Manufacturing & Quality
Body of Knowledge & Reference Guide

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Agenda

• Provide overview of the EP&S-developed Manufacturing & Quality (M&Q) Body of Knowledge (BoK)
  - Background:
  - Structure:
  - BoK as a Reference Guide:
  - Chapters:
  - Chapter Example: Materials Deep Dive
Background: Typical M&Q Activities
Background: M&Q BOK Development

• Need for BoK:
  - Manufacturing and quality issues experienced on acquisition programs (identified in acquisition documents, ITRAs & milestone decision reviews)
  - Many PQM functions are being performed by non-PQM personnel
  - Loss of M&Q experience across DoD (i.e., decentralization of M&Q functions, use of industry standards)

• BoK developed by EP&S M&Q support staff

• Draft provided to Government/Industry for comment (2018-2019)

• Encouraged input through: MRL Working Group, NDIA Manufacturing Division, Defense Manufacturing Conference, SAE G-23 Committee, M&Q Service Leads
  - Received substantial number of inputs from Industry, M&Q Service Leads and DCMA
  - All comments reviewed and adjudicated

• Plan for refresh—Update of content is key—need to keep current
  - Changes in policy and processes, references, terms (i.e., Agile Acquisition Framework paths)
  - Update for early systems engineering/manufacturing (i.e., lessons learned from modernization priorities)
Background: BoK Approach

• The BoK details M&Q activities throughout the system life cycle
  - Not intended to be read from “end to end”

• PQM managers may refer to the BoK to find information relevant to the phase of the program they are working on
  - Activities, Tasks, Metric, References and Tools

• Within a specific phase, the user may focus on the sections that apply to the M&Q activities the program is conducting

Bok is a Reference Guide — Similar to a “Play Book” for M&Q Managers
1. Add other BTP elements

Potential supply chain members

Technology & Industrial Base

Management Std

Management Pgm

MIL-HDBK-896A

Background: BoK Based on Key Documents

Contracting for M&Q

M&Q Body of Knowledge

DoDI 5000.02 AAF
DoDI 5000.88 (Engineering)
Defense Acquisition Guidebook
ITRA Guidance
Public Law
PQM Competencies

ISO & SAE Quality Standards

SAE AS6500 Commercial Manufacturing Management Std

MIL-HDBK-896A Manufacturing Management Pgm

RFP SOW DIDS FAR DFARS

Best Practices

NAVSO P-6071

Manufacturing Readiness Level (MRL) Toolkit

Level Criteria
Compilation of Best Practices
(Backed by experience, policy and guidance)

- **Activities and Tasks**
  - Tasks describe what should be done, or considered, to accomplish the activity

- **Tools**
  - Where can I learn how to perform the activity/task?

- **Metrics**
  - How do I know I accomplished the activity well?

- **Resources (References)**
  - Law, policy, guidance, regulations, or instructions affecting the activity
  - Where can I learn what is required, and why I need to perform the activity/task?

BoK Available at https://ac.cto.mil/maq/
The BoK includes 6 chapters:

- Introduction—“How to use the BoK” (included in each chapter)
- Chapter 1: Pre-Materiel Development Decision (Pre-MDD)
- Chapter 2: Materiel Solution Analysis (MSA)
- Chapter 3: Technology Maturation and Risk Reduction (TMRR)
- Chapter 4: Engineering and Manufacturing Development (EMD)
- Chapter 5: Production and Deployment (P&D)
- Chapter 6: Operations and Support (O&S)

- Appendices: Resource documents (with links), Tools (with links) and Acronyms

Each Chapter is a “Stand-Alone” Document
The User can refer only to the specific chapter for the program phase they are working
BoK Structure: Modeled on Existing Approaches

• 12 Threads
  A. DoD Acquisition System
  B. Defense Contracting System
  C. Surveillance System
  D. Technology & Industrial Base
  E. Design
  F. Cost & Funding
  G. Materials Management
  H. Process Capability & Control
  I. Quality Management
  J. Manufacturing Workforce
  K. Facilities
  L. Manufacturing Management & Control

• 6 Acquisition Lifecycle Phases
  - Pre-Materiel Development Decision (Pre-MDD)
  - Materiel Solution Analysis (MSA)
  - Technology Maturation and Risk Reduction (TMRR)
  - Engineering and Manufacturing Development (EMD)
  - Production & Deployment (P&D)
  - Operations and Support (O&S)
3. Technology Maturation and Risk Reduction

Introduction:

The purpose of Technology Maturation and Risk Reduction (TMR) phase is to transition technology, engineering, operations, and life cycle control to the point that it is mature enough for the Engineer and Manufacturing Development (EMD) phase. Risk reduction activities include applying lessons learned from technology development and engineering activities. The phase also includes preliminary design activities, including a Preliminary Design Review (PDR), leading to source selection for the EMD phase.

Gray Boxes & Tasks:

**Metrics:**

- Technology Maturity Reaches REA Maturity (Phase 1): The technology reaches a level of maturity that is suitable for the subsequent programs.
- Technology Maturity Reaches EIA Maturity (Phase 2): The technology reaches a level of maturity that is suitable for the EMD phase.
- Technology Maturity Reaches EIA Maturity (Phase 3): The technology reaches a level of maturity that is suitable for the production phase.

**Tools & Resources:**

- Results and recommendations from assessment of current state and capability to support proposed solution.
- Results of maturity and capability assessments for manufacturing and process development.
- Recommendations for future work in technology development and process development.
- Analysis and recommendations on the contractor’s technology development and process development.

Introduction:

Gray Boxes & Tasks:

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**Tools & Resources:**

- Results and recommendations from assessment of current state and capability to support proposed solution.
- Results of maturity and capability assessments for manufacturing and process development.
- Recommendations for future work in technology development and process development.
- Analysis and recommendations on the contractor’s technology development and process development.
• **Start with a Phase Map:**

  - **Documents:**
    - Updated SEP
    - SEP
    - TEMP
    - ICSOP
    - IMP/IM
  - **Activities:**
    - A.1 Update Program Documentation
    - A.2 Support CDR
    - A.3 Support Program Technical Reviews
    - A.4 Support Program Decision Reviews
    - A.5 Support Program Technical Reviews
  - **Reviews:**
    - CDR
    - TRR
    - PRR
    - SMR
    - ITRA

**Activities:**

- **Tasks**
  - Tasks describe how to accomplish the Activity
  - Linked to other Activities, Swim Lanes, and Phases

- **Metrics**
  - How do I know I did the activity well?

- **Tools**
  - What can I use to accomplish the Activity or Task?
  - What can I use to measure the metrics?

- **References**
  - Policy, guidance, or instruction affecting the Activity
  - Where can I go to learn how to do the Activity?
  - How must the Activity be performed?
Chapter 1 - Pre-MDD Activities

Pre-MDD

A. DoD Acquisition System
   A.1 Support Early Systems Engineering
   A.2 Understand User Needs
   A.3 Support Tech. Reviews of Material Solutions
   A.4 Provide Mfg. IDA Input for MDD

B. Defense Contracting System
   B.1 Support Market Research

C. Surveillance System
   C.1 Understand DCMA PDM Requirements
   C.2. DCMA Support at Industry & Facility Sites

D. Manufacturing Technology & Industrial Base
   D.1 Characterize Industrial Base Capabilities
   D.2 Support Manufacturing Technology Development

E. Design
   E.1 Support Program Productivity Requirements
   E.2 Evaluate Design Maturity

F. Cost/Funding
   F.1 Understand Production Cost
   F.2 Develop Cost Analysis
   F.3 Estimate M&G Investment Budget

G. Materials Management
   G.1 Understand Materials Maturity Requirements
   G.2 Characterize Material Availability
   G.3 Understand Supply Chain Mgmt. Requirements
   G.4 Understand Special Handling Requirements

H. Process Capability & Control
   H.1 Investigate M&G Capabilities
   H.2 Investigate Mfg. Process Maturity
   H.3 Develop Process Yield & Rate Estimates

I. Quality
   I.1 Quality Management Requirements
   I.2 Product Quality Requirements
   I.3 Supplier Quality Management Requirements

J. Manufacturing Workforce
   J.1 Identify Mfg. Workforce Requirements

K. Facilities
   K.1 Identify Tooling/STI/SIE Requirements
   K.2 Identify Facilities Requirements

L. Manufacturing Mgmt. & Control
   L.1 Manufacturing Management Requirements
   L.2 Understand Mfg. Planning & Scheduling Requirements
   L.3 Understand Materials Planning Requirements
Chapter 2 - MSA Activities

A. DoD Acq. System

- A.1 Support conduct of the AoA
- A.2 Provide inputs to the AoA
- A.3 Provide inputs to SEP
- A.4 Support Program Mgmt. Reviews

B. Defense Contracting System

- B.1 Provide input to TMRB SEP
- B.2 Provide inputs to TMRB SEP
- B.3 Identify Contract Incentives/Award Fee Criteria

C. Surveillance System

- C.1 Utilize DCMA data for AoA
- C.2. Utilize DCMA data for Program Management
- C.3 Monitor and identify impacts to Program

D. Technology & Industrial Base (IB)

- D.1 Update Industrial Base Assessment and Analysis
- D.2 Identify CTE Maturity and Limitations
- D.3 Identify Mfg. Technology Gaps and Requirements
- D.4 Plan Potential ManTech Projects
- D.5 Plan IB Risk Mitigation

E. Design

- E.1 Assess Mfg. Feasibility for AoA
- E.2 Participate in Design IPT
- E.3 Initial Productivity Planning
- E.4 Identify Key Characteristics

F. Cost/Funding

- F.1 Identify Mfg. and Quality Cost Drivers
- F.2 Refine Cost Model
- F.3 Prepare Initial M&Q Budget

G. Materials Management

- G.1 Evaluate Materials Characteristics and Maturity
- G.2 Determine Materials Risk

H. Process Capability/Control

- H.1 Identify Required Process Capability
- H.2 Initiate Process Capability Studies

I. Quality Management

- I.1 Quality Management Systems Requirements Analysis
- I.2 Product Quality Requirements Analysis
- I.3 Supply Chain Quality Management Requirements Analysis
- I.4 Prepare Quality Strategy

J. Mfg. Workforce

- J.1 Update Manufacturing and Quality Workforce Requirements
- J.2 Manufacturing and Quality Workforce Planning

K. Facilities

- K.1 Facilities and Tooling Requirements
- K.2 Facilities and Tooling Planning

L. Manufacturing Mgmt./Control

- L.1 Update Manufacturing Management Requirements
- L.2 Develop Initial Mfg. Strategy
# Chapter 3 - TMRR Activities

## TMRR

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<tbody>
<tr>
<td>A.1 Support Early Program Reviews</td>
<td>B.1 Provide Input to EMD RFP</td>
<td>C.1 Utilize DCMA data for Program Management Reviews</td>
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<tr>
<td>A.2 Provide Updates to Program Documentation</td>
<td>B.2 Provide Input to EMD SSP</td>
<td>C.2 Conduct Pre-Award Survey</td>
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<tr>
<td>A.3 Support PDR</td>
<td>B.3 Develop Manufacturing Incentives</td>
<td>C.3 Perform ( \text{PDR} ) and EMD SSIP</td>
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<tr>
<td>A.4 Support Program Decision Reviews</td>
<td>B.4 Update RFP Post-CDR</td>
<td>C.4 Utilize EMD Data for Program Management Reviews</td>
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## D. Technology & Industrial Base (IB)

<table>
<thead>
<tr>
<th>D.1 Update Industrial Base Capabilities Assessment and Analysis</th>
<th>D.2 Update Mfg. Technology Gaps and Requirement</th>
<th>D.3 Address CTE Process Limitations</th>
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<tr>
<td>D.4 Initiate ManTech Projects</td>
<td>D.5 Initiate IB Risk Mitigation</td>
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## E. Design

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<tr>
<th>E.1 Participate in Design PPT</th>
<th>E.2 Evaluate Design/Mfg. Capability</th>
<th>E.3 Update Productivity Plan</th>
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<tr>
<td>E.4 Perform Productivity Assessments</td>
<td>E.5 Identify Key Characteristics</td>
<td>E.6 Assess Design Maturity</td>
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<td>E.7 Support PDR</td>
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## F. Cost/Funding

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<th>F.1 Identify Mfg. Cost Drivers</th>
<th>F.2 Develop Mfg. Cost Mitigation/Maturation Plan</th>
<th>F.3 Develop Learning Curve</th>
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<td>F.4 Prepare Initial Mfg. Budget</td>
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## G. Materials Management

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<tr>
<th>G.1 ID Materials Cost Drivers</th>
<th>G.2 Assess Mfg. Material Maturity and Determinate Material Risks</th>
<th>G.3 ID Scale-Up Requirements</th>
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<td>G.4 Review Initial SCM Program</td>
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<td>G.5 Develop Alternative Source Option</td>
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## H. Process Capability/Control

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<tr>
<th>H.1 Identify Required Process Capability</th>
<th>H.2 MBB at Functional Level</th>
<th>H.3 Conduct Process Capabilities Studies</th>
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## I. Quality Management

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<tr>
<th>I.1 Update Quality Strategy</th>
<th>I.2 Prepare Initial Program Quality Plan</th>
<th>I.3 Verify Subcontractor Quality Mgmt. Plan</th>
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<td>I.4 Assess Contractor Quality Mgmt. System</td>
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<td>I.5 Update Quality Strategy</td>
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## J. Mfg. Workforce

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<tr>
<th>J.1 Identify Required Workforce Skills</th>
<th>J.2 Update M &amp; Q Workforce Plan</th>
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## K. Facilities

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<tr>
<th>K.1 Update Tooling and Facility Strategy</th>
<th>K.2 Conduct Production Facilities Assessment</th>
<th>K.3 Identify Special Tooling, Test, &amp; Inspection Equipment</th>
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## L. Manufacturing Mgmt./Control

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<td>L.4 Finalize Mfg. Strategy and Plan for EMD</td>
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Example
Example: Materials Management “Deep Dive”

G.2 “Activity” Evolution Over the Life Cycle

- Pre-MDD: Characterize Material Availability
- MSA: Determine Materials Risk
- **TMRR**: Assess Material Maturity and Determine Material Risk
- EMD: Manage Materials Cost Driver Factors
- P&D: Manage Material Risk
- O&S: Identify & Develop Alternative Sources
Example: TMRR Activity Description

G.2 Assess Materials Maturity and Determine Materials Risk

Risk can be described as anything that has the potential to impact negatively on cost, schedule, or performance.

- Material risks and issues can slow or delay a program, can add additional costs to a program, or can create field failures because of poor material reliability.
- Material risks could include availability of the material, maturity of the material, or need for special handling and control.
- Material risks can occur anywhere in the supply chain from the prime contractor all the way down to the lowest level (raw materials).
- Manufacturing and QA managers need to support the identification and management of material risks and material maturity especially as suppliers and vendors are brought on board and the prime contractor begins to collect and analyze actual data.

Each Activity includes a brief overview/description to orient the User to Activity objectives
Example: TMRR G.2 Task (1 of 5 Tasks)

- Analyze and Assess the contractor’s make/buy process for adequacy and completeness to include:
  - Contractor’s make/buy processes for key and/or critical subsystems, items, parts, and components to include volatility
  - Contractor’s supply chain (including other divisions) make/buy processes for vendors to meet quality requirements, schedule, and cost targets
  - Identification of and mitigation of counterfeit parts and materials (e.g., end items, components, parts, or assemblies)
  - Identify hazardous and special handling/storage/environmental compliance procedures, risks, and issues to include:
    - Potential regulatory requirements
    - Hazardous materials and handling procedures
    - Security requirements (physical, cyber, etc.)
    - Transportation, storage, and shelf life
    - GFP, GFE (tooling, test equipment, ranges, chambers, etc.)
    - Disposal
  - Assess the characterization of materials (maturity) and degree of M&Q risks applicable to the system under development.
  - Determine if materials have been manufactured or produced in a relevant environment (e.g., a factory, a similar application/program, as part of a prototype, etc.)
  - Assess and characterize all GFE, GFF, GFM, GFP
    - Methods for conserving critical and strategic materials and mitigating supply disruption risks and program impacts associated with those materials
  - Analyze government and contractor maturation efforts to mitigate material (existing and new) production risks

Bok identifies 5 tasks to accomplish the “Assess Materials Maturity and Determine Materials Risk” activity.
Process metrics to assess/validate each task is completed are also provided.
Example: TMRR Resources Materials Thread

- AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
- AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materiel
- DMSMS Guidebook, SD-22
- DoD 4140.1-R, Supply Chain Management Regulation
- DoD 5000.60, Defense Industrial Capabilities Assessments
- DoD 5000.60H, Assessing Defense Industrial Capabilities
- DODI 5000.84, Analysis of Alternatives
- DoD 4140.01, DoD Supply Chain Materiel Management Regulation
- IEEE 15288.2, Standard for Technical Reviews and Audits on Defense Programs
- Public Law 114-328, §807, Cost, Schedule, and Performance of Major Defense Acquisition Programs
- Manufacturing Readiness Level (MRL) Deskbook
- Defense Technical Risk Assessment Methodology (DTRAM)
- NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy
- Technology Readiness Assessment (TRA) Deskbook
Example: TMRR Tools Materials Thread

- DMSMS Product Life Cycle Assessment (Consult DLA)
- Industrial Base Assessment Survey Form, DCMA Industrial Analysis Center
- Interactive MRL Users Guide Checklist for the Materials thread
- Manufacturing Maturation Plan
- Independent Technical Risk Assessment Checklist/DTRAM Criteria
- Supply Chain Management Risk Assessment Checklist
- Producibility Assessment Worksheet
- TRL Assessment Questionnaire
- Technology Readiness Assessment Guide (Best Practices) (GAO-20-48G)
## Chapter 4 - EMD Activities

### A. DoD Acq. System
- A.1 Update Program Documentation
- A.2 Support CDR
- A.3 Support Program Technical Reviews
- A.4 Support Program Decision Reviews

### B. Defense Contracting System
- B.1 Provide Inputs to WFP
- B.2 Provide Inputs to SSP
- B.3 Develop Manufacturing Incentives

### C. Surveillance System
- C.1 DCMA Support for EMD
- C.2 DCMA Participation in Program Reviews
- C.3 Utilize DCMA Surveillance Capabilities for CDR
- C.4 DCMA CAS Support Activities
- C.5 Conduct Pre-Award Survey

### D. Technology & Industrial Base (IB)
- D.1 Update Industrial Base Capabilities Assessment & Analysis
- D.2 Implement Mfg. Technology Projects
- D.3 Update CTE Processes
- D.4 Insert ManTech Projects
- D.5 Update and Validate IB Capabilities

### E. Design
- E.1 Participate in Design IPT
- E.2 Assess Design vs. Mfg. Capability
- E.3 Update Productivity Plans
- E.4 Conduct Productivity Assessments
- E.5 Develop Detailed Design
- E.6 Assess Design Maturation
- E.7 Assess SRP
- E.8 Support CDR
- E.9 Update SFP
- E.10 Validate Design
- E.11 Plan Line Build

### F. Cost/Funding
- F.1 Update Mfg. Costs
- F.2 Develop Mfg. Cost Mitigation/Maturan Plan
- F.3 Validate Proposed Learning Curves
- F.4 Update Mfg. Costs with Actuals
- F.5 Update Mfg. and QA Budget

### G. Materials Management
- G.1 Manage Materials Risk
- G.2 Manage Materials Cost Driver Factors
- G.3 Manage Scale-Up
- G.4 Assess Contractor SCM Program
- G.5 Assess Material Lead Times
- G.6 Assess Alternate Critical Sources
- G.7 Assess Material Availability
- G.8 Assess Material Availability for LRIP

### H. Process Capabilities/Control
- H.1 Update Process Capability Requirements
- H.2 Update and Validate M&S
- H.3 Mature Key Mfg. Processes
- H.4 Demonstrate Mfg. Maturity on Pilot Line
- H.5 Validate Yields and Rates

### I. Quality Management
- I.1 Assess Contractor-QMS
- I.2 Assess and Revise Quality Strategy
- I.3 Evaluate SCM Quality
- I.4 Support CDR
- I.5 Support Configuration Audits
- I.6 Assess Pilot Line
- I.7 Finalize QA Strategy and Plan for LRIP

### J. Mfg. Workforce
- J.1 Assess Workforce for Pilot Line
- J.2 Assess Workforce for LRIP

### K. Facilities
- K.1 Assess Facilities
- K.2 Assess Tooling, Test, & Inspection Equipment
- K.3 Assess Facilities, Tooling and Test Equipment for LRIP

### L. Manufacturing Mgmt. Control
- L.1 Assess Contractor Mfg. Management System
- L.2 Update Mfg. Strategy and Plan
- L.3 Evaluate SCM
- L.4 Support CDR
- L.5 Execute Pilot Line
- L.6 Finalize Mfg. Strategy and Plan for LRIP
Chapter 6 - O&S Activities

O&S

A. DoD Acq. System
- A.1 Provide Mfg./QA Updates to ISD
- A.2 Support Program Management Reviews

B. Defense Contracting System
- B.1 Provide Input to Sustainment RFP
- B.2 Provide Inputs to Sustainment STRP
- B.3 Provide Manufacturing Incentives Performance Tracking
- B.4 Validate & Track Sustainment Learning Curves

C. Surveillance System
- C.1 Conduct Mfg./QA Performance Meetings
- C.2 Participate in Sustainment Program Reviews
- C.3 Conduct Sustainment Pre-Award Survey
- C.4 Participate in other CAS On-Site Activities

D. Technology & Industrial Base (IB)
- D.1 Conduct Industrial Capabilities Assessment
- D.2 Assess Mfg. Technology Voids
- D.3 Assess CTE Process Limitations
- D.4 Perform IC Analysis

E. Design
- E.1 Update Productivity Plan for Sustainment
- E.2 Complete Productivity Assessments
- E.3 Participate in Design IPT
- E.4 Dev. Detailed Product Design
- E.5 Dev. Work Breakdown Structure
- E.6 Assess Design Stability

F. Cost/Funding
- F.1 Update Mfg. Cost Estimate
- F.2 Update Mfg. Cost Drivers w/ Actuals
- F.3 Develop Mfg. Cost Mitigation/Maturation Plan

G. Materials Management
- G.1 Manage Materials Risk
- G.2 Identify & Develop Alternate Sources
- G.3 Review and Manage Critical Sources

H. Process Capability/Control
- H.1 Identify/Manage Required Process Capability
- H.2 Mature Critical Mfg. Processes
- H.3 Focus on Mfg. Risk Reduction

I. Quality Management
- I.1 Update Quality Strategy/Plans
- I.2 Verify Subcontractor Quality Mgmt. Plan
- I.3. Evaluate Contractor Quality Mgmt. System

J. Mfg. Workforce
- J.1 Identify/Manage Critical Skills

K. Facilities
- K.1 Update Facility Strategy/Plans
- K.2 Conduct Production Facilities Assessment
- K.3 Identify/Manage Special Tooling, Test, & Inspection Equipment

L. Manufacturing Mgmt./Control
- L.1 Update Mfg. Strategy
- L.2 Review Sustainment Mfg. Plan
- L.3 Evaluate Materials & Inventory Control Systems
- L.4 Review/Update Make/Buy Decisions
- L.5 Evaluate Mfg. Planning & Control Systems
Summary

• M&Q BoK combines: best practice, policy and guidance and experience
  - Provides reference guide to PQM and non-PQM workforce that perform M&Q functions across DoD
• “Play-book” to assist accomplishment of M&Q functions
• Need to keep current as policy evolves
• Investigating options for improved user interface & navigation within the document
• Accessible via the Engineering website https://ac.cto.mil/maq/