Manufacturing Readiness Levels (MRLs)

for

Multi-Dimensional Assessment of Technology Maturity

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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

Concept Refinement	Technology Development	System Development & Demonstration	Production & Deployment

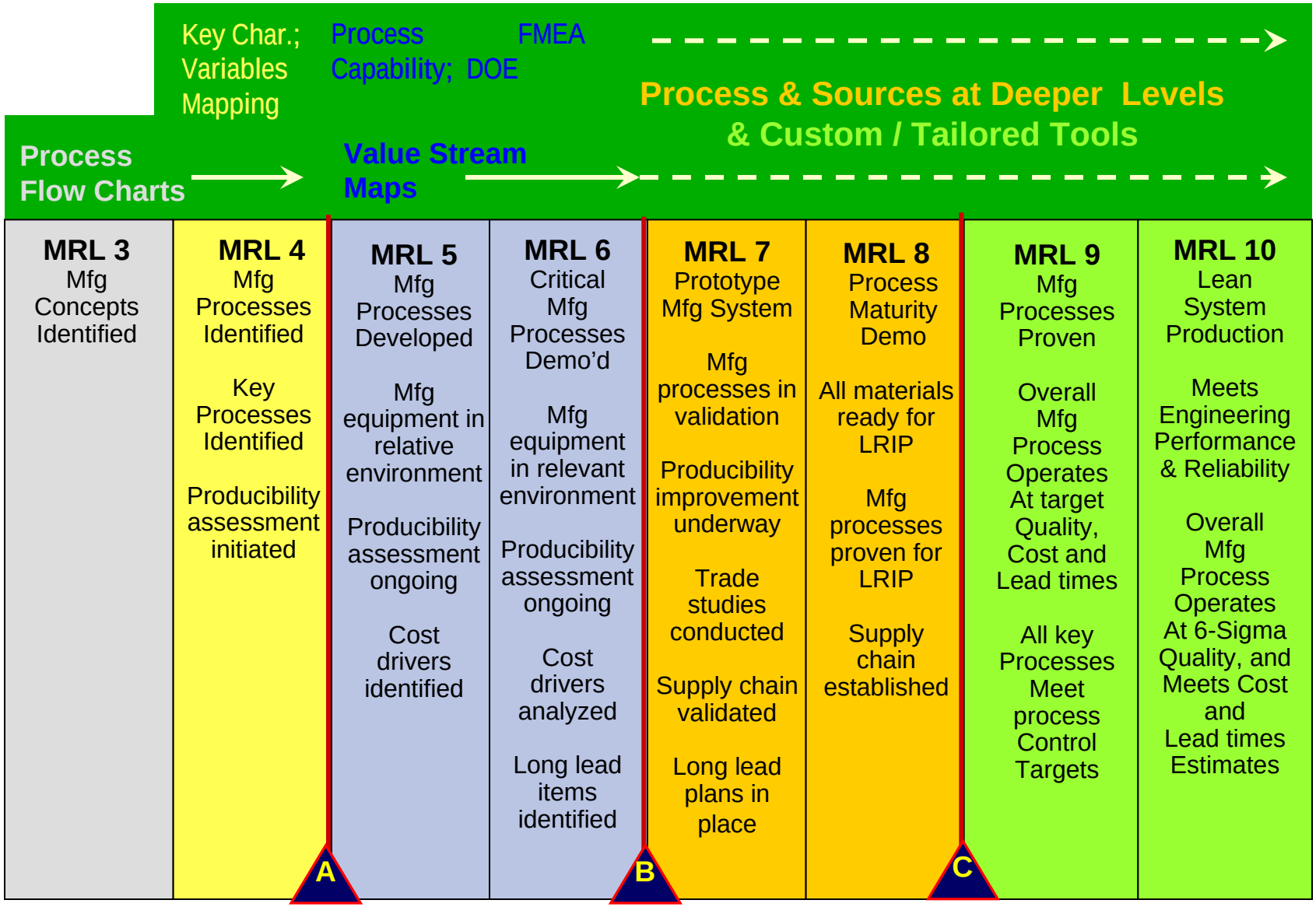
A B C

MRL 3	MRL 4	MRL 5	MRL 6	MRL 7	MRL 8	MRL 9	MRL 10
Mfg Concepts Identified	Mfg Proc's In Lab Environmt	Mfg Proc's In Relevant Environmt	Mfg Proc's In Prod Rep Environmt	Mfg Proc's Maturing for LRIP	Mfg Proc's In Place for LRIP	Mfg Proc's In Place for FRP	Lean Mfg Proc's

Relationship To Technology Readiness Levels

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

MRL Definitions & Tools



Mapping Tools for MRL

MRL	Tools	Use to Evaluate…
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

MRL	Tools	Use to Evaluate…
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	**Failure Modes and Analysis**	**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

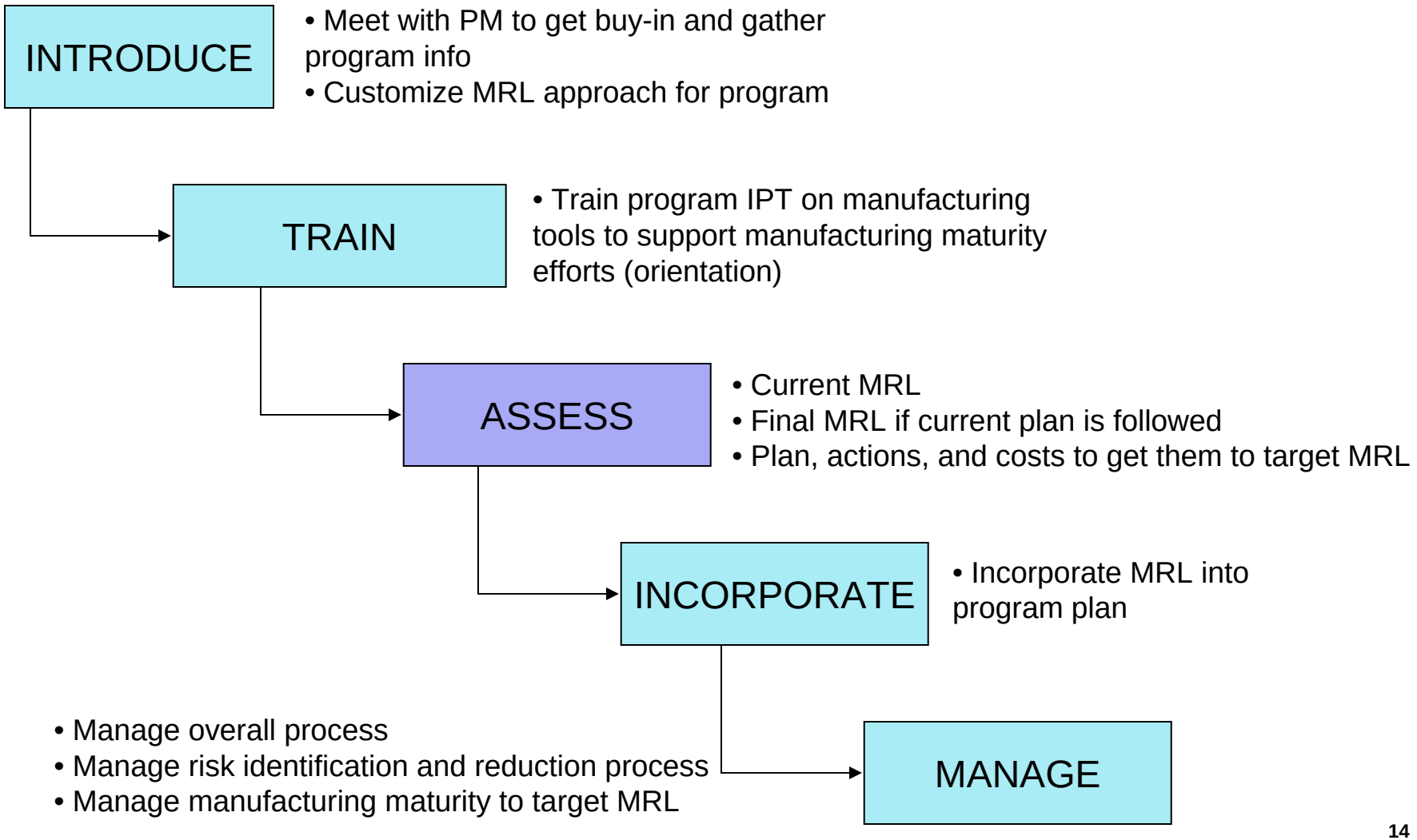
What is an ATD?

- 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…