Department of Defense
Manufacturing and Quality Body of Knowledge
(M&Q BoK)

Chapter 1
Pre-Materiel Development Decision (Pre-MDD)

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Research and Engineering

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Department of Defense Manufacturing and Quality Body of Knowledge (M&Q BoK)

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Introduction: How to Use the M&Q BoK

The Department of Defense (DoD) Manufacturing and Quality (M&Q) Body of Knowledge (BoK) is a compilation of best practices and lessons learned for completing M&Q activities across the DoD system acquisition life cycle. The office of the Executive Director, Systems Engineering and Architecture (ED, SE&A) prepared the BoK and will update the work periodically to reflect current policy, guidance, tools, and best practices. This document does not supersede DoD policy, guidance, or law.

The BoK details M&Q activities throughout the system life cycle but is not intended to be read from end to end. DoD Engineering and Technical Management (ETM) practitioners and managers may refer to the BoK to find information relevant to the phase of the program they are working on. Within a specific phase, the user may focus on the section and tasks that apply (with appropriate tailoring) for the M&Q activities the program is conducting.

The BoK chapters cover recommended M&Q activities and tasks during each acquisition life cycle phase to meet DoD Instruction (DoDI) 5000.02, Operation of the Adaptive Acquisition Framework (AAF)

The BoK includes 6 chapters:

- 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)

Each chapter focuses on the DoDI 5000.02 activities and program documentation required for that phase. Each chapter uses the following format:

- **Introduction:** Discusses the objectives of that phase to allow the user to understand the environment and requirements.
- **Manufacturing and Quality Objectives:** Discusses roles, goals, and objectives of program M&Q during this phase.
- **Threads:** Twelve threads or topic areas include discussions of major M&Q functions based on the "5 Ms" (Manpower, Machines, Materials, Methods, Measurement); Manufacturing Readiness Level (MRL) criteria; and DoD-unique M&Q-related functions not found in industry (i.e., DoD acquisition system, defense contracting system, and surveillance system). The 12 threads are labeled with letters A through L as follows:

  A. DoD Acquisition System
  B. Defense Contracting System
  C. Surveillance System

D. Technology and Industrial Base
E. Design
F. Cost and Funding
G. Materials Management
H. Process Capability and Control
I. Quality Management
J. Manufacturing Workforce
K. Facilities
L. Manufacturing Management and Control

Each thread includes several **Activities** represented by gray boxes in the corresponding chapter figure (Figure 1). Activities are numbered A.1, A.2, A.3 . . . B.1, B.2, B.3, etc. The BoK includes the following for each activity:

- Activity overview description
- **Tasks** that M&Q personnel could be expected to support or lead.
- **Tools** such as checklists, templates, and samples available to M&Q personnel intended to help them to accomplish these tasks.
- **Resources** including guidance documents, handbooks, manuals, instructions, memos, etc., that provide direction to M&Q personnel for tasks identified in the gray box.

Example: Figure 1 shows Threads, Documents, Activities, and Reviews for the EMD Phase.

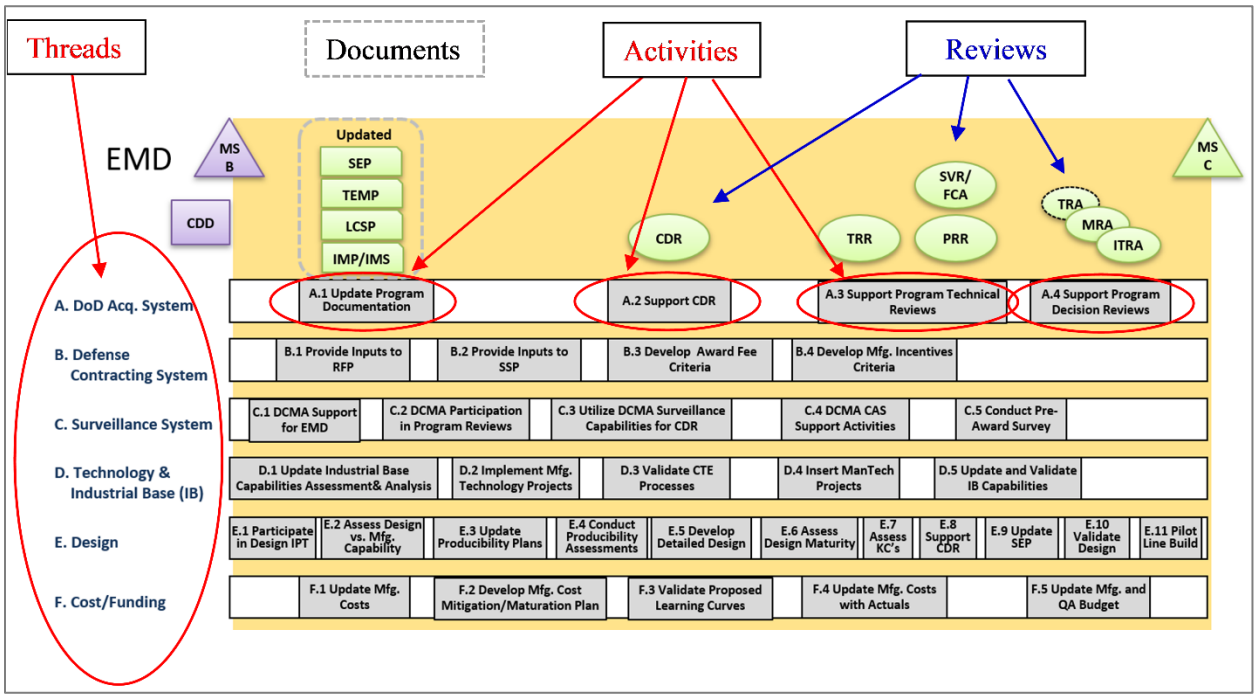
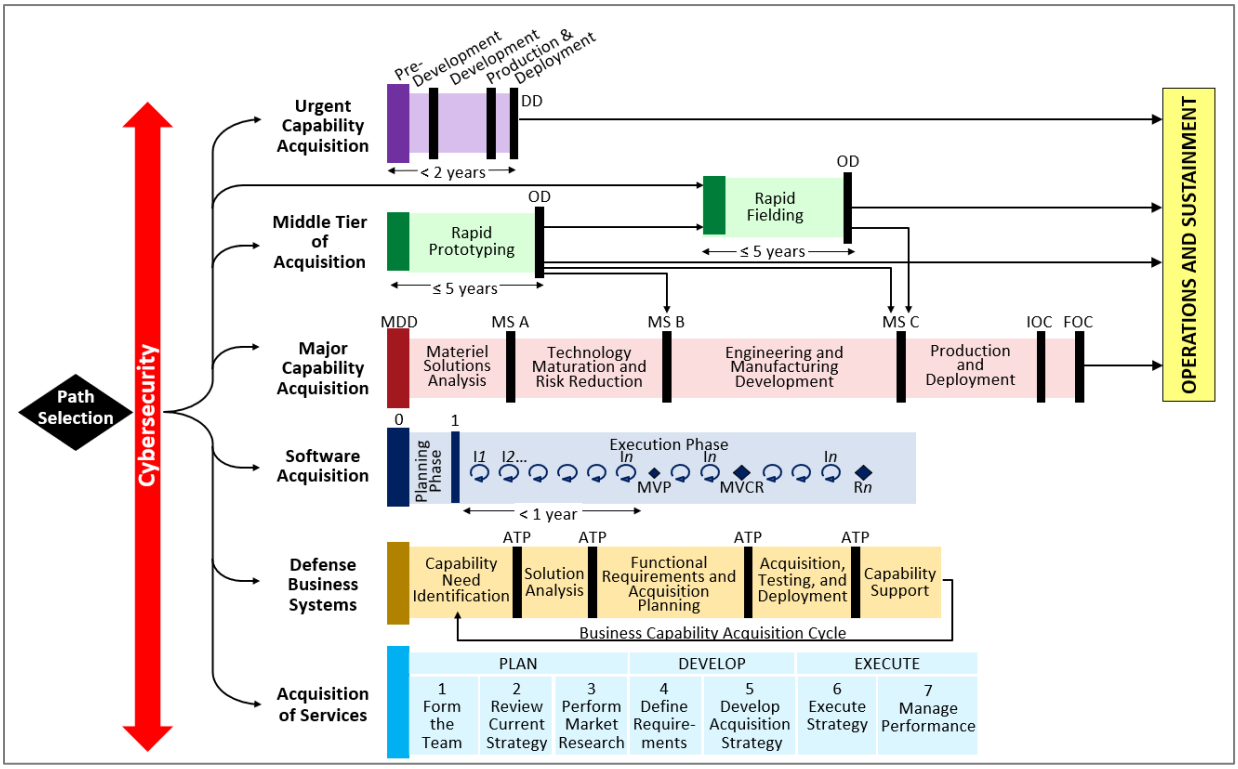


Figure 1. Sample Activity Chart

Adaptive Acquisition Framework (www.aaf.dau.edu)

This BoK follows DoDI 5000.02, and for the most part will describe M&Q activities for the path labeled Major Capability Acquisition (MCA). This path includes a comprehensive and systematic approach for applying M&Q best practices; however, the M&Q BoK best practices are applicable to the alternative AAF pathways as well. AAF pathways are depicted in Figure 2.



Source: DoD Instruction 5000.02, Operation of the Adaptive Acquisition Framework, January 23, 2020

Figure 2. Adaptive Acquisition Framework Paths

For example, under the AAF, a program may have an Urgent Capability Acquisition (UCA) and may have less than 2 years to provide a solution to the Warfighter, or the program may be involved in a Middle Tier of Acquisition (MTA) approach focused on rapid prototyping or rapid fielding. If so, users can see how these efforts are aligned with the MCA process in Figure 2 and use those BoK chapters to identify and accomplish required tasks and activities.

In addition to DoDI 5000.02, the following associated policies provide information for the paths:

- DoD Instruction 5000.74, Defense Acquisition of Services
- DoD Instruction 5000.75, Business Systems Requirements and Acquisition
- DoD Instruction 5000.80, Operation of the Middle Tier of Acquisition
- DoD Instruction 5000.81, Urgent Capability Acquisition
- DoD Instruction 5000.85, Major Capability Acquisition

- DoD Instruction 5000.88, Engineering of Defense Systems
- DoD Instruction 5000.89, Test and Evaluation

With any acquisition model, the program office should include M&Q personnel on the technical Integrated Product Team (IPT) and to support M&Q activities and tasks, many of which are support tasks for activities that control specific acquisition areas. For example, M&Q personnel do not have authority to sign contracts, but they should be involved in submitting M&Q input for consideration. This BoK serves as a framework for identifying and accomplishing the tasks and activities. It is up to the individual program office or acquisition organization to tailor this BoK for their application.

Manufacturing and Quality Planning

M&Q planning, control, and management activities represent an important and central effort that begins early in the life cycle (Pre-Materiel Development Decision (MDD) and/or Materiel Solution Analysis (MSA) phases) and continues throughout the life of a program though Operations and Support. Although planning is discussed in detail in each chapter, Figure 3 provides key elements of M&Q planning activities in relation to overall program life cycle activities.

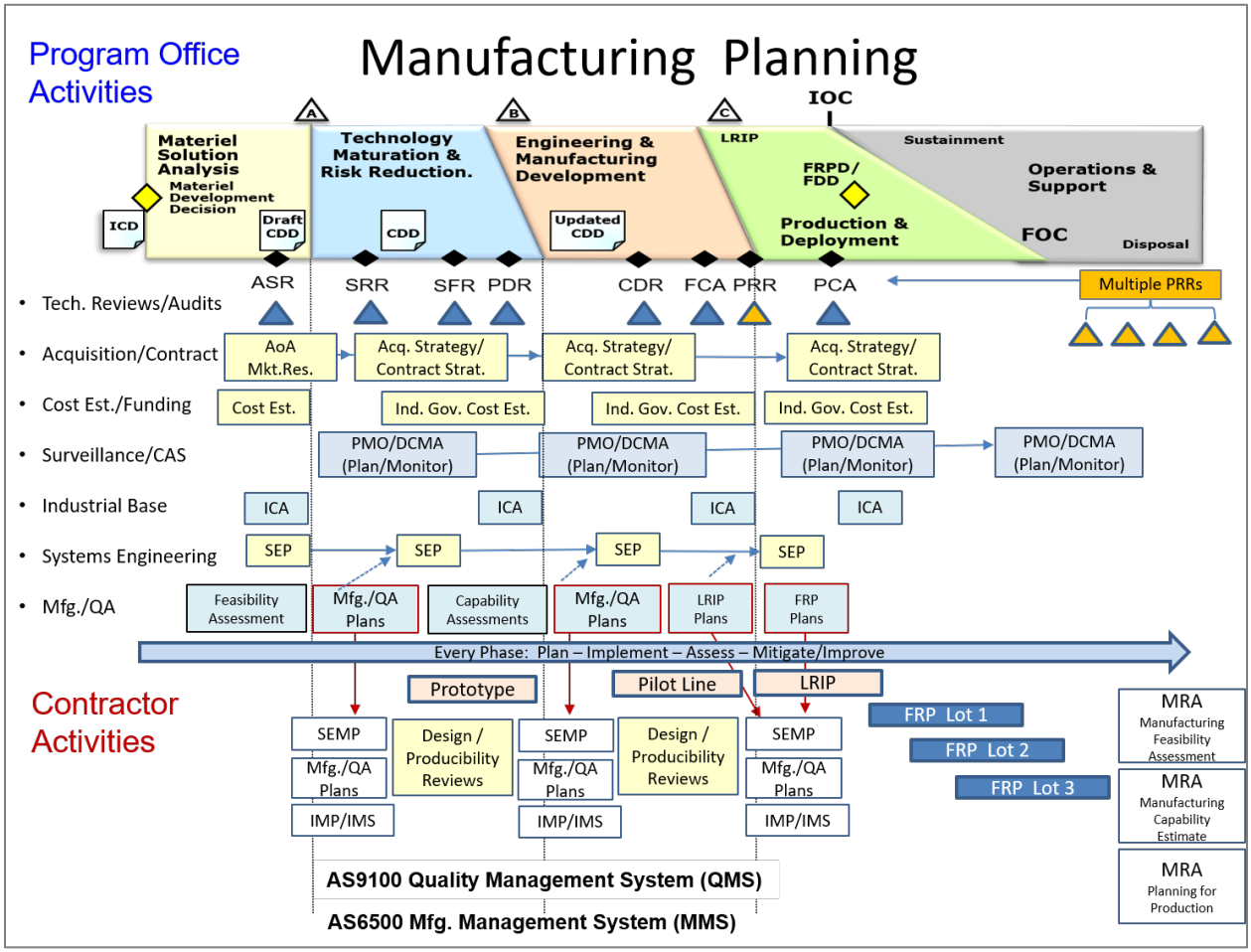


Figure 3. Typical Manufacturing and Quality Planning Activities

Most activities begin with the need to identify requirements, risks, and gaps, followed by planning activities. The top-most planning document is the Acquisition Strategy, and numerous documents feed into the Acquisition Strategy to include the Contracting Strategy and the Systems Engineering Plan (SEP). M&Q strategies should be a component of the SEP. Plans are then evaluated and updated on a recurring basis, usually just before a milestone decision.

Once the plans have been developed and the requirements handed off to the contractor in the form of a contract, then the detailed planning and execution occur. The contractor is responsible for the execution of the program and in planning for success. The government Program Management Office (PMO), along with the Defense Contract Management Agency (DCMA) or other contract surveillance organizations and engineering support activities, is responsible for oversight and management of the acquisition. Risk assessment and mitigation is an ongoing effort that should be conducted throughout the system life cycle. Key references for DoD M&Q planning and management approaches include: MIL-HDBK-896, Manufacturing Management Program Guide; SAE Standard AS6500, Manufacturing Management Program; and Quality Management Systems standards ISO 9100 and/or AS9100. In addition, MRL criteria and assessments are a best practice for identifying and mitigating M&Q risks across the system life cycle. As a best practice, DoD ETM practitioners and managers should become familiar with these fundamental planning and management approaches.

Tools and Resources

DoD tools and resources are available from many sources. Most should be available through open web-based links, but some may require a ".mil" address or a Common Access Card (CAC), or they may be available only to users in a specific community. Commercial tools and resources should be available to everyone but may require the organization to purchase a user's license/rights (e.g., ISO 9001 Quality Management System industry standard). In many cases, commercial resources and tools have been identified as a best practice. The M&Q BoK lists these tools for reference only; DoD does not necessarily endorse these resources or the publishing organizations. In addition, this document may reference a source for a specific tool (i.e., Pareto Chart), but there may be other widely available sources for this tool or for similar tools.

Sections labeled "Tools and Resources" are provided throughout the document chapters. The following section includes a summary of key references and links by publisher or topic. A more comprehensive list of references is included in Appendix B.

Key Manufacturing and Quality Body of Knowledge References and Resources

Department of Defense (DoD) Issuances, Directives Division https://esd.whs.mil/DD/

- DoD Directive 5000.01, The Defense Acquisition System
- DoD Instruction 5000.02, Operation of the Adaptive Acquisition Framework
- DoD Instruction 5000.80, Operation of the Middle Tier of Acquisition (MTA)
- DoD Instruction 5000.81, Urgent Capability Acquisition

- DoD Instruction 5000.84, Analysis of Alternatives
- DoD Instruction 5000.85, Major Capability Acquisition
- DoD Instruction 5000.88, Engineering of Defense Systems
- DoD Instruction 5000.89, Test and Evaluation
- DoD Instruction 5000.93, Use of Additive Manufacturing in the DoD
- DoD Instruction 5000.94, Use of Robotic Systems for Manufacturing and Sustainment in the DoD
- DoD Instruction 5000.60, Defense Industrial Capabilities Assessments
- DoD Handbook 5000.60-H, Assessing Defense Industrial Capabilities
- DoD Instruction 5000.73, Cost Analysis Guidance and Procedures
- DoD Directive 5105.84, Director of Cost Assessment and Program Evaluation
- DoD Directive 4200.15, Manufacturing Technology (ManTech) Program
- DoD Directive 4400.01E, Defense Production Act Programs
- DoD Manual 4140.01, DoD Supply Chain Materiel Management Procedures

Defense Acquisition University (DAU) www.dau.edu

- DAU Guidebooks and References https://aaf.dau.edu/guidebooks/
- Acquisition Notes (AcqNotes) www.acqnotes.com
- Adaptive Acquisition Framework (AAF) https://aaf.dau.edu
- Analysis of Alternatives (AoA) www.acqnote/acquisitions/analsis-of-alternatives
- Market Research www.acqnotes/acqnote/acquisitions/market-research
- Acquisition Strategy (AS) Process/Guidance https://ac.cto.mil/wp-content/uploads/2019/06/PDUSD-Approved-TDS_AS_Outline-04-20-2011.pdf
- Systems Engineering Plan (SEP) Outline https://ac.cto.mil/erpo/ (Engineering Guidance tab)
- DoD Risk, Issue, and Opportunity (RIO) Management Guide for Defense Acquisition Programs https://ac.cto.mil/wp-content/uploads/2019/06/2017-RIO.pdf
- Logistics Assessment Guidebook www.dau.edu/tools/t/logistics-assessment-guidebook

Defense Contract Management Agency (DCMA) www.dcma.mil

- DCMA Policies https://www.dcma.mil/Policy/
- DCMA Instructions https://www.dcma.mil/Policy/
- DCMA-INST 204, Manufacturing and Production
- DMCA-INST 205, Program Support
- DMCA-INST 207, Engineering Surveillance
- DMCA-INST 309, Government Contract QA Surveillance Planning
- DCMA-INST 401, Industrial Analysis
- DCMA-INST 3401, Defense Industrial Base Mission Assistance

Defense Federal Acquisition Regulation (DFAR) Supplement
https://www.acquisition.gov/dfars

- DFARS 252.204-7012, Safeguarding Covered Defense Information and Cyber Incident Reporting
- DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance System
- DFARS 252.246-7008, Sources of Electronic Parts
- DFARS 252.242-7004, Material Management and Accounting System (MMAS)
- DFARS Subpart 242.7200, Contractor Material Management and Accounting

Defense Logistics Agency (DLA) Website www.dla.mil

- DMSMS Guidebook, SD-22 https://www.dsp.dla.mil/Programs/DMSMS
- ASSIST (Database of specifications and standards) https://assist.dla.mil
- ASSIST Quick Search https://quicksearch.dla.mil/qsSearch.aspx
- DoD 4140.01, Supply Chain Materiel Management Regulation www.dla.mil

Federal Acquisition Regulation (FAR) https://www.acquisition.gov/

Manufacturing Readiness Levels (MRLs) www.dodmrl.org

- MRL Assessment Criteria Matrix www.dodmrl.org
- Interactive MRL Users Guide (MRL Assessment Criteria) www.dodmrl.org
- MRL Deskbook www.dodmrl.org
- MIL-HDBK-896, Manufacturing Management Program Guide www.dodmrl.org

National Institute of Standards and Technology (NIST) www.nist.gov

- NIST 800-82, Guide to Industrial Control Systems (ICS) Security
- NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations
- NIST Manufacturing https://www.manufacturing.gov

Office of the Director, Cost Assessment and Program Evaluation (CAPE)
www.cape.osd.mil

OSD Manufacturing Technology (ManTech) Program Office https://www.dodmantech.mil

OUSD(R&E) Systems Engineering and Architecture (SE&A) https://ac.cto.mil/engineering

Relevant Government Publications (Available via Web/Internet Search)

- DoD 4245.7-M Manual, Transition from Development to Production, 1985
- NAVSO P-3687, Producibility Systems Guidelines, 1999

- MIL-HDBK-766, Design to Cost
- MIL-HDBK-727, Design Guidance for Producibility, 1984

Standards, Specifications, and Standards Organizations

- ASSIST (Defense Logistics Agency Database of Specifications and standards) https://assist.dla.mil
- ASSIST Quick search https://quicksearch.dla.mil/qsSearch.aspx
- SAE International www.sae.org
- International Organization for Standards (ISO) www.iso.org
- Institute of Electrical and Electronics Engineers (IEEE) www.ieee.org
- *Note:* Many specifications and standards can be accessed at http://everyspec.com/

Technology Readiness Levels (TRLs)

- Technology Readiness Assessment Deskbook www.acqnotes.com
- Technology Readiness Assessment Calculator www.acqnotes.com
- Technology Readiness Assessment Guide (Best Practices) (Report GAO-20-48G) www.gao.gov

1. Pre-Materiel Development Decision (Pre-MDD)

Introduction

The Pre-Materiel Development Decision (Pre-MDD) phase can be considered the front-end of the DoD acquisition process. Pre-MDD objectives include: obtain a clear understanding of user needs, identify a range of technically feasible materiel solutions, consider near-term opportunities to provide a more rapid interim response, and develop a plan for the next acquisition phase—including the required resources. This knowledge supports the MDD by the Milestone Decision Authority (MDA), a decision to authorize entry into the acquisition life cycle and pursue a materiel solution.

The Pre-MDD manufacturing and quality (M&Q) activities are displayed below (Figure 1-1).

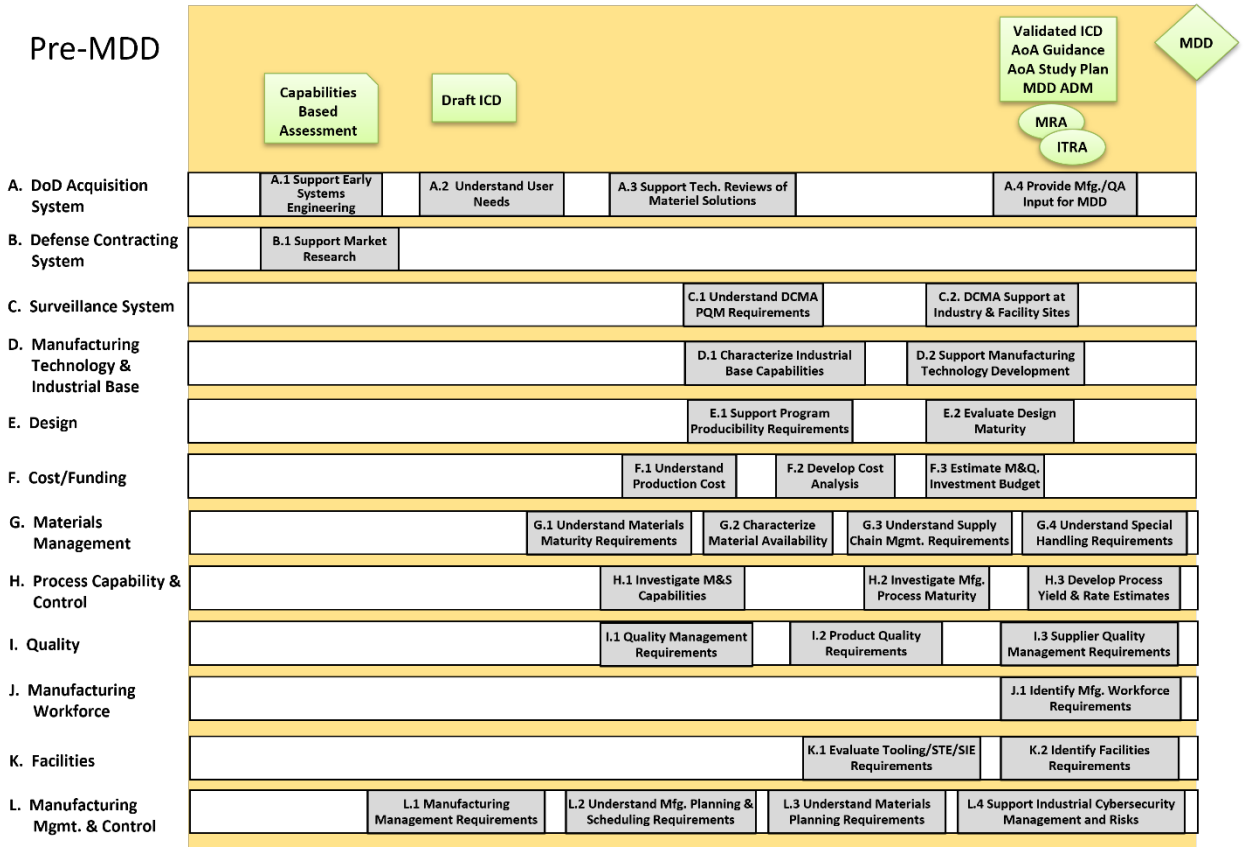


Figure 1-1. Pre-MDD Phase Manufacturing and Quality Activities

An important aspect of the Pre-MDD effort is narrowing the field of possible solutions to a reasonable set that is analyzed in the Analysis of Alternatives (AoA). Early recognition of constraints, combined with analysis of technical feasibility, can eliminate some initial ideas because they lack the potential to meet the need in a timely, sustainable, and cost-effective manner. Conversely, the range of alternatives analyzed in the AoA need to be selected from a sufficiently broad solution space. A Government Accountability Office (GAO) study states that *"programs that considered a broad range*

of alternatives tended to have better cost and schedule outcomes than the programs that looked at a narrow scope of alternatives." (*See* GAO-09-665 Analysis of Alternatives, page 6.)

To this end, DoD has many approaches to look at a broad range of technologies that could be used to satisfy a current or potential DoD need to include Basic Research, Applied Research, and Advanced Technology Demonstrations.

- Basic Research is a 6.1 Budget Activity directed toward a greater understanding of the fundamental aspects of phenomena and/or observable facts without specific applications toward processes or products.
- Advanced Research is a 6.2 Budget Activity directed toward gaining greater knowledge necessary to determine how a recognized and specific need may be met. It connects the technology with a user.
- Advanced Technology Development is a 6.3 Budget Activity directed toward efforts that will move the development and integration of hardware for field experiments and tests.

Many organizations and activities participate in these early studies, to include:

- Service Laboratories and Manufacturing Technology (ManTech) offices develop Technology Roadmaps (e.g., AFRL, NRL, ARL, DARPA, national laboratories, or ManTech centers).
- Service Centers of Excellence (CoEs) (e.g., Navy Metalworking CoE or Energetics CoE, Air Force Multi-Fidelity Modeling of Rocket Combustion Dynamics CoE, or the Army Cyber CoE).
- Service Assistant Secretaries of Defense all have Critical Technology Portfolios that the Services are investing in (e.g., Hypersonic, Non-Kinetic Warfare Capabilities, Soldier-Protection).
- Colleges and universities participate in thousands of studies, some with potential application for the DoD.
- Commercial businesses using Independent Research and Development (IRAD) funding are often on the leading edge of new material and process development that may have potential application for the DoD.

Manufacturing and Quality Objectives

Manufacturing is concerned with the conversion of raw materials into products based upon a detailed design. This conversion is accomplished through a series of M&Q procedures and processes. It includes major functions such as: manufacturing planning, cost estimating and scheduling; engineering; fabrication and assembly; installation and checkout; demonstration and testing; and quality assurance. M&Q considerations begin before the AoA during Pre-MDD, when the manufacturing feasibility and quality risks that are associated with each materiel solution must be understood and incorporated into study guidance for the next acquisition phase.

The first objective is to ensure that M&Q are part of the design process. The role of manufacturing is to influence the design so it is producible. The role of quality is to influence the design so it is reliable and robust. In other words, the material attributes, performance features, and characteristics of a product satisfy a given need. The result is an efficient design that can be manufactured using existing facilities, tools, equipment, and people, and meets quality needs. This role is critical because of the impact design decisions have on life cycle costs.

The second objective is to assess manufacturing feasibility and quality risks for the various materiel solutions identified.

The next objective is to support Knowledge-Based Acquisition to include the reduction of M&Q risks and demonstration of producibility.

To meet these objectives, M&Q strategy development must begin during the earliest stages of concept development. The M&Q strategy should be part of the Capabilities-Based Assessment (CBA) and the draft Initial Capabilities Document (ICD) and should be included in the AoA Study Guidance for the MDD.

Chapters 1-3 of this BoK (Pre-MDD through EMD) specify M&Q activities and tasks during early system development. The DoD Early Manufacturing and Quality Engineering Guide (www.ac.cto/maq) provides additional context for these activities within other early development activities (e.g., JCIDS, mission engineering, development planning, and systems engineering, digital engineering, acquisition planning). Increased M&Q practitioner involvement is encouraged during these early system development phases.

A. DOD ACQUISITION SYSTEM

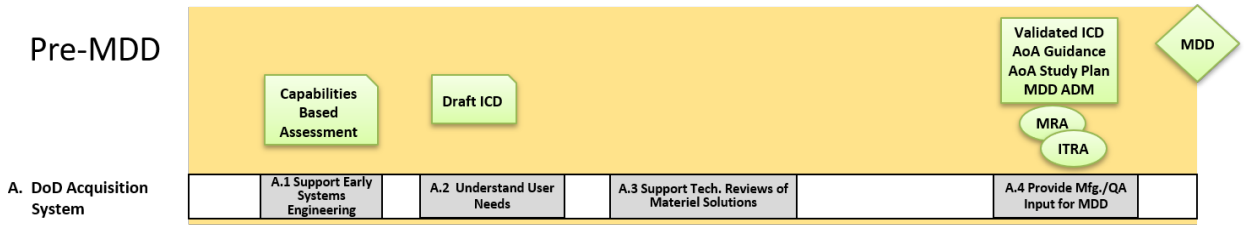


Figure 1-2. DoD Acquisition System Manufacturing and Quality Activities

Introduction

The Defense Acquisition System (DAS) is an event-based process. This includes a series of milestones (five phases), and risk-based reviews in which a Milestone Decision Authority (MDA) determines whether a program will proceed into the next phase. Major Defense Acquisition Programs (MDAPs) and major systems with production requirements should address industrial and manufacturing readiness in the Acquisition Strategy, during milestone reviews, and in program documentation as outlined in this Body of Knowledge (BoK).

This initial section ("thread") titled the "DoD Acquisition System" will focus on the following:

- Requirements (Joint Capabilities Integration and Development System (JCIDS))
- Program, Planning, Budget, and Execution (PPBE)
- DAS as implemented by DoDI 5000.01, The Defense Acquisition System; DoDI 5000.02, Operation of the Adaptive Acquisition Framework; and supporting instructions for each acquisition pathway.
- Analysis of Alternatives (AoA)
- User Requirements
- Acquisition Strategy
- Program Documentation
- Program Support
- Milestone Decisions

For major systems, during these early system development activities, the Joint Staff conducts a Capabilities-Based Assessment (CBA), and/or other studies as part of the JCIDS process, producing a draft Initial Capabilities Document (ICD). The draft ICD contains the initial Key Performance Parameters (KPP), Key System Attributes (KSA), and Additional Performance Attributes (APAs). The draft ICD is assigned to a lead Service or Services. Before determining if a materiel solution should be developed, the lead Service initiates activities to develop the AoA Study Guidance. These activities include manufacturing feasibility, studies from the science and technology (S&T) community, and other supporting studies (threat analysis, gap studies, etc.) contributing pertinent data and information for the MDD.

Another major early system development focus is mission engineering (ME): the deliberate planning, analyzing, organizing, and integrating of current and emerging operational and system capabilities to increase the likelihood of meeting warfighter requirements within cost, schedule, and performance constraints. ME facilitates the transition from JCIDS processes (requirements definition) to early systems analysis and architecture approaches, and to the SE development process. During Pre-MDD, ME is a top-down approach to provide mission-based outputs to the requirements process, guide design options, and inform investment decisions.

ME products and artifacts identify and quantify mission capability gaps and help the SE IPT to focus on technological solutions to meet future mission needs, inform requirements, prototypes, and acquisition; and support capability portfolio management. The ME practitioner needs to identify a well-established set of metrics that can be used to evaluate the completeness and efficacy of the components of mission-enabling activities.

M&Q studies are conducted prior to the MDD to assist the lead Service activities in identifying potential constraints, risks, and capabilities of the concepts to validate the draft ICD. These studies should be included in the AoA Study Guidance. After the MDD, DoDI 5000.02 specifies that the AoA

analyze cost, schedule, sustainment, and required capabilities associated with each proposed materiel solution, including technology maturity, integration risk, manufacturing feasibility, and, where necessary, technology maturation and demonstration needs.

In addition, the Office of the Under Secretary of Defense Research and Engineering (OUSD(R&E)) established policy (DoDI 5000.88, Engineering of Defense Systems) for the conduct of Independent Technical Risk Assessments (ITRAs) in accordance with 10 USC 2448b. Independent assessments should be conducted in accordance with the Defense Technical Risk Assessment Methodology (DTRAM). DTRAM focus areas include:

- Mission Capability
- Technology
- System Development and Integration
- Modular Open Systems Approach (MOSA)
- Software
- Security/Cybersecurity
- Manufacturing
- Reliability, Availability, and Maintainability (RAM) and Sustainment

To understand the implications of manufacturing feasibility, studies must address the feasibility, maturity, and quality risks of the proposed alternatives, including the need for:

- Industrial base (IB) development and impacts
- New materials and novel processing methods
- Additional research and development
- Manufacturing technology development and capital equipment
- Special test equipment and environments, special inspection equipment, and tooling
- New or expanded facilities
- New manufacturing skill sets

Development planning activities are initiated before the MDD, continue throughout the Materiel Solution Analysis phase, and eventually transition to the program environment. Development planning encompasses the engineering analysis and technical planning activities that provide the foundation for informed investment decisions that effectively, affordably, and sustainably meet operational needs.

Attention to critical systems engineering processes and functions is essential to ensure that programs deliver capabilities on time and on budget. The effective execution of Pre-MDD efforts provides technically feasible solution options that satisfy user-driven requirements for the AoA. At the MDD, the MDA not only decides whether an investment is made to fill the capability gap but also determines the fundamental path the materiel development will follow. This decision should be based on effective development planning.

A.1 Support Early Systems Engineering

As a best practice, M&Q personnel should to be actively engaged in the early systems engineering management and technical management processes. This includes developing early acquisition plans, identification of risks, and the development of risk mitigation plans.

Manufacturing and Quality Tasks

- Support the MDA MDD process to authorize entry into the acquisition life cycle and pursue a materiel solution.
- Analyze IB capabilities and manufacturing feasibility as part of a Capabilities-Based Assessment (CBA).
- Identify a range of materiel solutions across the entire solution space including user input as appropriate.
- Conduct a gap analysis for manufacturing feasibility to eliminate unfeasible materiel solutions based on factors such as timeliness, sustainability, cost-effectiveness, etc.
    - The gap analysis of manufacturing feasibility includes the use of near-term, commercial, or current systems as a materiel solution for rapid fielding
- Draft a top-level plan that includes scheduling, manpower, and cost projections based on the results of manufacturing feasibility analysis of materiel solutions.
- Develop technical planning with respect to performance characteristics and analysis of capability gaps in manufacturing as part of the analysis of materiel solutions.
- Assess materiel solutions for external dependencies and integration impacts on the industrial base.
- Analyze materiel solutions for producibility and manufacturability and associated costs for the AoA Study Guidance.
- Analyze the potential alternatives that address the feasibility of a rapid interim response to the need.

Tools

- Acquisition Decision Memorandum (ADM) Materiel Development Decision (MDD) Template
- Acquisition Strategy Outline
- Analysis of Alternatives (AoA) Study Plan Template
- AoA Study Guidance Template
- Capability Development Document (CDD) Template
- Defense Contract Management Agency (DCMA) Industrial Capability Assessment Survey
- Interactive MRL Users Guide
- Manufacturing Maturation Plan
- Market Research Reporting Template

- Pugh Matrix Template
- Quality Function Deployment Excel Spreadsheet
- Quality Function Deployment or House of Quality Matrix
- Requirements Roadmap Worksheet, DAU
- Requirements Traceability Matrix Template, DAU
- Tailoring Worksheet for Materiel Solution Analysis Phase
- Technology Readiness Level (TRL) Assessment Checklist

Resources

- Air Force Analysis of Alternatives (AoA) Handbook
- Capabilities-Based Assessment (CBA) User's Guide
- DAU AcqNotes Market Research website
- DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities
- DoD Market Research Guide
- DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook
- Pre-MDD Analysis Handbook
- Requirements Traceability Matrix Guide
- Technology Readiness Assessment (TRA) Guide
- Technology Readiness Assessment Guide (GAO-20-48G)

A.2 Understand User Needs

M&Q personnel need to support the development of the Initial Capabilities Document (ICD), Capabilities-Based Assessment (CBA), AoA Study Plan, and AoA Guidance.

Manufacturing and Quality Tasks

- To obtain a clear understanding of user needs M&Q personnel need to:
    - Participate in development of draft Initial Capabilities Document (ICD) to provide M&Q inputs to development of KPPs, KSAs, and APAs, including inputs to Force Protection, System Survivability, Sustainment, and Energy KPPs (four of the six mandatory KPPs)

  - Participate in the CBA or equivalent to provide manufacturing perspective on IB capability and manufacturing feasibility for both processes
- Identify near-term opportunities that address user needs per the draft ICD and the CBA to provide a more rapid interim response.
- Develop understanding of user needs as they relate to materiel solutions and proactively collaborate with the user communities to:
  - Support Technical Reviews of materiel solutions
  - Initiate characterization of trade space, risks, and mission interdependencies as input to support the AoA Study Guidance.

Tools

- Capabilities-Based Assessment (CBA) Tool, DAU
- Capability Development Document Temp
- Initial Capabilities Document (ICD) Template
- Interactive MRL Users Guide (Checklist)
- Manufacturing Maturation Plan
- Pugh Matrix Template
- Quality Function Deployment Excel Spreadsheet

Resources

- AFI 10-601 Operational Capability Requirements Development
- Capability-Based Assessment User's Guide
- DAG Chapter 14.3.1.3, Build Requirements Roadmap
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- CJCSI 5123.01I, JCIDS Instruction
- CJCS JCIDS Manual
- DoD Mission Engineering Guide
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Manufacturing Readiness Level (MRL) Deskbook
- Pre-MDD Analysis Handbook

A.3 Support Technical Reviews of Materiel Solutions

M&Q personnel may need to support an ITRA and/or a Manufacturing Readiness Assessment (MRA) to assess risks and to provide the MDA with information needed to approve entry into the Materiel Solution Analysis phase.

Manufacturing and Quality Tasks

- Provide manufacturing inputs to support the MDA MDD process to authorize entry into the DoD acquisition process and pursue a materiel solution.
    - Identify and provide inputs to the AoA Study Guidance that specify the minimum set of Concept of Operations (CONOPS) and ICD manufacturing and/or quality requirements that must be met for each of the materiel solutions
    - Assess each of the materiel solutions for manufacturing feasibility and producibility
    - Identify M&Q risks (technical/engineering) for each materiel solution
        - Identify the capability and capacity risks for rapid fielding of potential solutions
        - Identify source consideration risks for fragile, single, sole, domestic, and foreign sources
    - Identify M&Q scheduling impacts and constraints (risks and opportunities) for each materiel solution
- Identify initial M&Q Measures of Effectiveness for each materiel solution.
- Initiate characterization of trade space, risks, and mission interdependencies of each materiel solution as input to support the AoA Study Guidance.
- Analyze capability and gaps of each materiel solution approach to meet the need in a timely, sustainable, and cost-effective manner.
- Support the conduct of an MRA
- Support the conduct of an ITRA (when required by the MDA during Pre-MDD)

Tools

- Acquisition Decision Memorandum (ADM) MDD Template
- Analysis of Alternatives (AoA) Study Plan Template
- Critical to Customer/Critical to Quality Tree Template
- Defense Technical Risk Assessment Methodology (ITRA criteria)
- Interactive MRL Users Guide (Checklist)
- Manufacturing Capability Assessment Worksheet
- Manufacturing Maturation Plan
- MDD Development Planning Templates

Resources

- AcqNotes (DAU)
- Air Force AoA Guide
- Air Force AoA Handbook
- Defense Manufacturing Management Guide for Program Managers, Chapter 1.3 and 2.6 Industrial and Manufacturing Capability Assessments in the Acquisition Lifecycle

- Defense Technical Risk Assessment Methodology (DTRAM)\DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook
- MSA Guide

A.4 Provide Manufacturing Input for the Materiel Development Decision

M&Q personnel need to provide the MDA with M&Q information to support the MDD.

Manufacturing and Quality Tasks

- Support the MDA MDD process to authorize entry into the acquisition life cycle and pursue a materiel solution
- Identify a range of technically feasible materiel solution approaches that address considerations of industrial, production, manufacturing, and quality constraints
- Develop manufacturing inputs for the AoA Study Guidance and Study Plan planning for the next acquisition phase, including the required resources
- Develop draft guidance on the application and use of assessments of manufacturing readiness on the concepts under consideration
    - Identify target Manufacturing Readiness Levels (MRLs) that should be achieved at key milestones and decision points for MDAPs
    - Identify tools and models that may be used to assess, manage, and reduce risks that are identified during MRL assessments
- Initiate characterization of trade space, risks, and mission interdependencies as input to support the AoA Study Guidance.
- Conduct a complete and rigorous manufacturing analysis/assessment of alternatives and their non-materiel implications as part of a systems engineering analysis
- Assess alternatives for manufacturing and their non-materiel implications (cost, staffing, contracting, etc.) as an input to the MDD
- Assess the industrial base for production capability and capacity, and M&Q constraints to eliminate non-supportable materiel solutions (i.e., those that are not timely, sustainable, or affordable) as an input to the AoA Study Guidance

- Collaborate with the user communities to understand system performance requirements and with the S&T community to identify materiel solutions and potential manufacturing issues as an input to the AoA Study Guidance
- Technical Reviews have been conducted with M&Q support and address the following:
    - Assess the draft ICD, the AoA Study Guidance, and preliminary CONOPS for M&Q analysis of materiel solution alternatives
    - Support the ITR to provide detailed M&Q information and understanding of each concept or alternative for:
        - Engineering trades
        - Development of a Cost Analysis Requirements Description (CARD)
        - Cost drivers, material, and process risks

Tools

- Acquisition Decision Memorandum (ADM) Materiel Development Decision (MDD) Template
- AoA Study Plan Template
- DCMA Industrial Capability Assessment Survey Form
- MRL Users Guide
- Manufacturing Maturation Plan
- Multi-Attribute Tradespace Exploration (MATE)
- Pugh Matrix Template

Quality Function Deployment Resources

- Air Force AoA Handbook
- DCMA Instruction 3401, Defense Indusial Base Mission Assurance
- DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- DoD 5000.60H, Assessing Defense Industrial Capabilities
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook
- Pre-MDD Analysis Handbook

B. DEFENSE CONTRACTING SYSTEM

Figure 1-3. Defense Contracting System Manufacturing and Quality Activities

Introduction

The contract is the vehicle used to establish the formal relationship between the government and a prime contractor. Government business processes include the business strategy or acquisition strategy, contracting approach, contracting strategies, contract language, and financial strategies. Programs should address manufacturing and quality considerations in their business processes starting with Pre-MDD. M&Q personnel often are called upon to support various contracting functions and activities.

This thread (Contracting) will focus on the following sub-threads, tasks, activities, tools, and resources:

- Market Research
- Contract Strategy
- Source Selection Plan
- Request for Proposal
- M&Q Inputs to the Contract (Sections C, E, L and M) (refer to MIL-HDBK-245D)
- Contract Evaluation and Award

DoD contracting requirements and activities are outlined by the Federal Acquisition Regulation (FAR)/Defense Federal Acquisition Regulatino (DFAR) and DoD, Service, and Agency regulations, policies, and guidance documents.

M&Q resources should be focused on the entire acquisition cycle including areas such as production planning, transition to production, concurrent engineering, quality management, continuous improvement, could cost, and manufacturing technology. A clear understanding of these focus areas is key during Pre-MDD for contracting activities in the following acquisition phases. These activities include proactively collaborating with the S&T and user communities to develop understanding of materiel solutions to make necessary and substantive inputs to future contracts and acquisition planning.

Market research, as defined in Federal Acquisition Regulation (FAR) Part 2, “Definitions,” is the process of collecting and analyzing information about capabilities within the market to satisfy agency needs. To elaborate, market research is a continuous process of gathering data on business and industry trends, characteristics of products and services, suppliers’ capabilities, and related business practices.

The data resulting from market research are analyzed and used to make informed decisions about whether DoD's needs can be met by commercial products or services. When making such decisions, many factors are considered, such as the following examples:

- Degree to which commercial practices allow the products or services to be customized or tailored to meet DoD needs.
- Terms and conditions, such as warranties, discounts, and customer support, under which commercial sales are made.
- Ability of potential suppliers' distribution and logistics support systems to meet DoD's needs.

Market research information can be used to shape the acquisition strategy, to determine the type and content of the product description or statement of work, and to develop the support strategy, the terms and conditions included in the contract, and the evaluation factors used for source selection.

B.1 Support Market Research

Market research is a pre-solicitation activity that involves the identification of the market or market of interest, the sources of market information, the collection of market information, and the evaluation of the market's ability to satisfy the user needs. M&Q personnel need to support market research to identify suppliers and evaluate potential sources and opportunities to assess the risks associated with these opportunities. Trade studies can help users sort out what requirements can be fulfilled, what requirements can be fulfilled within cost objectives, and what requirements can be fulfilled given schedule constraints. By addressing all these issues, market research enables the user to make informed decisions about the trade-offs among all the alternatives. Users who fail to consider these issues when defining the requirements risk investing in a system that may encounter technical difficulties during manufacturing or operation, have long production lead-times, and be excessively costly to produce, operate, and support. Market research can be conducted at the weapon system, subsystem, component, or part level and during any phase.

Early market research can help to identify emerging or latest developments in their area of concern and leading to solicitation and award. Once market research has been completed, requirements may be defined in the form of Performance Work Statements, Statements of Work, or Statements of Objectives. The development of RFPs is included in the solicitation-award phase of the contracting process leading to contract evaluation, negotiation, and award. The contract at this point is used to bring that product further along, preparing it for further development and testing.

Manufacturing and Quality Tasks

- Develop and build the technical knowledge base for candidate materiel solutions based on inputs from the S&T community (across government, industry, and academia) as well as other collaborators.

- Survey the industrial base for necessary resources for the potential materiel solutions and the current state industrial practices.
- Support requests for information and solicit industry and academia responses to warfighter needs.
    - Provide M&Q inputs for sources sought activity, as appropriate.
    - Support the development of contracts as appropriate.
- Identify and characterize materiel solutions resulting from the sources sought to support Requests for Information (RFI) activities and Industry Day events.
    - Ensure the Request for Information (RFI) is open to alternative solutions
- Analyze potential trade space to identify performance versus cost benefit discriminators for potential materiel solutions.
- Initiate planning for the M&Q efforts required during the next phase.

Tools

- Market Research Reporting Template
- Pugh Matrix Template
- Systems Engineering Plan (SEP) Outline

Resources

- Federal Acquisition Regulation (FAR) https://www.acquisition.gov/
- Defense Federal Acquisition Regulation Supplement (DFARS) https://www.acquisition.gov/dfars
- DoD Market Research Guide (*See* DAU AcqNotes Market Research website)
- FAR Part 10 Market Research
- SD-5 Market Research
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- SEP Outline

C. SURVEILLANCE SYSTEM

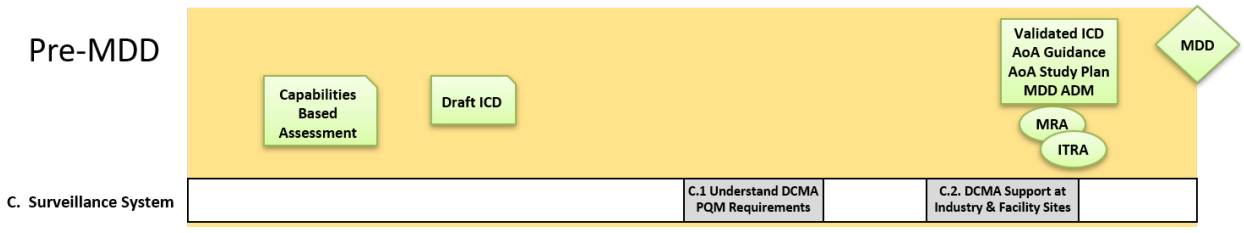


Figure 1-4. Surveillance System Manufacturing and Quality Activities

Introduction

The purpose of contract administration is to ensure that the contractor performs in accordance with the terms and conditions of the contractual agreement (surveillance). DoD contractor surveillance requirements and activities are further outlined by the FAR/DFAR and by many DoD, Service and Agency regulations, policies, and guidance documents. DFAR Part 242.2 Contract Administration Services; DFAR Part 242.3, Contract Administration Office Functions; and PGI 242.3 Contract Administration Functions outline the 70 CAS functions that are required and the many that may require M&Q support in order to accomplish. M&Q personnel often are called upon to support numerous CAS functions and activities.

- Contract Administration Service (CAS) Functions
- DCMA Support
- DCMA Documentation
- Monitor and Track Risks
- Participate in Program Reviews

Often these activities may be performed under mutual agreement by the program office and the Defense Contract Management Agency (DCMA). In many cases these contractor surveillance activities may be performed by on-site program office contract administrators, delegated Service contract surveillance offices, or a variety of engineering support activities (i.e., supervisor of shipbuilding (SUPSHIP), or development command field activities). The activity managing the concept, or the Program Manager, should maximize the use of DCMA and engineering support activity at personnel contractor facilities where there is delegation of authority and expertise available. They should request the DCMA Contract Management Offices jointly support development of program support plans for all Acquisition Category I program contracts to ensure agreement on contract oversight needs and perspectives.

C.1 Understand DCMA M&Q Data Inputs

DCMA maintains a presence in many contractor facilities that produce goods for the Department of Defense. As a result of their day-to-day presence, DCMA personnel can continuously review, assess, and document contractor performance. M&Q personnel need to understand and be able to use DCMA generated data to support the achievement of program objectives.

Manufacturing and Quality Tasks

- Contract requirements and agreements with other agencies (e.g., DCMA) developed and include quality and manufacturing requirements.
    - Request DCMA recommend the appropriate quality (i.e., ISO 9001 or SAE AS9100) and manufacturing management program requirements (i.e., SAE AS6500 or contractual) language to be included in solicitations, requests for proposals, and contracts and in appropriate agreements with other agencies (e.g., DCMA)

  - Request DCMA provide supporting rationale for recommendations on the emerging technology maturity

- Conduct manufacturing feasibility assessments of each concept being considered and include request information and data input for similar products and manufacturing processes from DCMA:
  - Assessment of manufacturing maturity of similar products and processes
  - Status and readiness of industrial capabilities
  - Current available facilities and equipment
  - Workforce availability and training
  - Quality system processes and results
- Identify the manufacturing and/or production, quality, engineering and software development risks for similar products and processes relevant to each concept being considered for the AoA Study.
  - Request DCMA provide data to support analysis of the identified risks including lessons learned

Tools

- AoA Study Plan Template
- DCMA Industrial Capability Assessment Survey Form
- DCMA Pre-Award Survey
- DCMA Program Support Plan per DCMA-ANX 205-02
- Interactive MRL Users Guide (Checklist)
- Manufacturing Maturation Plan
- Risk Assessment Template – DAU
- TRL Assessment Checklist

Resources

- Air Force AoA Handbook
- DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities
- DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs
- DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- DoDI 5000.85, Major Capability Acquisition
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook

- Technology Readiness Assessment (TRA) Guide

C.2 DCMA Support at Industry and Facility Sites

M&Q personnel need to develop program collaborative opportunities with DCMA in the form of Memorandums of Agreement (MOA) or Letters of Delegation (LOD) to gather their support and insight into:

- Manufacturing and Production Operations
- Quality Assurance Operations
- Property Management
- Engineering Surveillance
- Contract Administration and Oversight
- Quality Audits and Product Examination
- Technical Reviews
- Industrial Analysis

Manufacturing and Quality Tasks

- Develop MOAs or LODs with DCMA for support.
- Identify manufacturing investment programs based in part on inputs from DCMA (when requested and agreed to by DCMA) that support:
    - Develop and manage industrial base investment programs that create, expand, or preserve assured, affordable, and commercially viable production capabilities and capacities for items essential for national defense
    - Assess and evaluate candidate programs
- Identify manufacturing technology investments and Title III initiatives based in part on DCMA inputs (when requested and agreed to by DCMA) and develop recommendations to program and contracting personnel.
- Assistance requests developed for DoD and/or component manufacturing technology programs based in part on DCMA (when requested and agreed to by DCMA) that support:
    - Identify new manufacturing processes associated with the program and candidate components for the identified processes
    - Identify low-yield processes and components
    - Request manufacturing technology (ManTech) assistance for identified processes and components
    - Develop request for information and academia responses to warfighter needs
- Evaluate and submit recommendations on an emerging manufacturing technology maturity based in part on DCMA (when requested and agreed to by DCMA).

- Conduct manufacturing technology assessments to evaluate an emerging manufacturing technology to determine feasibility for production
- Assess the emerging manufacturing technology to ensure it meets production requirements
  - Develop recommendations on the emerging manufacturing technology maturity
  - Document assessment of industrial capabilities and recommendations for applicability of emerging manufacturing technology, and provide to decision maker

Tools

- Interactive MRL Users Guide (Checklist)
- Manufacturing Maturation Plan
- Pugh Matrix Template

Resources

- AFI 63-141, Defense Production Act ManTech, Air Force
- AR 700-90 Army Industrial Base Process
- DCMA Instruction 3401, Defense Indusial Base Mission Assurance
- DoD 5000.60H, Assessing Defense Industrial Capabilities
- DoDD 4200.15, DoD ManTech Program
- DoDI 5000.60, Defense Industrial Base Assessments
- DoDI 5000.85, Major Capability Acquisition
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook

D. MANUFACTURING TECHNOLOGY AND INDUSTRIAL BASE

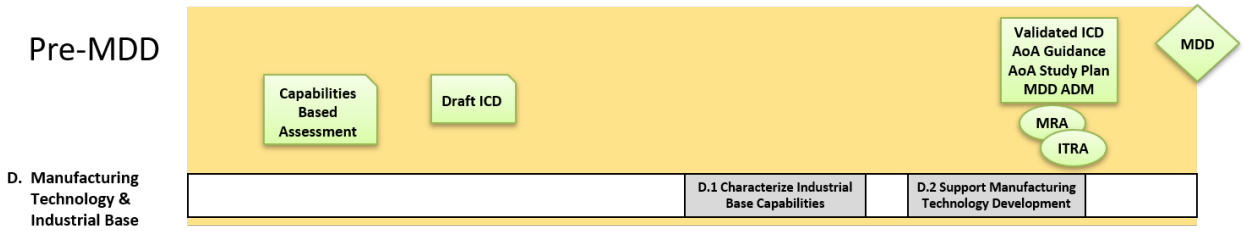


Figure 1-5. Manufacturing Technology and Industrial Base M&Q Activities

Introduction

10 USC 2440 requires the Secretary of Defense to consider the National Technology Industrial Base (NTIB) in the development and implementation of acquisition plans for each MDAP. The NTIB

consists of the people and organizations engaged in national security and dual-use research and development (R&D), production, maintenance, and related activities within the United States, Canada, the United Kingdom, and Australia. Acquisition planning and plans should include the following NTIB considerations for all MDAPs:

- The ability to support development and production (rates and quantities)
- The identification of IB risks in the supply chain
- The identification of single points of failure in the supply chain (sole source, foreign source, etc.)
- Support for a resilient supply base for critical defense capabilities
- Support for procurement surges and contractions

This thread (Manufacturing Technology and Industrial Base) requires an analysis of the capabilities of the NTIB to support the design, development, production, operation, uninterrupted maintenance support of the system, and eventual disposal (including environmentally conscious manufacturing). This thread will focus on the following sub-threads, tasks, activities, tools, and resources:

- Industrial Base Assessments (IBAs)
- Industrial Base Risks
- Critical Enabling Technologies
- ManTech Projects
- Industrial Base Mitigation Plans

D.1 Characterize Industrial Base Capabilities

10 USC 2440 and DFAR Subpart 207.1. require assessments of the capabilities of the U.S. industrial base (IB) to support defense operations. M&Q personnel need to assess and characterize the IB's capability for the types of commodities that may be expected to solve the warfighter needs.

Manufacturing and Quality Tasks

- Conduct industrial base sector studies (i.e., capabilities and capacities) relevant to potential and future needs inclusive of design, development, production, operation, and sustainment, and eventual disposal.
    - Identify and understand potential IB sources and needs
- Conduct an industrial base assessment to identify sources relevant to the concepts being considered for the ICD, AoA Study Guidance, and the MDD.
    - Identify unique manufacturing capabilities that are not readily accessible (i.e., require regeneration)
    - Request DCMA data that support the following:

    - Industrial Capability Assessments
    - Analytical Products
    - Defense Business and Economic Analysis
    - Acquisition Planning Support

- Analyze the capabilities of the identified IB sources to develop, produce, maintain, and support the concepts being considered for inclusion in the ICD, AoA Study Guidance, and the MDD:
    - Identify the external dependencies and integration impacts
    - Identify the availability of essential raw materials, special alloys, composite materials, components, tooling, and M&Q test equipment required to support the concepts being considered
    - Identify items that are sole or single sourced, fragile source, or available only from sources outside the NTIB
        - Analyze the effects on the sources for the concepts being considered that result from foreign acquisition of firms in the United States
    - Identify the availability of alternatives for obtaining such items from within the NTIB
        - Analyze the military vulnerability that could result from the lack of alternatives if such items become unavailable from sources outside the NTIB.
- Use models and simulations to develop required documentation for the MDD.

Tools

- AoA Study Plan Template
- DCMA Industrial Capability Assessment Survey Form
- Interactive MRL Users Guide (Checklist), Technology and Industrial Base thread
- Manufacturing Maturation Plan

Resources

- Air Force AoA Handbook
- DCMA Instruction 3401, Defense Indusial Base Mission Assurance
- DoD 5000.60H, Assessing Defense Industrial Capabilities
- DoDD 4200.15, Manufacturing Technology (ManTech) Program
- DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- DoDI 5000.85, Major Capability Acquisition
- DoD Systems Engineering Guidebook

- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook

D.2 Support Manufacturing Technology Development

The objective of the ManTech program is to improve performance while reducing acquisition cost by developing, maturing, and transitioning advanced manufacturing technologies. The manufacturing feasibility assessment should identify high-risk manufacturing process areas that represent technology voids or gaps and may require investments in ManTech or other programs. ManTech program investments should be directed toward areas of greatest need and potential benefit. These investments must be identified early so that these manufacturing capabilities will be matured on time to support rate production.

Manufacturing and Quality Tasks

- Survey M&Q technologies and capabilities relevant to potential and future needs as part of industrial base sector studies:
    - Identify and understand potential industrial base investment needs
- Identify the requirement for the use of advanced M&Q technology and processes for the concepts being considered.
- Conduct a survey of ManTech program technology concepts that are ongoing, in development, and support the concepts being considered.
    - Identify ongoing ManTech projects and conduct a survey of needs for manufacturing technology assistance
    - Provide recommendations on M&Q technology investments and Title III initiatives based on survey of needs

Tools

- Interactive MRL Users Guide (Checklist), Technology and Industrial Base thread
- Manufacturing Maturation Plan
- Technology Readiness Level (TRL) Assessment Checklist

Resources

- Air Force Technology Development and Transition Strategy Guidebook
- Defense Manufacturing Management Guide for Program Managers, Chapter 8, Technology Development and Investments
- DoDD 4200.15, ManTech
- DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework

- DoDI 5000.73, Cost Analysis Guidance and Procedures
- DoDI 5000.85, Major Capability Acquisition
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook
- Technology Readiness Assessment (TRA) Guide
- Technology Readiness Assessment Guide (GAO-20-48G)

E. DESIGN

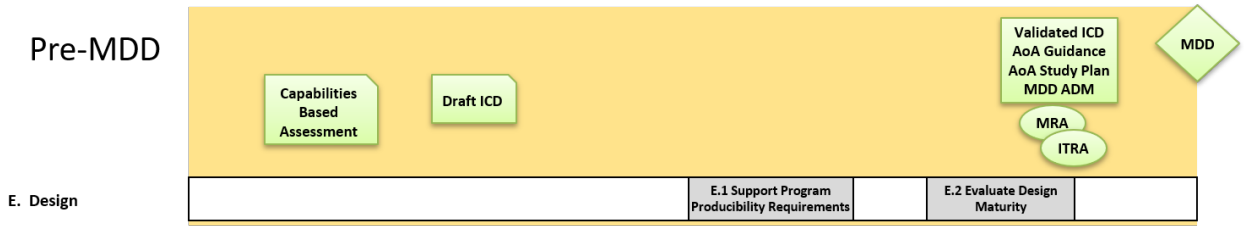


Figure 1-6. Design Manufacturing and Quality Activities

Introduction

DoD SE is a disciplined approach for the specification, design, development, realization, technical management, operation, and retirement of a weapon system. SE is an interdisciplinary and collaborative effort requiring close interaction with many disciplines to include operations, maintenance, logistics, test, production, quality, etc. The practice of SE is composed of 16 processes: 8 technical processes and 8 technical management processes. These 16 processes provide a structured approach to increasing the technical maturity of a system, increasing the likelihood that the capability being developed balances mission performance with cost, schedule, risks, and design considerations. M&Q personnel need to support these activities and processes. For a detailed description of SE processes refer to the DoD Systems Engineering Guidebook at www.ac.cto/erpo.

The lead systems engineer should assess the interdependence and integration of all design considerations and should ensure that all Specialty Engineering (Reliability and Maintainability (R&M), M&Q, Human Systems Integration (HSI), and System Safety) design considerations are addressed at the enterprise level. SE is typically structured as one or more integrated product teams (IPTs) that are collectively responsible for delivering a defined product or process.

As a best practice, M&Q personnel should be integrated into the SE IPT and should support the requirements process, AoA, assessments of costs, trade studies, selection of investment, and inputs to the development of technical performance measures.

One of the major objectives is to evaluate manufacturing feasibility, or to answer the question, "Can it be built?" Producibility is an engineering function directed toward generating a design which is compatible with manufacturing capability and quality processes. It is often considered the most important determinant of product cost, because on both production and sustainment costs.

Proposed materiel solutions should be assessed for manufacturability and producibility to ensure that one or more materiel solutions have the potential to be affordable, effective, and suitable, and can be developed to provide a timely solution to a need at an acceptable level of risk. This presents the first real opportunity to influence systems design and begin planning for production by balancing technology opportunities and current practices against cost, schedule, and performance. User needs should be expressed in terms of quantifiable parameters. The intent is to reduce technical risk, evaluate design concepts, support cost estimates, evaluate manufacturing processes, and refine design requirements.

Quality requirements are integral to design and development efforts as specified in industry best practice standards for quality management systems (ISO 9001, AS9100, etc.). These standards for systems engineering processes emphasize the importance of quality as part of program requirements in early design. The typical processes included in the QMS and included in this document are:

- Design and Development Planning (e.g., Engineering Management, FMECA, Safety)
- Design and Development Inputs/Outputs and Reviews (e.g., Verification and Validation (V&V), Test and Evaluation (T&E) Management, reviews, audits)
- Risk and Configuration Management

DoD acquisition programs may face a high risk of failure at the outset of the design process based on the maturity of the design. Some level of risk associated with new concepts may be unavoidable, historically this risk has been magnified by a misunderstanding of the efforts necessary to mature the concept into a mature product. The government and its contractors must share equal responsibility for this misunderstanding. The contractor's proposal and the government's source selection process provide the most cost-effective opportunity to ensure application of these critical efforts during design maturation.

A mature design in pre-MDD phase should begin to show these characteristics: the design meets requirements and overcomes shortfalls, the design is experiencing minimal changes, and initial testing and experiments indicate performance can be met. However, final design will be determined at Critical Design Review (CDR), much later in the program.

Current "Design Best Practices" include the use of computer-aided design (CAD) and computer-aided manufacturing (CAM).

CAD is the use of computer software to design and document a product's design process. CAD is used to accomplish preliminary design and layouts, design details and calculations, create 3D models, create and release drawings, and interface with analysis, marketing, manufacturing, and end-user personnel.

CAM is the use of software and computer-controlled machinery to automate a manufacturing process. Based on that definition, three components are required for a CAM system to function:

- Software that tells a machine how to make a product by generating toolpaths.
- Machinery that can turn raw material into a finished product.
- Post processing, which converts toolpaths into a language machines can understand.

E.1 Support Program Producibility Requirements

Producibility Engineering and Planning should be directed toward generating a design that is compatible with the current capability of the factory floor. Producibility is a major driver of product affordability because of the effect on both production and sustainment costs. The Producibility Plan should guide the design effort and describe activities that will be accomplished, the responsible organization, and the management controls that will be established to ensure successful accomplishment. Manufacturing and QA managers should consider the need for developing Initial Producibility Plans and requirements.

Manufacturing and Quality Tasks

- Assess the manufacturing producibility and feasibility of the concepts being considered as materiel solutions to ensure that one or more concepts have the potential to be affordable, effective, and suitable, and can be developed to provide a timely solution to a need at an acceptable level of risk. The assessment should include:
    - Evaluation of the contractor approach to design and systems engineering
    - Evaluation of the contractor's use of design tool and software
    - Evaluation of design concepts
    - Identification and determination of costs, cost drivers, and potential risks
    - Identification of M&Q processes needed and requirements
    - Identification of design requirements
    - Identification of technical risks
- Assess use of design analysis tools
    - Fault Tree Analysis (FTA)
    - Failure Mode and Effects Analysis (FMEA)
    - Process Failure Mode and Effects Analysis (PFMEA)
    - Design Failure Mode and Effects Analysis (DFMEA)
- Assess the organizations' ability to identify, manage, and control KCs and CCs
- Conduct additional analysis of the following areas as the concepts mature:

  - Technology maturity
  - Industrial base capability
  - Manufacturability
  - Funding required for maturing the M&Q processes
  - Materials availability
  - Tests and demonstrations for new materials and processes
  - Environmental impacts
  - Anticipated M&Q risks including potential cost and schedule impacts
- Conduct trade studies that consider and incorporate alternative system designs and other technical considerations.

Tools

- ISO 9001 Checklist
- SAE AS9100 Checklist
- SAE AS6500
- DCMA Industrial Capability Assessment Survey Form
- Interactive MRL Users Guide (Checklist), Design thread
- Manufacturing Maturation Plan
- Manufacturing Producibility Assessment Worksheet (PAW)
- Market Research Reporting Template
- CAD/CAM software
- Fault Tree Analysis
- Failure Modes and Effect Analysis
- Process Failure Modes and Effects Analysis
- Design Failure Modes and Effects Analysis
- Preliminary Hazards List
- Pugh Matrix
- TRA Checklist

Resources

- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- MIL-HDBK-896, Manufacturing Management Program Guide
- Quality Management System
- AS6500 Manufacturing Management Program
- AS9103 Variation Management of Key Characteristics
- MIL-STD-1629A Failure Modes Effect and Critical Analysis
- SAE J1739-202101 Potential Failure Mode and Effects Analysis

- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook
- Producibility Systems Guidelines, NAVSO P-3687
- Technology Readiness Assessment (TRA) Guide
- Technology Readiness Assessment Guide (GAO-20-48G)

E.2 Evaluate Design Maturity

M&Q personnel need to support the Design IPT in evaluating design maturity by assuring that top-level performance requirements are defined and trade-offs in design options are assessed based on experimentation.

Manufacturing and Quality Tasks

- Identify the manufacturing industrial base capabilities and the manufacturing technologies required by a materiel solution to evaluate the respective design maturities.
- Identify broad performance requirements of materiel solution approaches that may drive M&Q options.
- Assess the maturity of each materiel solution's design options based on experiments.
- Identify and evaluate materiel solution approaches life cycle and technical requirements.
- Identify and evaluate reasonable technologies that can be available in the timeframe available.
- Support the identification of future design validation and verification activities.

Tools

- DCMA Industrial Capability Assessment Survey Form
- Interactive MRL Users Guide (Checklist), Design thread
- Manufacturing Maturation Plan
- Market Research Reporting Template
- Producibility Assessment Worksheet (PAW)
- Pugh Matrix Template
- TRL Assessment Checklist

Resources

- SAE AS9100, Quality Management Systems – Requirements for Aviation, Space and Defense Organizations
- DoD 5000.60H Assessing Defense Industrial Capabilities
- DoD Market Research Guide
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- DoDI 5000.85, Major Capability Acquisition

- DoDI 5000.88, Engineering of Defense Systems
- ISO 9001, Quality Management Systems
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook
- Producibility System Guidelines, NAVSO P-3687
- Technology Readiness Assessment (TRA) Guide
- Technology Readiness Assessment Guide (GAO-20-48G)

F. COST/FUNDING

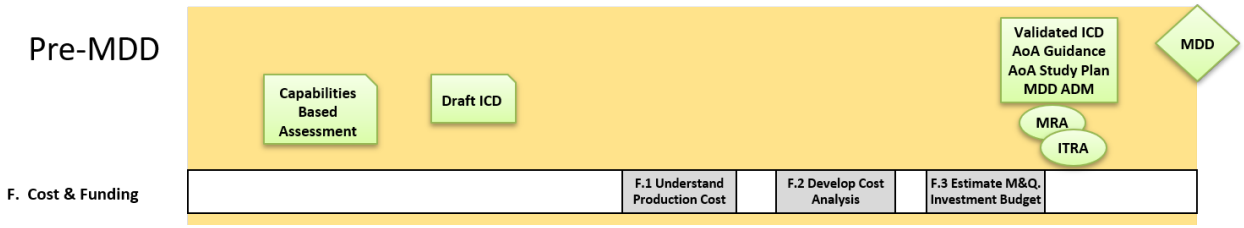


Figure 1-7. Cost and Funding Manufacturing and Quality Activities

Introduction

Services and Agencies develop Program Objective Memorandums (POMs) to identify and request funding to acquire capabilities and perform operations. The POM is part of the Programming phase of the Program, Planning, Budget, and Execution (PPBE) process. The DoD combines the various Service and Agency POM inputs and Budget Estimate Submission (BES) and submits a DoD Budget Request to the Office of Management and Budget (OMB).

DoD efforts at cost estimating and analysis play a critical role in supporting DoD procurement activities to include planning, programming, budgeting, acquisition, and requirements generation. Cost estimating is both a science and an art relying on sound mathematical and analytical skills, critical thinking, communication, and the ability to understand complex functions and processes.

Throughout the acquisition process, systems engineering provides the technical foundation for the acquisition program. In the early stages of an acquisition, systems engineering analysis and products are vital to the ability to assess appropriately the feasibility of addressing user needs, technology needs of potential solutions, and robust estimates of cost, schedule, and risk, all leading to predictable, disciplined acquisition.

The government's objective is to determine the costs to develop, execute, field, and maintain each materiel solution. The effort requires processes and systems that consider manufacturing, quality, and

design functions to achieve a product design that meets cost, schedule, and performance requirements with acceptable risk.

- Cost Capability Analysis (CCA)
- Independent Government Cost Estimate (IGCE)
- Should Cost Estimate (SCE)

Appropriate practices for implementation will include parametric and production cost modeling estimates. Parametric cost modeling requires identification of similar systems, products, components, and manufacturing processes, and other factors. Production cost modeling includes identification of critical characteristics and Key Characteristics (KC) and critical and key manufacturing and test processes; variability reduction; simulations of the manufacturing environment; cost/performance trade studies; manufacturing capability assessments; product and process validation; and key supplier relationships. Depending on the materiel solution, production cost modeling may have limited application in this phase.

Part of the task or role for M&Q is to identify investments needed in the industrial base or infrastructure for each materiel solution. The needed investments may include additional industrial capacity, test equipment, workforce training, special materials handling, transportation, etc.

In addition, investments in processes and systems to assure program affordability, through product quality and manufacturing efficiency, may include for implementation: product improvement initiatives, variability reduction on product and process, manufacturing process control and continuous improvement, key supplier relationships, and investments in manufacturing technology. To that end, ongoing and future ManTech, Title III, etc., program investments need to be considered to achieve the desired performance while controlling or meeting acquisition cost objectives. This is accomplished by developing, maturing, and transitioning advanced manufacturing technologies.

F.1 Understand Production Cost

M&Q personnel need to be able to understand potential production costs and manufacturing cost drivers to develop initial manufacturing cost estimates and targets. This effort requires knowledge of cost models and modeling techniques including analogy, parametric, engineering, and actual costs.

Manufacturing and Quality Tasks

- Evaluate the Cost Analysis and Program Assessment (CAPE) cost estimates for appropriateness and completeness of manufacturing considerations. Cost estimates could use one or more of the following estimating techniques:
    - Analogy: Identifies similar systems for which there is accurate cost and technical data to forecast the cost of the new system

- Parametric: Identifies a statistical (parameter) relationship between historical data and some variable to calculate the cost of the new system
- Engineering: A bottom-up estimate that builds the overall cost estimate by summing up a detailed estimate done at the lower levels of the WBS
- Actual: Uses actual cost data from current systems
- Cost estimates should include:
  - Identification of critical and key/critical product characteristics/features and critical and key/critical manufacturing and test processes
  - Identification of variability reduction needs
  - Simulations of the manufacturing environment
  - Trade studies of cost/performance
  - ESOH and HAZMAT cost impacts
  - Capability assessments of manufacturing and quality, product and process validation, and key supplier relationships
- Independent Cost Estimate (ICE)
- Component Cost Estimate (CCE)
- Component Cost Position (CCP)
- Cost Capability Analysis (CCA)
- Independent Government Cost Estimate (IGCE)
- Should Cost Estimate (SCE)
- Sufficiency Review

Tools

- Analogy and Parametric Estimating Techniques
- Cost Analysis Requirements Description Template (CARD) (*See* CAPE website for tools)
- Interactive MRL Users Guide (Checklist), Cost/Funding thread
- Manufacturing Cost Estimating Worksheet
- Manufacturing Maturation Plan

Resources

- DoD Cost Estimating Guide
- Defense Manufacturing Management Guide for Program Managers, Chapter 9, Manufacturing Cost Estimating
- DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook

- MIL-HDBK-766, Design to Cost
- Parametric Estimating Handbook

F.2 Develop Cost Analysis

M&Q personnel need to support the development of early cost estimates and analysis to include the conduct of sensitivity analysis to define cost drivers and production development strategy (i.e., lab to pilot to factory).

Manufacturing and Quality Tasks

- Identify the applicable guidance for developing M&Q cost estimates
- Identify investments needed in the industrial base or infrastructure for each materiel solution
- Support initial document development of the CARD with the M&Q inputs for the appropriate cost categories (e.g., producibility study costs).
- Identify any M&Q cost implications for materiel solutions.
- Identify M&Q cost drivers of materiel solutions (e.g., proposed materials and process selections that may be inherent).
- Conduct M&Q cost sensitivity analysis where appropriate if possible.
- Identify M&Q workforce and integration cost requirement implications.
- Identify investments needed in the industrial base or infrastructure for each materiel solution.
    - Investments may include additional industrial capacity, test equipment, workforce training, special materials handling, transportation, etc.

Tools

- Cost/Schedule Control System Criteria (widely replaced by Earned Value Management, but could use on a small project)
- Interactive MRL Users Guide (Checklist), Cost/Funding thread
- Manufacturing Cost Estimating Worksheet
- Manufacturing Maturation Plan
- *See* CAPE website for tools

Resources

- DoD Cost Estimating Guide
- Cost/Schedule Control System Criteria Reference Guide
- Manufacturing Cost Estimating (*See* Defense Manufacturing Management Guide for Program Managers, Chapter 9)
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook

- Manufacturing Readiness Level (MRL) Deskbook
- *See* CAPE website for guidance

F.3 Estimate Manufacturing and Quality Investment Budget

M&Q personnel need to support the development of program/project budget estimates for manufacturing activities that may need maturing to reach MRL 4 by MS A.

Manufacturing and Quality Tasks

- Estimate investments required for materiel solution approach:
  - Capital equipment (tooling, machines, structures, etc.)
  - Test equipment (specialized, environmental, etc.)
  - Facilities and modifications/expansion (handling, storage, transportation, disposal)
  - Government-furnished equipment (GFE)
- Identify new or high-risk M&Q processes that require investments as part of a manufacturing feasibility assessment to meet concept needs:
  - Assess ongoing ManTech, Title III, etc. program investments
  - Identify future ManTech, Title III, etc. program investments

Tools

- Interactive MRL Users Guide (Checklist), Cost/Funding thread
- Manufacturing Cost Estimating Worksheet
- Manufacturing Maturation Plan
- *See* CAPE website for tools http://www.cape.osd.mil/

Resources

- DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Manufacturing Readiness Level (MRL) Deskbook
- *See* CAPE website for guidance http://www.cape.osd.mil/

G. MATERIALS MANAGEMENT

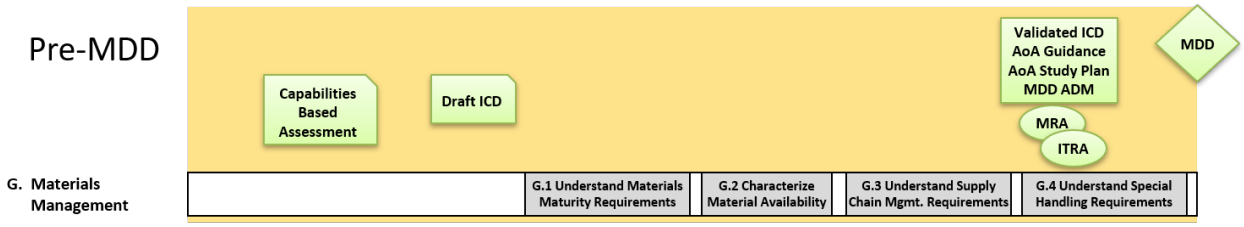


Figure 1-8. Materials Management Manufacturing and Quality Activities

Introduction

Materials management is a core function of supply chain management, including the process for planning and controlling material requirements and material flow through the entire supply chain. Materials management will require assessment of the maturity, the materials availability, the capability and capacity of the proposed supply chain to provide the materials, and the potential need for special handling, government-furnished property (GFP), shelf life, security, storage, environmental, requirements, etc. The process begins with the customer demand signal, and this information flows throughout the supply chain down many tiers: raw materials, fabrication, assembly, test, quality control, distribution, delivery, and acceptance by the customer. Major SCM functions include:

- Material characteristics and maturity
- Material risks
- Supplier management and quality
- Critical materials
- Special handling requirements
- Scale-up requirements / de-mil / shutdown

Materials management is a key focus of M&Q tasks for the concepts being considered for development. It requires assessment of the maturity, the materials availability, the capability and capacity of the proposed supply chain to provide the materials, and the potential need for special handling, government-furnished property (GFP), shelf life, security, storage, environmental, etc. requirements.

The assessment will identify the need for any additional research to mature materials and identify the properties, characteristics, and quality deemed necessary to support the concepts being considered. Material properties, characteristics, and quality will require experiments for validation and assessment for basic manufacturability.

The assessment will also identify materials that are available to support the concepts being considered, as well as the manufacturing, quality, and scale-up risks and issues. It will also identify those materials that are not readily available and will include identification of sources of material (from the NTIB or foreign sources). There are several ways the DoD can address material needs and shortages. One is through the Defense Production Act of 1950 and the implementation of the Defense Priorities and

Allocation System (DPAS) in which the government can designate programs as "high priority" and put them at the front of the contractor's production queue.

The complexity of the DoD supply chain for a weapon system is staggering with a supply chain that often encompasses hundreds of vendors and subcontractors. Adding to the complexity is the fact that on many large weapon system programs the prime contractor is often the integrator, with much of the program content coming from subcontractor, government, and other vendors or suppliers. Thus, managing the supply chain, which includes the materials and the associated schedules, becomes a key and critical management function.

This thread (Materials Management) requires an analysis of the risks associated with materials (including basic/raw materials, components, semi-finished, parts, and sub-assemblies).

G.1 Understand Materials Maturity Requirements

M&Q personnel need to assess and understand material properties for basic manufacturability using experiments. This will form the baseline for advancing the manufacturing readiness level as that material moves forward into acquisition and on into a weapon system.

Manufacturing and Quality Tasks

- Identify materials that require maturation plans to meet the next phase objectives.
- Identify needed material properties, characteristics, and quality for each materiel solution.
    - Identify and document appropriate metrics for evaluating materials against requirements
- Identify additional research and development (R&D) and experiments required for immature materials for validation and assessment of basic manufacturability
- Investigate ongoing programs (DoD, S&T, commercial, government, etc.) to identify materials that address each materiel solution need.
    - Assess materials manufacturing maturity
- Perform volatility assessments for each materiel solution:
    - Potential supply chain sources for critical materials
    - Special handling procedures that were applied in the lab and include in lead time estimates

Tools

- Design for Six Sigma (Tools)
- Design of Experiments Analysis
- Interactive MRL Users Guide (Checklist), Material Management thread
- Lead Time Estimator
- Manufacturing Maturation Plan

- Market Research Reporting Template
- Taguchi Loss Function Analysis

Resources

- Manufacturing Readiness Level (MRL) Deskbook

G.2 Characterize Material Availability

Material characterization refers to the process by which a material's structure and properties are analyzed and measured. It measures how a material will behave or perform. M&Q personnel need to support the identification and characterization of materials, material needs, and material availability to prepare for the introduction of that material on the factory floor.

Manufacturing and Quality Tasks

- Identify the availability of essential raw materials, special alloys, composite materials, and components required to support the concepts being considered.
- Assess material requirements, external dependencies, and availability for materiel solutions.
    - Identify materials that are:
        - Developed in a lab environment, but are not immediately available
        - Readily available within near term (i.e., commodities)
        - Commercially available, but have long lead times
        - Readily available, but have environmental or health concerns
- Assess material scale-up issues for materiel solutions.
- Identify items that are sole or single sourced, fragile source, or available only from sources outside the NTIB.
    - Assess the availability and lead time for alternatives for obtaining such items from within the NTIB
    - Conduct an analysis of any military vulnerability or gaps that could result from the lack of reasonable alternatives
- Assess the effects on the NTIB that result from foreign acquisition of firms in the United States.

Tools

- DCMA Industrial Capability Assessment Survey Form
- Diminishing Manufacturing Sources and Material Sources (DMSMS) Product Life Cycle Assessment (Consult Defense Logistics Agency (DLA))
- Interactive MRL Users Guide (Checklist), Material Management thread
- Lead Time Estimator

- Manufacturing Maturation Plan
- Market Research Reporting Template
- Technology Readiness Level Assessment Checklist

Resources

- DCMA Instruction 3401, Defense Indusial Base Mission Assurance
- DMSMS Guidebook, SD-22
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Manufacturing Readiness Level (MRL) Deskbook

G.3 Understand Supply Chain Management Requirements

M&Q personnel need to conduct an initial assessment of the supply chain to understand where the potential sources of supply are, and if there is any competition, or other supply chain risks.

Manufacturing and Quality Tasks

- Conduct an initial assessment of potential supply chain capability and capacity for materiel solution approaches.
- Recommend industry best practices to be followed for management of the materials supply chain for the concepts being considered.
    - Include industry best practices for M&Q to be followed in the supply chain for the concepts being considered
- Recommend M&Q processes or standards for the procurement team to follow to provide a basis for the team to work together and add value.
- Establish threshold and objective requirements for flow down of realistic and attainable requirements for a new concept to the supply chain as appropriate.
    - Identify realistic material estimates (time, material, manpower, etc.) to be provided to the entire supply chain
    - Evaluate the flow down process for gaps throughout the entire supply chain

Tools

- Interactive MRL Users Guide (Checklist), Material Management thread
- Lead Time Estimator
- Manufacturing Maturation Plan
- Supply Chain Management Risk Assessment Checklist

Resources

- DoD 4140.01-R, Supply Chain Materiel Management
- DoD Market Research Guide
- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook

G.4 Understand Special Handling Requirements

M&Q personnel need to be aware of the need for special handling of material to include government-furnished property (GFP), government-furnished equipment (GFE), hazardous materials, special storage and shelf-life, security, etc.

Manufacturing and Quality Tasks

- Identify the special requirements in the manufacturing processes that will be used to build the materiel solution approaches.
    - Hazardous materials and handling procedures
    - Security requirements
    - Storage and shelf life
    - GFP, GFE (tooling, test equipment, ranges, chambers, etc.)
    - Disposal
- Identify potential regulatory requirements, handling concerns, transportation, etc., for materiel solution approaches.

Tools

- Cyber Security Assessment
- DMSMS Product Life Cycle Assessment
- Hazardous Material Assessment Template
- Interactive MRL Users Guide (Checklist), for Material Management thread
- ISO 9001, Checklist Section 7.5.5, Preservation (Handling, Storage, Packaging and Delivery)
- ITAR Compliance Checklist
- Lead Time Estimator
- Manufacturing Maturation Plan
- Preliminary Hazard List (PHL) (*See* PHA checklist)
- Shelf Life Calculator for Composite Materials

Resources

- SAE AS9100 Quality Management Systems
- AS9133 Qualification Procedure for Aerospace Standard Products

- ESOH in Acquisition Guide
- ISO 9001, Quality Management Systems
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook

H. PROCESS CAPABILITY AND CONTROL

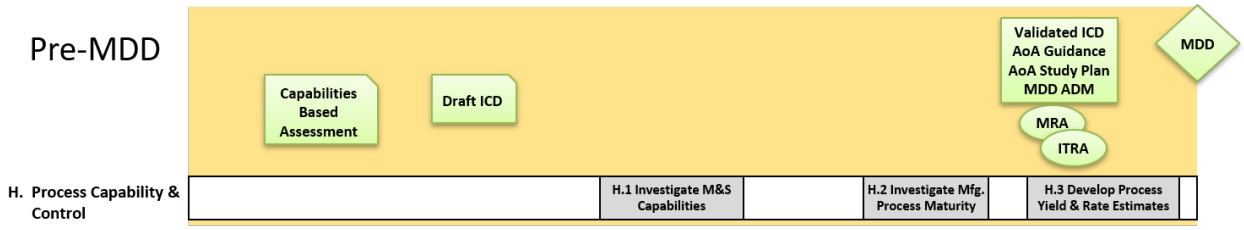


Figure 1-9. Process Capability and Control Manufacturing and Quality Activities

Introduction

One of the major goals of manufacturing is to provide the customer with "uniform, defect-free product" that has consistent performance and is affordable. Product quality comes from robust product and process design and process control activities including continuous process improvement to identify and remove sources of variation.

Process Capability and Control is a requirement of both SAE AS9100 Quality Management Systems and SAE AS6500 Manufacturing Management Program. It requires a process control plan that describes the actions and activities that will demonstrate process capabilities.

As a best practice, M&Q personnel should analyze process capabilities for each Key Manufacturing Process (KMP) and CMP. The engineering team should use statistical tools to minimize variability and calculate the process capability index (Cpk), if applicable.

For each concept being considered, the M&Q lead should determine the manufacturing process capability. This assessment of manufacturing feasibility will include the investigation of process maturity for similar manufacturing processes. Critical and key manufacturing processes can also be identified during the assessment and analysis either through M&S or experimentation, such as:

- Capability studies
- Yields and rates
- Process demonstrations

Important definitions include the following:

- Key Characteristics (KC): An attribute or feature whose variation has a significant influence on product fit, form, function, performance, service life, or producibility that requires specific actions for the purpose of controlling variation.
- Key Manufacturing Process (KMP): A process that creates or substantially affects a key characteristic.
- Critical Characteristic (CC): A characteristic whose variation has a significant impact on human safety, or could cause a catastrophic failure resulting in loss of life, permanent disability, or major injury to personnel.

Advances in digital engineering to include modeling and simulation (M&S) along with continual improvements in computer performance have made it possible to perform comprehensive analysis of virtual parts and to test and assess the capability of processes before actual manufacturing begins. The use of solid modeling, finite element analysis, multi-paradigm numerical computing environments, and simulation software analysis tools allows users to simulate different conditions that are likely to occur during manufacturing processes and model the behavior of systems under real-world conditions. An understanding of the capabilities to model products and processes for each of the concepts under consideration can be a valuable discriminator.

The activities managing the concept and program offices must understand the manufacturing feasibility (i.e., manufacturing risks) associated with each potential materiel solution. For example, managers may be under the false impression that identical production facilities will experience identical problems; often this is not the case. Another assumption may be that if a facility has operated smoothly in one location it will operate smoothly again if moved to another location. This often is not the case, even with the same workforce; variability from disassembly, movement, and reassembly will occur. A source of information for these feasibility risks comes from the “lessons learned” data captured by contractors as part of their systems to capture their overall capabilities, knowledge, and best manufacturing practices. Incorporating lessons learned from investigations of similar manufacturing processes maturity into the models and simulations may also increase fidelity of results and characterization of the items being analyzed.

Most companies use M&S and other data analysis tools to help identify, analyze, and remove bottlenecks in the production process, improve yields, reduce costs, and improve quality. By collecting and analyzing the M&Q data, one can get a realistic picture of the entire process. A process has three features: how much variation (spread), where (centering), and shape (normal, skewed, bimodal, etc.). If processes are stable, then the process features, spread, centering, and shape, will remain constant and predictable over time. If the process is unstable, then these features will change, and the product output will become unpredictable. Data and information from similar manufacturing processes, as well as M&S processes, should be used to develop estimates of potential yields and rates of production of each concept under consideration as a discriminator as to which has the greatest potential to meet M&Q requirements.

This thread (Process Capability and Control) requires an analysis of the risk that the manufacturing processes may not be able to reflect the design intent (repeatability and affordability).

H.1 Investigate Modeling and Simulation (Product and Process) Capabilities

M&Q personnel need to support the understanding of needed process capabilities using modeling and simulation techniques.

Manufacturing and Quality Tasks

- Investigate initial product and or process models in development for materiel solution approaches.
- Investigate manufacturing concepts or producibility modeling and simulation needs of materiel solution approaches.
- Identify modeling and simulation tools that make it possible to perform a comprehensive analysis of virtual parts and to assess the capability of processes before actual manufacturing begins.
- Use modeling and simulation software to model the behavior of materiel solutions under simulated "real-world" conditions.
- Establish requirements and data needs for the learning curve (cost improvement curve, or experience curve).

Tools

- SAE AS9100 Checklist
- SAE AS6500 Checklist
- Interactive MRL Users Guide (Checklist), Process Capability and Control thread
- Learning Curve Worksheet
- Manufacturing Maturation Plan
- Plant Modeling and Simulation tools (e.g., FlexSim, SimFactory)
- Process Modeling Tools (e.g., Siemens PLM, Delmia)
- Solid modeling and analysis software programs (e.g., NX, CATIA, Pro-Engineer, Nastran add-ins)

Resources

- SAE AS9100, Quality Management System
- SAE AS6500, Manufacturing Management Program
- AS9103, Variation Management of Key Characteristics
- Manufacturing Readiness Level (MRL) Deskbook
- Manufacturing Simulation Applications
- Modeling and Simulation Guidance for the Acquisition Workforce

H.2 Investigate Manufacturing Process Maturity

M&Q personnel need to be able to assess a materials current process maturity and develop a roadmap for maturing that technology if it should move forward into acquisition.

Manufacturing and Quality Tasks

- Assess feasibility of similar materials and/or similar manufacturing process approaches, and the projected gaps based on the data collected for each concept under consideration for the AoA Study Guidance.
- Conduct a manufacturing feasibility assessment that identifies the M&Q risks incurred for each concept under consideration, which should include:
    - Producibility of the potential design concepts
    - Critical and key manufacturing processes
    - Special tooling development required
    - Demonstration, test, and qualification required for new materials, to include items, parts, and components
    - Alternate design approaches within the individual concepts
    - Lessons learned from similar approaches
    - Anticipated M&Q risks and potential cost and schedule impacts
- Establish plans for identifying critical manufacturing processes and their continuous improvement.

Tools

- SAE AS9100 Checklist
- SAE AS6500 Checklist
- Feasibility Study Checklist
- First Pass Yield Estimates Worksheet
- Interactive MRL Users Guide (Checklist), Process Capability and Control thread
- Manufacturing Maturation Plan
- Process Capability Studies (Cp and Cpk assessment)
- Producibility Assessment Worksheet (PAW)
- Six Sigma Worksheet

Resources

- SAE AS9100, Quality Management System
- SAE AS6500, Manufacturing Management Program
- AS9103, Variation Management of Key Characteristics
- DoD Systems Engineering Guidebook

- Engineering of Defense Systems Guidebook
- Manufacturing Readiness Level (MRL) Deskbook
- Producibility Systems Guidelines, NAVSO P-3687

H.3 Develop Process Yield and Rate Estimates

M&Q personnel need to be able to investigate a potential material's current or potential process yields and rates and develop estimates of yields and rates that may be required if the material goes past the MDD.

Manufacturing and Quality Tasks

- Identify or estimate the process capability for those critical manufacturing processes.
- Develop and estimate yields and rates of materiel solution approaches.
- Develop other product and process quality metrics, and set goals for production.
- Conduct an M&Q study of existing processes and the need for new processes for each concept under consideration to determine if the yield meets the requirements.
- Identify the sources of variations and plans to address for each concept under consideration.

Tools

- SAE AS9100 Checklist
- Cause and Effect Diagram
- First Pass Yield Estimates Worksheet
- Histograms
- Interactive MRL Users Guide (Checklist), Process Capability and Control thread
- Manufacturing Maturation Plan
- Pareto Analysis
- Process Capability Study Worksheet (Cp and Cpk Assessment)
- Six Sigma Worksheet

Resources

- SAE AS9100 Quality Management System
- SAE AS6500 Manufacturing Management Program
- AS9103 Variation Management of Key Characteristics
- DoD Systems Engineering Guidebook
- Engineering of Defense Systems Guidebook
- Manufacturing Readiness Level (MRL) Deskbook

I. QUALITY MANAGEMENT

Figure 1-10. Quality Management Manufacturing and Quality Activities

Introduction

DoD has increased focus on M&Q management during early program phases. Quality is the degree to which material attributes, performance features, and characteristics of a product satisfy a given need. Quality may apply to a product, process, or system and may be physical, sensory, behavioral, temporal, ergonomic, or functional.

Quality management is an integral part of design and development efforts. QMS standards include industry best practices such as ISO 9001, Quality Management Systems–Requirements. SAE AS9100, Quality Management Systems–Requirements for Aviation, Space and Defense Organizations, Product Realization (clause 7) includes typical SE tasks under sub-clause 7.3, Design and Development. The typical SE processes included in the QMS are:

- Design and Development Planning – SE Management, Failure Modes, Effects, and Criticality Analysis (FMECA), System Safety, etc.
- Design and development inputs/outputs – T&E, reviews, and audits
- Design and development review, verification, and validation
- Control of design and development changes – hardware and software configuration management
- Hardware and software configuration management
- Risk, issue, and opportunity management
- Corrective Action System
- Monitoring and measuring equipment calibration records
- Records of training, skills, experience, and qualifications
- Product/service requirements review records
- Record about design and development outputs review
- Record about design and development inputs
- Records of design and development controls
- Records of design and development outputs
- Design and development change records
- Characteristics of product to be produced and service to be provided
- Records about customer property

- Production/service provision change control records
- Record of conformity of product/service with acceptance criteria
- Record of nonconforming outputs
- Monitoring measurement results
- Internal audit program
- Results of internal audits
- Results of the management review
- Results of corrective actions

This thread (Quality) requires an analysis of the risk and management efforts to control quality and foster continuous quality improvement and will focus on the following sub-threads, tasks, activities, tools, and resources:

- Quality Management System (QMS)
- Quality Strategy and Plan
- Product Quality
- Supply Chain Quality
- Quality Risk

I.1 Quality Management Requirements

M&Q personnel should identify the potential requirements for a Quality Management System (QMS) of an identified material based on FAR 46.202 Types of Contract Quality Requirements, and FAR 52.2456-11 Higher-Level Contract Quality Requirements.

M&Q personnel may also consider related clauses to include:

- Inspection of supplies and services clauses, 52.246-2 thru 52.246-9 to ensure appropriate government access, oversight, and protection.
- Warranty for supplies and/or services: 52.246-17 thru 52.246-21 though mainly -18, -19, and -20 depending on what work is being done and what product is being delivered.

Best practice includes contractors operating to either ISO 9001 Quality Management System or SAE AS9100 Quality Management System. A typical QMS will address leadership and policy, planning, organizational support, operations, performance measurement and evaluation, and continuous improvement.

Manufacturing and Quality Tasks

- Specify the contract quality management requirements to be met by the contractor or government entity as appropriate.
- Evaluate each concept being considered and identify the capability to meet quality management needs.

  - Evaluate each concept being considered and identify the need for focused manufacturing or quality plans (e.g., a program Quality Assurance Plan) to guide the approach
  - Evaluate each concept being considered and identify the need for a stand-alone government manufacturing or quality assurance plan

- Assess the impact of technology and process state of the art on the concepts being considered and the impacts on quality management.
- Identify and understand potential solutions or systems that could address quality management needs.
  - Identify and understand M&Q management lessons learned and best practices among programs and across centers
  - Assess and evaluate quality technologies that could assist on materiel solution programs
- Identify potential solutions or systems to improve low-yield processes and components.
- Establish quality management metrics for each of the concepts being considered
  - Determine the frequency that the metrics should be reviewed, commensurate with M&Q risks
- Evaluate the QMS in use for each of the concepts being considered.
  - The QMS should include:
    - Management responsibility
    - Resource management
    - Quality System
    - Contract Review
    - Product Realization
    - Design Control
    - Document Control
    - Purchasing
    - Purchaser-Supplied Product
    - Product Identification and Traceability
    - Process Control
    - Measurement, Analysis, and Improvement (i.e., metrology and calibration)
  - Assess QMS audit records for frequency, compliance, and responsiveness
- Evaluate the contracts and in appropriate agreements with other agencies, e.g., the DCMA to ensure quality and manufacturing requirements are included.
- Ensure that the QMS evaluation of potential contractors and suppliers for each concept being considered includes DCMA input.

Tools

- SAE AS9100, Quality Audit Checklist

- Critical to Customer Assessment
- Critical to Quality Tree
- Interactive MRL Users Guide (Checklist), Quality Management thread
- ISO 9001, Quality Management Systems, Quality Audit Checklist
- Manufacturing Maturation Plan
- Quality Management Plan (Sample)

Resources

- AFMC Instruction 63-145, Manufacturing and Quality
- SAE AS9100, Quality Management System – Aerospace
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- ISO 9001, Quality Management Systems
- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook

I.2 Product Quality Requirements

M&Q personnel need to identify the potential product quality requirements of an identified material based on FAR 46.202, Types of Contract Quality Requirements, and FAR 52.246.1, Contractor Inspection Requirements. In addition, the organization needs to identify the process of measuring, examining, testing, or otherwise comparing the product to the requirements for acceptance. FAR 46.291 Production Lot Testing states that the purpose of production lot testing is to validate quality conformance of products before lot acceptance, which usually occurs after acceptance testing.

Manufacturing and Quality Tasks

- Evaluate product quality requirements for each concept being considered:
    - Identify product acceptance methods and determine sampling plan as appropriate
    - Identify product quality metrics and the frequency that the metrics should be reviewed, commensurate with M&Q risks
    - Identify the need for focused product quality requirements (i.e., specific product characteristics) to guide the approach
    - Identify the need for government-unique product quality requirements
- Identify and understand potential solutions that could address product quality needs.
    - Assess and evaluate quality technologies (e.g., metrology technologies) that could improve the materiel solution's product quality
    - Identify potential solutions to improve low-yield processes and components for each materiel solution's product quality

- Assess the impact of quality technology and process state of the art on the product quality requirements of the concepts being considered.
- Ensure that the QMS evaluation of potential contractors and suppliers for each concept being considered includes DCMA input.
- Ensure the contractor/organization provides and maintains a measurement system to validate that products conform to requirements.
- Ensure that measuring and testing devices are calibrated at specified intervals before use and are traceable to national standards.

Tools

- AS9100, Quality Audit Checklist
- Critical to Customer Assessment
- Critical to Quality Tree
- Interactive MRL Users Guide (Checklist), Quality Management thread
- ISO 9001, Quality Management Systems, Quality Audit Checklist
- Manufacturing Maturation Plan
- Lot Acceptance Testing Calculator
- Quality Management Plan (Sample)

Resources

- AS9100, Quality Management System
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- ISO 9001, Quality Management Systems
- MIL-STD-1916, DoD Test Method Standard
- ANSI Z1.4 Sampling Procedures and Tables for Inspection by Attributes
- ANSI Z1.9 Sampling Procedure and Tables for Inspection by Variables for Percent Nonconforming
- DCMA-INST 302, First Article and Production Lot Testing
- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook

I.3 Supplier Quality Management Requirements

M&Q personnel need to identify potential sources of supply for an emerging material and identify the proposed supplier quality requirements that should be invoked if the material goes forward.

Manufacturing and Quality Tasks

- Assess the impact of quality technology and process state of the art for the concepts being considered and the impacts on the supply chain (i.e., supplier's) quality management.
- Evaluate each concept being considered and identify supply chain quality management needs.
    - Evaluate each concept being considered and identify the need for focused supplier quality management requirements (e.g., a supplier Quality Assurance Plan) to guide the approach
    - Evaluate each concept being considered and identify the need for a stand-alone government supplier quality plan for the supply chain
- Establish supply chain quality management metrics for each of the concepts being considered for incoming quality inspection to include the identification of inspection and testing requirements including potential use of acceptable quality levels (AQLs).
    - Determine the frequency that the metrics should be reviewed, commensurate with M&Q risks
- Identify and understand potential solutions, tools, and techniques that could address supplier quality management requirements.
    - Assess and evaluate quality technologies (i.e., metrology technologies) that could improve the materiel solution's supply chain programs
    - Identify potential solutions (e.g., materials, machines, training) to improve low-yield processes and components and lower variability to meet supplier quality management requirements for each materiel solution
- Ensure that the assessment of potential supplier's quality management (in the lower supply chain) for each concept being considered includes DCMA input.
- Ensure quality and manufacturing requirements are included in contracts of proposed suppliers and in appropriate agreements with other agencies (e.g., DCMA).

Tools

- AS9100, Quality Audit Checklist
- AS9133, Supplier Audit Checklist
- Critical to Customer Assessment
- Critical to Quality Tree
- Interactive MRL Users Guide (Checklist), Quality Management thread
- ISO 9001, Quality Management Systems, Quality Audit Checklist
- Manufacturing Maturation Plan
- Supplier Quality Questionnaire

Resources

- AS9100, Quality Management System – Aerospace

- AS9133, Supplier Quality Program
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- ISO 9001, Quality Management Systems
- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook

J. MANUFACTURING WORKFORCE

Figure 1-11. Manufacturing Workforce Manufacturing and Quality Activities

Introduction

M&Q workforce requirements, planning, and analysis covers a range of knowledge, skills, and abilities from a competency perspective. Workforce availability is also a concern as companies may face shortfalls in personnel. In addition to specific labor skills (welding, machining, fabrication, assembly, inspection, testing, etc.) associated with production processes, there is a need for M&Q personnel to understand the requirements for fabrication and assembly of countless types of materials.

Manufacturing feasibility and industrial base analyses of the concepts being considered should address the existing skills of the appropriate workforce. The M&Q workforce has been aging in recent decades, especially in many key defense sectors. Established manufacturing capabilities are becoming high risks as skills, facilities, equipment, etc., atrophy. Manufacturers have experienced a moderate to severe shortage of available, qualified production workers and a moderate to severe skills shortage in their overall workforce. They anticipate these shortages to grow worse in the coming years, and workforce shortages and skills deficiencies in production roles are having a significant impact on the ability to expand operations or improve productivity.

This thread (Workforce) outlines the assessment of required personnel skills and availability to support the manufacturing effort.

J.1 Identify Manufacturing Workforce (Engineering and Production) Requirements

M&Q personnel need to support the identification of potential workforce skills, training, and availability requirements based on an identified emerging material and processes.

Manufacturing and Quality Tasks

- Identify new M&Q skills and training requirements for materiel solution approaches to include the need for a Training and Certification Program.
- Identify planned personnel loadings to ensure that adequate numbers of people with the required skills are made available for each candidate materiel solution approach
    - Define a profile of the required workforce
    - Identify workforce requirements, special skills, and training requirements.
    - Identify sources of personnel and their potential availability
    - Plan for the acquisition and training of new personnel
- Review appropriate workforce lessons learned to initiate development of tools and techniques that can be used to establish a better manufacturing workforce strategy.
- Assess new materials and technologies as they evolve and how the M&Q workforce will address processing, testing, and acceptance of these materials.
- Identify potential regulatory requirements and special handling (e.g., hazardous materials, environmental needs, storage requirements, etc.) impacts to the manufacturing workforce by the materiel solution approaches.
- Review and document workforce lessons learned and apply them to development of tools and techniques for a better manufacturing workforce strategy.
- Assess and document impacts of new materials and technologies on the M&Q workforce for each concept, including impacts of processing, testing, and acceptance of these materials and technologies.
- Assess and document potential regulatory requirements and special handling (e.g., hazardous materials, environmental needs, storage requirements, etc.) impacts to the manufacturing workforce for each concept, for the AoA Study Guidance.

Tools

- Assembly Chart Analysis
- Bottleneck Analysis (Theory of Constraints)
- Capacity Planning Worksheet
- Critical Chain Project Management
- Forecasting and Regression Analysis
- Interactive MRL Users Guide (Checklist), Manufacturing Workforce thread
- Learning Curve Estimator
- Line of Balance Template
- Manufacturing Maturation Plan
- Manufacturing Resource Planning (MRPII)
- Route Sheet Analysis
- Shop Floor Manufacturing Plan Analysis

- SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
- Work Measurement Analysis
- Workforce Planning Tools (SAP/Oracle/MRP II)

Resources

- Manufacturing Readiness Level (MRL) Deskbook
- Manufacturing Resource Planning (MRP II)

K. FACILITIES

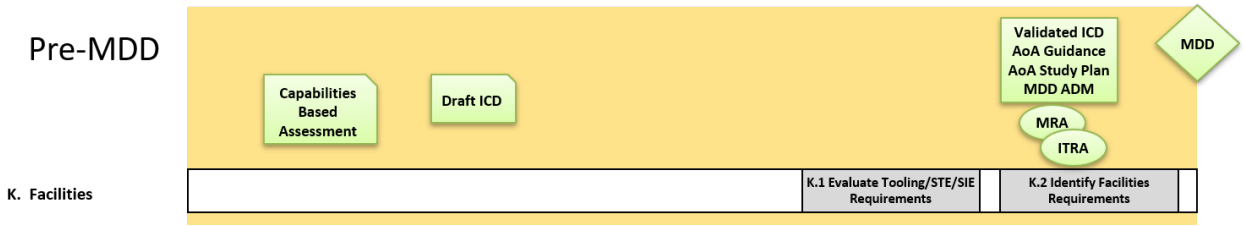


Figure 1-12. Facilities Manufacturing and Quality Activities

Introduction

Facilities management encompasses a variety of professional skills that focus on the design, construction, and management of an installation including plant and equipment. Facilities management includes all permanent and semi-permanent real property required to support a system throughout the system's life cycle. Facility management also includes studies of facility requirements to include: location, environmental and security considerations, and maintenance of property through disposal.

During the Pre-MDD phase, the proposed industrial and manufacturing facilities should be assessed for resources needed by each concept being considered as a materiel solution. Assessment of facility needs for concepts includes real property, factory capacity and storage, special handling and special environmental requirements, storage and handling of hazardous materials, capital equipment, manufacturing processes, tooling, and materiel transportation. Use of new materials and technologies will often require concurrent development and procurement of new capital equipment, test equipment and facilities, and development of new quality assurance procedures and equipment. Use of test ranges and special test facilities should be listed and a notional schedule of when those government assets will be needed. Many government facilities are becoming increasingly obsolete and constantly undergoing consolidation. The M&Q representatives should also identify any requirement for reconstitution or investment in government facilities, labs, ranges, etc. for each concept being considered.

The facility includes the plant, production equipment, and waste handling and storage equipment to be made available to accomplish the production task. In developing the facility plan, both the quantitative and qualitative demands of the product must be considered. The quantitative analysis will determine the size of the processing departments within the facility. This analysis should consider the number of

units to be delivered, and the rate of delivery. For example, the information collected in the analysis will provide a measure of the workstations, plant layout, and the floor space required. The qualitative analysis determines the types of processes that will be required. The contractor then has the option of utilizing currently existing facilities, acquiring new facilities, requesting government-furnished facilities (must be requested in the proposal), or subcontracting a portion of the effort.

Funding profiles for all the aspects of each concept being considered must provide for up front development of capital equipment, manufacturing processes, tooling, and verification that new components can be produced at production rates. A top-level schedule and target costs should be developed. Development for each concept and installation of tooling, test equipment, and facilities are necessary drivers of each concept's costs and development schedule. The overall results of these assessments, estimates, and evaluations should be included in the AoA Study Guidance.

This thread (Facilities) requires an analysis of the capabilities and capacity (Prime, Subcontractor, Supplier, Vendor, and Maintenance Repair) that are key risks in manufacturing.

K.1 Evaluate Special Tooling/Special Test and Inspection Equipment Requirements

M&Q personnel need to support the identification of special tooling (ST), special test equipment (STE), and special inspection equipment (SIE) requirements based on an identified emerging material and processes.

Manufacturing and Quality Tasks

- Identify new capital equipment and tooling required for new technology and material M&Q processes for each concept being considered.
    - Assess new tooling requirements for capability to produce at planned production rates and target unit costs
    - Assess needs for soft tooling vs. hard tooling for facility and funding impacts
    - Assess supplier and sub-tier capabilities and investment incentives
    - Assess the funding requirements and develop appropriate funding profiles
- Evaluate each concept being considered to include alternative designs for ST/STE/SIE:
    - Assess the requirements for ST/STE/SIE
    - Assess the capabilities of ST/STE/SIE to meet needs
- Evaluate each concept being considered to include alternative designs for government-furnished equipment (GFE):
    - Assess the requirements for GFE
    - Assess the capabilities of GFE to meet needs
- Identify requirements for unique or special transportation, handling, and storage equipment to be manufactured for each materiel solution.

- Identify the funding required for capital equipment, M&Q processes, tooling, and test equipment for each concept being considered.

Tools

- Bottleneck Analysis (Theory of Constraints)
- Critical Chain Project Management
- Interactive MRL Users Guide (Checklist), Facilities thread
- Manufacturing Maturation Plan
- Manufacturing Resource Planning (MRPII)

Resources

- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook
- Manufacturing Resource Planning (MRP II)

K.2 Identify Facilities Requirements

M&Q personnel need to support the identification of production facility requirements should the emerging material go forward into the MSA phase. Facility considerations include the capability and capacity to produce an item at potential rates and quantities, at the appropriate quality levels, and in an affordable manner.

Manufacturing and Quality Tasks

- Identify the facilities and capital equipment required by each of the concepts being considered.
- Identify the quantitative and qualitative demands of the each of the concepts being considered.
    - Identify the availability, design, rate, and capacity capabilities of the facilities under consideration (existing, new, or redeveloped)
    - Identify the types of processes required and the resulting impacts on facilities by each of the concepts being considered (e.g., specialized fixtures, test chambers, laboratories, clean rooms, waste storage and disposal, etc.)
    - Identify the unique or special facility requirements for transportation, handling, and storage equipment being manufactured for each materiel solution
- Identify the funding required for facilities and capital equipment for each concept being considered.

Tools

- Bottleneck Analysis (Theory of Constraints)

- Critical Chain Project Management
- Interactive MRL Users Guide (Checklist), Facilities thread
- Manufacturing Maturation Plan
- Manufacturing Resource Planning (MRP II)
- Manufacturing Resource Planning (MRPII)
- MRL Assessment using Facilities thread
- Plant Design and Facility Layout Software Evaluation Tools

Resources

- Manufacturing Readiness Level (MRL) Deskbook
- Manufacturing Resource Planning (MRP II)

L. MANUFACTURING MANAGEMENT AND CONTROL

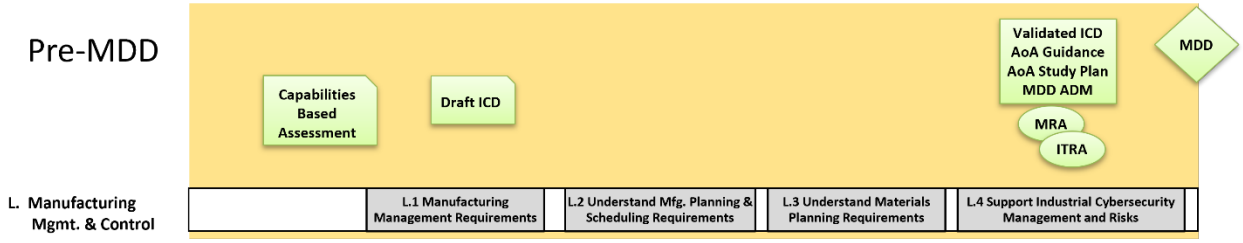


Figure 1-13. Manufacturing Management and Control Manufacturing and Quality Activities

Introduction

Programs with any manufacturing aspects will require a manufacturing management system. The timely development, production, modification, fielding, and sustainment of affordable products by managing manufacturing risks and issues throughout the program life cycle will only be met by a comprehensive system. Meeting this objective is best accomplished by including best practices and standards (i.e., AS6500, Manufacturing Management Program) in the contracts with industry. MIL-HDBK-896, Manufacturing Management Program Guide, provides a comprehensive description of considerations.

Beginning in this phase, the activities managing the concept (or program office) should begin the planning for manufacturing management and control of the concepts under consideration. This planning will evolve and should be updated during the subsequent acquisition phases. The purpose of manufacturing planning is to identify resources and integrate resources into a structure that provides the capability to achieve production objectives. Manufacturing planning should include:

- Manufacturing requirements in contracts and in appropriate agreements with other agencies (e.g., DCMA)

- Manufacturing assessments to support program milestone decision points and major design reviews
- Manufacturing metrics and reviews at a frequency commensurate with manufacturing risks

DoD Manufacturing Management is concerned with the conversion of raw materials into products based upon a detailed design. This conversion is accomplished through a series of manufacturing procedures and processes. It includes such major functions as manufacturing planning, cost estimating and scheduling; engineering; fabrication and assembly; installation and checkout; demonstration and testing; and product assurance. Manufacturing considerations begin as early as during the Analysis of Alternatives (AoA) in which the manufacturing manager and the PM must be able to understand the "manufacturing feasibility (risks)" are that are associated with each materiel solution.

- Manufacturing strategy and planning
- Manufacturing management system program
- Material management system
- Manufacturing resource planning
- Assess production lines
- Manufacturing strategy and planning
- Manufacturing management system program
- Material management system
- Manufacturing resource planning
- Assess production lines

L.1 Manufacturing Management Requirements

M&Q personnel need to identify the potential need for a Manufacturing Management Program for the emerging requirement.

Manufacturing and Quality Tasks

- Identify the manufacturing management system requirements (i.e., AS6500) to be met by the contractor or government entity during subsequent phases as appropriate in the areas of:
    - Design analysis for manufacturing
    - Manufacturing risk identification
    - Manufacturing planning
    - Manufacturing operations management
- Evaluate each concept being considered and identify the capability to meet manufacturing management needs.
    - Evaluate each concept being considered and identify the need for focused manufacturing or quality plans (e.g., a program Manufacturing Management Plan) to guide the approach

  - Evaluate each concept being considered and identify the need for a stand-alone government manufacturing or quality assurance plan

- Assess the impact of technology and process state of the art on the concepts being considered and the impacts on manufacturing management.
- Identify and understand potential sources that could address manufacturing management needs.
  - Identify and understand M&Q management lessons learned and best practices among programs and across centers
  - Assess and evaluate manufacturing technologies that could assist on materiel solution programs.
- Establish manufacturing management metrics for each of the concepts being considered
  - Determine the frequency that the metrics should be reviewed, commensurate with M&Q risks
- Contact DCMA for input on manufacturing management system evaluation of potential contractor and suppliers for each concept being considered.

Tools

- Interactive MRL Users Guide (Checklist), Manufacturing Management and Control thread
- Manufacturing Maturation Plan
- Manufacturing Resource Planning (MRP II)

Resources

- MIL-HDBK-896, Manufacturing Management Program Guide
- AS6500, Manufacturing Management Program
- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook
- Manufacturing Resource Planning (MRP II)

L.2 Understand Manufacturing Planning and Scheduling Requirements

M&Q personnel need to support the identification of Manufacturing Resource Planning requirements.

Manufacturing and Quality Tasks

- Initiate planning for each materiel solution approach to include, as a minimum:
  - Description of the M&Q organization
  - Describe the make or buy plan
  - Description and initial identification of resources and M&Q capabilities

  - Identification of M&Q data requirements for facilities, processing, and scheduling

- Evaluate the overall manufacturing feasibility analysis for inputs to planning and scheduling. The analysis should have included:
  - Producibility
  - Critical and key M&Q processes
  - Special tooling requirements
  - Test and demonstration requirements for new materials and processes
  - Alternate design approaches
  - Anticipated M&Q risks and potential cost impacts and identify the needed actions to be incorporated into the initial M&Q plan
- Ensure manufacturing planning addresses transition considerations that may be impacted by:
  - Funding constraints and phasing of money
  - Design considerations, goals, and risks
  - Test and evaluation methods and approaches along with success criteria
  - Production processes, methods, workforce, facilities, equipment, and capabilities
  - Life cycle logistics and sustainment criteria, approach, and goals
  - Management approach to transition risks

Tools

- Assembly Chart
- Interactive MRL Users Guide (Checklist) Manufacturing Management and Control thread
- Line of Balance Assessment
- Manufacturing Maturation Plan
- Manufacturing Resource Planning (MRP II)
- Operations Process Chart
- Route Sheet
- Work Breakdown Structure

Resources

- SAE AS6500, Manufacturing Management Program
- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook
- Manufacturing Resource Planning (MRP II)

L.3 Understand Materials Planning Requirements

M&Q personnel need to support the identification for Material Requirements Planning.

Manufacturing and Quality Tasks

- Assess feasibility and quality of materials to be used for each materiel solution approach.
  - Assess the maturity (technical and characterization) of material sources, essential raw materials, special alloys, composite materials, etc.
  - Understand alternatives to preferred materials for each materiel solution
- Assess all aspects of tasks in materiel availability (*See* Section G.2).
  - Assess the quality, processing, aging, handling, and transit times, etc., as an impact to lead times to include alternative materials
  - Evaluate military vulnerability from source considerations such as quality, fragility, sole source, domestic vs. foreign, etc., for the AoA Study Guidance and MDD processes that could result from the lack of alternatives

Tools

- Bill of Material assessment
- Interactive MRL Users Guide (Checklist), Manufacturing Management and Control thread
- Make/Buy Decision
- Manufacturing Maturation Plan
- Parts List
- Production Plan (schedule)

Resources

- SAE AS6500, Manufacturing Management Program
- Manufacturing Readiness Level (MRL) Deskbook Manufacturing Resource Planning (MRP II)

L.4 Support Industrial Cybersecurity Management and Risk Assessment

Industrial cybersecurity is concerned with the ability of organizations to share information digitally (government to industry, prime contractor to subs, labs to program offices, etc.). While the sharing of information is critical, it is equally important to do so in a safe and secure environment. Industrial cybersecurity is concerned with the transfer of digital data via Operational Technologies (OT) inside a facility and through the cloud to other organizations and facilities.

NIST standard NIST SP 800-37, "Risk Management Framework for Information Systems and Organizations" defines Operational Technology as:

> "*Programmable systems or devices that interact with the physical environment (or manage devices that interact with the physical environment). These systems/devices detect or cause a direct change through the monitoring and/or control of devices,*

processes, and events. Examples include industrial control systems, building management systems, fire control systems, and physical access control mechanisms."

There are three main types of operational technologies of concern:

- Product lifecycle management (PLM) systems for creating and managing the design process.
- Manufacturing execution system (MES) support the planning, execution, and synchronization of manufacturing processes across multiple functions, distributed plants, and suppliers.
- Enterprise resource planning (ERP) system supports functional management resources within an enterprise, and control process performance.

These data systems are often digital and shared across multiple functions and organizations.

DFARS 252.204-7012 requires contractors to follow NIST SP 800-171 and to:

- Provide adequate security to safeguard covered defense information that resides on or is transiting through a contractor's internal information system or network.
- Report cyber incidents that affect a covered contractor information system or the covered defense information residing therein.
- Submit malicious software discovered and isolated in connection with a reported cyber incident to the DoD Cyber Crime Center.
- Submit media/information as requested to support damage assessment activities.
- Flow down the contract clause in subcontracts for operationally critical support, or for which subcontract performance will involve covered defense information.

Manufacturing, as an industry, is the most targeted industry for cyber-attacks. DoD policy and best business practices require that data be protected from attack. This includes classified data, controlled unclassified data (CUI), personal data, financial data, etc.

This thread (Industrial Cybersecurity) requires an analysis of the risk that the manufacturing environment may not be able to protect digital and other forms of data from cyber risks and will focus on the following sub-threads, tasks, activities, tools, and resources:

- Identification of Cybersecurity Risks
- Cybersecurity Planning and Management (Execution)

M&Q personnel need to identify and manage industrial cybersecurity risks for system concepts identified, and cybersecurity vulnerabilities at potential industrial facilities. The focus on cybersecurity must encompass platforms, weapons, and the DIB and must be regularly assessed, properly resourced, and continually mitigated. Cybersecurity crosses all pathways within the AAF.

M&Q personnel need to develop and execute industrial cybersecurity planning for system concepts identified and execute the management of those plans. Programs will employ system security engineering methods and practices, including cybersecurity, cyber resilience, and cyber survivability

in design, test, manufacture, and sustainment. Such methods and practices will ensure that systems function as intended, mitigating risks associated with known and exploitable vulnerabilities to provide a level of assurance commensurate with technology, program, system, and mission objectives.

Manufacturing and Quality

- Identify cybersecurity requirements for potential concepts.
- Identify potential OT cybersecurity vulnerabilities of potential manufacturing facilities.

Tools

- Cybersecurity and Acquisition Lifecycle Integration Tool (DAU)
- Cybersecurity Strategy ADDM Template
- MRL Deskbook and Assessment Criteria
- Interactive MRL Users Guide (Checklist), Cybersecurity thread
- USMC Cybersecurity Management Checklist

Resources

- FAR 52.202.21 Basic Safeguarding of Covered Contractor Information Systems
- DFAR 252.7012 Safeguarding Covered Defense Information and Cyber Incident Reporting
- DoDI 5000.83, Technology and Program Protection
- DoDI 8500.01, Cybersecurity
- DoDI 5000.90, Cybersecurity for Acquisition Decision Authorities and Program Managers
- DoD 5220.22-M, National Industrial Security Program
- DoD Program Managers Guidebook for Integrating Cybersecurity Risk Management Framework into Acquisition Life Cycle
- NIST SP 800-171, Protecting Controlled Unclassified Information in Nonfederal Systems and Organizations
- NIST Special Publication 800-82, Guide to Industrial Control Systems (ICS) Security

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Appendix A: Abbreviations and Acronyms

A_m	Materiel Availability
A_o	Operational Availability
AAF	Adaptive Acquisition Framework
ADM	Acquisition Decision Memorandum
AFRL	Air Force Research Laboratory
AM	Additive Manufacturing
ANSI	American National Standards Institute
AoA	Analysis of Alternatives
APA	Additional Performance Attributes
APB	Acquisition Program Baseline
AQAP	Advanced Product Quality Planning
AQL	Acceptable Quality Level
ARL	Army Research Laboratory
AS	Acquisition Strategy
ASME	American Society of Mechanical Engineers
ASR	Alternative Systems Review
AT	Anti-Tamper
ATE	Automatic Test Equipment
AUPC	Average Unit Procurement Cost
BCA	Business Case Analysis
BER	Beyond Economical Repair
BES	Budget Estimate Submission
BoK	Body of Knowledge
BOM	Bill of Materials
C/SCSC	Cost/Schedule Control Systems Criteria
C4I	Command, Control, Communications, Computers, and Intelligence
CAB	Corrective Action Board
CAD	Computer-Aided Design
CAE	Component Acquisition Executive
CAI	Critical Application Item
CAIG	Cost Analysis Improvement Group
CAIV	Cost as an Independent Variable

CAM	Computer-Aided Manufacturing
CAPE	Cost Assessment and Program Evaluation
CARD	Cost Analysis Requirements Description
CAS	Contract Administration Services
CBA	Capabilities-Based Assessment
CCA	Cost Capability Analysis
CCB	Configuration Control Board
CCE	Component Cost Estimate
CDD	Capability Development Document
CDRL	Contract Data Requirements List
CI	Configuration Item
CI	Critical Item
CJCS	Chairman of the Joint Chiefs of Staff
CLIN	Contract Line Item Number
CM	Configuration Management
CMO	Contract Management Office
CMP	Configuration Management Plan
CMP	Critical Manufacturing Process
COE	Center of Excellence
COMSEC	Communications Security
CONOPS	Concept of Operations
COSSI	Commercial Operations and Support Savings Initiative
COTS	Commercial Off-the-Shelf
CPAR	Contractor Performance Assessment Report
CPC	Corrosion Prevention and Control
CPI	Continuous Process Improvement
Cp/Cpk	Process Capability/Process Capability Index
CRI	Cost Reduction Initiative
C/SCSC	Cost and Schedule Control Systems Criteria
CSI	Critical Safety Item
CTC	Critical to Customer
CTE	Critical Technology Element
CTQ	Critical to Quality
CUI	Controlled Unclassified Information

DAE	Defense Acquisition Executive
DAG	Defense Acquisition Guidebook
DARPA	Defense Advanced Research Projects Agency
DAU	Defense Acquisition University
DCMA	Defense Contract Management Agency
DPM	Defective Parts Per Million
DFA	Design for Assembly
DFARS	Defense Federal Acquisition Regulation Supplement
DFM	Design for Manufacturability
DFMA	Design for Manufacture and Assembly
DFMEA	Design Failure Modes and Effects Analysis
DFSS	Design for Six Sigma
DIB	Defense Industrial Base
DID	Data Item Description
DLA	Defense Logistics Agency
DMS	Diminishing Manufacturing Sources
DMMG	Defense Manufacturing Management Guide
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DoD	Department of Defense
DoDD	DoD Directive
DoDI	DoD Instruction
DoDM	DoD Manual
DOE	Design of Experiments
DPAS	Defense Priorities and Allocation System
DSS	Design for Six Sigma
DTRAM	Defense Technical Risk Assessment Methodology
DTC	Design to Cost
DT&E	Developmental Test and Evaluation
EAC	Estimate at Completion
ECP	Engineering Change Proposal
ED, SE&A	Executive Director, Systems Engineering and Architecture
EMC	Electromagnetic Compatibility
EMD	Engineering and Manufacturing Development
EMI	Electromagnetic Interference

EOQ	Economic Order Quantity
ERP	Enterprise Resource Plan
ESA	Engineering Support Activity
ESOH	Environment, Safety, and Occupational Health
ESS	Environmental Stress Screening
EVMS	Earned Value Management System
FA	First Article
FAI	First Article Inspection
FAR	Federal Acquisition Regulation
FAT	First Article Test
FCA	Functional Configuration Audit
FDD	Full Deployment Decision
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes, Effects, and Criticality Analysis
FOD	Foreign Object Damage
FOT&E	Follow-on Test and Evaluation
FPAF	Fixed Price Award Fee
FRACAS	Failure Reporting, Analysis, and Corrective Action System
FRP	Full-Rate Production
FRPDR	Full-Rate Production Decision Review
FTA	Fault Tree Analysis
FYDP	Future Years Defense Program
GAO	Government Accountability Office
GCQA	Government Contract Quality Assurance
GFE	Government-Furnished Equipment
GFM	Government-Furnished Material
GFP	Government-Furnished Property
GIDEP	Government and Industry Data Exchange Program
GOTS	Government Off-the-Shelf
HAZMAT	Hazardous Material
HSI	Human Systems Integration
HVAC	Heating, Ventilation, and Air Conditioning
HWCIs	Hardware Configuration Items
IB	Industrial Base

ICA	Industrial Capabilities Assessments
ICD	Initial Capabilities Document
ICE	Independent Cost Estimate
ICS	Industrial Control Systems
IEEE	Institute of Electrical and Electronics Engineers
IG	Inspector General
IGCE	Independent Government Cost Estimate
IPT	Integrated Product Team
ILA	Independent Logistics Assessment
IMP	Integrated Master Plan
IMS	Integrated Master Schedule
IOC	Initial Operational Capability
IP	Intellectual Property
IPS	Integrated Product Support
IPT	Integrated Product Team
IRAD	Independent Research and Development
ISO	International Organization for Standardization
ISR	In-Service Review
ITAR	International Trafficking in Arms Regulation
ITRA	Independent Technical Risk Assessment
JCIDS	Joint Capabilities Integration and Development System
JROC	Joint Requirements Oversight Council
KC	Key Characteristics
KLP	Key Leadership Position
KPP	Key Performance Parameter
KSA	Key System Attribute
LCC	Life Cycle Cost
LCSP	Life Cycle Sustainment Plan
LOD	Letter of Delegation
LFT&E	Live-Fire Test and Evaluation
LRIP	Low-Rate Initial Production
5Ms	Manpower, Machines, Materials, Methods, Measurement
M&S	Modeling and Simulation
ManTech	Manufacturing Technology

MATE	Multi-Attribute Trade Space Exploration
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MDD	Milestone Development Decision
MEP	Manufacturing Extension Program
MES	Manufacturing Execution System
MIL-STD	Military Standard
MMAS	Material Management and Accounting System
MMP	Manufacturing Maturation Plan
MMS	Manufacturing Management System
MOA	Memorandum of Agreement
MOE	Measure of Effectiveness
MOSA	Modular Open Systems Approach
MP	Mission Profile
MRO	Maintenance, Repair, and Overhaul
MMP	Manufacturing Maturation Plan
M&Q	Manufacturing and Quality
MRA	Manufacturing Readiness Assessment
MRB	Material Review Board
MRL	Manufacturing Readiness Level
MRO	Maintenance, Repair, and Overhaul
MRP	Material Requirements Planning
MRP II	Manufacturing Resource Planning
MS A	Milestone A
MS B	Milestone B
MS C	Milestone C
MSA	Materiel Solution Analysis
MSRA	Manufacturing Systems Risk Assessment
MTA	Middle Tier Acquisition
MTTR	Mean Time to Repair
MTBF	Mean Time Between Failure
MTBM	Mean Time Between Maintenance
NAVSO-P	Navy Standard Operating Procedure
NDAA	National Defense Authorization Act

NDI	Non-Developmental Item
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Technology
NRL	Naval Research Laboratory
NSPAR	Non-Standard Parts Approval Request
NTIB	National Technology Industrial Base
O&A	Over and Above
OEE	Overall Equipment Effectiveness
OEM	Original Equipment Manufacturer
OIPT	Overarching Integrated Product Team
O&M	Operations and Maintenance
OMB	Office of Management and Budget
OMS/MP	Operational Mode Summary/Mission Profile
O&S	Operations and Support
OSD	Office of the Secretary of Defense
OSHA	Occupational Safety and Health Administration
OT	Operational Technology
OTRR	Operational Test Readiness Review
OUSD(R&E)	Office of the Under Secretary of Defense for Research and Engineering
P3I/P^3I	Preplanned Product Improvement
PAOC	Post-Award Orientation Conference
PAW	Producibility Assessment Worksheet
PBL	Performance-Based Logistics
PCA	Physical Configuration Audit
PCO	Procurement Contracting Officer
P&D	Production and Deployment
PDR	Preliminary Design Review
PEP	Producibility Engineering and Planning
PESHE	Programmatic Environmental, Safety, and Occupational Health Evaluation
PFMEA	Process Failure Modes and Effects Analysis
PHL	Preliminary Hazard List
PHST	Packing, Handling, Storage, and Transportation
PLM	Product Lifecycle Management
PM	Program Manager

PMP	Parts, Materials, and Processes
PMR	Program Management Review
PMO	Program Management Office
POE	Program Office Estimate
POM	Program Objective Memorandum
Pp / Ppk	Process Performance/Process Performance Index
PPAP	Production Part Approval Process
PPBE	Program, Planning, Budget, and Execution
PPC	Production Planning and Control
PPP	Program Protection Plan
PPV	Production Part Verification
PQM	Production, Quality, and Manufacturing
Pre-MDD	Pre-Materiel Development Decision
PRR	Production Readiness Review
PSA	Program Support Assessment
PSM	Product Support Manager
PSS	Product Support Strategy
PTAC	Procurement Technical Assistance Center
PWBS	Program Work Breakdown Structure
QA	Quality Assurance
QALI	Quality Assurance Letter of Instruction
QDR	Quality Deficiency Report
QFD	Quality Function Deployment
QMS	Quality Management System
QSP	Quality Surveillance Plan
R&D	Research and Development
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
RIO	Risk, Issues and Opportunities
RFI	Request for Information
RFP	Request for Proposal
RFP DP	Request for Proposal Release Decision Point
RFV	Request for Variation
R&M	Reliability and Maintainability
RMBoK	Reliability and Maintainability Body of Knowledge

SAE	Society of Automotive Engineers
SAR	Safety Assessment Report
SAT	Software Acceptance Test
SCE	Should Cost Estimate
SCM	Supply Chain Management
SCMP	Software Configuration Management Plan
SCOR	Supply Chain Operations Reference
SCRM	Supply Chain Risk Management
SDP	Software Development Plan
SE	Systems Engineering
SEMP	Systems Engineering Management Plan
SEP	Systems Engineering Plan
SF	Standard Form
SFMEA	System Failure Modes and Effects Analysis
SFQT	Software Formal Qualification Testing
SFR	System Functional Review
SIE	Special Inspection Equipment
SLEP	Service Life Extension Program
SME	Society of Manufacturing Engineers
SOO	Statement of Objectives
SOW	Statement of Work
SPC	Statistical Process Control
SPI	Special Packaging Instructions
SQAP	Software Quality Assurance Plan
SRR	System Requirements Review
SSA	System Safety Assessment
SSE	Systems Security Engineering
SSP	Source Selection Plan
ST	Special Tooling
S&T	Science and Technology
STE	Special Test Equipment
STEM	Science, Technology, Engineering, and Math
SUPSHIP	Supervisor of Shipbuilding
SVR	System Verification Review

SWOT	Strengths, Weaknesses, Opportunities, and Threats
TAPP	Technology Area Protection Plan
TBD	To Be Determined
TDP	Technical Data Package
T&E	Test and Evaluation
TEMP	Test and Evaluation Master Plan
TMRR	Technology Maturation and Risk Reduction
TO	Technical Order
TOC	Total Ownership Cost
TOC	Theory of Constraints
TPM	Technical Performance Measure
TRA	Technology Readiness Assessment
TRL	Technology Readiness Level
TRR	Test Readiness Review
USD(R&E)	Under Secretary of Defense for Research and Engineering
USC	United States Code
VCRM	Verification Cross-Reference Matrix
VOLT	Validated Online Lifecycle Threat
VR	Variability Reduction
VSM	Value Stream Mapping
V&V	Verification and Validation
WBS	Work Breakdown Structure
WIP	Work in Progress

Appendix B: References

Resources identified in the Manufacturing and Quality Body of Knowledge (M&Q BoK) are listed below alphabetically and contain links to the referenced document or website. As many of these resources are revised frequently, readers are advised the documents may change or be updated, replaced, or cancelled between editions of this BoK. Readers may need to conduct an Internet search to find the most recent version.

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SF 1405 Preaward Survey of Prospective Contractor – Production
https://www.gsa.gov/forms-library/pre-award-survey-prospective-contractor-technical

SF 1406 Preaward Survey of Prospective Contractor – Quality Assurance
https://www.gsa.gov/forms-library/pre-award-survey-prospective-contractor-quality-assurance

SF 1407 Preaward Survey of Prospective Contractor – Financial Capability
https://www.gsa.gov/forms-library/pre-award-survey-prospective-contractor-financial-capability

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Appendix C: Manufacturing and Quality Tools

Tools identified in the M&Q BoK are listed below alphabetically and many contain a link to the referenced tools that are published by a U.S. Government entity and available in the public domain. If the tool is commercially available either for free or for a charge, the entry will direct the reader to *Internet Search*. Individual publishers may provide a short video on how to use the tool.

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Internet Search

AS9100 Quality Management System Checklist
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AS9100 Quality Audit Checklist
Internet Search

AS9103 Variation Management of Key Characteristics Assessment
Internet Search

AS9133 Qualification Procedure for Standard Products (Supplier Audit) Checklist
Internet Search

AS9134 Supply Chain Risk Management Guidelines
Internet Search

AS9137 Advanced Quality Assurance Procedure (AQAP) Checklist
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AS9145 Requirements for Advanced Product Quality Planning (APQP) and Production Part Approval Process (PPAP) Checklist
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https://www.acq.osd.mil/dpap/ccap/cc/jcchb/Files/Topical/1Restricted/award.fee.oct08.pdf

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Internet Search

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Internet Search

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Bottleneck Analysis (Theory of Constraints)
Internet Search

Capability Development Document (CDD) Template
http://acqnotes.com/acqnote/acquisitions/capability-development-document-cdd

Capabilities-Based Assessment (CBA) Tool, DAU
https://www.dau.edu/tools/t/CBA-Tool

Capability Development Document (CDD) Template
http://acqnotes.com/acqnote/acquisitions/capability-development-document-cdd

Capacity Assessment Worksheet
Internet Search

Cash Flow Tool for Evaluating Alternative Finance Arrangement
https://www.acq.osd.mil/dpap/policy/policyvault/USA005332-10-DPAP.pdf

Cause and Effect Diagram
Internet Search

Contractor Purchasing System Review (CPSR)
Note: User must register on the DCMA 360 portal to get access

Cost Analysis Requirements Description (CARD) Guidance (see CAPE website for tools)
http://acqnotes.com/acqnote/careerfields/cost-analysis-requirements-description

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Cost of Quality (CoQ) Estimates
Internet Search

Critical Chain Project Management
Internet Search

Critical Design Review (CDR) Checklist
http://acqnotes.com/acqnote/acquisitions/critical-design-review

Critical Path Template
Internet Search

Critical to Customer Template
Internet Search

Critical to Quality Tree Template
Internet Search

Cyber Security Assessment see Cyber Security Assessment see Cybersecurity & The Acquisition Lifecycle Integration Tool (CALIT)
https://www.dau.edu/tools/t/Cybersecurity-and-Acquisition-Lifecycle-Integration-Tool-(CALIT)

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DCMA Industrial Capability Assessment Survey
Note: User must register on the DCMA 360 portal

DCMA Manufacturing and Production Surveillance Plan
https://www.dcma.mil/Portals/31/Documents/Policy/DCMA-INST-204.pdf

DCMA Manufacturing Systems Risk Assessment (MSRA) Checklist
Note: User must register on the DCMA 360 portal

DCMA Material Management and Accounting System (MMAS) Audit
https://www.dcma.mil/Portals/31/Documents/Policy/DCMA-INST-211.pdf

DCMA Pre-Award Survey System (PASS) review
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DCMA Pre-Award Survey (SF 1403)
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DCMA Pre-Award Survey – Technical (SF 1404)
https://www.gsa.gov/forms-library/pre-award-survey-prospective-contractor-technical

DCMA Pre-Award Survey – Production (SF 1405)
https://www.gsa.gov/reference/forms?search_keyword=SF%201405

DCMA Pre-Award Survey – Quality Assurance (SF 1406)
https://www.gsa.gov/reference/forms?search_keyword=SF%201406

DCMA Pre-Award Survey – Financial Capability (SF 1407)
https://www.gsa.gov/reference/forms?search_keyword=SF%201407

DCMA Pre-Award Survey – Contractor Accounting System (SF 1408)
https://www.gsa.gov/reference/forms?search_keyword=SF%201407

DCMA Production Planning and Control Risk Assessment Checklist
https://www.dcma.mil/Portals/31/Documents/Policy/DCMA-INST-204.pdf

DCMA Program Assessment Report
https://www.dcma.mil/Portals/31/Documents/Policy/DCMA-MAN-3101-02.pdf

DCMA Program Support Plan (DCMA-ANX 205-02)
Note: *User must register on the DCMA 360 portal*

DMCA QA Surveillance Plan
https://www.dcma.mil/Portals/31/Documents/Policy/DCMA-INST-309.pdf

Design Failure Modes and Effects Analysis (DFMEA)
Internet Search

Design for Affordability
Internet Search

Design for Manufacture and Assembly (DFMA)
Internet Search

Design for Performance
Internet Search

Design for Producibility
Internet Search

Design for Six Sigma (DFSS)
Internet Search

Design of Experiments (DoE)
Internet Search

Design of Experiments (DoE) Analysis
Internet Search

DFAR Subpart 232.10 Performance-Based Payments
https://www.acq.osd.mil/dpap/dars/dfars/html/current/232_10.htm

DMSMS Cost of Alternative Solutions Worksheet (see SD-22)
https://www.dau.edu/tools/t/SD-22-Diminishing-Manufacturing-Sources-and-Material-Shortages-(DMSMS)-Guidebook

DMSMS Implementation Plan - DI-MGMT-81949
https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=280073

DMSMS Health Assessment Report
https://quicksearch.dla.mil/qsDocDetails.aspx?ident_number=283247

Earned Value Management
https://www.dau.edu/tools/t/EVM-General-Reference-(Gold-Card)

Failure Mode and Effects Analysis (FMEA)
Internet Search

Failure Modes, Effects, and Criticality Analysis (FMECA)
Internet Search

First Pass Yield Estimates Worksheet
Internet Search

First Article Inspection (FAI) Checklist, AFMC Form 260, First Article Requirements
https://www.e-publishing.af.mil/Product-Index/#/?view=form&orgID=4&catID=9&low=200&high=299&modID=449&tabID=131

First Article Test (FAT) Checklist
https://www.dcma.mil/Portals/31/Documents/Policy/DCMA-INST-302.pdf

Functional Configuration Audit (FCA) Checklist (Air Force)
Templates – USAF Acquisition Process Model (afacpo.com)

Gantt Charts
Internet Search

Government Property Compliance Checklist (Navy)
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiyivT-sbnsAhVHuVkKHaU5Di0QFjAAegQIAhAC&url=http%3A%2F%2Fwww.secnav.navy.mil%2Frda%2FDocuments%2FCompliance%2520Checklist.xlsx&usg=AOvVaw0Jec3r4-gNaxYYoLYbcDLM

Histograms
Internet Search

IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
Internet Search

IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
Internet Search

IG5315.204-5(b) Section L Guide and Template
https://far.affinitext.com/public/book?id=18966&toc_id=5280626#PG_5280626_60386996

IG5315.204-5(c) Section M Guide and Template
https://far.affinitext.com/public/book?id=18966&toc_id=5280779#PG_5280779_60387780

Incentive Fee Template
https://www.dau.edu/tools/t/FPIF-CPIF

Independent Logistics Assessment Checklist (MCSC)
https://www.dau.edu/cop/log/_layouts/15/WopiFrame.aspx?sourcedoc=/cop/log/DAU%20Sponsored%20Documents/MCSC%20ILA%20Checklist%20v3%206AUG09.xls&action=default

Independent Technical Risk Assessments (ITRAs) Execution Guidance
https:ac.cto.mil/wp-content/uploads/2020/12/DoD-ITRA-ExecGuide-2020s.pdf

Industrial Base Assessment Survey Form (DCMA Industrial Analysis Group)
Internet Search

Industrial Base Sector Plans (no specific tool)
Internet Search

Initial Capabilities Document (ICD) Template (on page 2 of ICD Writers Guide
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiz0K6U09XtAhUNWq0KHYuuAMEQFjABegQIARAC&url=http%3A%2F%2Fwww.acqnotes.com%2FAttachments%2FCapability%2520Development%2520Document%2520Template%252030%2520Oct%252012.doc&usg=AOvVaw167Ffrt1uVVB8BdH4AjRAj

In-Service Review (Checklist)
In-Service Review - AcqNotes

Integrated Master Plan/Integrated Master Schedule (IMP/IMS)
Internet Search MS Project

Interactive MRL Users Guide (Checklist), all threads
http://www.dodmrl.com/

Initial Capabilities Document (ICD) Template
http://acqnotes.com/acqnote/acquisitions/initial-capabilities-document-icd

ISO 9001, Quality Management Systems, Quality Audit Checklist
Internet Search

ISO 14001 Environmental Management System (EMS) Gap Analysis Checklist
Internet Search

ITAR Compliance Checklist
Internet Search

Lead Time Estimator
Internet Search

Learning Curve Calculator (Estimator)
https://www.dau.edu/tools/t/Learning-Curve-QuickCalc

Learning Curve Estimation (M&S Software)
Internet Search

Learning Curve Worksheet (in Excel)
Internet Search

Life Cycle Sustainment Plan outline
https://www.dau.mil/tools/t/Life-Cycle-Sustainment-Plan-(LCSP)-Outline

Life Cycle Sustainment Plan template (AFLCMC)
https://www.dau.mil/tools/Lists/DAUTools/Attachments/56/Life%20Cycle%20Sustainment%20Plan%20(LCSP)%20%20Outline%20AFLCMC%20ADDM%20Template%20v2.docx

Line of Balance Template
Internet Search

Logistics Assessment Guidebook (DAU), Appendix A: Integrated Product Support Element
https://www.dau.edu/tools/t/Logistics-Assessment-Guidebook

Long Lead Times Material Report, DI-PSSS-82201
https://standards.globalspec.com/std/10291122/di-psss-82201

Make/Buy Plans/Decision
Internet Search

ManTech Roadmap
Internet Search

ManTech Strategic Plan
Internet Search

Manufacturing Capability Assessment Worksheet
Internet Search

Manufacturing Cost Estimating Worksheet (commercial)
Internet Search

Manufacturing Maturation Plan (see MRL Deskbook)
http://www.dodmrl.com/

Manufacturing Plan, DI-MGMT-81889A
http://everyspec.com/DATA-ITEM-DESC-DIDs/DI-MGMT/DI-MGMT-81889A_55798/

Manufacturing Resource Planning (MRP II)
Internet Search

Manufacturing Resource Planning (MRPII) Assessment
Internet Search

Manufacturing Technology (ManTech) Report, DI-MISC-81176A
http://everyspec.com/DATA-ITEM-DESC-DIDs/DI-MISC/DI-MISC-81176A_13522/

Manufacturing Strategy (no template available)
Internet Search

Market Research (DAU)
https://www.dau.edu/tools/t/Market-Research-Methods

Market Research Report Template
https://www.dau.edu/tools/t/Market-Research-Report-Template-v1-1
Material Forecasting Models
Qualitative Forecasting
Executive Opinion
Sales Forecast Composite
Consumer Market Survey
Delphi
Group Discussion
Quantitative Forecasting
Time Series
Regression Modeling
Internet Search

Material Management and Accounting System (MMAS) Audit
https://www.dcaa.mil/Portals/88/Documents/Guidance/Directory%20of%20Audit%20Programs/12500%20Material%20Management%20and%20Accounting%20System%20(MMAS)%20AP.pdf?ver=2020-07-01-133628-443

Material Requirements Planning (MRP I)
Internet Search

Materials Requirements Planning (MRP) Assessment
Internet Search

Materiel Development Decision (MDD) ADM Template
https://www.dau.edu/tools/t/Acquisition-Decision-Memorandum-(ADM),-Materiel-Development-Decision-(MDD)-Template-v1-4

Materiel Development Decision (MDD) ADM Template (Air Force)
https://www.afacpo.com/apm/core-documents/templates/

Materiel Development Decision (MDD) Development Planning Templates
https://www.afacpo.com/apm/core-documents/templates/

Milestone Charts (Program)
Internet Search

Multi-Attribute Tradespace Exploration (MATE) (see MIT Thesis)
Internet Search

Operational Test Readiness Review (OTRR) Checklist
http://acqnotes.com/acqnote/acquisitions/operational-test-readiness-review

Operations Process Chart
Internet Search

Pareto Analysis
Internet Search

Parts List
Internet Search

Performance-Based Payments Guide
https://www.acq.osd.mil/dpap/cpic/cp/docs/Performance_Based_Payment_(PBP)_Guide.pdf

PERT/Network Charts
Internet Search

Pilot Line Demonstration and Assessment
Internet Search

Plant Design and Facility Layout Software Evaluation Tools
Internet Search

Plant Modeling and Simulation tools (FlexSim, SimFactory, etc.)
Internet Search

Pre-award Survey – Technical (SF 1404)
http://www.acqnotes.com/Attachments/SF%201404%20Preaward%20Survey%20of%20Prospective%20Contractor%20-%20Technical.pdf

Pre-award Survey – Production (sf 1405)
http://www.acqnotes.com/Attachments/SF%201405%20Preaward%20Survey%20of%20Prospective%20Contractor%20-%20Production.pdf

Pre-award Survey – Quality Assurance (SF 1406)
http://www.acqnotes.com/Attachments/SF%201406%20Preaward%20Survey%20of%20Prospective%20Contractor%20-%20Quality%20Assurance.pdf

Pre-award Survey – Financial Capability (SF 1407)
http://www.acqnotes.com/Attachments/SF%201407%20Preaward%20Survey%20of%20Prospective%20Contractor%20-%20Financial%20Capability.pdf

Preliminary Hazard List (PHL) (*See* MIL-STD-882E, Task 201)
https://www.dau.edu/cop/armyesoh/DAU%20Sponsored%20Documents/MIL-STD-882E.pdf

Preliminary Hazards Analysis (PHA) (*See* MIL-STD-882E, Task 202)
https://www.dau.edu/cop/armyesoh/DAU%20Sponsored%20Documents/MIL-STD-882E.pdf

Preservation, Handling, Storage, Packaging and Delivery (PHSPD) Checklist
Internet Search

Process Capability Studies (Cp and Cpk assessment)
Internet Search

Process Capability Study Worksheet (Cp and Cpk Assessment)
Internet Search

Process Control Document (PCD)
Internet Search

Process Control Plan Worksheet
Internet Search

Process Failure Modes and Effects Analysis (PFMEA)
Internet Search

Process Modeling Tools (Siemens PLM, Delmia)
Internet Search

Producibility Assessment Worksheet (PAW) (see NAVSO P-3687, page F-20)
https://www.dau.edu/cop/pqm/DAU%20Sponsored%20Documents/NAVSO%20P%203687.PDF

Producibility Engineering and Planning (PEP) Data Item Description – DI- MGMT-80797A
http://everyspec.com/DATA-ITEM-DESC-DIDs/DI-MGMT/DI-MGMT-80797_4277/

Production Part Approval Process (PPAP), see AS9137 Advanced Quality Assurance Procedure (AQAP)
Internet Search

Production Part Approval Process (PPAP) Checklist
Internet Search

Production Plan (schedule)
Internet Search

Production Readiness Review (PRR) Checklist
Internet Search

Production Verification Test
Internet Search

Product Support Business Case Analysis Guidebook Appendix A BCA Checklist
https://www.dau.edu/tools/t/Product-Support-Business-Case-Analysis-(BCA)-Guidebook

Product Support Strategy Development Tool, Defense Acquisition University (DAU)
https://www.dau.edu/guidebooks/Shared%20Documents/Product%20Support%20Strategy%20Development%20Tool.pdf

Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) Template
https://www.dau.mil/cop/pm/DAU%20Sponsored%20Documents/PESHE%20AFLCMC%20ADDM%20Template%20v2.1.docx

Progress-Based Payments Tool (recommend changing to Performance Based Payments Analysis Tool (DAU)
https://www.dau.edu/tools/t/Performance-Based-Payments-Analysis-Tool

Pugh Matrix Template
Internet Search

Quality Assurance Program Plan, DI-QCIC-81794
http://everyspec.com/DATA-ITEM-DESC-DIDs/DI-QCIC/DI-QCIC-81794_20418/

Quality Assurance Provisions, DI-SESS-80789A
http://everyspec.com/DATA-ITEM-DESC-DIDs/DI-QCIC/DI-QCIC-81794_20418/

Quality Function Deployment (QFD) or House of Quality Matrix
Internet Search

Quality Function Deployment (QFD) Excel Spreadsheet
Internet Search

Quality Management Plan (Sample)
Internet Search

Quality Management System (QMS), DI-MGMT-82184
https://quicksearch.dla.mil/qaDocDetails.aspx?ident_number=282795

Quality Program Plan, DI-QCIC-81722
http://everyspec.com/DATA-ITEM-DESC-DIDs/DI-QCIC/DI-QCIC-81722_43871/

Quality Status Report, DI-MGMT-82186
https://quicksearch.dla.mil/qaDocDetails.aspx?ident_number=282783

Requirements Roadmap Worksheet, DAU
https://www.dau.edu/tools/Documents/SAM/resources/Requirements_Roadmap.html

Requirements Traceability Matrix Template, DAU
https://www.dau.edu/tools/Documents/SAM/resources/RTM_Risk_Register.html

Risk, Issue, and Opportunity (RIO) Management Guide for Defense Acquisition Programs (DoD)
http://acqnotes.com/wp-content/uploads/2017/07/DoD-Risk-Issue-and-Opportunity-Management-Guide-Jan-2017.pdf

Risk, Issue, and Opportunity (RIO) assessment
Internet Search

Risk Management Plan Template – DAU
https://www.dau.edu/tools/t/Risk-Management-Plan-Template-2017

Robust Design (Taguchi)
Internet Search

Rough Cut Capacity Planning Spreadsheet
Internet Search

Route Sheet
Internet Search

Route Sheet Analysis
Internet Search

Safety and Industrial Hygiene Hazard Assessment Checklist
https://www.dla.mil/Portals/104/Documents/Strategic%20Materials/IATK/Copy%20of%20Safety%20and%20health%20checklist%20Strategic%20Materials.pdf?ver=2015-09-23-114310-987

Shop Floor Manufacturing Plan Analysis
Internet Search

Six Sigma Worksheet
Internet Search

Solid modeling and analysis software programs (e.g., NX, CATIA, Pro-Engineer, Nastran add-ins)
Internet Search

Source Selection Plan Template (USMC)
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiOiba-i8bsAhUCR6wKHfTRAGsQFjAAegQIBRAC&url=https%3A%2F%2Fwww.quantico.marines.mil%2FPortals%2F147%2FDocs%2FRCO%2FSource%2520Selection%2520Plan%2520Template.doc&usg=AOvVaw0v19l6mRlO1PqWG6r6zOWY

Supplier Quality Questionnaire
Internet Search

Supply Chain Management Risk Assessment Checklist
Internet Search

Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis
Internet Search

System Capabilities Analytic Process (SCAP)
https://apps.dtic.mil/dtic/tr/fulltext/u2/a539905.pdf

Systems Engineering Management Plan, DI-SESS-81785A
http://everyspec.com/DATA-ITEM-DESC-DIDs/DI-SESS/DI-SESS-81785A_53778/

Systems Engineering Plan (SEP) Outline
http://acqnotes.com/acqnote/acquisitions/systems-engineering-plan

Systems and Software Engineering–System Life Cycle Processes, ISO/IEC/IEEE 15288
Internet Search

System Verification Review (SVR) Checklist
http://acqnotes.com/acqnote/acquisitions/system-verification-review-svr#:~:text=The%20System%20Verification%20Review%20(SVR,and%20Development%20(EMD)%20Phase.

Taguchi Loss Function Analysis
Internet Search

Technology Readiness Assessment Calculator
https://www.dau.edu/cop/stm/Lists/Tools/AllItems.aspx

Technology Readiness Assessment Guide (Best Practices) (Report GAO-20-48G)
https://www.gao.gov/products/GAO-20-48G

Technology Readiness Level (TRL) Assessment Checklist
Internet Search

Test and Evaluation Master Plan (TEMP) Guidebook
http://www.acqnotes.com/Attachments/DOT&E%20and%20TEMP%20Guidebook%20-%2028%20Mar%2013.pdf

Test and Evaluation Master Plan (TEMP) template
https://www.dau.edu/tools/t/Test-and-Evaluation-Master-Plan-(TEMP)-Template--v3-0

Test Readiness Review (TRR) Checklist
http://acqnotes.com/acqnote/careerfields/test-readiness-review-te

Theory of Inventive Problem Solving (TRIZ) Matrix
Internet Search

Tolerance Design
Internet Search

Transition from Development to Production, DoD 4245.7-M
https://apps.dtic.mil/dtic/tr/fulltext/u2/a303209.pdf

TRIZ Matrix Template
Internet Search

Work Breakdown Structure (Template)
Internet Search

Work Measurement Analysis
Internet Search

Work Measurement Time Study Worksheet (DD Form 2042-1)
https://www.esd.whs.mil/Portals/54/Documents/DD/forms/dd/dd2042-1.pdf

Workforce Planning Tools (SAP/Oracle/MRP II)
Internet Search

Yield Rate Assessment
Internet Search

Appendix D: Sample Manufacturing and Quality Assurance Request for Proposal Input

Sample Manufacturing and Quality Assurance Request for Proposal Input

Office of the Under Secretary of Defense for Research and Engineering

2021

Developed in coordination with Air Force Life Cycle Management Center and industry representatives following the 2017 Defense Manufacturing Conference Manufacturing and Quality Roundtable, which identified the need for more consistent manufacturing and quality contracting approaches across the Department of Defense.

Contents

Introduction

This document provides examples for Manufacturing and Quality Request for Proposal (RFP) inputs, including the Statement of Work (SOW), Sections L and M for competitive acquisitions, and Federal Acquisition Regulation (FAR)/Defense Federal Acquisition Regulation (DFAR) requirements.

The Core SOW requirements should be used on all Acquisition Category (ACAT) I programs. They may be used on other programs but should be tailored as needed to match the scope and needs of each program. For all of the requirements and other inputs in this guide, program team with input from manufacturing and quality specialist should conduct specific tailoring to ensure requirements are appropriate to meeting the unique needs and circumstances of each program.

If possible, developing contractual requirements should be a collaborative process between the government program office and the prime contractor.

Data Item Descriptions (DIDs):

- Prior to using a DID, ensure the most current version is being referenced.
- Use caution when calling out DIDs: Some requirements in the SOW do not have DIDs that directly correspond to them. In those cases, the closest, related DID is suggested. In other cases, some DIDs may be significantly outdated. They were provided to serve as a potential starting point and may need to be tailored. These will be discussed in each section, if applicable.

Manufacturing and Quality RFP Guide Summary Applicability Matrix

The following table is provided for general guidance only. Specific determinations of program and contract applicability should be made on a case-by-case basis.

All requirements are applicable to land, sea, air, and space-based systems. The only exception is for Aviation Critical Safety Items, which are applicable only to air and space systems.

Where checkmarks are shown, that requirement should be considered for inclusion in a SOW. Requirements may still be tailored to meet program needs.

Manufacturing and Quality Input to RFP

Manufacturing/Quality RFP Inputs	MSA	TMRR	EMD	P&D	O&S	Design Change	NDI/COTS
Core SOW Inputs							
Manufacturing Management Program		✓	✓	✓	✓	✓	
Quality Management System Requirements		✓	✓	✓	✓	✓	✓
Manufacturing Readiness Levels and Assessments (MRLs)	✓	✓	✓	✓	✓	✓	✓
Quality and Manufacturing Metrics		✓	✓	✓	✓	✓	✓
Counterfeit Parts Prevention		✓	✓	✓	✓	✓	✓
First Article Inspections/First Article Tests			✓	✓	✓	✓	✓
GIDEP Participation			✓	✓	✓	✓	
Production Readiness Review			✓	✓		✓	✓
Other SOW requirements to consider							
Aviation Critical Safety Items		✓	✓	✓	✓	✓	
Manufacturing Modeling and Simulation		✓	✓	✓	✓	✓	
Calibration			✓	✓	✓	✓	
Configuration Management		✓	✓	✓	✓	✓	
Risk Management		✓	✓	✓	✓	✓	
Parts, Materials, and Processes Control Program		✓	✓	✓	✓	✓	
Environmental Stress Screening		✓	✓	✓	✓	✓	
Key Characteristics and Variation Reduction		✓	✓	✓	✓	✓	
Advanced Product Quality Planning (APQP) & Production Part Approval Process (PPAP)			✓	✓	✓	✓	

1. Core SOW Inputs

1.1. Manufacturing Management Program

The contractor shall establish and maintain a Manufacturing Management Program that meets the requirements of SAE AS6500A and flow this requirement down to major/critical suppliers. The contractor shall document this program as part of their Manufacturing Plan. The contractor shall include its plans for Production Readiness Reviews (PRRs) and Manufacturing Readiness Level (MRL) Assessments in the Manufacturing Plan.

Suggested Data Item Description (DID):

- DI-MGMT-81889B, Manufacturing Plan

Guidance:

1. Major and critical suppliers are defined in AS6500A:

Critical Supplier: A contractor whose performance could seriously jeopardize the successful achievement of a program's cost, schedule, technical, or supportability requirements if not satisfactorily managed (e.g., a sole source supplier or supplier of critical parts, strategic and critical materials, or unique or special processes.)

Major Supplier: A supplier, distributor, vendor, or firm that furnishes supplies or services to or for the prime contractor whose total costs are a significant portion of the total purchased value for the program.

2. While the requirement for a manufacturing management system is applicable during the TMRR phase, it may be too early to require a deliverable manufacturing plan.

3. The DID for a Manufacturing Plan, DI-MGMT-81889B, was updated to be consistent with AS6500A.

1.2. Quality Management System Requirements

The contractor shall establish and maintain a Quality Management System (QMS) that meets the requirements of AS9100. The quality system shall ensure delivery of product that complies with all technical requirements. The Contractor shall document how the QMS is implemented with any unique requirements within the Quality Assurance Program Plan. Major/critical suppliers and suppliers with design authority shall be required to establish and maintain a Quality Management System (QMS) in accordance with requirements of AS9100. Suppliers without design authority shall be compliant to SAE AS9003, Inspection and Test Quality System, as a minimum.

Suggested DID:

- DI-QCIC-81794A, Quality Assurance Program Plan, contractor format acceptable

Guidance:

1. AS9100 is the preferred requirement for a Quality Management System for ACAT I programs in Aviation, Space, and Defense Organizations. The Federal Acquisition Regulation, Part 46, also recognizes overarching quality management system standards such as ISO 9001, ASQ/ANSI E4; ASME NQA-1, SAE AS9003, and ISO/TS 16949. If applying any of these other standards, ensure they are appropriate to the complexity and criticality of the product.

2. The most recent version of AS9100 (or equivalent standard) shall be specified.

3. While the requirement for a quality management system is applicable during the TMRR phase, it may be too early to require a deliverable quality plan.

1.3. Manufacturing Readiness Levels and Assessments (MRLs)

The contractor shall conduct assessments of manufacturing readiness in accordance with AS6500A and use the definitions, criteria, and processes defined in the Manufacturing Readiness Level Deskbook as a guide. Assessments will be conducted at the locations and frequencies specified in Appendix TBD. They will be led by the government program office at the prime contractor's facilities. The prime contractor shall lead the assessments at suppliers and include government participants. The selection of supplier assessments should be determined by the government and prime contractor using the MRL Deskbook, Section 4.3 as a guide. The contractor shall develop and implement Manufacturing Maturation Plans or their equivalent for criteria in which the MRL is lower than the target MRL. The contractor shall monitor and provide status at all program reviews for in-house and supplier MRLs and shall re-assess MRLs in areas for which design, process, source of supply, or facility location changes have occurred that could impact the MRL.

Suggested DIDs:

- DI-SESS-81974, Assessment of Manufacturing Risk and Readiness
- DI-ADMIN-81249B, Conference Agendas
- DI-ADMIN-81250B, Conference Minutes
- DI-MISC-80508B, Technical Report – Study/Services

Guidance:

1. Ensure DIDs are current and appropriate.

1.4. Quality and Manufacturing Metrics

In accordance with AS6500A, the contractor shall maintain a manufacturing surveillance process. The contractor shall submit quality and manufacturing metrics at the agreed upon frequency that report the contractor's and major/critical suppliers' performance and progress. Metrics shall include cost, schedule, and quality metrics to monitor the effectiveness of the contractor's manufacturing, quality, and supplier management programs. Metrics shall be

presented at design, technical, and program management reviews. The contractor shall provide on-line access of these metrics to the government.

Suggested DIDs:

- DI-QCIC-82323, Manufacturing and Quality Assurance Status Report

Guidance:

1. Tailor the list of metrics in the DID to meet your specific program needs.

2. On-line access to contractor metrics may be desired, but not feasible. Discuss this with the prime contractor before including this as a requirement.

1.5. Counterfeit Parts Prevention

The contractor shall develop and implement a Counterfeit Parts Prevention (CPP) program in compliance with SAE AS5553 and AS6174 to prevent the inclusion of counterfeit parts or parts embedded with malicious logic into products intended for sale to the Government. These requirements shall be flowed to suppliers to ensure requirements are met. As part of CPP, the contractor shall make available to the government Certificates of Conformance (CoC) as well as supply chain traceability for all electronic part purchases.

Suggested DID:

- DI-MISC-81832, Counterfeit Prevention Plan

Guidance:

1. The RFP could request the elements of DI-MISC-81832 be included in the contractor's Program Protection Implementation Plan (PPIP), DI-ADMN-81306. Another good reference source is SAE-AS6081; Parts, Electronic, Fraudulent/Counterfeit: Avoidance, Detection, Mitigation, and Disposition.

2. The DID may be significantly out of date. Review for appropriateness prior to use.

1.6. First Article Inspections (FAI)/First Article Tests (FAT)

The contractor shall establish an FAI/FAT process and perform FAIs/FATs on new and modified product in accordance with AS9102, "Aerospace First Article Inspection Requirement." First article inspections shall be conducted on new products representative of the first production run and when changes occur that invalidate the original results (e.g., engineering changes, manufacturing process changes, tooling changes). The contractor shall notify the Government program office, and designated representative(s) of first article inspection events to allow for participation. An FAI/FAT report shall be generated for each product as evidence that the engineering requirements have been met.

Suggested DIDs:

- DI-NDTI-81307A, First Article Qualification Test Plan and Procedures
- DI-NDTI-80809, Test/Inspection Report

Guidance:

1. The DIDs may be out of date or not related exactly to the SOW requirement. Review for appropriateness prior to use.

2. Applicability to O&S phase is based on new designs, suppliers, or other changes.

1.7. Government Industry Data Exchange Program (GIDEP) Participation

The contractor shall implement procedures and processes for their participation in GIDEP, including the submission of alerts/advisories to GIDEP when warranted. The processes and procedures shall describe how the contractor (a) receives alerts and advisories from GIDEP and other sources, (b) determines any impact to their product design and already manufactured hardware, (c) implements corrective action procedures when design and/or produced hardware are affected, and (d) includes supplier participation.

Suggested DID:

- DI-QCIC-80125B, Government Industry Data Exchange Program (GIDEP) Alert/Safe-Alert Report
- DI-QCIC-80126B, Government Industry Data Exchange Program (GIDEP) Alert Response

1.8. Production Readiness Review (PRR)

The contractor shall perform PRRs in support of the Milestone C/FRP Decision in accordance with IEEE 15288.2. These requirements shall be flowed to the contractor's major and critical suppliers.

Suggested DIDs:

- DI-ADMIN-81249B, Conference Agendas
- DI-ADMIN-81250B, Conference Minutes
- DI-MISC-80508B, Technical Report – Study/Services

Guidance:

1. The requirement for a PRR is a Core requirement for contracts that will result in a Milestone C or FRP Decision

2. Ensure deliverable plans, minutes, etc., are not already required in another section of the SOW for technical reviews and audits. Ensure DIDs are compatible with IEEE 15288.2 requirements, if imposed.

2. Other SOW Requirements to Consider

2.1. Aviation Critical Safety Items (CSIs)

The contractor shall identify, establish and manage aviation CSIs using the Joint Aeronautical Logistics Commanders (JALC) Critical Safety Item Management Handbook and SAE AS9017, "Control of Aviation Critical Safety Items," as guides. The contractor shall develop a list of Critical Safety Items, their Key or Critical Characteristics (KCs/CCs), and associated Critical Manufacturing Processes. The contractor shall identify, measure and reduce variability of KCs/CCs and provide a formal method to manage and monitor all critical processes associated with CSIs. The contractor shall flow requirements to the lowest level of the supply chain.

Suggested DIDs:

- DI-SAFT-81932, Critical Safety Item (CSI) / Critical Application Item (CAI) List
- DI-SAFT-80970A, Critical Safety Item, Characteristic and Critical Defect Report

Guidance:

1. Requirements for CSI management should be balanced against the costs.

2. The DIDs may be out of date. Review for appropriateness prior to use.

2.2. Manufacturing Modeling and Simulation

The contractor shall analyze manufacturing processes using Modeling & Simulation (M&S) techniques to identify potential bottlenecks or constraints and confirm the achievability of planned cycle times, etc., and provide the government access to the model and data. The model should use commercially available simulation software used to evaluate scenarios and impacts of process variabilities, plant optimizations, production rate changes, capacity planning, and estimate required quantities of tooling, personnel, and inventory. The contractor shall update the production simulation model for facility modifications and other significant changes.

Suggested DID:

DI-MISC-80508B, Technical Report – Study/Services

Guidance:

1. While AS6500A requires the use of Modeling & Simulation, this additional requirement should be imposed if the government program office needs to obtain the contractor's manufacturing model(s) as a deliverable item. This would enable the program office to conduct independent capacity and schedule assessments and to better identify risks independently from the contractor.

2. The DID may be out of date. Review for appropriateness prior to use.

2.3. Calibration

The contractor shall maintain a calibration system in accordance with ANSI/NCSL Z540.3. The calibration system shall control the accuracy of measuring and test equipment, and measurement standards, used to ensure that products delivered to the Government comply with all contract technical specifications. The calibration system shall prevent inaccuracy by ready detection of deficiencies and timely positive action for their correction. Contractors who operate and maintain calibration laboratories or subcontract to outside calibration laboratories shall ensure compliance with requirements of ISO/IEC 17025:2017, General Requirements for the Competence of Testing and Calibration Laboratories.

2.4. Configuration Management

The contractor shall establish, document, and maintain a Configuration Management (CM) system for control of all configuration documentation, physical media, and physical parts representing or comprising the product, which includes all hardware, software, and firmware. The contractor's configuration management system shall consist of these elements:

a. Configuration management and planning.
b. Configuration identification.
c. Configuration change management.
d. Configuration status accounting.
e. Configuration audit.
f. Configuration management of digital data.

The contractor may use MIL-HDBK-61A as additional guidance for CM.

Guidance:

1. Applicability during TMRR should be determined on a case-by-case basis. Consult Configuration Management Subject Matter Experts for guidance.

2.5. Risk Management

The contractor shall establish and maintain a risk management program to continuously identify, analyze, mitigate, monitor, and report systems engineering process, product, technology, cost, schedule, and other program risks. Risk management process results shall be used for continual improvement and risk reduction. Program risks must be assessed and managed at the appropriate level. The contractor shall establish and maintain risk management programs consistent with the DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs.

2.6. Parts, Materials, and Processes Control Program

The contractor shall establish, document, and maintain a Parts, Materials, and Processes Control Program (PMPCP) to ensure selection and use of parts, devices, and materials, including commercial and non-developmental items, meet specified performance, quality, reliability, safety, supportability, and configuration management requirements throughout the life cycle of

the system. The program shall include provisions for mitigating the impact of counterfeit parts and parts obsolescence on product integrity.

The contractor shall flow down applicable PMPCP requirements to applicable lower-tier suppliers.

The contractor may use SD-22, MDA-QS-003-PMAP, MIL-STD-3018, or SMC Standard SMC-S-009 as additional guidance for control of Parts, Materials, and Processes.

Suggested DID:

- DI-MGMT-81949, DMSMS Implementation Plan

2.7. Environmental Stress Screening

The contractor shall implement an Environmental Stress Screening (ESS) program to surface defects by stressing the item without degrading its inherent reliability. Environmental stresses (i.e., thermal cycling and random vibration) may be applied in sequence or in combination, with the intent of stimulating hardware defects. The ESS program should not be used to simulate an operational environment. Results of ESS shall be used to continually improve manufacturing processes. The contractor may use MIL-HDBK-344 as additional guidance for planning, controlling, and measuring the effectiveness of the ESS program.

Guidance:

1. Imposing ESS requirements should be a joint determination by engineering, manufacturing, Quality, and Reliability functional experts. Consider using ESS on major and critical suppliers of electrical, electronic, electro-optical, electromechanical or electrochemical components in demonstration & validation, engineering & manufacturing development and production phases.

2.8. Key Characteristics and Variation Reduction

The contractor shall identify Key Characteristics and implement a Variation Reduction program in accordance with AS9103.

2.9. Advanced Product Quality Planning (APQP) & Production Part Approval Process (PPAP)

The contractor shall implement APQP and PPAP programs in accordance with AS9145.

3. Suggested Section L and M inputs

3.1. Instructions to Offerors Guidance (Section L):

1. Manufacturing Readiness Level Demonstration. The offeror's proposal shall identify those elements (systems, subsystems, suppliers, and/or processes) being assessed for manufacturing risk and their current Manufacturing Readiness Levels using the criteria and process identified in the Manufacturing Readiness Level Deskbook (Link http://www.dodmrl.com). The contractor shall describe the approach used to assess the MRLs. For any element that is assessed to be below the target MRL of 'X', the offeror shall identify the current MRL and the plan to achieve the target MRL.

(Note: DFARS Subpart 215.304 requires that the manufacturing readiness of offerors be considered during source selection for ACAT I programs.)

2. Manufacturing Plan. The offeror shall describe:

a. How their manufacturing management system meets the requirements of AS6500A.
b. The major assembly sequence chart and anticipated manufacturing process flow.
c. The manufacturing build schedule, including drawing release; tooling design, build, and proofing; key supplier deliveries; and fabrication, assembly, and delivery schedules.
d. Facility requirements and layouts.
e. The offeror's plans to provide the needed manpower, facilities, and equipment for expected delivery rates.

3. Quality Systems. The offeror shall describe how their quality system assures product quality; achieves stable, capable processes; prevents defects; and employs effective methods for conducting root cause analyses and implementation of corrective actions.

4. Supplier Management. The offeror shall describe their:

a. Approach to selecting and managing key suppliers.
b. Processes for integration of key supplier activities into the overall program plan to assure that supplier activities support the overall program performance.
c. Specific supplier risks to the program and plans for mitigating those risks.
d. Plan for preventing the intrusion of counterfeit parts in factory equipment and delivered products.

3.2. Evaluation Criteria Guidance (Section M):

1. Manufacturing Readiness Level Demonstration. The offeror's proposal will be evaluated on the maturity of their proposed manufacturing capability, the adequacy of their supporting documentation to justify this capability, and the adequacy of the offeror's process and plans to achieve the target MRL as described in the Manufacturing Readiness Level Deskbook.

This sub-factor is met when the offeror's proposal identifies the elements being assessed for manufacturing readiness and their current MRLs. As described in the proposal, the offeror's

MRL assessment process is consistent with the MRL Deskbook. For elements that are below the target MRL, the proposal describes an achievable plan to meet the target MRL.

2. Manufacturing Plan. This sub-factor evaluates the proposed methods, schedules, and resources for producing the required products. This sub-factor is met when the offeror's proposal:

a. Describes how their manufacturing management system meets the requirements of AS6500A.
b. Describes the major assembly sequence and manufacturing process flows.
c. Includes an integrated, achievable schedule incorporating design, tooling, supplier, fabrication, assembly, and delivery milestones.
d. Describes facility requirements and layouts.
e. Describes achievable plans to provide the needed manpower, facilities, and equipment for expected delivery rates.

3. Quality Systems. This sub-factor evaluates the offeror's planned quality assurance system. This sub-factor is met when the offeror's proposal describes policies and practices that will:

a. Assure product quality.
b. Achieve stable, capable processes.
c. Prevent defects.
d. Result in effective root cause analyses and corrective actions.

4. Supplier Management. This sub-factor evaluates the offeror's proposed supplier management program. This sub-factor is met when the offeror's proposal:

a. Describes how key suppliers are selected and managed.
b. Describes how supplier activities will be integrated into the overall program plan.
c. Lists specific supplier risks and achievable plans for mitigating those risks.
d. Describes effective plans for preventing the intrusion of counterfeit parts in factory equipment and delivered products.

4. FAR/DFARS Clauses

Although the Contracting Officer is ultimately responsible for applying the appropriate FAR and DFARS clauses to the contract, the following sections address topics relevant to the Manufacturing and Quality function. Manufacturing and Quality Subject Matter Experts should be familiar with the requirements of these sections and offer their support and recommendations to the Contracting Officer.

4.1. Higher Level Quality Requirements

FAR Part 46, "Quality Assurance," prescribes the use of various FAR clauses that address quality and inspection requirements, depending upon the nature of the contract. For critical or complex items, clause 52.246-11 must be included in the contract. This clause requires the identification of a specific higher-level contract quality standard. Section 46.202-4 lists examples, such as ISO 9001 and AS9100. The Manufacturing/Quality Subject Matter Expert should work with the Contracting Officer to ensure the appropriate clause is included in the contract and the appropriate higher-level quality requirement is included in 52.246-11.

4.2. Counterfeit Parts Prevention

DFARS 246.870-3 prescribes the use of clauses 252.246-7007, "Contractor Counterfeit Electronic Part Detection and Avoidance System," and 252.246-7008, "Sources of Electronic Parts" when procuring electronic parts or end items that contain electronic parts.

4.3. First Article Approvals

FAR Subpart 9.3 governs First Article Testing and Approval and describes when this testing is required. When it is required, Subpart 9.3 requires either FAR clause 52.209-3 for contractor testing or 52.209-4 for government testing.

4.4. Contract Administration Functions

FAR Subpart 42.302, "Contract Administration functions," lists the activities performed by the Contract Administration Office (typically DCMA.) Manufacturing & Quality-related functions include activities such as performing production surveillance and status reporting, conducting pre-award surveys, monitoring industrial labor relations, ensuring contractor compliance with contractual quality assurance requirements, and reviewing waivers and deviations.

4.5. Labor Relationships

FAR Part 22 describes the government's policies and practices regarding labor relations at contractor facilities. Subpart 22.103-5 prescribes the use of Clause 52.222-1 to require the contractor to notify the government of labor disputes.

4.6. Government Property

FAR Part 45 governs the use of government property. Subpart 45.107 prescribes the use of Clause 52.245-1 when government property is being used.

4.7. Records Retention

FAR Subpart 4.7 governs records retention. Many Manufacturing and Quality-related items, such as receiving and inspection reports, purchase orders, and quality control and inspection records must be retained for four years.

4.8. Contractor Debarment, Suspension, and Ineligibility

FAR Subpart 9.4 discusses reasons that contractors may not be allowed to obtain government contracts. This includes limitations on subcontracting (Subpart 9.405-2). Most contracts must include Clause 52.209-6 that protects the government's interests when subcontracting with debarred (or soon to be debarred) or suspended suppliers.

Acronyms

3D	Three-Dimensional
A_o	Operational Availability
AAF	Adaptive Acquisition Framework
AFRL	Air Force Research Laboratory
AM	Additive Manufacturing
AoA	Analysis of Alternatives
ASR	Alternative Systems Review
CARD	Cost Analysis Requirements Description
CBA	Capabilities-Based Assessment
CCTD	Concept Characterization and Technical Description
CDD	Capability Development Document
CoI	Community of Interest
CONOPS	Concept of Operations
COTS	Commercial Off-the-Shelf
Cpk	Process Capability
CSI	Critical Safety Item
CTE	Critical Technology Element
DARPA	Defense Advanced Research Projects Agency
DID	Data Item Description
DCMA	Defense Contact Management Agency
DTIC	Defense Technical Information Center
DE	Digital Engineering
DFARS	Defense Federal Acquisition Regulation Supplement
DFMA	Design for Manufacturing and Assembly
DFMEA	Design Failure Modes and Effects Analysis
DIU	Defense Innovation Unit
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DoD	Department of Defense
DoDD	DoD Directive
DoDI	DoD Instruction
DP	Development Planning
DTRAM	Defense Technical Risk Assessment Methodology
EMD	Engineering and Manufacturing Development
ESOH	Environment, Safety, and Occupational Health
FFRDC	Federally Funded Research and Development Center
FMEA	Failure Modes and Effects Analysis
FOC	Full Operational Capability
FRP	Full-Rate Production
GAO	Government Accountability Office

GFE	Government Furnished Equipment
GOTS	Government off-the-shelf
IB	Industrial Base
IBA	Industrial Base Assessment or Industrial Base Analysis
ICA	Industrial Capability Assessment
ICD	Initial Capabilities Document
IMP/IMS	Integrated Master Plan/Integrated Master Schedule
IoT	Internet of Things
IIOT	Industrial Internet of Things
IOC	Initial Operational Capability
IPT	Integrated Product Team
ISO	International Organization for Standardization
IT	Information Technology
ITRA	Independent Technical Risk Assessment
JCIDS	Joint Capabilities Integration and Development System
KC	Key Characteristic
KPP	Key Performance Parameter
KSA	Key System Attribute
LCSP	Life Cycle Sustainment Plan
LRIP	Low-Rate Initial Production
M&S	Modeling and Simulation
M&Q	Manufacturing and Quality
ManTech	Manufacturing Technology
MBE	Model-Based Engineering
MBSE	Model-Based Systems Engineering
MCA	Major Capability Acquisition
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MDD	Materiel Development Decision
ME	Mission Engineering
MFA	Manufacturing Feasibility Assessment
MOE	Measure of Effectiveness
MOP	Measure of Performance
MOS	Measure of Suitability
MOSA	Modular Open Systems Approach
MTBF	Mean Time Between Repair
MTTR	Mean Time To Repair
MMP	Manufacturing Maturation Plan
MRA	Manufacturing Readiness Assessment
MRL	Manufacturing Readiness Level

MS A	Milestone A
MS B	Milestone B
MS C	Milestone C
MSA	Materiel Solution Analysis
MS&T	Manufacturing Science and Technology
MTA	Middle Tier of Acquisition
NDAA	National Defense Authorization Act
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Technology
NRL	Naval Research Laboratory
NTIB	National Technology and Industrial Base
O&S	Operations and Support
OT	Operational Technology
OT&E	Operational Test and Evaluation
PDR	Preliminary Design Review
PESHE	Programmatic Environmental, Safety, and Occupational Health Evaluation
PFMEA	Process Failure Modes and Effects Analysis
PM	Program Manager or Program Management
Ppk	Process Performance
PPP	Program Protection Plan
Pre-MDD	Pre-Materiel Development Decision
P&D	Production and Deployment
PRR	Production Readiness Review
QA	Quality Assurance
QMS	Quality Management System
R&D	Research and Development
RAM	Reliability, Availability and Maintainability
RCO	Rapid Capability Office
RCT	Requirements Correlation Table
RFP	Request for Proposal
RIO	Risk, Issue, and Opportunity
ROI	Return on Investment
SBIR	Small Business Innovation Research
SE	Systems Engineering
SEMP	Systems Engineering Management Plan
SEP	Systems Engineering Plan
SETR	Systems Engineering Technical Review
SFR	System Functional Review
SME	Subject Matter Expert
SRD	System Requirements Document

SRR	System Requirements Review
STTR	Small Business Technology Transfer
S&T	Science and Technology
TAPP	Technology Area Protection Plan
T&E	Test and Evaluation
TEMP	Test and Evaluation Master Plan
TMRR	Technology Maturation and Risk Reduction
TPM	Technical Performance Measure
TRA	Technology Readiness Assessment
TRL	Technology Readiness Level
UCA	Urgent Capability Acquisition
WBS	Work Breakdown Structure

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