

Manufacturing Readiness Levels (MRLs)

for
**Multi-Dimensional Assessment of
Technology Maturity**

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U.S. AIR FORCE

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Outline



- **Why MRLs?**
- **What are MRLs?**
- **MRL implementation plan**
- **Status**
- **ACAT pilots**



Why MRLs?

Manufacturing & Industrial Base Challenge



- Consensus among Congress, OSD, CSAF, GAO:
“Advanced weapon systems cost too much, take too long to field, and are too expensive to sustain”
- Recent GAO study of 54 weapons programs:
 - Core set of 26 programs: RDT&E costs up by 42% and schedule slipped by 20%
 - \$42.7B total cost growth
 - 2.5 years slip on average
 - Characteristics of successful programs (GAO):
 - *Mature technologies, stable designs, production processes in control*
 - *S&T organization responsible for maturing technologies, rather than program or product development manager*
- Defense Science Board evaluated ManTech roles/impacts for AT&L
 - ManTech can significantly impact across all acquisition phases
 - Facilitates manufacturing/industrial base readiness for S&T transition and acquisition



Technology Readiness Levels (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

TRLs leave major transition questions unanswered:

- Is this level of performance reproducible in items 2- 1000?
- What will these cost in production?
- Can these be made in a production environment by someone without a PhD?
- Are key materials and components available?



Manufacturing Readiness Levels (MRLs)



What are MRLs?

- Framework to evaluate “*manufacturing maturity*”
- Complements existing Technology Readiness Levels
- Used to assess maturity and risk of a technology’s underlying manufacturing processes
 - Enable rapid, affordable transition to weapon system programs
- Designed to address manufacturing risk mitigation



DoD MRL Implementation



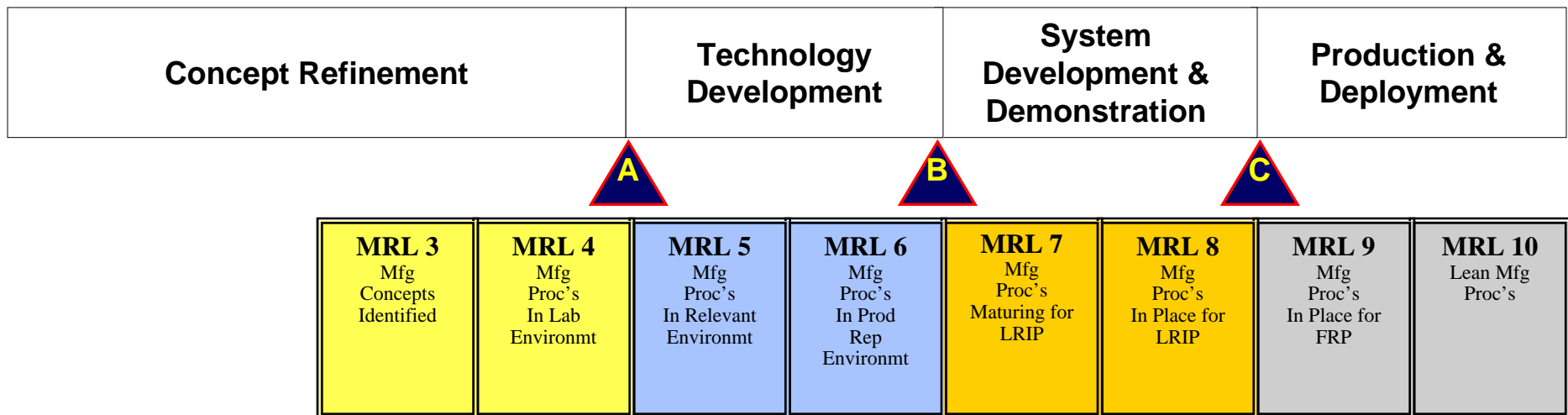
- **DoD (AS&C) vision is to develop and institutionalize MRLs**
 - Assess the manufacturing maturity of a technology or product and plans for its future maturation; common language to convey status
 - Understand the level of manufacturing risk in trying to produce a weapon system or transition the technology into a weapon system application
- **DoD Joint Defense Manufacturing Technology Panel (JDMTP) chartered an MRL Working Group to refine definitions and develop plans to institutionalize MRLs within the AT&L community**
 - Government and industry representatives participating
 - Developed definitions that interface with TRLs and milestone decision points
 - Develop implementation strategy consistent with DoD 5000 acquisition doctrine, practice, and milestone decision points
- **SAF/AQ**
 - Conduct ACAT pilots and then develop policy
- **AFRL/CD**
 - Implement into all AFRL ATDs



MRL Relationships



Relationship To System Milestones

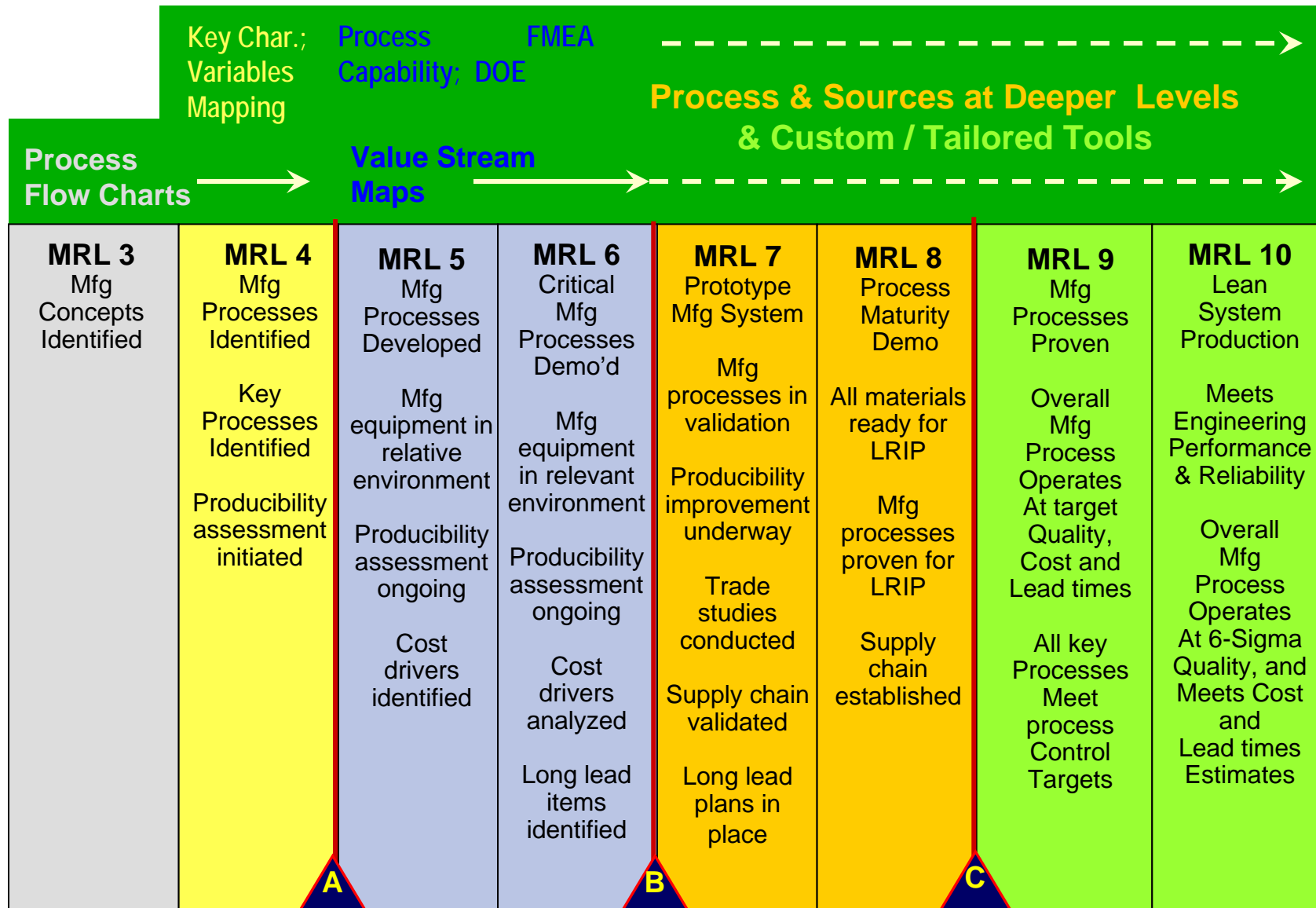


Relationship To Technology Readiness Levels

TRL 1 Basic Principles Observed	TRL 2 Concept Formulat	TRL 3 Proof of Concept	TRL 4 Breadbrd in Lab	TRL 5 Breadbrd in Rep Environmt	TRL 6 Prototype in Rep Environmt	TRL 7 Prototype in Ops Environmt	TRL 8 System Qual	TRL 9 Mission Proven
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MRL Definitions & Tools





Mapping Tools for MRL



<u>MRL</u>	<u>Tools</u>	<u>Use to Evaluate...</u>
3	Process Flow Charts	Basic manufacturing concepts
4	Detailed Process Flow	Key manufacturing processes charts
5	Value Stream Mapping and identifying waste	Mapping the current state
6-10	Value Stream Mapping and eliminating waste	Mapping the future state



Process Control Tools for MRL



<u>MRL</u>	<u>Tools</u>	<u>Use to Evaluate...</u>
4-6	Key Characteristics	Requirements and tolerances
4	Process Variables Map	Which variables to control
5-9	Process Capability Performance	Predictability of process
5-9	Design of Experiments independent variables	Multiple factors and levels of
6-9 Analysis	Failure Modes and	Risks associated with failure effects



MRL Evaluation Criteria



- **Technology and Industrial Base**
- **Design**
- **Materials**
- **Cost and Funding**
- **Process Capability and Control**
- **Quality Management**
- **Manufacturing Personnel**
- **Facilities**
- **Manufacturing Management**



What is an ATD?



- **Any Air Force science and technology program (6.3)**
 - **Objective of demonstrating an integrated set of technologies**
 - **Superior warfighting capability**
 - **Ready to transition before the end of the FYDP**
- **Sufficiently mature the technology(ies) for transition into an advanced system development or a fielded system upgrade**
- **Categories**
 - **CAT 1**
 - **MAJCOM/Agency supports and has programmed required funding for transition within the FYDP**
 - **CAT 2A**
 - **MAJCOM/Agency supports and is committed to identify transition funding in next programming cycle**
 - **CAT 2B**
 - **MAJCOM/Agency supports but is not currently able to POM for transition**



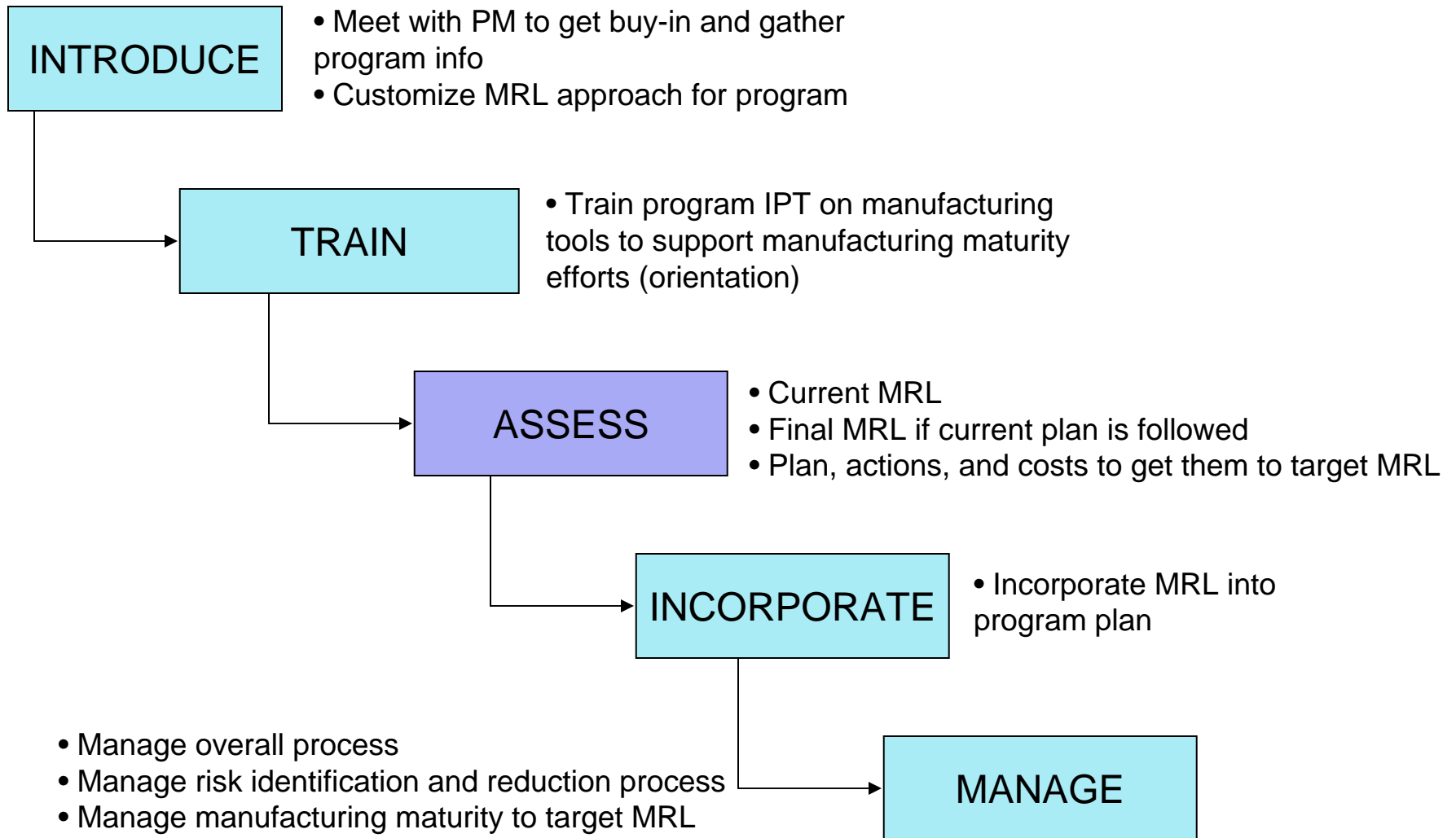
MRL Incorporation into AFRL ATDs



- **Conducted ATD pilot assessments on five ATDs**
- **Tasked to implement MRLs into hardware intensive ATDs**
- **Developed basic approach/process for implementation**
- **Developed training for ATD IPTs and ManTech personnel**
- **Identified core ManTech funding for MRAs and selected follow-on MRL maturation**
- **Conducted assessments of four additional ATDs**
- **Currently working with ten total ATDs**



ATD MRA Approach





Current ATD Portfolio



- **F135 (PR)**
- **F136 (PR)**
- **Common Weapons Data Link (MN)**
- **X-band Thin Radar Array (SN)**
- **Shredder (MN)**
- **High Temperature Polymeric Matrix Composites (ML)**
- **High Durability Hot Exhaust Structures (ML)**
- **Affordable Responsive Space Lift (VA)**
- **Battlefield Air Operations Kit (MN)**
- **Advanced Multi-junction Solar Cells (VS)**



Manufacturing Readiness Current Planning Process



- **ATD selection has been by TD**
 - **Primary Customer Base, CAT I ATDs**
 - **PR, SN, MN, VA, VS, and ML**
 - **Implement MRLs into five ATDs per quarter**
 - **Introduced MRLs to wide AFRL community**
- **Training ManTech personnel to conduct effective assessments**
- **Train IPT, conduct assessment, execute plan to reach target MRL**
- **Developing process with AFRL/XP for timely new ATD identification**
 - **ManTech to become an integral part of ATD selection process**



ATDs Planned for FY06



- **Choose ATDs based on similar technologies areas**
- **ATD candidate technology areas**
 - **Electronics**
 - **Propulsion & Power**
 - **Space**
 - **Structures**
- **Identify cross-cutting technologies**
 - **Develop ManTech program to satisfy several ATDs**
 - **Leverage on-going programs**
- **Planning a summer blitz to implement into several ATDs**



FY06 ACAT Tactical Plan



- **Per SAF/AQ tasking, select pilots with SAF/AQR**
 - **Need to manage with on-going ATD workload**
- **Convene experienced assessment team**
 - **Experience with assessment process**
 - **Subject matter expertise**
 - **Acquisition wing personnel and contractors**
- **Conduct MRAs on pilots – key technologies or components**
 - **E.g. F-22A, AMRAAM**
- **Develop/refine assessment process for acquisition programs**
 - **Will vary from ATD process and may be program specific**
 - **Dependent on current or target milestone**
 - **Significant program office involvement**



MRA Deliverables



- **Current MRL**
 - **Key risk areas**
 - **Driving issues**
- **Plan to obtain target MRL**
 - **Risk mitigation plans**
 - **Schedule**
 - **Funding**
 - **Contract modification language**



Additional Information



- MRL definitions can be found at DAU web site:
 - https://acc.dau.mil/simplify/ev_en.php
 - Click on Production Quality & Manufacturing
 - Click on Manufacturing Readiness Assessments



In Closing



- **MRL working definitions established**
 - **JDMTP on board**
 - **Exercising on ATDs and ACATs**
 - **But no formal policy yet**
- **MRL process established in AFRL ATDs**
- **Managing current manpower issues**
- **Initializing ACAT pilot efforts**

Moving forward but still developing...