilities that are unproven in the current environment?
- **Quality:** Does the item have historical or anticipated yield or quality issues; or are there new quality requirements (i.e., inspection techniques, test equipment) that must be developed and proven?
- **Schedule:** Does this item present lead-time issues or manufacturing concerns on the critical path that could significantly impact the program schedule?
- **Facilities:** Does this item require a new manufacturing facility or major updates of existing facilities (e.g., new capability or capacity) to meet production and scale-up requirements?
- **Supply Chain Management:** Does the item have anticipated or historical sub-tier supplier problems (e.g., sole source, foreign source) that could negatively impact cost, quality, or delivery?
- **Industrial Base:** Is the industrial base footprint capable of meeting the program's needs, or are there identified critical shortfalls or gaps in the industrial base?

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- **Cybersecurity:** Are there anticipated cybersecurity weaknesses and vulnerabilities associated with manufacturing, supply chain or Operational Technology related to Critical Program Information in the Program Protection Plan or that need to be addressed?

The above questions do add the Cybersecurity topic, which is not included in the Deskbook filter questions and should be. This is the extent of §3.3 in the *Guide*.

Appendix A

In the Appendix A of the *Guide*, there is an explanation of a different approach to “MRA Lite” and provides examples of risk areas to subsystem, items, or components.

This approach introduces a new subthread sequence and a combination of MRL criteria, which are not directly traceable to the MRL criteria. The selected criteria leave out MRL subthreads on cost, cybersecurity, industrial base, and manufacturing management. One subthread is mislabeled as “Technology Maturity” and is focused on “manufacturing technology” development of product technology maturity. The *Guide* shows a sample with 16 subthreads and combined levels that on analysis are not consistent with existing MRL criteria at the appropriate levels.

This initial paragraph offers a good explanation of an approach to focus manufacturing risk identification and again closes with the recommendation that a more rigorous “MRA” should be conducted. The section then discusses use of certain criteria from the MRL matrix, creating pairs of MRL levels, and omitting criteria on Cost and Cybersecurity.

As stated in Appendix A:

Using select MRA criteria referenced at www.dodmrl.org, the assessment team can select appropriate criteria for the early assessment. Table A-1 provides an example MRA-Lite evaluation approach using select criteria.

There are no “select MRA criteria referenced at dodmrl.org.” What is referenced at that site is the body of knowledge on conducting an MRL assessment. The subthreads and criteria “sample” below are from the *Guide* and are not what is stated in the MRL criteria. Comments about the criteria have been added and are in bold below each table section.

Table A-1. Sample MRA Lite Criteria

MRL 1-2 DESIGN THREAD	MRL 3-4 DESIGN THREAD	MRL 5-6 DESIGN THREAD
<i>Producibility and manufacturability issues identified and correlated to key product/technology variables</i>	<i>Producibility and manufacturability criteria established and used to identify improvement opportunities</i>	<i>Producibility and manufacturability assessments used to guide system element optimization activities</i>
Above is not completely tied to MRLs 1 and 2, subthread B.1, which also discusses identification of elements that impact producibility.	Above is not what is stated in MRLs 3 and 4, subthread B.1, which includes use of experiments for manufacturability and	Above is one criterion from MRL 6: “Results used to shape AS, SEP, manufacturing and producibility plans, and planning for EMD or

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	producibility and completed assessments of same for AoA.	technology insertion programs,” but not the rest of the criteria.
<i>Part family design, material, and process capability gaps identified and characterized</i>	<i>Part family design, material, and process requirements traceable to system-level operational requirements</i>	<i>Prototype part key characteristics identified with sensitivities correlated to system performance requirements</i>
Not what is stated in MRLs 1-2 criteria. What is stated is identification of capability gaps to meet system requirements and objectives.	Establishing traceability of product requirements to operational requirements might occur in MRLs 5 and 6, not 3 and 4! Identification of FFF and manufacturing capabilities, and initial KPPs is part of MRL 4.	MRL 6 states “preliminary KCs for the design identified and mitigation plans initiated,” nothing about system performance. Product data for prototyping released and features and requirements defined for PDR.
MRL 1-2 MATERIALS THREAD	MRL 3-4 MATERIALS THREAD	MRL 5-6 MATERIALS THREAD
<i>Material process-property-structure cause-effect relationships and key variables have been characterized</i>	<i>Material process-property-structure relationships can be analytically or computationally predicted</i>	<i>Material properties are adequately characterized and preliminary material specifications are in place</i>
Not part of MRLs 1-2, which discuss material property identification, manufacturing, and quality.	Not part of MRLs 3-4, which discuss validation during experiments and laboratory demonstration.	Two of MRL 6 criteria only and not MRL 5. Missing is use in production relevant environment and verification by demonstration.
<i>Material availability and/or obsolescence issues identified along with potential solutions to address</i>	<i>Material availability, obsolescence, and long lead time mitigation plans in place to support prototype builds</i>	<i>Material availability, obsolescence, and long lead time scale-up plans in place for transition to production</i>
Global trends on availability, obsolescence, and DMSMS with gaps. No potential solutions to availability in MRLs 1-2.	Again, overly mature criteria (MRL 5). MRL 3 is about identification of strategy. MRL 4 is about AoA and inclusion of mitigation plans in the SEP.	Scale-up planning is just initiated, not in place (MRL 5). Risks and issues for prototype addressed for MRL 5 and EMD build for MRL 6. Long Leads identified for MRL 6. This is more like an MRL 7 criteria set to address LRIP.
<i>Supply chain capability and capacity gaps identified along with potential solutions to address</i>	<i>Supply chain gap closure solution strategies defined with potential additional sources identified</i>	<i>Critical supply chain suppliers identified with additional qualified sources being developed</i>
No mention of “potential solutions” in MRL 2; identification of gaps only.	First part is MRL 3, but “additional sources” is an MRL 5 criteria. Capability and	Again, too advanced; “additional qualified sources” are merely identified for MRL 6 maturity. No mention of

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	capacity should be considered in the AoA.	sole/single/Foreign Owned Controlled or Influenced sources identified or minimized.
MRL 1-2 PROCESSES THREAD	MRL 3-4 PROCESSES THREAD	MRL 5-6 PROCESSES THREAD
The correct title is "Process & Capability Control," not "Processes." The order of criteria is flipped with E.2 coming first, then E.3, and E.1.		
<i>Process stability and repeatability cause-effect relationships and key variables have been characterized</i>	<i>Process control variability limits defined and statistically monitored for critical process variables</i>	<i>Process capability data from prototype builds used to establish production requirements</i>
MRLs 1-2 do not discuss characterization. Discussion is on hypotheses development and testing.	Process control variables and repeatability validated by experiment. Process capability requirements and improvements identified and documented.	This is more likely an MRL 7 criteria. MRL 5 is identify process capability requirements for production. MRL 6 is demonstration and data collection from prototype build to REFINE process capability requirements.
<i>Process yield drivers and capacity bottlenecks identified along with potential solutions to address</i>	<i>Process yield and capacity improvement strategies defined with plans in place to address gaps</i>	<i>Process yield, scrap, rework, and capacity utilization metrics and improvement targets defined</i>
Hypotheses development and validation of potential yields and rates.	Beyond MRL 5, by saying "plans in place." MRL 5 is plans developed/initiated. MRL 3 is identification of yield/rate gaps and MRL 4 is gap closure strategies and documentation.	MRL criteria are confined to yield and rates. MRL 5 is defining targets, issues, and improvement plans. MRL 6 is data collection used to further improvements.
<i>Process modeling and simulation analysis tool gaps identified along with potential solutions to address</i>	<i>Process modeling and simulation analysis tools utilized to define manufacturing and quality requirements</i>	<i>Process modeling and simulation analysis tools utilized to guide prototype process optimization</i>
Process modeling and simulation tools identified and use initiated (MRL 2).	Here is where gaps are identified in MRL 3 and then tools are used to define requirements (MRL4).	Above is using tools for optimization. MRLs state use tools to determine constraints (limitations).
MRL 1-2 QUALITY THREAD	MRL 3-4 QUALITY THREAD	MRL 5-6 QUALITY THREAD
<i>Quality management system gaps identified along with potential solutions to address</i>	<i>Quality management system business processes established for prototype and production scale-up</i>	<i>Quality management system used to establish quality plans for prototype and production scale-up</i>
Here they identify gaps in QMSs. In MRLs, considerations of QMSs are surveyed and	In MRLs, QMS requirements are identified and considered in an AoA with documentation in the SEP. Not mentioned is	No mention for plans for prototype/production scale up in MRLs. MRL 5 is QMS inclusion of KCs, and MRL 6 is

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needs are assessed, analyzed, and validated.	prototype and production scale up.	about quality plans and quality metrics, risks, and issues identification.
<i>Product quality drivers identified for prototype builds along with potential solutions to address</i>	<i>Product quality criteria and inspection and acceptance test methods defined for prototype builds</i>	<i>Product key characteristics and acceptance test verification criteria defined for prototype builds</i>
MRLs are evaluating technology variability impact on quality, not necessarily identification of quality drivers.	Above is more like MRL 5, not MRLs 3-4. MRL 3 is identifying initial product quality requirements, risks, and issues. MRL 4 determining inspection and test strategies and documenting mitigation plans in the SEP.	MRLs 5-6 are identifying and defining roles, responsibilities, test procedures, statistical controls, and final inspection requirements and procedures for prototype through EMD units.
<i>Supplier quality management business process gaps identified with potential solutions to address</i>	<i>Supplier quality management business processes established for supplier requirements flow down</i>	<i>Supplier quality management business processes established for supplier development initiatives</i>
“Business process gaps” are not defined in the Guide. MRLs are evaluating Supplier Quality Management.	MRL criteria are verifying that supplier quality management system requirements are defined and documented. No mention of “flow down.”	MRLs 5-6 criteria are identifying Supply chain quality capabilities, risks, and improvement initiatives.
MRL 1-2 WORKFORCE THREAD	MRL 3-4 WORKFORCE THREAD	MRL 5-6 WORKFORCE THREAD
This is supposed to be “Manufacturing Workforce”, not simply “Workforce.” This evaluation is divided into “Engineering” and “Production” criteria, where MRLs are not.		
<i>Engineering workforce skill set gaps identified along with potential solutions to address</i>	<i>Engineering workforce skill set development requirements defined along with training solutions</i>	<i>Engineering workforce skill sets and talent pipeline sufficient to support prototype and production scale-up</i>
<i>Production workforce skill set gaps identified along with potential solutions to address</i>	<i>Production workforce skill set development requirements defined along with training solutions</i>	<i>Production workforce skill sets and talent pipeline sufficient to support prototype and production scale-up</i>
MRLs are identifying and evaluating workforce skill sets for emerging manufacturing technologies.	MRLs are focused on skill sets, requirements, and training development to close gaps.	This is close to the MRLs 5-6 requirements .

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MRL 1-2 FACILITIES THREAD	MRL 3-4 FACILITIES THREAD	MRL 5-6 FACILITIES THREAD
<i>Plant capacity and equipment modernization gaps identified along with potential solutions to address</i>	<i>Plant capacity and equipment modernization requirements defined to meet production scale-up requirements</i>	<i>Plant capacity and equipment modernization plans in place to meet production scale-up requirements</i>
MRLs in the Facility subthreads do not address equipment modernization.		
MRL 3 requires gap analyses. MRLs 1-2 require identification of available facility capabilities and capacities.	MRLs 3-4 continue requirements identification and include analysis in the AoA for prototype development and production, along with other requirements.	This is an MRL 7 requirement. MRLs 5-6 are concerned with prototypes and pilot line.
<i>Specialized tooling, inspection, and test equipment gaps identified along with potential solutions to address</i>	<i>Specialized tooling, inspection, and test equipment requirements defined along with implementation strategies</i>	<i>Specialized tooling, inspection, and test equipment in place to support prototype and production scale-up</i>
Should have been phrased as tooling and specialized test and inspection equipment.		
MRLs 1-2 requirements are only about identification of potential tooling, test equipment, and inspection equipment.	MRLs 3-4 requirements concern analyses that identify gaps in tooling, test equipment, and inspection equipment and includes analysis in the AoA.	MRLs 5-6 consider requirements for tooling, test equipment, and inspection equipment with rationale and schedule; demonstration in a relevant environment and completed requirements development for production.
MRL 1-2 TECHNOLOGY THREAD	MRL 3-4 TECHNOLOGY THREAD	MRL 5-6 TECHNOLOGY THREAD
This Thread should be titled “Manufacturing Technology Subthread,” because it is focused on ManTech, ignoring “Technology and the Industrial Base” subthreads.		
<i>Manufacturing technology gaps identified and gap closure solutions and investment needs defined</i>	<i>Manufacturing technology requirements and maturation/implementation projects defined</i>	<i>Manufacturing technology maturation/implementation projects funded, staffed, and under way</i>
MRLs 1-2 require identification of trends and gaps in manufacturing science and technology.	MRL 3 identifies requirements to address potential manufacturing capability gaps. MRL 4 defines initiatives for manufacturing technology development.	MRL 5 is manufacturing technology efforts initiated and MRL 6 requires demonstration of solutions in a production relevant environment.

The above material could serve as an “MRA Lite.” It should not refer to the MRL levels since it does not align with the MRL Matrix and it creates new criteria without correlation to existing MRL criteria. This approach is not a reduced burden MRL assessment.

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Summary

The OUSD issuance, *Early Manufacturing and Quality Engineering Guide, Jul 2022*, under section 3.3 *Early System Development MRA (MRA “Lite”)*, presents two approaches for identifying manufacturing maturity and risk. These are intended for early screening of system concepts and prototypes during early pre-MDD candidate solution set development, or use prior to Milestone A in MCA.

The first approach is the use of questions as a tool to quickly identify areas of manufacturing risks in system concepts at all levels. The *Guide* implies that the technical team can use certain initial questions to identify potential risk and determine “where they should focus early manufacturing maturity assessments.” From this, they can use applicable criteria for a tailored assessment, implying this is a “Tailored MRL” assessment, which it is not. At best this is an “MRA Lite.” Using these questions at this stage does not reflect the complete MRL criteria, especially since they are not linked to the specific threads and subthreads.

The second approach is to perform an “MRA Lite,” using selected subthreads and combined MRL criteria to conduct a tailored MRA assessment. The term “MRA Lite”, as presented in *Appendix A*, suggests choosing certain MRL subthreads to include and combines MRL maturity levels in the criteria. Choosing which subthreads to apply results in an MRA, but not an assessment using the MRL process.

The *Guide* constrains these approaches to the Pre-MDD and early-stage MSA phase with the intent that a full MRL assessment of the system should be performed later in the MSA Phase.¹ If this approach is used, and referred to as an “MRA Lite” it could provide indications of manufacturing risks, but it is not a reduced burden MRL assessment.

To reduce the burden of a full MRL Assessment, a streamlined MRL process should be applied. The APT paper *Streamlining MRL Assessments, Apr 2025*², develops an effective approach to reducing the burden of a full MRL Assessment, while still identifying products or elements that are likely to have manufacturing risks.

¹ Early M & Q Engineering Guide, Appendix A, Jul 2022.

² Streamlining MRL Assessments can be found at APT-US.com under the resources tab.