Manufacturing Readiness Levels Overviews

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Report Documentation Page

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Session Outline

- **What are Manufacturing Readiness Levels (MRLs)**
- Implementing MRLs into a Program
- What is a Manufacturing Readiness Assessment (MRA)?
- How to perform a MRA
- Sample Outputs and Deliverables
- Findings and Conclusions
- Additional Information

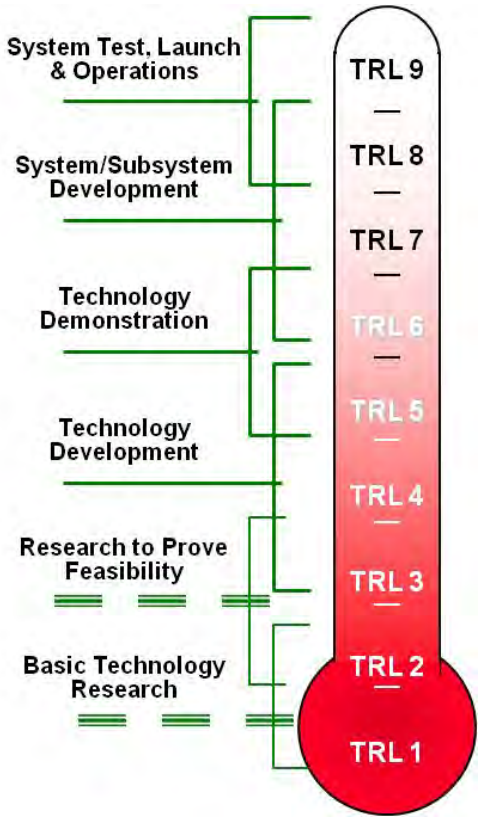
What are MRLs?

- Common language and standard for
  - Assessing the ***manufacturing maturity*** of a technology or product and plans for its future maturation
  - Understanding the level of ***manufacturing risk*** in trying to produce a weapon system or transition technology into a weapon system application
- Designed to complement TRLs
- Designed to help set the agenda for manufacturing risk mitigation
- Establish an expectation of achieving manufacturing maturity at critical decision points

NOTE: FY04 - Joint Defense Manufacturing Technology Panel (JDMTP) formed MRL Working Group to develop basic MRL definitions and criteria

What are TRLs?

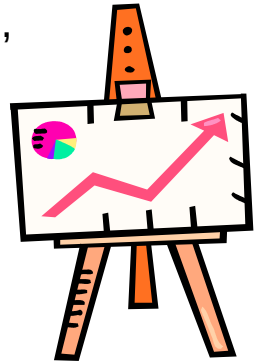
- Provide a common language and widely-understood standard for:
  - Assessing the *performance maturity* of a technology and plans for its future maturation
  - Understanding the level of performance risk in trying to transition the technology into a weapon system application



Why MRLs?

•Acquisition Performance perceived as broken

•Numerous Studies conducted in last 25 Years to improve Acquisition Process
    - •Packard Commission, Goldwater –Nichols Act, SecDef Perry Memo, etc



•GAO continues to identify cost and schedule overruns on Major DoD Acquisition Programs
    - •Need better knowledge early in acquisition to guide decisions

•Congress trying to help improve Acquisition Process
    - •TRL Legislation
    - •Weapons Systems Acquisition Reform Act of 2009

•New DoDI 5000.02 adding new requirements to perform manufacturing assessments

•**BOTTOM LINE** Current Performance in Acquisition must be improved – MRLs just one key tool to help

New Emphasis on Manufacturing

Per 5000.02, all programs shall:

assess the manufacturing feasibility and risk of alternatives being evaluated in the Analysis of Alternatives,

assess the manufacturing feasibility and risk of the proposed materiel solution for use in the Milestone A decision,

conduct assessments to identify manufacturing risks and ensure manufacturing processes have been demonstrated in a relevant environment in conjunction with the Preliminary Design Review (PDR) for use in the Milestone B decision,

conduct assessments to ensure the maturity of critical manufacturing processes has been demonstrated in a representative environment in conjunction with the Critical Design Review (CDR), and

conduct assessments to ensure that manufacturing processes have been effectively demonstrated in a pilot line environment and that there are no significant manufacturing risks for use in the Milestone C or FRP decisions.

How does MRLs Help

- Great Management Tool

- Defines Disciplined Process – Industry Best Practice
  - Analogous to Stage Gates for new product development

- Improves Communications and alignment of purpose between key stakeholders:
  - Government and Contractor
  - Prime and Suppliers
  - Industry's functional organizations (i.e. engineering, manufacturing, supply chain, quality, and program office

- Opportunity to generate fact-based technical discussions

MRLs A Great Management Tool

- Structured Approach
  - Develops Knowledge
    - Manufacturing processes, characteristics, constraints, requirements
    - Supports analysis of cost, schedule, producibility, scale-up, trades
  - Identifies & Manages Risk
    - Key manufacturing risks identified as early as milestone A
    - Comprehensive assessment of total manufacturing requirements
  - Great Program Review Tool
    - Assess manufacturing progress at reviews

- Products/Processes now aligned prior to entering production

- Can be used both tactically to solve a problem and strategically to identify Global and Enterprise issues that need to be addressed

MRLs A Best Practice

- Good Commercial Companies address manufacturing maturity early in development

- Provides discipline in addressing key manufacturing areas
  - Prime and Suppliers on same work sheet
  - Requires both Government and Industry to address manufacturing risk

- Developed with SMEs from over 60 major DoD suppliers and Multiple Government Agencies

MRLs A Great Communication Tool

- Standardize methodology across multiple suppliers
  - Requirements to achieve a defined level of manufacturing maturity is consistent
  - Provides consistency across the industrial base
- Provides a consistent set of expectations throughout the life cycle
- Identifies systemic problems across programs, suppliers, and services

Key Variables for Successful MRL Implementation

- Program leadership commitment
- Doing MRL Assessments early in Acquisition Process can lead to greater impact
- Using qualified SMEs to effectively implement and assess
- Follow through on planning and execution of necessary maturity/risk reduction efforts

MRL Benefits

- MRLs provide a lot of value at very little cost
  - Benefits significantly out weigh cost
  - Cost to implement and manage MRLs should not be considered “added cost” but rather early focus of risk mitigation efforts that tend to occur later, after the fact, and in worst case scenarios….not at all

- MRLs provide the required early visibility into manufacturing maturity to effectively manage risk

- MRLs set measurable and performance-based goals and provide oversight of contractor’s performance at both Prime and Suppliers

- MRLs provide clear expectations on what’s expected -more effective planning from everyone

- MRLs provide needed visibility and encourages proactive risk management

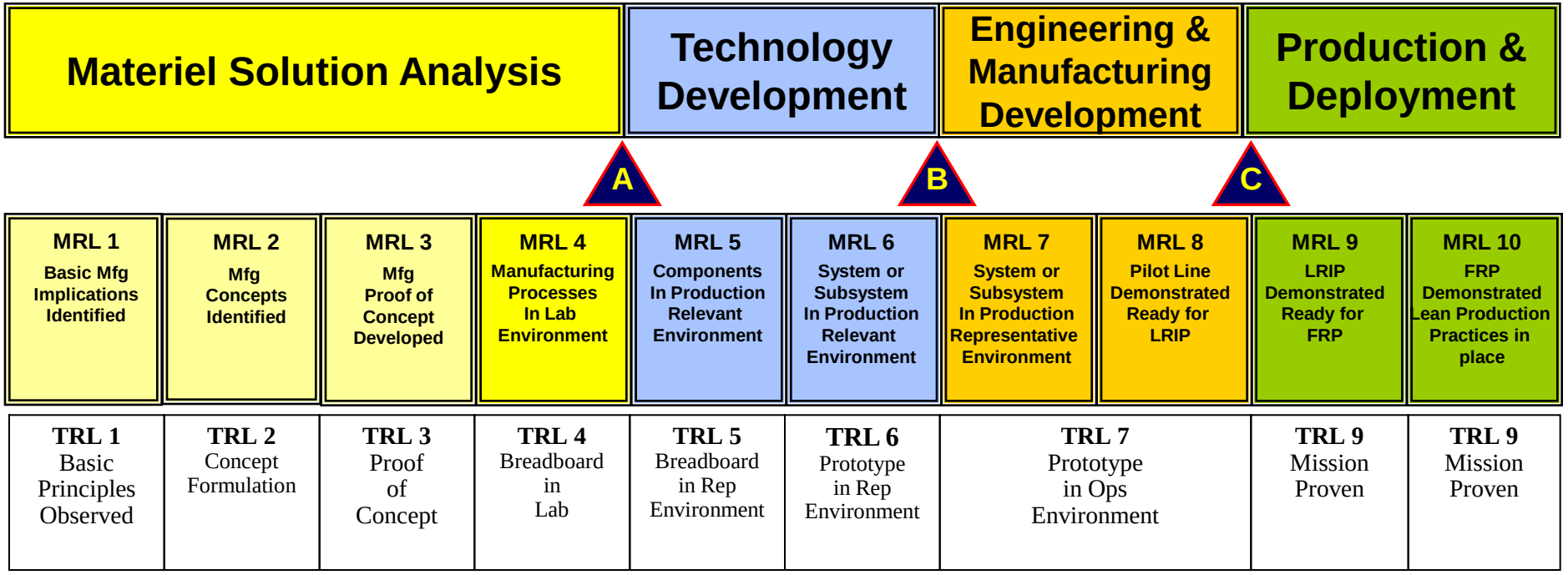
- Implementing MRL process can answer the new DoDI 5000.02 requirements for performing manufacturing assessments

Today's Air Force Reality

- Diminishing manufacturing infrastructure
  - People, policy, programs gutted
  - Lost recipe on how to manage manufacturing risk
  - Won't get infrastructure back, but still need to manage and mitigate manufacturing risk

MRL & TRL Relationships In Acquisition Process

Relationship to System Acquisition Milestones



Relationship to Technology Readiness Levels

MRL Definitions

DoD Manufacturing Readiness Level Definitions — Version 7.0- October, 2008

MRL	Definition	Description	Phase
1	Basic Manufacturing Implications Identified.	Basic research activities expand scientific principles that may have manufacturing implications. The focus is on a high level assessment of manufacturing opportunities. The research is unfettered.	Pre Concept Refinement
2	Manufacturing Concepts Identified.	Invention begins. Manufacturing science and/or concept is described in application context. Identification of material and process approaches are limited to paper studies and analysis. Initial manufacturing feasibility and issues are emerging.	Pre Concept Refinement
3	Manufacturing Proof of Concept Developed.	Analytical or laboratory experiments are conducted to validate paper studies. Experimental hardware or processes have been created, but are not yet integrated or representative. Materials and/or processes have been characterized for manufacturability and availability but further evaluation and demonstration is required.	Pre Concept Refinement
4	Capability to produce the technology in a laboratory environment.	Required investments, such as manufacturing technology development identified. Processes to ensure manufacturability, producibility and quality are in place and are sufficient to produce technology demonstrators. Manufacturing risks identified for prototype build. Manufacturing cost drivers identified. Producibility assessments of design concepts have been completed. Key Performance Parameters (KPP) identified. Special needs identified for tooling, facilities, material handling and skills.	Concept Refinement (CR) leading to a Milestone A decision.
5	Capability to produce prototype components in a production relevant environment.	Mfg strategy refined and integrated with Risk Mgt Plan. Identification of enabling/critical technologies and components is complete. Prototype materials, tooling and test equipment, as well as personnel skills have been demonstrated on components in a production relevant environment, but many manufacturing processes and procedures are still in development. Manufacturing technology development efforts initiated or ongoing. Producibility assessments of key technologies and components ongoing. Cost model based upon detailed end-to-end value stream map.	Technology Development (TD) Phase.
6	Capability to produce a prototype system or subsystem in a production relevant environment.	Initial mfg approach developed. Majority of manufacturing processes have been defined and characterized, but there are still significant engineering/design changes. Preliminary design of critical components completed. Producibility assessments of key technologies complete. Prototype materials, tooling and test equipment, as well as personnel skills have been demonstrated on subsystems/ systems in a production relevant environment. Detailed cost analyze includes design trades. Cost targets allocated. Producibility considerations shape system development plans. Long lead and key supply chain elements identified. Industrial Capabilities Assessment (ICA) for MS B completed.	Technology Development (TD) phase leading to a Milestone B decision.
7	Capability to produce systems, subsystems or components in a production representative environment.	Detailed design is underway. Material specifications are approved. Materials available to meet planned pilot line build schedule. Manufacturing processes and procedures demonstrated in a production representative environment. Detailed producibility trade studies and risk assessments underway. Cost models updated with detailed designs, rolled up to system level and tracked against targets. Unit cost reduction efforts underway. Supply chain and supplier QA assessed. Long lead procurement plans in place. Production tooling and test equipment design & development initiated.	System Development & Demo (SDD) leading to Design Readiness Review (DRR).
8	Pilot line capability demonstrated. Ready to begin low rate production.	Detailed system design essentially complete and sufficiently stable to enter low rate production. All materials are available to meet planned low rate production schedule. Manufacturing and quality processes and procedures proven in a pilot line environment, under control and ready for low rate production. Known producibility risks pose no significant risk for low rate production. Engineering cost model driven by detailed design and validated. Supply chain established and stable. ICA for MS C completed.	System Development & Demo leading to a Milestone C decision.
9	Low Rate Production demonstrated. Capability in place to begin Full Rate Production.	Major system design features are stable and proven in test and evaluation. Materials are available to meet planned rate production schedules. Manufacturing processes and procedures are established and controlled to three-sigma or some other appropriate quality level to meet design key characteristic tolerances in a low rate production environment. Production risk monitoring ongoing. LRIP cost goals met, learning curve validated. Actual cost model developed for FRP environment, with impact of Continuous improvement.	Production & Deployment leading to a Full Rate Production (FRP) decision
10	Full Rate Production demonstrated and lean production practices in place.	This is the highest level of production readiness. Engineering/design changes are few and generally limited to quality and cost improvements. System, components or items are in rate production and meet all engineering, performance, quality and reliability requirements. All materials, manufacturing processes and procedures, inspection and test equipment are in production and controlled to six-sigma or some other appropriate quality level. FRP unit cost meets goal, funding sufficient for production at required rates. Lean practices well established and continuous process improvements ongoing.	Full Rate Production/ Sustainment

MRL Definitions con't

MRL 1	MRL 2	MRL 3	MRL 4	MRL 5	MRL 6	MRL 7	MRL 8	MRL 9	MRL 10
Basic mfg implications identified	Mfg concepts identified	Mfg proof of concept developed	Capability to produce the technology in a laboratory environment	Capability to produce prototype components in a production relevant environment	Capability to produce a prototype system or subsystem in a production relevant environment	Capability to produce systems, subsystems or components in a production representative environment	Pilot line capability demonstrated. Ready to begin low rate production	Low rate production demonstrated. Capability in place to begin full rate production	Full rate production demonstrated and lean production practices in place

A B C

• Production relevant environment –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. Furthermore, there must be an indication of how the contractor(s) intend to achieve the requirements in a production representative and pilot environments.

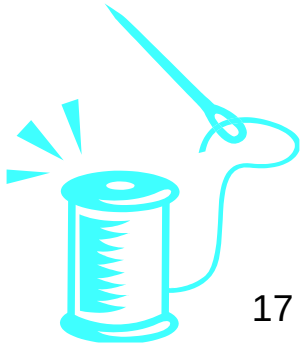
• Production representative environment – An environment that has as much production realism as possible, considering the maturity of the design. Production personnel, equipment, processes, and materials that will be present on the pilot line should be used whenever possible. The work instructions and 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.

• 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.

9 MRL Evaluation Criteria

("Threads")

1. **Technology and Industrial Base**
   - Technology maturity, technology transition to production, ManTech development
2. **Design**
   - Producibility program, design maturity
3. **Cost and Funding**
   - Production cost knowledge (cost modeling), cost analysis, mfg investment budget
4. **Materials (raw matls, components, subassys, subsystems)**
   - Maturity, availability, supply chain management, special handling
5. **Process Capability and Control**
   - Modeling & Simulation (product & process), mfg process maturity, process yields/rates
6. **Quality Management, to include supplier quality**
7. **Manufacturing Personnel, to include specialization, training, & certification**
8. **Facilities, to include capacity and plant layout & design**
9. **Manufacturing Management**
   - Manufacturing planning and scheduling
   - Materials planning
   - Tooling and special test equipment



MRL Criteria Matrix

DoD Manufacturing Readiness Levels (MRLs)											
Acq Phase		**Pre CR**	**Pre CR**	**Pre CR**	**CR - MS A** →	**TD**	**MS B** →	**SDD**	**MS C** →	← **LRIP - FRP** →	**FRP**
Thread	**Sub-Thread**	**MRL 1**	**MRL 2**	**MRL 3**	**MRL 4**	**MRL 5**	**MRL 6**	**MRL 7**	**MRL 8**	**MRL 9**	**MRL 10**
Technology & Industrial Base	**Technology Maturity**	Should be assessed at TRL 1.	Should be assessed at TRL 2.	Should be assessed at TRL 3.	Should be assessed at TRL 4.	Should be assessed at TRL 5.	Should be assessed at TRL 6.	Should be assessed at TRL 7	Should be assessed at TRL 7.	Should be assessed at TRL 8.	Should be assessed at TRL 9.
	Technology Transition to Production			Potential sources identified for technology needs. (Understand state of the art).	Industrial Base capabilities and gaps/risks identified for key technologies, components, and/or key processes.	Industrial Base assessed to identify potential manufacturing sources.	Industrial Capability Assessment (ICA) for MS B has been completed. Industrial capability in place to support mfg of development articles. Plans to minimize sole/foreign sources complete. Need for sole/foreign sources justified. Potential alternative sources identified.	Industrial capability to support production has been analyzed. Sole/foreign sources stability is assessed/monitored. Developing potential alternate sources as necessary.	Industrial Capability Assessment (ICA) 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.	Industrial capability is in place to support start of FRP.	Industrial capability supports FRP. Industrial capability assessed to support mods, upgrades, surge and other potential manufacturing requirements.
	Manufacturing Technology Development		New manufacturing concepts and potential solutions identified.	Manufacturing technology concepts identified through experiments / models.	Mfg science & advanced mfg technology requirements identified.	Required manufacturing technology development efforts initiated.	Manufacturing technology efforts continuing. Required manufacturing technology development solutions demonstrated in a production relevant environment.	Manufacturing technology efforts continuing. Required manufacturing technology development solutions demonstrated in a production representative environment.	Manufacturing technology efforts continuing. Required manufacturing technology solutions validated on a pilot line.	Manufacturing technology efforts continuing. Manufacturing technology process improvement efforts initiated for FRP.	Manufacturing technology efforts continuing. Manufacturing technology continuous process improvements ongoing.
Design	**Producibility Program**			Relevant materials/processes evaluated for manufacturability using experimental results.	Producibility & Manufacturability assessment of design concepts completed. Results guide selection of design concepts and key components/technologies for Technology Development Strategy. Required Test Evaluation Strategy (TES) includes Design for Test during production.	Producibility & Manufacturability assessments of key technologies and components initiated. Systems Engineering Plan (SEP) requires validation of design choices against manufacturing process and industrial base capability constraints. Manufacturing processes assessed for capability to test and verify in production, and influence on Operations & Support (O&S).	Producibility assessments of key technologies/components and producibility trade studies (performance vs. producibility) completed. Results used to shape System Development Strategy and plans for SDD or technology insertion programs phase.	Detailed producibility trade studies using knowledge of key design characteristics and related manufacturing process capability completed. Producibility enhancement efforts (e.g. Design For Mfg Assembly) initiated.	Producibility improvements implemented on system. Known producibility issues have been resolved and pose no significant risk for LRIP.	Prior producibility improvements analyzed for effectiveness during LRIP. Producibility issues/risks discovered in LRIP have been mitigated and pose no significant risk for FRP.	On-going producibility improvements analyzed for effectiveness. Producibility refinements continue. All mods, upgrades, Diminishing Mfg Sources & Material Shortages (DMSMS) and other changes assessed for producibility.
	Design Maturity	Manufacturing opportunities identified.	Applications defined. Broad performance goals identified that may drive manufacturing options.	Top level performance requirements defined. Trade-offs in design options assessed based on experiments. Product lifecycle and technical requirements evaluated.	Initial Systems Engineering Plan and Test and Evaluation Strategy recognize the need for the establishment/validation of manufacturing capability and management of manufacturing risk for the product lifecycle. Initial Key Performance Parameters (KPPs) identified.	Identification of enabling/critical technologies and components is complete and includes the product lifecycle. Evaluation of design Key Characteristics (KC) initiated.	Basic system design requirements defined. All enabling/critical technologies/components have been tested and validated. Product data required for prototype manufacturing released. A preliminary performance as well as focused logistics specification is in place. Key Characteristics and tolerances have been established.	Product requirements and features are well enough defined to support detailed systems design. All product data essential for manufacturing of component design demonstration released. Potential KC risk issues have been identified and mitigation plan is in place. Design change traffic may be significant.	Detailed design of product features and interfaces is complete. All product data essential for system manufacturing released. Major product design features are sufficiently stable such that key LRIP manufacturing processes will be representative of those used in FRP. Design change traffic does not significantly impact LRIP. Key characteristics are stable and have been demonstrated in SDD or technology insertion program.	Major product design features are stable and LRIP produced items are proven in product testing. Design change traffic is limited to minor configuration changes. All KCs are controlled in production to 3-sigma or other appropriate quality levels.	Product design is stable. Design changes are few and generally limited to those required for continuous improvement or in reaction to obsolescence. All KCs are controlled to 6-sigma or other appropriate quality levels.
	Production Cost Knowledge (Cost modeling)		Cost model approach defined.	Technology cost models developed for new process steps and materials based on experiments.	Detailed process chart cost models driven by key characteristics and process variables. Manufacturing, material and specialized reqt. cost drivers identified.	Detailed end-to-end value stream map cost model for major system components includes materials, labor, equipment, tooling/STE, setup, yield/scrap/rework, Work In Progress (WIP), and capability/capacity constraints. Component simulations drive	Cost model inputs include design requirements, material specifications, tolerances, integrated master schedule, results of system/subsystem simulations and production relevant demonstrations.	Cost models updated with detailed designs and features, collected quality data, plant layouts and designs, and obsolescence solutions.	Engineering cost model driven by detailed design and validated with data from relevant environment.	Actual cost model developed for FRP environment. Variability experiments conducted to show FRP impact and potential for continuous improvement.	Cost model validated against actual FRP cost.

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- What are Manufacturing Readiness Levels (MRLs)
- Implementing MRLs into a Program
- What is a Manufacturing Readiness Assessment (MRA)?
- Why Manufacturing Readiness?
- Sample Outputs and Deliverables
- Findings and Conclusions
- Additional Information

MRLs in Program

- Address MRLs in Key Documents
  - SEP, TDS, Acq Plans, RFP
- Use manufacturing maturity/risk in Source Selection
- Manufacturing Risk needs to be integrated into Program's Risk Management activity
- Implementing MRLs into a Program Management Activity
  - Incorporate in IMP and IMS
  - EVS data
  - Address Manufacturing Maturity into Program Management Reviews
- Assess manufacturing maturity in Technical Reviews
  - PDRs, CDRs, etc
  - Perform manufacturing readiness assessments
- Status manufacturing maturity at milestone reviews
  - Address DoDI 5000.02 requirements
- **BOTTOM LINE – Manufacturing is important and needs to be addressed in your programs**

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What is an MRA?

- An evaluation of a program's ability to produce on schedule while meeting cost and performance requirements
- A tool to develop and implement:
  - Manufacturing risk mitigation plans
  - Business strategies

- Results in an assignment of MRLs to key system components
- Results in the development of a manufacturing maturation plan as required

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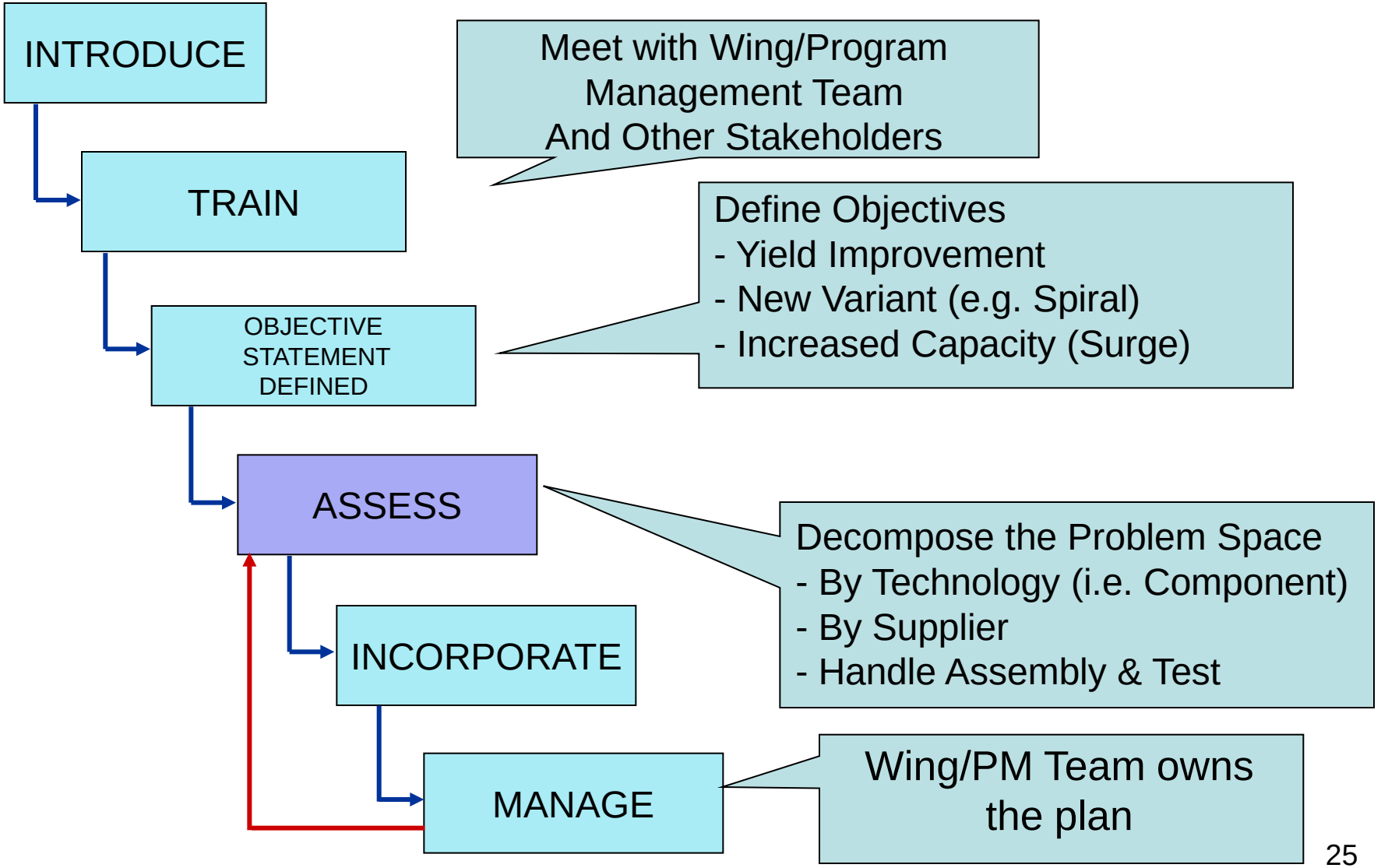
MRA Process

- Assessment Lead works with PM and contractor on Manufacturing Assessments Process
  - MRA Deskbook spells out process
- Assessment lead responsibilities
  - Determine appropriate level to perform Manufacturing Readiness Assessment(s) (MRAs) -- System may contain several critical technologies/components/manufacturing cells
  - Schedule on-site MRA with contractor(s)
  - Send Orientation Package to contractor(s)
  - Define Assessment Team Membership
  - Define Deliverables of Assessment Results
  - Conduct on-site assessment with contractor(s)
  - Deliver final report/briefing

Manufacturing Readiness Implementation Approach (ACATs)



Preparations

- Determine where to perform MRAs
  - Address **contract issues**
- Notify companies and send orientation package
  - Purpose, approach, questions, strawman agenda
  - MRL definitions/threads
  - Self-Assessment
- Select Assessment team(s)
  - Typically 2-6 members per team
  - Appropriate members (include Gov't customer)
    - Specialists for key technologies (if needed)
- Schedule On-site assessments
  - Months prior to key milestone decisions
    - Allow time to develop/implement risk mitigation plans
- Team Orientation–Meet prior to on-site assessment

Where to perform MRA

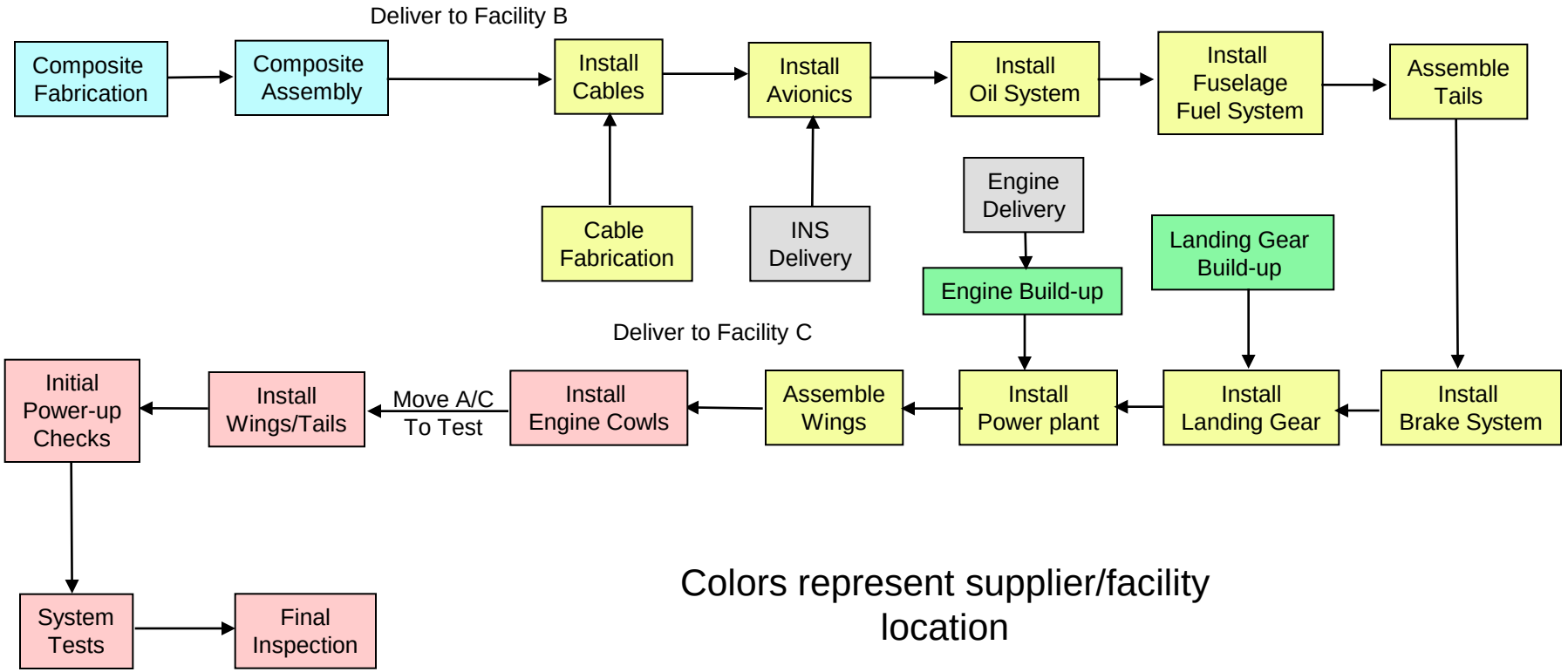
- **Key questions to ask!**
- **Materials:** Are there materials which have not been demonstrated in similar products or manufacturing processes?
- **Cost:** Is this item a driver that significantly impacts life-cycle cost (development, unit, or operations and support costs)? Is the technology new with 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?
- **If yes, consider performing an MRA at this facility**.

On-Site Activities

- **Introduce team and highlight specific roles**
  - Purpose of assessment and how results will be used
  - Assessment process
  - Expectations
- **Contractor should:**
  - Introduce contractor participants – highlight responsibilities
  - Provide detailed responses to questions provided in orientation package
  - Indicate who is available to work with team counterparts in later meetings for detailed discussions
  - Lead shop floor tour
- **Perform initial assessment**
- **Private meeting of Government assessment team to:**
  - Prepare feedback and identify any action items
  - Key strengths/risks/issues
  - Key missing data (if any)
  - Proposed action items
- **Out-briefing by Government team to contractor**

Example Process Flow
Generic Aircraft

- Large programs can require multiple MRAs



Supplier MRA Plan

- Identify and prioritize critical suppliers to perform MRA
- Determine Contract requirements (e.g. SOW)
  - Scope of MRA detailed
  - Method of MRA detailed
  - Output defined
- Developed detailed MRA execution plan with each supplier (schedule, format, personnel)
- Execute MRA
- Define/Plan/Execute MRL mitigations
- Measure mitigation effectiveness, update assessment
- NOTE: Similar to prime MRA – Prime should lead

Follow-on Activities

- Gather any key missing data
- Convene team meeting -- Typically within 2 weeks of on-site assessment
  - Discuss and finalize assessment
  - Examine current program and manufacturing risk reduction plans
  - Agree on likely MRL at completion of milestone if current plan is followed
- Share results with contractor
- Identify the specific risk reduction activities necessary to reach the next milestone
- Identify the funding, time-phasing and approach to carrying out each activity
- Prepare and submit final report

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MRA Deliverables

- Provide briefing and/or written report
  - Identify target MRL
  - Identify current MRL
  - Identify key factors where manufacturing readiness falls short of target MRL
    - Define driving issues
  - Identify programs and plans to reach target MRL
  - Assess type and significance of risk to cost, schedule or performance
- Next step: Implement and execute the Manufacturing Maturation Plan

SAMPLE SUMMARY ROLL-UP OF COMPONENTS

Subsystem	Top Level MRL	Observations	Most Critical
Guidance	3	- Lacking detailed process information - Key suppliers identified; Need key performance parameters - Need detailed process plans	Detector from supplier A - Design & production issues - No alternate source
Data Processor	3	- New processor architecture -Immature design tools - New attachment processes needed	Board Supplier can't test at their site Low yields on initial run
Propulsion	6	- Same as other systems in use - New component scheme	Re-validate manufacturing process Supplier handle increased rate
Air Vehicle	7	- Same supplier as system X - Need to test new mating and assembly processes at the prime	No critical items
Test Plan	6	Several instances of re-design work and new test processes	- New test strategy and plan - What will new design incorporate? - Manufacturing experience vital

SAMPLE SUMMARY (Drill down)

Guidance Sub systems	Top Level MRL	Observations	Most Critical
Front End Sensor	3	- Lacking details on builds - Process procedures need more work - Test and assembly procedures have not been verified in manufacturing environment	Detector from supplier A - Design & production issues - No alternate source
Data Processing PWB	3	- New processor architecture -Awaiting Design for Manufacturing and Assembly (DFMA) results	Low yields on initial build Working process controls Looking at re-design for easier fabrication
Cables For: Power Data	3	- Using same suppliers other weapon systems - Have not received prototypes, awaiting supplier delivery	Re-validate manufacturing process as seen on past programs Need new process plan
Housing	4	- New supplier: limited experience - Need new assembly processes at the prime	Need supplier management process; need new process plans
Cooling	3	- Form, fit factors for new cooling design not in place Initial process plan for build in place	Final cooling plan will be defined after front end is stable
Integration Process that includes assembly and test	3	- Several new test processes need development for new components	New test strategy and plan New special test equipment must be ordered

MRA Risk Management

- Assessing Risk is independent of the MRL value assigned
  - Higher MRL value may be highest risk
    - Eg. Requires new equipment, high cost process
- Risk Assessment should consider
  - Time needed to reach target MRL
  - Require new personnel, training, capital, or more POM samples to flush out the process
  - Leverage other programs
  - Captive or Merchant Supplier Dependency??
  - Part of a company's core business
    - Leads into an industrial base assessment
- Effective of use of Design for Manufacturing Tools and other simulation techniques.

Session Outline

- What are Manufacturing Readiness Levels (MRLs)
- Implementing MRLs into a Program
- What is a Manufacturing Readiness Assessment (MRA)?
- How to perform a MRA
- Sample Outputs and Deliverables
- **Findings and Conclusions**
- Additional Information

Some MRL Thoughts

- MRLs are not a report card
  - ***MRL 7 might not be good***
  - ***MRL 3 might not be bad***
- MRLs are a tool to manage and mitigate manufacturing risk
  - ***A common language used to assess manufacturing maturity***
  - ***Provide insight not <u>oversight</u>***

MRA Thoughts

- MRA process highlights areas needing attention to lower production risk
- Sets expectation and measures Prime contractor and Suppliers Manufacturing's progress as program matures
- Detailed analysis rank ordered; Can be an investment strategy and feeds into risk management
- Effective tool to convince Senior Leaders you are ready for production

Manufacturing maturity through the MRA process enables efficient, cost effective manufacturing

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Additional Information

- DoD Manufacturing Readiness Reference

http://www.dodmrl.com/

  - MRL Definitions
  - MRL Criteria Matrix
  - MRL Deskbook
  - Defense Acquisition University MRL Website
  - AF ManTech's MRA Tool and Users Manual