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

Chapter 2
Materiel Solution Analysis (MSA) Phase

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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.

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.

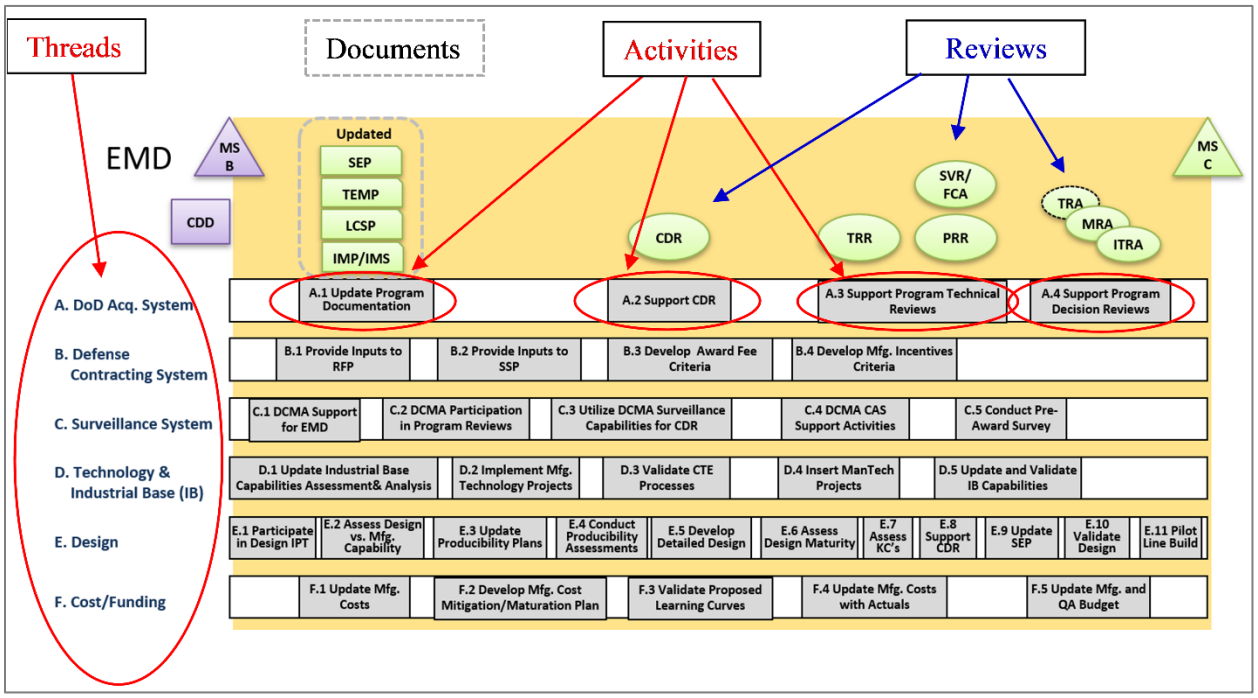
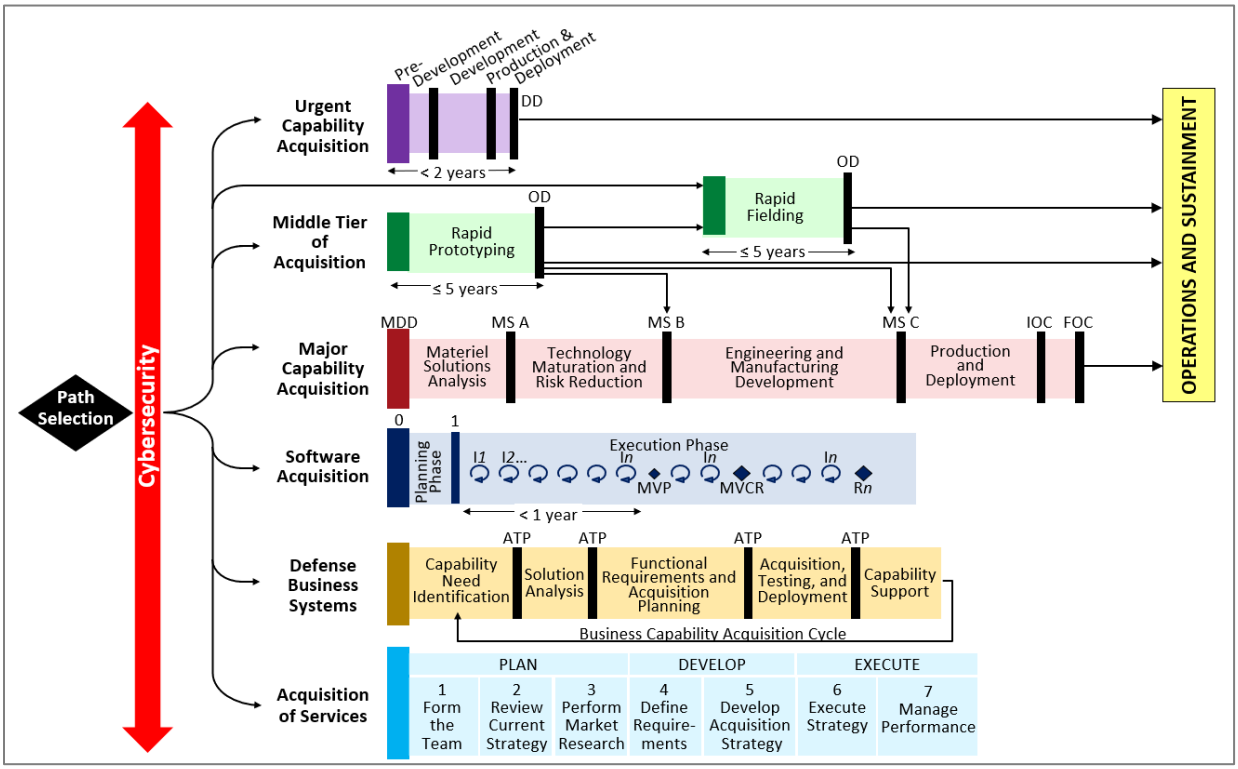


Figure 1. Sample Activity Chart

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.

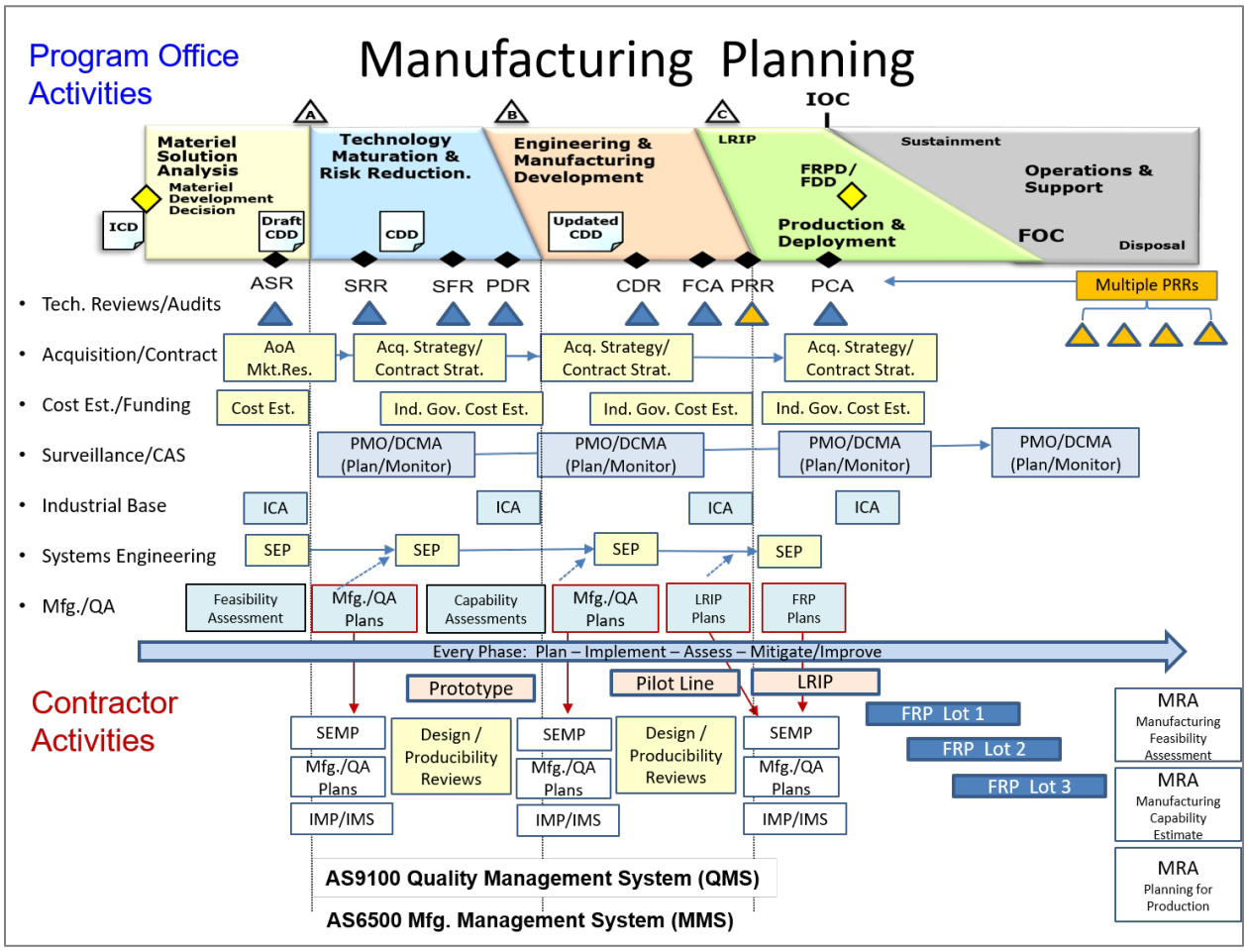


Figure 3. Typical Manufacturing and Quality Planning Activities

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

2. Materiel Solution Analysis (MSA) Phase

The purpose of the Materiel Solution Analysis (MSA) phase is to conduct the analysis and other activities needed to choose the concept for the product that will be acquired. This phase culminates in a risk reduction decision, Milestone A, which is an investment decision to pursue a specific product or design concept and to commit the resources required to mature technology and/or reduce any risks that must be mitigated before decisions committing the resources for development. This phase also is an opportunity for manufacturing and quality (M&Q) to influence chosen system design by balancing requirements against producibility, manufacturability, quality, and affordability.

Figure 2-1 shows the M&Q management activities typical of the MSA phase.

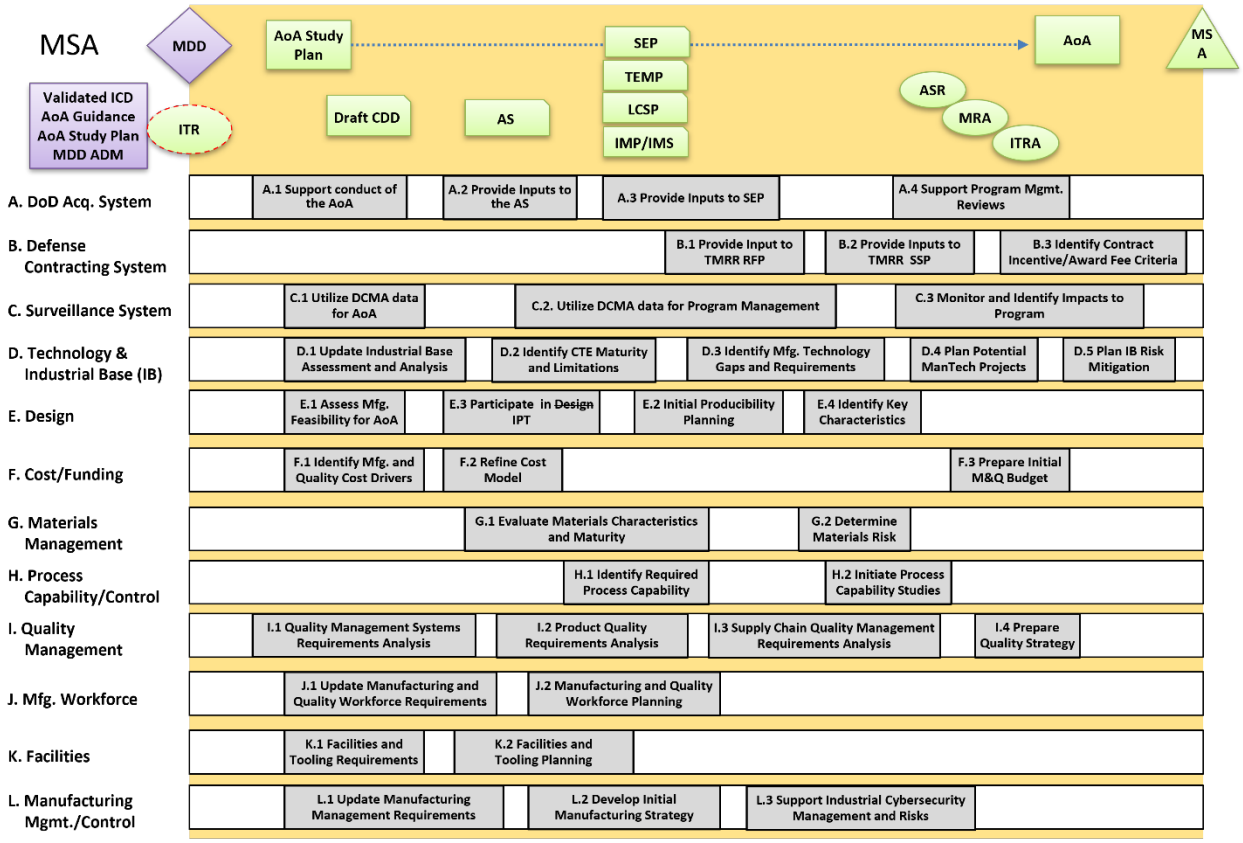


Figure 2-1. MSA Phase Manufacturing and Quality Activities

To support the MSA phase and the Milestone Decision Authority (MDA) decision process, M&Q should perform and/or support activities during the phase including:

- Conduct and complete the Analysis of Alternatives (AoA) with M&Q inputs needed to enable selection of a preferred materiel solution.
- Translate validated Key Performance Parameters (KPPs) and Key System Attributes (KSAs) into Key Characteristics (KCs) for M&Q.

- Conduct M&Q key trades for feasibility and affordability analyses; conduct risk, issue, and opportunity analyses; and plan for mitigations that impact cost, schedule, and performance.
- Develop M&Q goals for any needed development of critical enabling technologies.
- Translate the Initial Capabilities Document (ICD) with M&Q validation and verification analyses results into a draft Capability Development Document (CDD).
- Initiate the Test and Evaluation Master Plan (TEMP), the Systems Engineering Plan (SEP), and the Acquisition Strategy (AS) with inclusion of M&Q requirements.

Phase Description

In conducting and completing the AoA, the various alternative solutions are analyzed for key trades among affordability analyses, risk analyses, and planning for risk mitigations that impact cost, schedule, and performance. It is the role of M&Q to provide inputs to the AoA process with respect to feasibility and industrial base (IB) analyses, performed as part of the AoA Study Guidance, the validated ICD, and the AoA Study Plan, which guide the AoA and MSA phase activities. The analyses focus on identification and analysis of alternatives; measures of effectiveness; key trades between cost and capability; life cycle cost, including sustainment; schedule; concepts of operations; and overall risk. The AoA will include affordability analyses, cost analyses, early systems engineering analyses, threat projections, and market research. Minimum funding required for this phase includes all funding and staffing plans for the AoA and the engineering analysis and planning for the next milestone including the milestone certification requirements.

The AoA will address the M&Q feasibility and technology maturity of the proposed alternatives including the risks, issues, and opportunities associated with varying production rates; IB health and needs; manufacturing technology research; facilities and tooling, special test equipment, and special inspection equipment; manufacturing skill sets; and maturity of new materials and novel processing methods.

Before completion of this phase, the Department of Defense (DoD) Component combat developer will prepare a Concept of Operations/Operational Mode Summary/Mission Profile (CONOPS/OMS/MP) that will include the operational tasks, events, durations, frequency, operating conditions, and environment in which the recommended materiel solution is to perform each mission and each phase of a mission. The Systems Engineering (SE) Integrated Product Team (IPT) uses the outputs of the CONOPS/OMS/MP to identify and validate capability gaps and risks and translate these into system-specific requirements. These KPPs and KSAs are translated by M&Q into identified system, product, and component M&Q KCs. In addition, these outputs are used to provide M&Q inputs to the Acquisition Strategy, TEMP, and SEP, and the Milestone A decision. During the MSA phase, the Component Acquisition Executive (CAE) will select a Program Manager (PM) and establish a program office to complete the necessary actions associated with planning the acquisition program with emphasis on the next phase.

The MSA phase ends when a DoD Component has completed the necessary analysis and the activities necessary to support a decision to proceed to an acquisition phase. The next phase can be Technology Maturation and Risk Reduction (TMRR), Engineering and Manufacturing Development (EMD), or Production and Deployment (P&D), depending on the actions needed to mature the product being acquired. Each of these phases has associated decision points to authorize entry.

A. DOD ACQUISITION SYSTEM

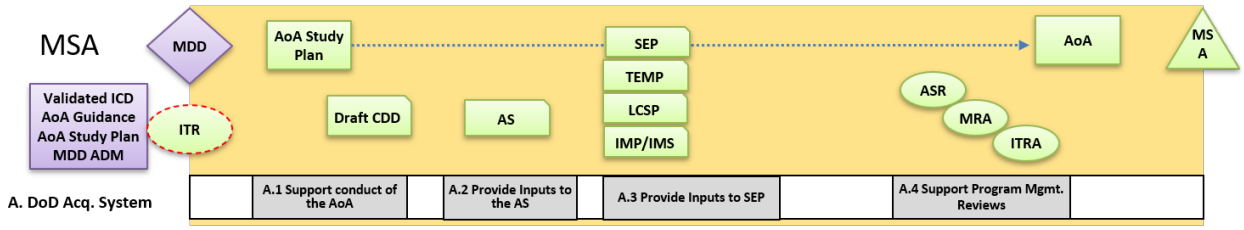


Figure 2-2. DoD Acquisition System Manufacturing and Quality Activities

Introduction

The Defense Acquisition System (DAS) is an event-based process. For Major Capability Acquisition, an acquisition program progresses through 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).

During the MSA phase, trade studies are conducted to identify materiel solutions and address gaps in capability based on an AoA. At the close of the AoA, a program office is assigned ownership of the approach. At this point, program management establishes the appropriate IPT structure to support program execution. The IPT conducts systems engineering analysis to support the development of the Acquisition Strategy, the SEP, and the draft CDD. The MSA phase also provides the opportunity to influence system design and plan for production by evaluating technology opportunities and current practices against cost, schedule, and performance. The intent is to reduce technical risk, validate designs, validate cost estimates, evaluate manufacturing processes, and refine requirements. The PM will ensure manufacturing, quality, and producibility risks are identified and managed throughout the program life cycle. Assessments of M&Q readiness, risks, and mitigation plans will be developed and documented in the SEP and the Acquisition Strategy.

Analysis of Alternatives

From an M&Q perspective during the AoA, each competing alternative under consideration is analyzed for its impact to industrial and manufacturing capabilities. The analysis uses the IBAs performed previously to determine the likelihood that a proposed materiel solution can be produced using existing

manufacturing capabilities while meeting quality, rate, cost, and schedule requirements. The AoA also identifies new or high-risk manufacturing capability or capacity requirements if they are needed. The AoA should also identify critical technologies and the associated manufacturing process areas in each alternative requiring risk-reduction effort. The results of the analyses are used to quantify the differences between alternatives and select a preferred solution. At the close of the AoA, the program office takes ownership of the approach and conducts additional engineering analyses to support the development of the Acquisition Strategy and the SEP.

Acquisition Strategy

Early systems engineering provides the foundation for the development of the Acquisition Strategy. The strategy is based on engineering analyses, trade studies, and preliminary system functional and performance requirements to meet a capability need. The Acquisition Strategy should address the following program objectives:

- The likely outcome is worth the investment in both resources (real costs) and schedule (opportunity costs).
- The end item meets required performance objectives.
- All risks, issues, and opportunities are identified, managed, and mitigated to an acceptable level.
- The business strategy effectively executes the program.

In addition, an Acquisition Strategy should emphasize and provide incentives for the important aspects of the program. The Acquisition Strategy should include:

- A market analysis and associated acquisition planning.
- An assessment of the IB to support design, development, production, sustainment, or restart of an acquisition program.
- An assessment of manufacturing feasibility to answer the question, “Can it be built?”
- An initial M&Q strategy.

As an integral part of the overall Acquisition Strategy, the initial M&Q strategy should include considerations such as:

- Competition: Competition can be a major contributor to reducing weapon system costs but can also be a major contributor to M&Q complexity and must be carefully planned.
- New manufacturing technologies: If required by the system concept, new manufacturing technologies will require specific plans for development, proofing, and transition of the technology to the eventual producer.
- Production rates and quantities: Rates and quantities play a major role in driving manufacturing cost as they will drive decisions on what production processes to use, types of tooling required, make-buy decisions, etc.

- Materials sourcing: Sources that are sole, single, fragile, or foreign sources, and those domestic sources that are vulnerable to foreign acquisition introduce risks to manufacturing.
- Contracting strategies: Acquisition Strategies and program planning should include M&Q technologies, facilities, investment incentives, risk mitigation efforts, etc.

Other M&Q considerations that should be addressed in the M&Q strategy as part of the Acquisition Strategy:

- How risk areas will be addressed and minimized in the TMRR phase, on the path to full manufacturing capability in the P&D phase.
- How new manufacturing capabilities with a beneficial impact to the program will be addressed.
- The technical or manufacturing risks associated with the program and any critical technologies or manufacturing processes that need to be matured and demonstrated in a manufacturing-relevant environment during the TMRR phase.
- The quality history of the item or system.

Systems Engineering Plan

M&Q input to critical systems engineering processes and functions is essential to ensure that programs deliver capabilities on time and on budget. The effective execution of MSA efforts provides a feasible, producible, and effective solution that satisfies user requirements. The intent is to reduce M&Q risks, validate designs, validate cost estimates, evaluate manufacturing processes, and refine requirements. Program Managers will prepare a SEP as a management tool to guide the systems engineering activities on the program. The SEP will be submitted for approval for each milestone review, beginning with Milestone A. At each milestone, M&Q will support the Acquisition Strategy and SEP, including input for interdependencies, and overall manufacturing approach to balance system performance, life cycle costs, and risks. The SEP should include:

- Description of the program overall technical approach, including M&Q inputs for key risks, processes, resources, organization, metrics, and design considerations.
- Details of the timing and M&Q criteria for the conduct of technical reviews.
- Details for M&Q planning to provide effective management and control of the progress and the execution of risk mitigation activities.
- Plans for addressing M&Q integration with existing and approved architectures and capabilities.
- Identification of M&Q risks from external dependencies (outside the span of control).
- Guidance on the M&Q details in the program schedule with documentation of the planning.

Finally, the SEP should be included in the Request for Proposals (RFP) with an approved plan or a draft plan as either guidance or a compliance document and will be synchronized with the

Acquisition Strategy. PMs should consider using Systems Engineering Management Plan, DI-SESS-81785A, as a CDRL item.

Program Management Reviews

Management reviews are a major part of the systems engineering process and are conducted by members of the IPT. Reviews serve to confirm:

- Major systems engineering efforts have been conducted and completed.
- The program is ready to proceed to the next major schedule event.

Technical reviews are also an important tool for program management, independent assessors, and subject matter experts including M&Q, to identify and evaluate risks early and throughout the program. If conducted in conjunction with the Materiel Development Decision (MDD), M&Q should support all technical reviews, which should assess the draft ICD, the AoA Study Guidance, and preliminary CONOPS for M&Q analyses of the materiel solution alternatives. Support of the technical reviews will 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.

The primary review during MSA is the Alternative Systems Review (ASR), which is conducted by the program office prior to the Milestone A decision and entry into TMRR phase. The ASR assesses the preferred materiel solution to ensure it has the potential to be affordable, producible, operationally effective and suitable, and can be developed to provide a timely solution to a need at an acceptable level of risk. The ASR helps ensure that sufficient effort has been given to conducting trade studies that consider and incorporate alternative system designs, M&Q alternatives, and other technical considerations. The technical understanding, assessed at the ASR, is sufficient and rigorous enough to support a valid cost estimate (CARD, or CARD-like Document).

Other reviews that should be conducted include a Manufacturing Readiness Assessment (MRA) and an Independent Technical Risk Assessment (ITRA).

The Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)) established policy for the conduct of ITRAs in accordance with 10 USC 2448b. These independent assessments should be conducted in accordance with the current 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
- RAM & Sustainment

In general, technical risks are those events or conditions typically emanating from areas such as mission/requirements, technology, engineering, integration, test, software, manufacturing/quality, logistics, and system security/cybersecurity that may prevent a program from meeting cost, schedule, and/or performance objectives.

ITRAs will leverage ongoing program activities whenever practical, e.g., Technology Readiness Assessments (TRA), Manufacturing Readiness Assessments (MRA), and Systems Engineering Technical Reviews. These assessments and activities will inform the ITRA; however, the team will provide an independent assessment of any risks or maturity concerns identified. As such, there may not be a direct correlation between external assessments or measures, such as Technology Readiness Levels, and the ITRA team's assessment.

A.1 Support Conduct of the Analysis of Alternatives

The Analysis of Alternatives (AoA) is an analytical comparison of the operational effectiveness, suitability, and life cycle cost of alternatives that could satisfy user capability needs as identified in the Initial Capabilities Document (ICD). The AoA process is used to better define the trade space across cost, schedule, and performance to support the selection of a solution among alternative solutions. The AoA has three primary products:

- AoA Study Guidance is developed and approved by the Director of Cost Assessment and Program Evaluation (DCAPE) with input from other DoD officials. The Milestone Decision Authority (MDA) must certify in writing to Congress that the Department has completed an AoA consistent with the study guidance developed by DCAPE. The AoA should be updated and performed in each acquisition phase throughout the life cycle of a program to guarantee that the correct materiel solution has been developed, to refine the materiel solution, and to reaffirm the cost-effectiveness of that solution.

- The AoA Study Plan establishes the road map for the conduct of the AoA. M&Q personnel need to be engaged in the assessment of the alternative solutions to assess manufacturing impacts and plan for future implementation.

- The AoA Final Report outlines the AoA process and provides an effectiveness analysis, cost analysis, risk assessment, and conclusions and recommendations.

Manufacturing and Quality Tasks

- Provide analyses of the M&Q requirements and feasibility contained in the draft ICD, the AoA Study Guidance, and the preliminary CONOPS for the AoA.
    - Analyses should verify adequacy, relevance, and completeness
    - Analyses should identify and quantify M&Q risks
- Provide analyses of the M&Q requirements in the AoA Study Plan to include the following:
    - Critical technology elements (CTEs) associated with each proposed alternative, including technology maturity, integration risks, manufacturing feasibility, and technology maturation and demonstration
    - Lifecycle cost estimate and identified methodology including use of models and data, cost sensitivity, and identification of cost drivers and risks
    - Identification of study team and organization; M&Q personnel should be on this team
- Ensure IBAs and market analyses are updated for concepts included in the AoA (conduct if not previously accomplished).
    - IBAs should illustrate the differences between alternatives based on the industrial and manufacturing capabilities and the required resources during the AoA
    - Manufacturing feasibility should answer the question "Can it be built?"
- Ensure assessments of manufacturing feasibility for the AoA preferred concepts are up to date including engineering trade studies, early prototypes, models or data, and the industrial capabilities required to design, develop, manufacture, and maintain each (conduct if not previously accomplished).
    - Identify M&Q risks
        - Include materials, processes, and technology
        - Identify new or high-risk manufacturing processes or capacity requirements
    - Identify manufacturing, quality, materials, and unique requirements that are cost drivers for the AoA
    - Ensure the phase-by-phase requirements for M&Q skills and training are updated for the AoA preferred materiel solutions
    - Ensure the facilities and capital equipment requirements for each AoA preferred concept are updated
    - Ensure that each AoA preferred concept includes and is analyzed for quality management requirements
    - Ensure each AoA preferred concept includes and is analyzed for manufacturing management requirements

Tools

- Acquisition Decision Memorandum (ADM) Template
- Acquisition Strategy (AS) Outline
- Alternative Systems Review Checklist
- Analysis of Alternatives (AoA) Study Plan Template
- AS6500, Manufacturing Management Program Checklist
- AS9100, Quality Management System Checklist
- Assessment of Manufacturing Risk and Readiness, DI-SESS-81974
- DAU Acquisition Notes (AcqNotes)
- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
- Interactive MRL Users Guide (Checklist)
- ISO 9001, Quality Management System Checklist
- Market Research Reporting Template
- Multi-Attribute Tradespace Exploration (MATE)
- Pugh Matrix Template
- Quality Function Deployment Excel Spreadsheet
- Quality Function Deployment or House of Quality Matrix
- Requirements Traceability Matrix Template
- Requirements Verification Matrix
- Tailoring Worksheet for Materiel Solution Analysis Phase
- Technology Readiness Level (TRL) Assessment Checklist

Resources

- Air Force Analysis of Alternatives (AoA) Guide
- Air Force Analysis of Alternatives (AoA) Handbook
- AS6500, Manufacturing Management Program
- AS9100, Quality Management Systems
- DoD Systems Engineering Guidebook
- DoD Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- DAU Acquisition Notes (AcqNotes)
- Defense Technical Risk Assessment Methodology (DTRAM)
- DoD 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
- DSMC Acquisition Strategy Guide
- ISO 9100, Quality Management Systems
- Manufacturing Readiness Level (MRL) Deskbook
- Pre-MDD Analysis Handbook
- Quality Function Deployment
- Requirements Traceability Matrix Guide
- Technology Readiness Assessment Guidebook
- Technology Readiness Assessment Guide (GAO-20-48G)

A.2 Provide Inputs to the Acquisition Strategy

M&Q personnel need to be actively engaged in the development and update of numerous documents to include:

- Acquisition Strategy (AS)
    - Acquisition Approach
    - Contracting Strategy
    - Market Research
    - Risk Management
    - *Manufacturing Strategy (if developed should go into the Acquisition Strategy)
    - *Quality Strategy (if developed should go into the Acquisition Strategy)
- Systems Engineering Plan (SEP)
    - Manufacturing Plan
    - Quality Plan

Programs will develop a Systems Engineering Plan (SEP) for Milestone Decision Authority (MDA) approval in conjunction with each milestone review and integrated with the Acquisition Strategy. This plan should describe the program's overall technical approach, including processes, resources, metrics, and applicable performance incentives. The SEP should detail the timing, conduct, and success criteria of technical reviews.

Manufacturing and Quality Tasks

- Provide a summary of an updated M&Q IB capability analysis for the Acquisition Strategy, as required by DoDI 5000.02.
    - Provide inputs on the capability of the IB to design, develop, produce, support, and restart the acquisition program, if appropriate
    - Provide inputs on IB capabilities, fragility, gaps, and risks for the Acquisition Strategy (e.g., key technologies, processes, components, etc.)

  - Provide the impacts and interdependencies of this acquisition on the National Technology Industrial Base (NTIB) and the analyses used to make this determination
  - Summarize M&Q impacts, how they will be managed, and the plan for future assessment, including frequency
  - Provide inputs for the government strategy and actions necessary to preserve the IB capabilities (e.g., incentivizing the contractor to support IB capability preservation, ManTech/Title III initiatives, etc.)

- Develop and provide a Manufacturing Strategy and a Quality Strategy to address the question "Can it be built?" The strategy should support the Acquisition Strategy development and include considerations of:
  - Competition and contracting strategies
  - New manufacturing technologies
  - Design (feasibility, producibility, KCs, risks, etc.)
  - Materials (characteristics, sourcing, risks, etc.)
  - Process, rates, and quantities (capabilities, control, risks, etc.)
  - Facilities, tooling, and workforce (including government-furnished equipment (GFE), special test equipment (STE), special inspection equipment (SIE), special requirements, etc.)
  - Management (quality, manufacturing, supply chain, risks, etc.)
- Provide M&Q inputs to Acquisition Strategy contracting strategy based on IB capabilities analyses, to support selection of a competitive award, a sole source award, or multiple source development (with down-select for production contract) as the best course of action.
  - Include M&Q metrics to differentiate the value of each contract type such as performance, capacity, functional, economic, etc.
  - Include impacts on IB capabilities and risks that may result from different contract types (firm fixed price (FFP), fixed price incentive fee (FPIF), cost plus fixed fee (CPFF), etc.)
  - Determine prototyping approach for TMRR, either competitive, single, or prototyping of critical subsystems (statutory requirement for Major Defense Acquisition Program (MDAP) Acquisition Strategy, regulatory requirement for all other programs)
- Develop M&Q inputs to the Acquisition Strategy for the source selection approach that establishes and maintains access to competitive suppliers at the system, subsystem, and component level (e.g., requiring a modular open systems approach, alternative sources of supplies or services, etc.).
- Develop M&Q inputs for the Acquisition Strategy that identify and address the sustainment of industrial capabilities, including manufacturing technologies and capabilities, and the maturation required during the TMRR and subsequent phases.
  - Provide M&Q inputs on product or component obsolescence (known and/or projected), use and replacement of limited-life items, options for unique manufacturing processes

and products (avoidance or regeneration), and the capability to convert off-the-shelf items to required specifications at the subsystems, item, and component levels.
    - Provide M&Q inputs on products or components (known and/or projected) from sole, single, fragile, or foreign sources including options for:
        - Domestic alternatives through regeneration of prior capability
        - Creation of new capability for manufacturing products and processes
        - Lifetime buy of items at the subsystem and component levels
- Develop Manufacturing Technology (ManTech) plans for new or high-risk manufacturing capabilities and processes for the Acquisition Strategy that address risks, issues, and opportunities.
    - Specify how this new capability will be demonstrated in a relevant manufacturing environment for the TMRR phase
- Provide M&Q inputs for required technical reviews, production decisions, events, prototypes, and deliveries, including sub-tier subsystem, item, and components, to be included in the Acquisition Strategy based on:
    - Requested inputs from Defense Contract Management Agency (DCMA)
    - Materials availability (lead-time and scale-up) and maturity (characterization)
    - Achievable rates and yields for M&Q
        - Provide methodologies for determining rates and schedules (e.g., Economic Order Quantities, affordability goals, etc.)
    - M&Q maturity
    - Facilities, tooling, and workforce considerations
    - Capital equipment requirements
- Provide M&Q inputs to the Integrated Master Plan (IMP) and Integrated Master Schedule (IMS), based on inputs to the Acquisition Strategy, for required technical reviews, production decisions, events, prototypes, and deliveries, to include:
    - Schedule for any planned use of government-furnished special test equipment, government facilities/ranges, unique tooling, or other similar requirements (specific modeling and simulation (M&S), communications, restricted environment, etc.)
    - Schedule impacts from the requirements for special materials and allotments, and the reasons for them if applicable
    - M&Q internal and external interdependencies and integration with existing programs, systems, and other programs in development that potentially impact the critical path
- Develop the government M&Q management approach to:
    - M&Q requirements for program plans

  - M&Q contributions to resource management (minimizing cost, schedule, and performance risks for the product life cycle)
  - M&Q organization and staffing with leadership positions and necessary skilled manpower
  - M&Q support organization required to meet program projected needs for TMRR and subsequent phases including:
    - Earned Value Management requirements
    - Cost control requirements
    - Data collection, reporting, and management

- Identify the M&Q requirements for the TMRR contractor's Manufacturing Management System (MMS) and Quality Management System (QMS).
  - Specify the standards to be used to promote industry best practices (e.g., Society of Automotive Engineers (SAE) AS6500, International Organization for Standardization (ISO) ISO 9001, SAE AS9100, IEEE 15288.0, -.1, -.2, etc.)
  - If M&Q standards are not specified, develop requirements for a program-specific Manufacturing Management Plan and Quality Management Plan
  - Identify M&Q opportunities, initiatives, and systems that will contribute to minimizing cost, schedule, and performance risks throughout the product life cycle
- Identify and assess M&Q risks, issues, and opportunities, and associated plans with key risk reduction events specified as inputs for the TMRR Acquisition Strategy and subsequent phases on the path to full capability.
  - Identify risks from the IB, materials, facilities, workforce, interdependencies with other programs, manufacturing technology voids, quality, software, and engineering-related risks, etc.
  - Identify maturation of critical technologies and manufacturing processes to the required level
  - Assess M&Q cost and schedule impacts from these identified risks
- Specify the ongoing requirements for identification, analysis, mitigation, tracking, and control of M&Q risks, issues, and opportunities that impact performance, technical, cost, schedule, sustainment, and programmatic areas throughout the life of the program.
- Develop as inputs to the Acquisition Strategy specific and detailed M&Q exit criteria metrics for MSA, TMRR, and subsequent phase decision points.
  - Metrics should include current and projected M&Q maturity of identified critical technologies and manufacturing processes
  - Metrics should also include the planned Manufacturing Readiness Level (MRL) target for system, subsystems, components, and items

- Develop the M&Q support plan for the mandated independent assessment for the Acquisition Strategy.
- Request DCMA inputs on strategies for quality, manufacturing, production, engineering, software development, configuration management, testing, and quality.

Tools

- Acquisition Strategy (AS) Outline
- Assessment of Manufacturing Risk and Readiness, DI-SESS-81974
- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
- Initial Capabilities Document (ICD) Template
- Interactive MRL Users Guide (Checklist)
- ISO 9001, Quality Management System Checklist
- Manufacturing Maturation Plan
- Pugh Matrix Template
- Quality Function Deployment Excel Spreadsheet
- Requirements Roadmap Worksheet
- SAE AS6500 Manufacturing Management System Checklist
- SAE AS9100 Advanced Quality Management System Checklist

Resources

- Acquisition Plan Preparation Guide
- AS6500, Manufacturing Management Program
- AS9100, Quality Management Systems
- DoD Systems Engineering Guidebook
- DoD Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Capabilities-Based Assessment (CBA) User's Guide
- DCMA Industrial Analysis (DCMA-INST 401)
- DoD 5000.60H, Assessing Defense Industrial Capabilities
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- DSMC Acquisition Strategy Guide
- IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
- IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs
- IEEE 15288-2014, Systems and Software Engineering
- ISO 9001: Quality Management Systems
- Manufacturing Readiness Level (MRL) Deskbook

- PL114-328 and subsequent guidance (TBD)
- Pre-Materiel Development Decision Analysis Handbook
- Quality Function Deployment (Reference Books)

A.3 Provide Inputs to the Systems Engineering Plan

M&Q personnel need to be actively engaged in the development and update of numerous documents to include:

- Systems Engineering Plan (SEP)
  - Manufacturing Plan
  - Quality Plan
- Test and Evaluation Master Plan (TEMP)
- Integrated Master Plan/Integrated Master Schedule (IMP/IMS)
- Life Cycle Sustainment Plan (LCSP)
- Capability Development Document (CDD)
- Requests for Proposals (RFP)
- Source Selection Plans (SSP)

The SEP should describe the program's overall technical approach, including processes, resources, metrics, and applicable performance incentives. It should also detail the timing, conduct, and success criteria of technical reviews.

Manufacturing and Quality Tasks

- Update the assessment of manufacturing feasibility for the preferred concept, if not completed; conduct an assessment, for inclusion in the SEP.
- Provide M&Q inputs to the SEP on all IB, design, manufacturing, production, and quality risks and risk reduction and mitigation efforts.
  - Identify critical technologies and M&Q process areas requiring risk reduction and mitigation efforts for the SEP, including the following activities:
    - Initial M&Q approaches for system requirements and system design concepts
    - M&Q trade studies
    - Potential M&Q solutions
  - Identify M&Q risks, issues and opportunities from existing architectures, capabilities, and external dependencies
  - Maintain up-to-date status on all key M&Q inputs to the SEP
- Provide M&Q plans and support to assist in development of the SEP and the program schedule based on the M&Q strategies in the Acquisition Strategy, to include:

  - Inputs on required M&Q products (e.g., assessment, metrics, etc.) for all systems engineering (SE) reviews
  - Inputs on specific and detailed M&Q entry and exit criteria metrics for technical reviews and MSA, TMRR, and subsequent phase decision points
    - Metrics should include current and projected M&Q maturity of identified critical technologies and manufacturing processes
    - Metrics should also include the planned Manufacturing Readiness Level (MRL) target for system, subsystems, components, and items
  - M&Q criteria, metrics, and frequency for SE reviews
  - Planned significant M&Q activities and tools (i.e., modeling and simulations, M&Q assessments, long lead or advanced procurements, prototype builds, production lots/phases, etc.)
  - Specifications for the M&Q organization, billets, and leadership positions
  - Specification of the roles, responsibilities, and organization of the Manufacturing Working Group to support SE
  - M&Q roles and responsibilities within other program IPTs (e.g., Design, Risk Management, Systems Engineering, Test and Evaluation (T&E), Sustainment, Facilities, etc.)
- Provide M&Q requirements, risks, issues, and opportunities (e.g., design, producibility, manufacturing technology, facilities, sustainment, cost, and schedule, etc.), for the SEP to be addressed by all IPTs.
- Identify M&Q inputs on required technical reviews/audits (e.g., Preliminary Design Review, Critical Design Review, Production Readiness Reviews, etc.) to be conducted at the sub-tier level on Configuration Items to be designed and developed by a sub-tier supplier.
- Plan for M&Q activities for the next phase:
  - Summarize key M&Q systems engineering, integration, and verification processes and activities established or modified since the previous phase, including updated
    - Risk and risk mitigation strategies
    - Technical and manufacturing maturity
    - M&Q metrics to support key management focus areas

Tools

- Analysis of Alternatives (AoA) Study Plan Template
- Assessment of Manufacturing Risk and Readiness, DI-SESS-81974
- Critical to Customer/Critical to Quality Tree Template
- Interactive MRL Users Guide (Checklist)
- Manufacturing Capability Assessment Worksheet
- Manufacturing Maturation Plan

- Manufacturing Plan, DI-MGMT-81889A
- MDD Development Planning Templates
- MSA Template
- Producibility Assessment Worksheet (PAW)
- Quality Assurance Plan
- Quality Assurance Program Plan, DI-QCIC-81794
- Systems Engineering Management Plan, DI-SESS-81785A
- Systems Engineering Plan (SEP) Outline

Resources

- Air Force Analysis of Alternatives (AoA) Guide
- Air Force Analysis of Alternatives (AoA) Handbook
- DoD Systems Engineering Guidebook
- DoD Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- MIL-HDBK-896, Manufacturing Management Program Guide
- DMMG for PMs, Chapter 1.3 and 2.6 Industrial and Manufacturing Capability Assessments in the Acquisition Lifecycle
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- DoDI 5000.89, Test and Evaluation
- IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
- IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs
- IEEE 15288-2014, Systems and Software Engineering
- Manufacturing Readiness Level (MRL) Deskbook
- MRL Users Guide
- Systems Engineering Plan (SEP) Outline
- Technology Readiness Assessment Guidebook

A.4 Support Program Management Reviews

M&Q personnel should be actively engaged in the organization and execution of numerous formal reviews and audits during this phase to include:

- Alternative System Review (ASR)
- Manufacturing Readiness Assessments (MRAs)
- Technical Readiness Assessments (TRAs)
- Independent Technical Risk Assessments (ITRAs)
- Independent Logistics Assessment (ILA)

- Program offices could request an informal review at any time and M&Q managers need to be prepared to support such reviews.

Sources of data used to assess and manage industrial and manufacturing readiness include technical reviews and audits, Program Status Reviews, Pre-Award Surveys, Manufacturing Readiness Assessments, ITRAs, Industrial Capabilities Assessments, trade studies, etc. An important output includes actions to reduce or address any remaining risks.

Manufacturing and Quality Tasks

- Support the conduct of the ASR.
- Support the conduct of an MRA.
- Support the conduct of a TRA.
- Support the conduct of an ITRA.
- Support the conduct of an ILA.
- Perform M&Q analyses of the draft ICD, the AoA Study Guidance, and the preliminary CONOPS of the materiel solution alternatives.
    - Provide detailed M&Q information to promote an understanding of each concept or alternative for:
        - Engineering trades
        - Cost drivers, material, and process risks, issues, and opportunities
        - Development of a CARD
- M&Q provides inputs and analyses to the ASR to support that the preferred materiel solution(s) resulting from the AoA have the best potential to be cost effective, affordable, operationally effective, and suitable, and can be developed to provide a timely solution to the need at an acceptable level of risk. M&Q representatives supporting program IPTs will:
    - Review, evaluate, and update the M&Q producibility assessments for the preferred system concept(s) for adequacy
    - Review, evaluate, and update the comprehensive risk, issue, and opportunity assessment for completeness and adequacy of all M&Q risks and update mitigation plans (develop if not initiated)
        - Complete trade studies or technical demonstrations for manufacturing concept risk reduction
        - Incorporate producibility and manufacturing considerations that could impact program decisions (e.g., critical components, materials and processes, tooling and test equipment development, production testing methods, long lead items, and facilities/personnel/skills requirements)

- Review and evaluate the risks to M&Q associated with the use of a commercial off-the-shelf (COTS)/government off-the-shelf (GOTS)/non-developmental item (NDI) solution versus a new design
- Complete the M&Q input to the initial hazard analysis and/or the system safety analysis for the preferred solution(s)
- Assess the M&Q requirements of the draft CDD to verify that all KCs are traceable to user needs through preliminary system specifications, key assumptions, and constraints back to KPPs and KSAs (from JCIDS)
- Assess the results of the AoA materiel solution(s) to meet M&Q cost, schedule, and performance objectives
- Review, evaluate, and update the comprehensive M&Q plans that address critical items, parts, components, and prototypes to be developed and demonstrated, along with their cost, and critical path drivers
- Provide M&Q inputs on the scope and planning of competitive prototyping of the materiel solution systems, subsystems, and components
- Provide M&Q inputs on the scope, planning, and resources needed for the initial end-item development
- Review Lessons Learned for M&Q drivers of system life cycle cost
- Provide inputs to the CARD that reflect realistic materiel solutions that meet the draft CDD within M&Q IB constraints including workforce estimates
- Review and update M&Q inputs to the SEP and the Acquisition Strategy, if necessary

Tools

- Alternative Systems Review Checklist
- Army Acquisition Logistician's Assessment Checklist v.5
- Assessment of Manufacturing Risk and Readiness, DI-SESS-81974,
- Independent Technical Risk Assessment (ITRA) Execution Guidance
- Interactive MRL Users Guide (Checklist)
- Manufacturing Maturation Plan
- MCSC Independent Logistics Assessment Checklist, v3
- NAVSO P-3690, Acquisition Logistics: An Assessment Tool
- Quality Status Report, DI-MGMT-82186
- Technical Readiness Assessment (TRA) Checklist

Resources

- DoD Systems Engineering Guidebook
- DoD Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- DAU AcqNotes website
- Defense Technical Risk Assessment Methodology (DTRAM)

- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
- IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs
- Independent Logistics Assessment Guidebook
- Logistics Assessment Guidebook Tool
- Independent Technical Risk Assessment (ITRA) Resources
- Defense Technical Risk Assessment Methodology (DTRAM)

B. DEFENSE CONTRACTING SYSTEM

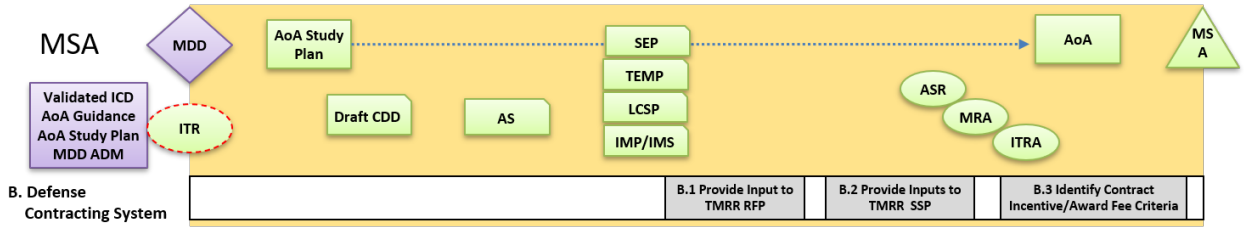


Figure 2-3. Defense Contracting System Manufacturing and Quality Activities

Introduction

M&Q program office personnel will participate in all phases of the development of Technology Maturation and Risk Reduction (TMRR) RFP, Source Selection Plan (SSP), and Award Fee incentive criteria. Many programs do not consider M&Q management requirements until the later stages of the EMD phase and beyond; however, there is a need to manage and control the emerging M&Q risks in the early acquisition phases.

M&Q inputs to the RFP for TMRR should be based on the M&Q inputs to the AoA in order to successfully develop and deliver the preferred solution and to provide a mature product with reduced risks that meet schedule and cost. These inputs will require specifying the use of best practices in manufacturing management and quality management. As part of the RFP, the contractor will be required to identify and to describe their proposed processes, methods, and actions to address manufacturing feasibility, producibility, and M&Q risks associated with the proposed materiel solution. The RFP will require these "ilities," risks, and other requirements to be appropriately documented in Contract Data Requirements List (CDRL), Data Item Description (DID), and other deliverables subject to a specified approval and acceptance process.

Each of the M&Q inputs to the RFP should note appropriate criteria and metrics to be met, included in the SSP, to ensure a fair and equitable source selection. The M&Q criteria and metrics should be coupled with appropriate award fee incentives, with processes and procedures, to reward successful management and execution, including incremental achievements of program goals. The criteria and

metrics should also be used to incentivize domestic manufacturing and technology capability improvements that contribute to performance enhancement, schedule improvement, cost savings, etc.

The early inclusion of M&Q inputs into the RFP, SSP, and other program processes will help guide the future development program success and help minimize risk.

This thread (Defense Contracting System) will focus on the following:

- 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

Appendix D of the BoK provides sample contracting and RFP approaches.

B.1 Provide Input to TMRR Request for Proposal

The RFP is an opportunity to communicate government requirements to the contractor. The RFP should identify the information required in the contractor's proposal and the criteria that will be used to evaluate the proposal, and the relative importance of those criteria. M&Q managers typically support the development of the RFP by identifying M&Q considerations and criteria for inclusion in the RFP and subsequent contract. These considerations need to ensure there is linkage between the ongoing M&Q considerations, warfighter requirements, and the evaluation factors and sub-factors. Evaluation factors often include cost or price, and quality of product or service, which includes technical considerations, past performance, and others.

Prior to developing an RFP, market research is often conducted to collect information and evaluate the market's ability to satisfy the user needs. M&Q personnel should support market research to identify suppliers and assess potential sources, opportunities, and risks to be addressed in the RFP.

Manufacturing and Quality Tasks

- Ensure M&Q personnel are included in the TMRR market research and RFP writing and review teams.
- Support the development of performance specifications for inclusion in the SOW:
    - Support the requirements process and the identification and decomposition of requirements into performance, detail, process, and/or material specifications
- Ensure traceability between requirement or capability and production/quality verification; analyze the M&Q results from the AoA Study Guidance and the AoA as a basis for RFP requirements.

  - Results from other relevant M&Q feasibility and IB studies should be used as additional data for RFP requirements

- Specify appropriate requirements for CDRLs, DIDs to support M&Q processes and the requisite approval process.
  - Include requirements for reporting of manufacturing, quality, and supplier management metrics
- Specify the requirements for best practices for the contractor's Manufacturing Management System (per Section L.1) and Quality Management System (per Section I.1) to be used (e.g., AS6500, ISO 9001, AS9100, etc.).
  - Specify the requirements for the contractors to identify and describe their proposed specific processes, methods, and actions to address manufacturing feasibility, producibility, and M&Q risks associated with the proposed solutions
- If AS6500 is not invoked in the contract(s), the manufacturing management requirements cited in AS6500 should be the basis for specific contractual requirements for a contractor plan. The requirements, at a minimum, should specify that the contractor address:
  - Manufacturing Management System:
    - Documenting how, when, and by whom each requirement of their system is to be accomplished and the authority and responsibility for each
  - Design Analysis for Manufacturing:
    - Conducting producibility analyses
    - Identifying and managing key and critical characteristics in the Technical Data Package (TDP)
    - Implementing Variability Reduction (VR) to reduce part-to-part variation of key and critical characteristics
    - Identifying and managing key and critical manufacturing processes
    - Conducting Process Failure Modes and Effects Analysis (PFMEA) on critical manufacturing processes
  - Manufacturing Risk Identification:
    - Integrating manufacturing risk management activities into the program risk, issue, and opportunity management process, including the identification of manufacturing risk areas and the development and implementation of risk mitigation plans tracked to completion
    - Conducting and documenting manufacturing feasibility assessments for each competing design alternative under consideration
    - Identifying MRL targets and documenting manufacturing risks through the MRL assessments

        - Conducting Pre-Award Survey if applicable
    - Manufacturing Planning:
        - Establishing and maintaining a manufacturing plan that includes supply chain and material management, manufacturing technology development, manufacturing modeling and simulation, manufacturing costs, manufacturing system verification, manufacturing workforce, and tooling, test equipment, and facilities
    - Manufacturing Operations Management including:
        - Production Scheduling and Control
        - Manufacturing Surveillance
        - Continuous Improvement
        - Process Control Plans
        - Process Capabilities
        - Quality Plans
        - Production Process Verification
        - First Article Inspections and First Article Tests
        - Supplier Management and Quality
- Specify industry best practices for systems engineering to be used (e.g., IEEE 15288, -1, -2, etc.) in the RFP.
    - Include requirements for the contractors to identify and describe their proposed processes, methods, and actions to address technical processes, technical management processes, and essential specialty engineering
- Specify contractual M&Q requirements for:
    - Conducting M&Q reviews of engineering and software (with frequency of reviews)
    - Providing M&Q information for cost models
    - Implementing a risk, issue, and opportunity management and mitigation program that includes M&Q (including IB risks)
    - Implementing a M&Q variability reduction program
    - Managing materials and subcontractors
    - Using commercial off-the-shelf (COTS), government off-the-shelf (GOTS), and non-developmental items (NDIs)
- Specify M&Q for:
    - Content for Statement of Work (SOW) and contract sections C, E, L, M, and H
    - Metrics to be met as exit criteria for TMRR phase
    - Requirements for cost estimates that include rate, alternate materials, quantity, etc. (including cost-of-quality data, if available).
    - Requirements for identification and description of manufacturing technology capability improvement efforts

  - Requirements for identification and description of producibility efforts
    - Include cost sharing and incentive plans relevant to the solution
  - Requirements for identification and description of contractor cost sharing and incentive initiatives
    - Requirements that encourage acquisition of modern technology, production equipment, and production systems that increase the productivity and reduce life cycle costs
    - Requirements that encourage investment in U.S. domestic sources
  - Requirements for facilities, tooling, and test equipment
  - Requirements for workforce (e.g., training, certifications, etc.)
  - Requirements for supply chain management
- Specify the requirement that the contractor support conduct of independent risk assessments to include the identification of any critical technologies or manufacturing processes that have not been successfully demonstrated in a relevant environment.

Tools

- AS6500 Manufacturing Management Program Checklist
- AS9100 Quality Management System Checklist
- ISO 9001 Quality Management System Checklist
- DOORS or other Requirements Management Tool
- RFP Template
- DCMA Pre-Award Survey System (PASS)
- SF 1403 DCMA Pre-Award Survey General
- SF 1404 DCMA Pre-Award Survey Technical
- SF 1405 DCMA Pre-Award Survey Production
- SF 1406 DCMA Pre-Award Survey Quality Assurance
- SF1407 DCMA Pre-Award Survey Financial Capability
- 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
- 10 USC 2366b
- AS6500, Manufacturing Management Program
- AS9100, Quality Management Systems
- DoD Systems Engineering Guidebook

- DoD Engineering of Defense Systems Guidebook
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- FAR 46-202 Types of Contract Quality Requirements
- IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
- IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs
- ISO 9001:2015, Quality Management Systems
- SD-15 Performance Specification Guide
- DI-IPSC-81431A/T System Performance Specification Data Item Description
- MIL-STD-961 Defense and Program-Unique Specifications Format and Content
- MIL-HDBK-245D, Handbook for Preparation of Statement of Work
- MIL-HDBK-29612-1A, Guidance for Acquisition of Training Data Products and Services
- AFMC Inst 23-113 Pre-Award Qualification of New or Additional Parts Sources
- DCMA Pre-Award Survey Guide
- Pre-Award Survey User's Manual
- Systems Engineering Plan (SEP) Outline

B.2 Provide Input to TMRR Source Selection Plan

The Source Selection Plan (SSP) specifies how the source selection activities will be organized, initiated, and conducted. The SSP serves as the guide for conducting the evaluation and analysis of proposals, and the selection of contractor(s) for the acquisition. The SSP must clearly and succinctly express the Government's minimum needs (evaluation factors) and their relative order of importance. M&Q managers, as members of the technical IPT, should be involved in the development of the SSP and in the identification of evaluation factors for their respective functions.

Manufacturing and Quality Tasks

- Support the drafting of the SSP and provide inputs and metrics.
    - Analyze the M&Q results from the AoA Study Guidance and the AoA as a basis for SSP requirements and metrics
    - Results from other relevant M&Q feasibility and IB studies to be used as additional data for SSP requirements and metrics
- Specify the criteria and metrics for evaluating the contractor's use of best practices for Manufacturing Management, Quality Management (e.g., AS6500, ISO 9001, AS9100, etc.), and Systems Engineering management (i.e., IEEE 15288).
    - Specify the criteria and metrics for evaluating the contractor's proposed processes, methods, and actions to address manufacturing feasibility, producibility, and quality risks associated with the proposed solutions

- Support SSP with appropriate criteria and metrics for submission, review, revision, and approval of CDRLs, DIDs, etc., to support M&Q processes.
- Specify M&Q criteria and appropriate metrics to be met for:
    - All milestone and technical reviews
    - M&Q reviews (including frequency of reviews)
    - Cost models and data (include cost-of-quality data)
    - Management processes for key and critical characteristics
    - Risk, issue, and opportunity identification, management, and mitigation program
    - Variability reduction program
    - Materials management process
    - Supply chain management program
    - Facilities, tooling, and test equipment plan
    - Workforce planning
- Specify the criteria and metrics for evaluating the contractor's:
    - Manufacturing and technology capability improvement plans and efforts.
        - Include cost sharing and incentive plans
    - Producibility efforts relevant to the solution.
        - Include cost sharing and incentive plans
    - Planning for IB risk management and mitigation
    - Plan to meet the exit criteria for TMRR phase
    - Strategy for acquisition of modern technology, production equipment, and production systems that increase productivity and reduce life cycle costs
        - Methods to encourage investment in U.S. domestic sources
- Specify the criteria and metrics for contractor support of independent risk assessments to include the identification of any critical technologies or manufacturing processes that have not been successfully demonstrated in a relevant environment.

Tools

- AS6500 Manufacturing Management Program Checklist
- AS9100 Quality Management System Checklist
- Quality Management System Checklist
- Source Selection Plan Template (Navy)

Resources

- Air Force Manufacturing Development Guide
- AS6500, Manufacturing Management Program

- AS9100, Quality Management Systems
- DoD Systems Engineering Guidebook
- DoD Engineering of Defense Systems Guidebook
- Defense Federal Acquisition Regulation Supplement, Procedures, Guidance and Information, Subpart 215.3 – Source Selection
- IEEE 15288, Systems and Software Engineering
- IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
- IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs
- ISO 9001:2015, Quality Management Systems
- PL 114-328
- Source Selection Plan Guide

B.3 Identify Contract Incentive/Award Fee Criteria

FAR Subpart 16.4 notes that "incentive contracts are designed to obtain specific acquisition objectives by establishing reasonable and attainable targets that are clearly communicated to the contractor; and include incentive arrangements designed to motivate the contractor to improve or discourage contractor inefficiency and waste."

Contracts should produce measurable performance outcomes that cumulatively contribute to the system Key Performance Parameters (KPPs)/Key System Attributes (KSAs), to their threshold or objective levels. To motivate the contractor to achieve the desired behavior, appropriate contract incentives (including award fee, incentive fee, award term, and cost sharing) need to be developed to promote and facilitate contractor performance.

M&Q managers need to support the development of Award Fee/Incentive Fee criteria in their respective areas. These criteria may focus on manufacturing investments and outcomes, process capability and control, reduction of waste, producibility improvements, etc.

Manufacturing and Quality Tasks

- Develop M&Q entrance and exit criteria for technical reviews and decision points.
    - Specify metrics for partial achievements, incremental awards, penalties for failure to meet contract requirements, and achievement beyond expectations
- Support the development of contract incentives for early delivery of completed, comprehensive, and acceptable M&Q CDRLs, DIDs, and other program documentation to meet the requirements for timely government approval.
    - Specify metrics for partial achievement and penalties for failure to meet contract requirements

- Provide incentives for achievement of M&Q specific thresholds, objectives, and sub-goals with respect to rate, schedule, performance, quality, etc.
    - Specify metrics for partial achievements, incremental awards, and penalties for failure to meet contract requirements
- Specify thresholds for the adoption and effective implementation of industry best practices in M&Q (e.g., AS6500, ISO 9001, AS9100. etc.).
    - Develop program-specific metrics that measure progress
    - Specify incentives for exceeding thresholds
- Specify thresholds and metrics for comprehensive manufacturing, quality, and subcontracting management plans.
    - Develop metrics for a Manufacturing Management Plan that includes identifying KCs and critical manufacturing processes; performing variability reduction activities; performing manufacturing capability assessments; and including a producibility program
    - Develop metrics for a Quality Management Plan that implements an effective Quality Management System, focused on defect prevention
    - Develop metrics for a subcontract management plan that implements a comprehensive supplier management organization, promoting exceptional performance
- Develop M&Q program-specific criteria and metrics that include key trades for and among cost, schedule, and performance, affordability analysis, risk analysis, and risk mitigation.
- Develop M&Q criteria and metrics that incentivize domestic manufacturing capability improvement investments, contributing to enhanced performance, schedule improvement, cost savings, etc. Include as appropriate the following:
    - Continuous Process Improvement (CPI) program or initiatives
    - Cost sharing, risk reduction, cost recovery, etc.
    - Investments in domestic advanced manufacturing equipment and processes

Tools

- AS6500 Manufacturing Management Program Checklist
- AS9100 Quality Management System Checklist
- Award Fee or Incentive Fee Template
- Quality Management System Checklist
- Source Selection Plan Template (Navy)

Resources

- AS6500, Manufacturing Management Program
- AS9100, Quality Management Systems
- DoD Systems Engineering Guidebook

- Award Fee Guide, (Army, Navy or Air Force guidance)
- Defense Production Act Title III (Manufacturing Technology Programs)
- DoDD 4400.01E, Defense Production Act Programs
- ISO 9001:2015, Quality Management Systems
- MIL-HDBK-896, Manufacturing Management Program Guide

C. SURVEILLANCE SYSTEM

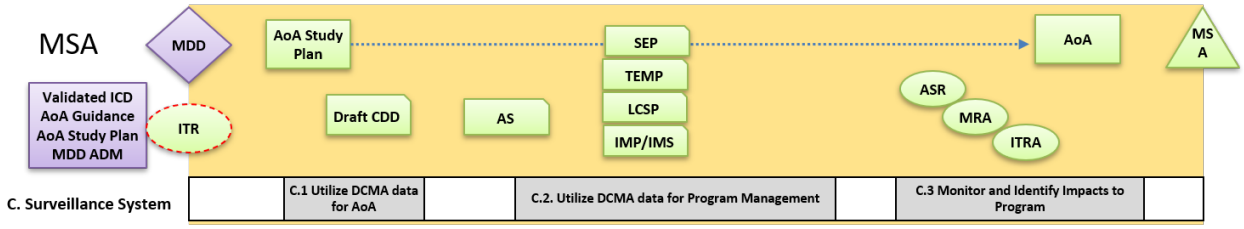


Figure 2-4. Surveillance System Manufacturing and Quality Activities

Introduction

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

Typically, these contractor surveillance activities may be performed under mutual agreement by the program office and DCMA. In many cases the activities may be performed by on-site program office contract administrators, delegated Service contract surveillance offices, or a variety of engineering support activities (e.g., supervisor of ships, development commands). This thread (Surveillance System) will focus on the following sub-threads, tasks, activities, tools, and resources:

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

The purpose of contract administration is to ensure the contractor performs in accordance with the terms and conditions of the contractual agreement (surveillance). DFAR subpart 242.3 identifies 71 CAS functions that need to be accomplished and managed. Contractor surveillance is defined by

several FAR and DFAR clauses. Many CAS activities fall under the umbrella of production or quality surveillance activities.

Contractors often depend on their own policies, procedures, processes, plans, controls, and schedules to meet government requirements. Often their plans, procedures, and processes mirror government regulations, directives, instructions, and other documentation that may or may not be contractual.

Government surveillance is often multifunctional, requiring the support of business and technical personnel. Program office, ESA, and DCMA personnel may be required or asked to support surveillance functions at the prime and subcontractor facilities. M&Q managers play an integral and vital role in defining the total scope of contract administration. Program offices can delegate many CAS activities to DCMA as a best practice. Delegations may require a Memorandum of Agreement (MOA) or a Letter of Delegation (LOD). The program office should coordinate with DCMA on required support, provided there is adequate manpower and funding to support the proposed MOA/LOD.

DCMA can provide input into requirements and commitments that enable programs to have current and predictive insight into performance. Access to reliable and accurate data and process information on costs, schedule, and technical performance can assist with objective assessment of supplier plans and the verification of initial and continuing compliance with requirements.

An AoA is an analytical comparison of the operational effectiveness, suitability, and life cycle cost of alternative materiel solutions that satisfy an established capability need identified in an Initial Capabilities Document (ICD). The AoA focuses on identifying and analyzing alternatives, Measures of Effectiveness (MOE), schedule, Concepts of Operations (CONOPS), and overall risk. An AoA also assesses CTEs associated with each proposed materiel solution, including technology maturity, integration risk, manufacturing feasibility, and technology maturation and demonstration needs.

C.1 Use DCMA Data for Analysis of Alternatives

The AoA authority or PM should maximize the use of DCMA information, data, and analyses from contractor facilities where there is delegation of authority and expertise available. DCMA, using a systematic approach to supplier manufacturing and supply chain evaluation, supply chain improvement initiatives, and best practices, is a valuable resource.

Manufacturing and Quality Tasks

- For manufacturing feasibility assessments of AoA concepts, request information and data input for similar products and manufacturing processes from DCMA in the following areas:
    - Manufacturing maturity
    - Status and readiness of industrial capabilities
    - Current available facilities and equipment

  - Workforce availability and training
  - Quality system processes and results

- Use DCMA M&Q data to analyze the M&Q requirements and feasibility for the AoA.
- Use DCMA M&Q data relevant for emerging technology maturity to develop and provide recommendations/rationale for the AoA preferred concepts.
- Use DCMA data to assist in identifying the manufacturing, quality, and/or supply chain risks for similar products and processes relevant for the AoA.
- Request and use DCMA M&Q data in support of the AoA to include data that supports the following analyses:
  - Manufacturing System Analysis
    - Supplier Surveillance
    - Production Planning and Control System
    - Material Management and Accounting System (MMAS)
  - Manufacturing Program and Product Analysis
    - Development Program-Specific Surveillance
    - Industrial Labor Relations
    - Past Performance
  - Manufacturing Continuous Improvement and Analysis
    - Surveillance of Supplier Continuous Improvement System
    - Supplier Performance Measurement
  - Supply Chain System Analysis
    - Materials Planning
    - Supplier/Sub-tier Qualification/Requirements Decomposition
    - Communication/Systems Integration
    - Continuous Improvement
    - Supplier Performance Measurement System and Surveillance Improvement
    - Data Analysis, Statistics, and Sampling
  - Supply Chain Risk Assessment
    - Risk Realization
    - Program/Platform/Sector Analysis and Modeling
    - Critical Item Risk
    - Capacity/Lead Time Analysis

Tools

- Analysis of Alternatives (AoA) Study Plan Template
- AS6500 Checklist

- AS9100 Checklist
- DCMA Pre-Award Survey
- DCMA Program Support Plan
- Interactive MRL Users Guide (Checklist)
- ISO 9001 Checklist
- SF 1404 Pre-Award Survey – Technical
- SF 1405 Pre-Award Survey – Production
- SF 1406 Pre-Award Survey – Quality

Resources

- Air Force Analysis of Alternatives (AoA) Guide
- Air Force Analysis of Alternatives (AoA) Handbook
- AS6500, Manufacturing Management Program
- AS9100, Quality Management Systems
- DoD Systems Engineering Guidebook
- DCMA Industrial Analysis (DCMA-INST 401)
- DCMA Pre-Award Survey Guide
- DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- ISO 9001:2015, Quality Management Systems

C.2 Use DCMA Data for Program Management

The program office should maximize the use of DCMA information, data, and analyses from contractor facilities where there is delegation of authority and expertise available. This may require the program office to establish a Memorandum of Agreement (MOA) or a Quality Assurance Letter of Instruction (QALI) with DCMA. DCMA may then use a systematic approach deploying surveillance through the supply chain to evaluate the supply chain and supplier improvement initiatives. At resident and non-resident facilities, DCMA personnel can tap into contractor databases to assess manufacturing, quality, engineering, and business processes.

Manufacturing and Quality Tasks

- Support the development of program documentation, planning, and investments using DCMA information and data with respect to:
    - Manufacturing maturity
    - Industrial capability status and readiness
    - Facilities and equipment availability
    - Workforce availability and training
    - Quality system processes and results

  - Manufacturing and/or supply chain risks

- Support the systems engineering process, trade studies, design, analyses, etc., using DCMA M&Q data from DCMA reports on:
  - Manufacturing and Quality System Analyses
  - Manufacturing and Quality Program and Product Analyses
  - Manufacturing and Quality Continuous Improvement and Analysis
  - Supply Chain System Analysis
  - Supply Chain Risk Assessment
- Recommend manufacturing investment programs required to mature emerging manufacturing technologies and industrial capabilities based in part on DCMA inputs.
- Request DCMA Contract Management Offices support development of M&Q to ensure agreement on contract oversight needs and perspectives with respect to:
  - Product support analysis
  - Software development
  - Counterfeit parts
  - Cybersecurity

Tools

- Army Manufacturing Technology (ManTech) Proposal Rating Template
- Assessment of Manufacturing Risk and Readiness, DI-SESS-81974
- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
- Interactive MRL Users Guide (Checklist)
- Pugh Matrix template
- Technology Readiness Assessment Checklist
- Technology Readiness Assessment Guide (GAO-20-48G)

Resources

- Counterfeit Parts Prevention Strategy Guide
- DCMA-INST 401, Industrial Analysis
- DCMA-INST-204, Manufacturing and Production
- DCMA-INST-205, Major Program Support
- DCMA-INST-207, Engineering Surveillance
- DCMA-INST-309, Government QA Surveillance Planning
- DCMA-INST-325, Technical Reviews
- DoD 5000.60H, Assessing Defense Industrial Capabilities
- DoD Directive 4200.15, DoD ManTech Program
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.60, Defense Industrial Capabilities Assessments

- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- DoD Systems Engineering Guidebook
- ManTech Strategic Plan
- Manufacturing Readiness Level (MRL) Deskbook
- Technology Readiness Assessment Guide

C.3 Monitor and Identify Impacts to the Program

Monitoring contractor progress and performance is an ongoing activity. Monitoring begins with an understanding of the contract requirements as specified in the SOO/SOW/PWS. The contractor has the primary responsibility for producing and delivering its supplies or services. The contractor's performance must be monitored daily to ensure that the supply or service delivered conforms to contract requirements. Unsatisfactory performance under a contract may jeopardize a project or may directly affect an activity's ability to perform its mission. Most program offices may not have the manpower or capability to monitor contractor performance closely and thus must depend on DCMA for assistance in this area.

Manufacturing and Quality Tasks

- Monitor and track external environment for potential impacts to M&Q for the program.
    - Environmental impacts to supply chain (legal and natural disasters)
    - Strategic and political changes/risks (domestic and foreign)
    - New laws and regulations (state and federal)
    - Obsolescence impacts
    - New industry or updated standards (e.g., AS6500, IEEE 15288, etc.)
- Monitor and track IB for trends, business startups, technology breakthroughs, etc., for impacts on M&Q.
- Monitor and track economic and business environment developments and impacts on M&Q regarding:
    - Acquisitions
    - Mergers
    - Bankruptcies
    - Market changes/disruptions

Tools

- Hazardous Material Assessment Template
- Interactive MRL Users Guide (Checklist)
- ISO 9001 Checklist Section Preservation (Handling, Storage, Packaging and Delivery)
- Preliminary Hazard List (PHL) See PHA checklist

Resources

- AS9100, Quality Management Systems, SCM Model
- ESOH in Acquisition Guide
- ISO 14001, Environmental Management
- ISO 9001, Quality Management System
- Manufacturing Readiness Level (MRL) Deskbook

D. TECHNOLOGY AND INDUSTRIAL BASE

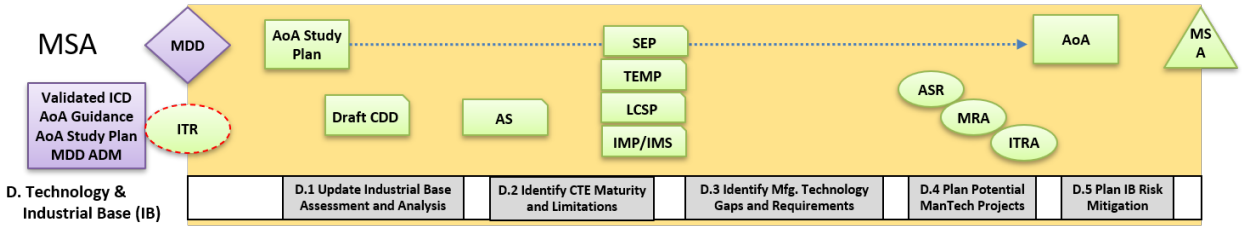


Figure 2-5. Technology and Industrial Base Manufacturing and Quality Activities

Introduction

10 USC 2440 requires the Secretary of Defense to consider the National Technology and 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. All MDAP acquisition planning and plans should consider the following with regard to NTIB:

- Ability to support development and production (rates and quantities)
- Identification of IB risks in the supply chain
- 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 (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

The MSA phase identifies materiel solutions to address gaps in capability based on an AoA. The AoA is performed independent of the Program Management Office and forms the basis for selecting the recommended approaches for materiel solutions. During the AoA, each competing alternative under consideration is analyzed for its impact to industrial and manufacturing capabilities. The results of the analyses are used to quantify the differences between alternatives based on the industrial and manufacturing capabilities and the resources needed.

The IBAs performed previously determine the likelihood that a proposed materiel solution can be produced. The assessments identify relevant sources and potential unique manufacturing capabilities, known gaps, risks, and potential sources, technological developments, market trends, processes, environmental factors, and policies, etc. The IBA focuses on availability, vulnerability, potential obsolescence, and actions necessary to mitigate.

The IBAs identify the high-risk manufacturing areas and highlight the need for investments in manufacturing technology improvements. These gaps must be identified early to reduce acquisition costs by providing the required investments in manufacturing capabilities in time to support production. The DoD ManTech program was created to address the concerns for high-risk manufacturing processes, with the objective of improving performance and reducing cost by developing, maturing, and transitioning advanced manufacturing technologies.

The assessments and analyses also highlight the need to support, maintain, or enhance essential or fragile industrial capabilities. The IBAs identify the IB risks incurred in selecting a design and highlight the need for mitigation of potential product or component obsolescence, supplier fragility, and process economic feasibility.

Note: When industrial capabilities require an investment greater than $10 million and affect more than one defense program or user, or if they support, maintain, or enhance essential or fragile industrial capabilities, the analyses and subsequent decisions must be coordinated within and across the Components in accordance with DoDI 5000.60.

D.1 Update Industrial Base Assessment and Analysis

As a member of the IPT, the program office should update previous IBAs to satisfy the requirements of 10 USC 2440 and DFAR Subpart 207.1.

Manufacturing and Quality Tasks

- M&Q support the update of the IBAs for concepts included in the AoA (conduct if not previously accomplished) by:
    - Ensuring identification of relevant sources including identification of unique manufacturing capabilities that are not readily accessible or available (e.g., capability is at maximum capacity, materials from a constrained source, etc.)

  - Determining the likelihood that a proposed materiel solution can be produced using existing manufacturing capabilities while meeting quality, production rate, and cost requirements
  - Ensuring the concept requirements and capabilities assessments are updated to include:
    - Identification of all known gaps, risks, and potential sources for key processes, technologies, and components
    - Identification of all potential and future M&Q needs inclusive of design, development, production, operation, sustainment, and eventual disposal
    - All technological developments, market trends, processes, environmental factors, and policies, etc., that could potentially impact M&Q of the preferred concepts

- Request updated DCMA industrial analysis data to support M&Q inputs to the AoA, including data that supports the following analyses:
  - Industrial Capability Assessments
  - Analytical Products
  - Defense Business and Economic Analyses
  - Acquisition Planning Support

- Ensure the M&Q focus of the IBAs is on the:
  - Capability to cost-effectively design, develop, produce, maintain, support, and restart the program (if necessary)
  - Approach to making production rate and quantity changes that support a response to contingency and support objectives
  - Vulnerability of supply chain (to include sole, single, fragile, foreign sources, foreign acquisition of domestic sources, and cybersecurity)
  - Availability of essential raw materials, special alloys, composite materials, components, tooling, and production test equipment required to include the availability of alternatives for obtaining such items from within the NTIB
  - Potential obsolescence
  - Impact of external dependencies and integration
  - New and unique capabilities and processes
  - Actions necessary to mitigate existing IB gaps/risks and identify when a needed industrial capability could be lost

- Prepare the M&Q inputs to the IBA considerations summary report to summarize the results for inclusion in the Acquisition Strategy:
  - Recommend actions or investments that address risks to cost, schedule, performance, and qualitative considerations
  - Define and recommend how and when the actions would be incorporated into the budget and schedule and, if possible, identify budget offsets

- If the required investment is greater than $10 million and is determined to affect more than one defense program, it must be coordinated within and across the Components per DoDI 5000.60

Tools

- AoA Study Plan Template
- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
- Interactive MRL Users Guide (Checklist), Technology and Industrial Base thread
- Manufacturing Maturation Plan
- Numerous M&S models available for contractor and government use

Resources

- 10 USC §2440, Technology and Industrial Base Plans
- Air Force AoA Handbook
- DCMA-INST 401, Industrial Analysis
- DFARS 207.105
- DoDD 4200.15, Manufacturing Technology (ManTech) Program
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.60, Defense Industrial Assessments
- DoDI 5000.60H, Defense Industrial Capabilities Assessments
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- DoD Systems Engineering Guidebook
- DoD Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- Manufacturing Readiness Level (MRL) Deskbook

D.2 Identify Critical Technology Element Maturity and Limitations

The ManTech program focuses on advancing state-of-the-art manufacturing technologies and processes from the research and development environment (laboratory) to the production and shop floor environment. ManTech addresses critical technology elements (CTEs) that are often immature and have process limitations that need to be assessed and plans made to mature the CTE.

Manufacturing and Quality Tasks

- Identify the CTEs and assess the M&Q maturity for the AoA.
  - Include necessary hardware and the associated embedded software maturity
  - Identify mature components, subsystems, M&Q processes, and alternatives for each immature CTE, and specify a plan for increasing the M&Q maturity

- Assess the manufacturing feasibility, and M&Q processes associated with each CTE in the validated ICD and develop a plan to improve and/or maintain maturity.
    - Include integration risk associated with the CTEs in trade studies and development
    - Include CTE interdependencies and associated risks
- Support the ASR, conduct M&Q analyses to document the likelihood that the CTEs will mature to the required level to meet operational effectiveness and suitability with an acceptable level of risk.
- Support the upcoming phase RFP and address M&Q maturation of critical technologies.

Tools

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

Resources

- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook
- MIL-HDBK-896, Manufacturing Management Program Guide
- Early Manufacturing and Quality Engineering Guide
- NAVSO P-3687, Producibility Systems Guidelines
- Technology Readiness Assessment Guidebook
- Technology Readiness Assessment Guide (GAO-20-48G)

D.3 Identify Manufacturing Technology Gaps and Requirements

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 the manufacturing capabilities will be matured on time to support rate production.

Manufacturing and Quality Tasks

- Conduct M&Q assessments to identify gaps and high risk in manufacturing processes needed for the preferred concept(s).
    - Analyze identified advanced manufacturing capabilities to confirm requirements
    - Analyze the gaps for potential manufacturing technology solutions that mitigate the risks
    - Estimate M&Q cost, schedule, and performance impacts

- Identify potential investments in M&Q technology that address gaps and risks.
- Conduct a survey that includes both DCMA reports and analyses and the ongoing DoD ManTech program projects for potential solutions to manufacturing technology gaps.
    - Request DCMA provide relevant data
    - Request ManTech assistance to identify processes and components
- Identify and develop M&Q assistance requests to DoD and/or component manufacturing technology programs that support:
    - Identification of new manufacturing processes associated with the program and candidate components for the identified processes
    - Identification of low-yield processes and components
    - Development of requests for information from other government agencies, industry, and academia responses to warfighter needs
- Identify recommendations for program and contracting personnel on emerging M&Q technology investments and Defense Production Act Title III initiatives.

Tools

- Interactive MRL Users Guide (Checklist), Technology and Industrial Base thread
- Manufacturing Maturation Plan
- Pugh Matrix
- Technology Roadmap
- TRL Assessment Checklist

Resources

- DoD Systems Engineering Guidebook
- Air Force Technology Development and Transition Strategy Guidebook, Nov 2010
- Defense Manufacturing Management Guide for PMs, Chapter 8, Technology Development, and Investments
- DoD Directive 4200.15, ManTech
- Manufacturing Readiness Level (MRL) Deskbook
- Technology Readiness Assessment (TRA) Guidebook
- Technology Readiness Assessment Guide (Report GAO-20-48G)

D.4 Plan Potential ManTech Projects

Accelerating the flow of technology to the warfighter is one of the top priorities of DoD, Services, and agencies. Technology transition involves the identification and maturation of technologies to the point where they are proven to be mature and ready for insertion into a system or element. As members of

the Technical IPT, M&Q managers need to support the identification of ManTech projects and plan for their insertion into production programs.

Manufacturing and Quality Tasks

- Develop plans for identified gaps and high-risk manufacturing processes that require investments in ManTech or other manufacturing programs.
- Develop a comprehensive plan for each required potential ManTech investment that mitigates M&Q technology gaps for the preferred concept.
    - Determine potential funding sources for ManTech projects (program office, Service, or DoD-wide funding)
- Use both DCMA reports and analyses and ongoing ManTech projects to support planning for potential solutions to M&Q technology gaps.
    - Include relevant DCMA and ManTech program data
    - Request M&Q planning support from DoD and/or component manufacturing technology programs for:
        - Development of new manufacturing processes associated with the program and candidate components for the identified processes
        - Development and maturation of low-yield processes and components
        - Program and contracting personnel supporting manufacturing technology investments and Defense Production Act Title III initiatives
        - Evaluating and maturing emerging manufacturing technology maturity

Tools

- Interactive MRL Users Guide (Checklist), Technology and Industrial Base thread
- Manufacturing Maturation Plan
- Manufacturing Technology Report, DI-MISC-81176A
- TRL Assessment Checklist

Resources

- Air Force Technology Development and Transition Strategy Guidebook
- Defense Manufacturing Management Guide for PMs, Chapter 8, Technology Development and Investments
- DoD Directive 4200.15, ManTech Program
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- Manufacturing Readiness Level (MRL) Deskbook
- Technology Readiness Assessment Guide (Report GAO-20-48G)

D.5 Plan Industrial Base Risk Mitigation

Industrial base risk mitigation activities may be a result of a formal study or analysis or may be a result of routine oversight that identifies a risk or an issue. M&Q managers need to assist in the development and management of risk management strategies and implementation plans.

Manufacturing and Quality Tasks

- Identify all M&Q capability risks that impact the preferred concept.
- Develop a mitigation strategy and plan for each M&Q IB risk.
- Develop an IB capabilities plan with contingencies to identify and mitigate the current and future M&Q capability risks. Plan should identify and mitigate:
    - All M&Q capabilities that should be maintained throughout the life of the program
    - Items projected to go out of production and plan for product or technology obsolescence, lifetime replacement, or regeneration
    - Fragility of unique M&Q capabilities and any facilities or corporations that provide unique services or products
    - The approach to making production rate and quantity changes that support a response to contingency and support objectives
    - Vulnerability of supply chain (to include sole, single, fragile, foreign sources, and foreign acquisition of domestic sources)
    - Availability of essential raw materials, special alloys, composite materials, components, tooling, and production test equipment required to include the availability of alternatives for obtaining such items from within the NTIB
    - Impact of external dependencies and integration
    - New and unique capabilities and processes

Tools

- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
- M&Q Risk Mitigation Plan (no template available)
- Interactive MRL Users Guide (Checklist), Technology and Industrial Base thread
- Manufacturing Maturation Plan
- Industrial Base Sector Plans (no specific tool)

Resources

- DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities, Part II, Chapter 5 Identify and evaluate Alternative Actions
- DoDI 5000.60, Defense Industrial Assessments
- DoD Systems Engineering Guidebook
- DCMA-INST 401, Industrial Analysis
- MRL Deskbook, Development of a Manufacturing Maturation Plan

E. DESIGN

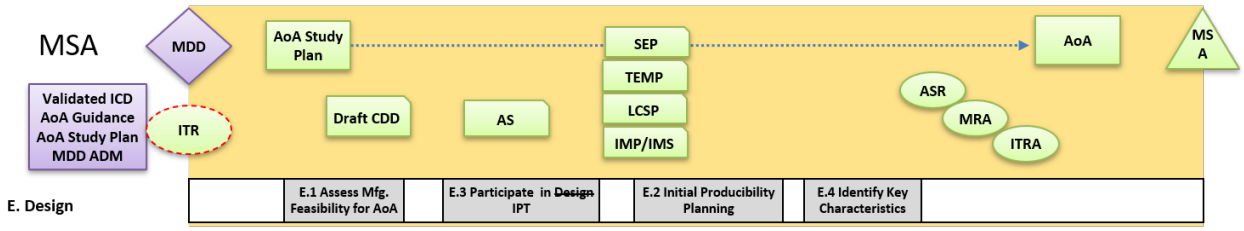


Figure 2-6. Design Manufacturing and Quality Activities

Introduction

The MSA phase presents the first real opportunity to influence system design and begin planning for production by balancing requirements against producibility, manufacturability, and affordability. The AoA team should ensure that a manufacturing feasibility assessment is accomplished as a part of the AoA. The feasibility assessment includes:

- Producibility of the potential design concepts
- Critical manufacturing processes and special tooling development required
- Test and demonstration required for new materials
- Alternate design approaches within the individual concepts
- Anticipated manufacturing risks and potential cost and schedule impacts

The feasibility analyses determine the likelihood that a proposed materiel solution(s) can be produced using existing manufacturing capabilities while meeting quality, production rate, and cost requirements. The feasibility assessments also identify the manufacturing risks incurred and the manufacturing capability gaps in selecting a design. Without these assessments, the PM, once assigned, may find that the program cannot be accomplished within the defined cost and schedule thresholds because of incompatibilities between the system design and the manufacturing capability available to execute it.

At the close of the AoA, a program office is assigned ownership of the approach. At this point, the program management establishes the appropriate IPT structure to support program execution. The IPT structure begins with the Overarching Integrated Product Team (OIPT). Additional IPTs will be designated as needed to support development of the proposed materiel solution(s). The IPTs may eventually include program activities from the macro to the micro (e.g., Systems Engineering; Design; Risk, Issue, and Opportunity Management; Manufacturing and Quality; Configuration Management; Critical Subsystems, components, and items, etc.). Not all IPTs will be present at all phases of development; however, M&Q participation in all program IPTs is essential to program success.

The IPTs conduct systems engineering analyses to support the development of the Acquisition Strategy and the SEP. The MSA phase also provides the opportunity to influence system design and plan for production by evaluating technology opportunities and current practices against cost, schedule, and

performance. The intent is to reduce technical risk, validate designs, validate cost estimates, evaluate manufacturing processes, and refine requirements. The PM is responsible for manufacturing, quality, and producibility risk identification and management throughout the program's life cycle. M&Q representatives will plan and conduct assessments of M&Q readiness and risk to be documented in the SEP.

As part of the IPTs, M&Q should conduct analyses that include initial producibility analyses. The IPTs should examine the management of overall requirements and the use of industry best practices, tools, and techniques in development of the established concept. Producibility analyses should include statistical process control, product characterization, modeling and simulations, and lessons learned from similar and/or prior programs.

Systems engineering analyses will also determine the initial KPPs and initial KSAs. User requirements need to be expressed in terms of KPPs and other quantifiable parameters to include:

- System performance requirements to meet mission requirements; and
- The full range of sustainment requirements (materiel availability, production capability, reliability, maintainability, logistics footprint, supportability criteria, etc.) needed to meet system sustainability and affordability over the life cycle.

The KPPs and the KSAs should have threshold values consistent with the requirements specified in the ICD and the performance specified in the preliminary performance specifications. The initial KPPs and KSAs will be documented in the draft CDD. From the initial KPPs and KSAs, M&Q analyses will determine the features of a material, system, subsystem, item, or component whose variation has significant influence on fit, performance, service life, or manufacturability. These features are the KCs, which will be linked to manufacturing processes with associated risks, and should be included as M&Q considerations in the Acquisition Strategy and SEP.

This thread (Design) requires an analysis of the degree to which the identified, evolving, or system design will meet user requirements and the degree to which the design is new and unproven. This thread will focus on the:

- Systems Engineering Plan (SEP)
- Systems Engineering Integrated Product Teams (IPTs)
- Work Breakdown Structure (WBS)
- Technical Reviews and Audits
- Producibility Planning and Assessments
- Key Characteristics
- Design Maturity

E.1 Assess Manufacturing Feasibility for Analysis of Alternatives

As members of the technical Integrated Product Team (IPT), M&Q managers should accomplish manufacturing feasibility assessments of the proposed alternatives identified in the AoA. A feasibility assessment should focus on identifying and reducing production risks of the proposed concepts and evaluating the capability of the factory floor to build to the design. This includes assessing manufacturing readiness and effective integration of industrial capability considerations into the design process. The first consideration is a need to understand the current manufacturing capabilities to see if they match up against the proposed AoA solutions so the program can plan for the enhancements of capabilities where there is a gap between the design and factory floor capabilities.

Manufacturing and Quality Tasks

- Update assessments of manufacturing feasibility for the AoA preferred concepts including the industrial capabilities required to design, develop, manufacture, and maintain each.
    - Update the anticipated M&Q risks for potential cost and schedule impacts
    - Update the producibility and manufacturability assessments for each concept
    - Analyze each AoA concept for manufacturing and producibility gaps and risks including:
        - Critical and unique manufacturing process requirements
        - Alternate design approaches within the concepts
        - Material requirements
        - Supply chain requirements
        - Production rate requirements
        - Facility requirements
        - Special tooling development requirements
        - Test and demonstration requirements for new materials
        - Manufacturing capability obsolescence
        - Manufacturing capability sustainment
- Ensure assessments provide the data required for the initial manufacturing and producibility inputs to KPPs and KSAs

Tools

- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
- Interactive MRL Users Guide (Checklist), Design thread
- Manufacturing Maturation Plan
- Manufacturing Producibility Assessment Worksheet (PAW)
- Market Research Reporting Template
- Preliminary Hazards List Developed
- Pugh Matrix

Resources

- DoD Market Research Guide
- CJCSI 5123.01I, JCIDS Instruction
- CJCS JDIDS Manual
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.60, Defense Industrial Assessments
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- DoD Systems Engineering Guidebook
- DoD Engineering of Defense Systems Guidebook
- Early Manufacturing and Quality Engineering Guide
- MIL-HDBK-896, Manufacturing Management Program Guide
- ESOH in Acquisition Guide
- Manufacturing Readiness Level (MRL) Deskbook
- NAVSO P-3687, Producibility Systems Guidelines
- Technology Level Assessment Guide (Report GAO-20-48G)

E.2 Participate in Design Integrated Product Teams

Major programs are organized around a core design team, usually composed of 20-50 of the contractor's engineers. This core design team makes 90-95 percent of all critical decisions with most made before production. M&Q should be one of the design team's primary concerns. If the considerations are delegated to secondary teams or not accomplished until late, the program could incur serious problems with cost, schedule, and performance.

Current design best practice includes digital engineering, digital twins, and defining the authoritative source of program data. This includes use of computer-aided design (CAD) and computer-aided manufacturing (CAM).

The PM and technical team need to include M&Q considerations in these early design trade-off decisions. The contractor will follow the government's lead. If the government shows concern for these areas in the development of the design and integration with M&Q, then the contractor receives the message and will show like concern. M&Q personnel must participate with the Design IPT in the development and review of the design and design documentation.

Manufacturing and Quality Tasks

- M&Q IPT participants should review and assess the proposed approach to systems engineering and use of tools and best practices
- M&Q IPT(s) participants provide design inputs and design support to:
    - Develop initial view of system requirements and system design concepts

  - Formulate initial system solutions
  - Develop a system functional definition that incorporates the user needs
  - Perform engineering analyses
  - Conduct initial design trade studies including external dependencies
  - Create a system specification document
  - Develop preliminary system functional and performance requirements
  - Derive and document draft KPPs and KSAs
  - Plan modeling and simulation
  - Identify critical technologies, and conduct a manufacturing maturity assessment of the hardware and embedded software options
  - Identify and assess M&Q risks as part of identification and assessment of system level risks
  - Identify future design validation and verification requirements
- M&Q IPT(s) participants provide inputs and support to:
  - Program management reviews
  - Other program IPTs (e.g., Systems Engineering, Configuration Management, Risk Management, Producibility etc.)
  - The Acquisition Strategy, SEP, draft CDD, and the TEMP in preparation for and participation in the ASR

Tools

- Acquisition Strategy (AS) Outline
- Draft CDD Template
- Interactive MRL Users Guide (Checklist), Design thread
- Manufacturing Maturation Plan
- Systems Engineering Plan (SEP) Outline
- Technology Readiness Assessment
- TEMP Template

Resources

- Acquisition Plan Preparation Guide
- CDD-CPD Writing Guide
- CJCSI 5123.01I, JCIDS Instruction
- CJCS JDIDS Manual
- Manufacturing Readiness Level (MRL) Deskbook
- DoD Systems Engineering Guidebook
- Systems Engineering Plan (SEP) Outline
- Technology Readiness Assessment Guide (GAO-20-48G)
- Test and Evaluation Management Guide

E.3 Initial Producibility Planning

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. M&Q managers should be developing the Initial Producibility Plans to support prototype design efforts with a focus on the realism, completeness, and clarity of the planning accomplished by the contractor.

Manufacturing and Quality Tasks

- Establish a Producibility sub-IPT.
    - Implement a producibility risk management process
    - Identify and deploy producibility design guidelines
    - Identify producibility best practices to be followed
- Analyze potential M&Q process risks and capabilities to determine producibility goals to include:
    - Identification and analysis of state-of-the-art manufacturing and production M&S approaches
    - Critical M&Q processes (yield and rates, if available)
    - Potential cost and schedule impacts
    - Special tooling, testing, and qualification
- Provide producibility planning guidance that emphasizes efficient manufacturing and product design and addresses:
    - Industry best practices, tools, and techniques
    - Design analyses that include:
        - Requirements validation analyses
        - FMEA
        - Trade studies on alternative product and process designs
        - Product complexity analyses
        - Manufacturing process analyses
        - Quality process analyses
        - Design for manufacture and assembly
        - Tolerance analyses
    - Costs, cost drivers, and controls
    - Material characterization and goals
    - KCs

  - Risk and risk mitigation planning
  - Prototypes
  - Learning curve projections
  - Planning for product and process measurements
  - Statistical Process Control (SPC)
  - Data and database management
  - Testing
- Ensure producibility planning is incorporated into the Manufacturing Management Plan.

Tools

- Benchmarking
- CAD/CAM software
- Design Failure Modes and Effects Analysis (DFMEA)
- Design for Manufacture and Assembly (DFMA)
- Design of Experiments (DOE)
- FMEA
- Interactive MRL Users Guide (Checklist) for the Design thread
- Manufacturing Maturation Plan
- Process Failure Modes and Effects Analysis (PFMEA)
- Producibility Engineering and Planning (PEP) Data Item Description
- Quality Functions Deployment (QFD)
- Six Sigma and Lean

Resources

- DoD Systems Engineering Guidebook
- MIL-HDBK-896, Manufacturing Management Program Guide
- AS6500, Manufacturing Management Program
- Defense Manufacturing Management Guide for Program Managers, Chapter 7.6 Producibility Engineering and Planning (PEP)
- Manufacturing Readiness Level (MRL) Deskbook

E.4 Identify Key Characteristics

AS9103 is the industry standard and best practice for the identification and control of Key Characteristics (KCs). The standard requires the producer to maintain documentation of KCs and control the manufacturing processes that directly influence variation of those KCs. KCs should have a Capability Index (Cpk) of 1.33 or greater or as specified by the customer. The concept of identifying KCs is linked to the Pareto principle, which asserts that a small number of features will have the most significant impact on performance. M&Q managers should be involved in the identification and

assessment of KCs early on during the development of the prototype design to see if the design and manufacturing can meet customer requirements and identify risks from not meeting those requirements. Often in the past, companies identified KCs only after experiencing cost problems, in the plant and in the field. Proactive or robust engineering would have contractors identifying KCs early in the design phase.

Manufacturing and Quality Tasks

- Provide M&Q inputs and support to deriving and documenting draft KPPs, KSAs, and Additional Performance Attributes (APA).
- Perform analyses of initial KPPs, KSAs, and APAs to determine the features of a material, system, subsystem, item, or component whose variation has significant influence on fit, performance, service life, or manufacturability and develop initial KCs.
    - Provide analysis and quantification of constraints to form, fit, and function for the preferred concept
    - Provide linkage to M&Q processes and risks
- Provide analyses of draft KPPs, KSAs, and initial determination of KCs as M&Q inputs to program documentation.
- Assess the organizations' ability to identify, manage, and control Key Characteristics (KCs) and Critical Characteristics (CCs).

Tools

- ISO 9001 Checklist
- AS9100 Checklist
- AS6500 Checklist
- Interactive MRL Users Guide (Checklist) for the Design thread
- Manufacturing Maturation Plan
- Critical to Quality Tree
- FMEA
- Process Capability Analysis Worksheet
- Producibility Assessment Checklist
- TRL Assessment Checklist

Resources

- ISO 9001 Quality Management Systems – Requirements
- AS9100 Quality Management System
- AS6500, Manufacturing Management Program, Nov 2014
- AS9103, Variation Management of KCs
- DoD Systems Engineering Guidebook

- JCIDS Manual
- Manufacturing Readiness Level (MRL) Deskbook
- NAVSO P-3687, Producibility Systems Guidelines
- Technology Readiness Assessment Guide (GAO-20-48G)

F. COST/FUNDING

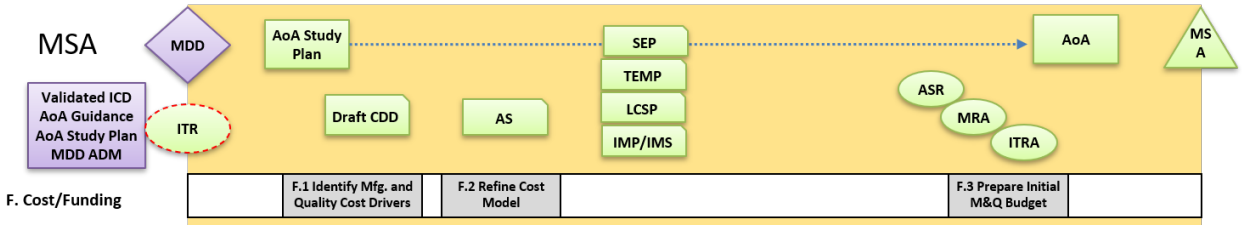


Figure 2-7. Cost and Funding Manufacturing and Quality Activities

Introduction

To identify and prioritize program resources, Services and agencies develop Program Objective Memorandums (POMs). The POM is part of the programming phase of the Planning, Programming Budgeting 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).

As part of these processes, detailed M&Q cost estimates usually cannot be finalized during the MSA phase, but cost drivers can be identified and initial cost estimates developed based on proposed materials and processes that are inherent in the proposed materiel solution(s).

For example, producibility cost drivers can be identified to estimate required investments in manufacturing technologies. These M&Q cost estimates support development of the total program cost budget. Cost estimates are further used to evaluate affordability (a discriminator) and in establishing initial thresholds for the proposed materiel solution(s). In many cases, the estimates are developed using statistically based cost estimating relationships or analogy with similar systems. The cost estimating team should incorporate M&Q considerations from the AoA and ASR. During MSA, the cost estimates support the evaluation and selection of a preferred system concept for the Milestone A decision.

This thread (Cost/Funding) requires an analysis of the risk that the system development and deployment will not meet the DoD cost and funding goals and will focus on:

- Cost Modeling (Initial Estimates)
- Identification of Cost Drivers
- Assessment of M&Q Costs
- Preparation of M&Q Budgets

- Development of M&Q Cost Mitigation Plans
- Development and Validation of Learning Curves

F.1 Identify Manufacturing and Quality Cost Drivers

M&Q managers need to support the development and update of government cost estimates and the assessment of contractor cost estimates. This responsibility includes identifying manufacturing cost drivers, those costs that have the most impact on cost and affordability.

Manufacturing and Quality Tasks

- Identify manufacturing, quality, materials, and unique or specialized requirements and associated risks that are cost drivers for the AoA and update for the ASR.
    - Include assumptions on process, materials, rate, supplier quality, workforce, special handling, environmental compliance, security, etc., and quantify the cost driver uncertainties
    - Estimate the cost of quality for each concept
    - Estimate the cost of ESOH and HAZMAT requirements and risks
    - Estimate the cost and impact of testing requirements
- Identify producibility cost drivers and associated risks for the AoA and update for the ASR.
    - Estimate impact of producibility opportunities and risks on rates, process, throughput, etc.
    - Estimate cost of implementation for producibility improvements
- Provide updates to the CARD with the M&Q inputs for the ASR.
    - Provide M&Q cost sensitivity analyses updates
- Support cost estimates as appropriate:
    - 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

- Cost, Schedule Control Systems Criteria (C/SCSC)
- Earned Value Management (EVM)
- Design to Cost Estimates

- Interactive MRL Users Guide (Checklist), Cost/Funding thread
- Manufacturing Cost Estimating Worksheet
- Manufacturing Maturation Plan
- *See* CAPE website for tools

Resources

- CAPE website
- Cost/Schedule Control System Criteria Reference Guide
- DoDD 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- DoD Systems Engineering Guidebook
- Guidelines for the Preparation and Maintenance of CARD Tables
- Guidelines for the Preparation and Maintenance of the Cost Analysis Requirements Description
- Manufacturing Cost Estimating (*see* Defense Manufacturing Management Guide for Program Managers, Chapter 9)
- MIL-HDBK-766, Design to Cost
- Manufacturing Readiness Level (MRL) Deskbook

F.2 Refine Cost Model

A cost estimate is an evaluation and analysis of future costs of hardware, software, and/or services. Cost estimates are derived from models based on historical cost, performance, schedule, and technical data associated with similar items or services. Early in a program that model may be based on analogy when the system is still being defined and created. In reality, even these early models may have some very real data. For example, the warfighter may need a new missile, one that goes faster and farther. Parts of the missile may be new technology and the basis of estimate may need to be analogy, but if the booster is an existing technology and is in production, for that part of the Work Breakdown Structure the program can use actual costs in their modeling.

Manufacturing and Quality Tasks

- Provide M&Q inputs to update cost targets and error bands for proposed materiel solutions for the AoA.
    - Review the assumptions behind these targets
    - Prepare detailed M&Q process charts to ensure the validity behind cost targets
    - Identify and quantify M&Q cost variables
    - Quantify the uncertainties
- Update the cost estimates for the proposed materiel solutions for the AoA including estimates for:

  - KCs and key processes
  - Variability reduction needs
  - Manufacturing environment simulations
  - Cost/performance trade studies
  - M&Q capability requirements
  - Product and process validation requirements
  - Key supplier management
  - Producibility
  - Environmental compliance
  - Manufacturing systems security (physical, cyber, etc.)
- Upon completion of the AoA, develop M&Q inputs to initial cost models for the preferred solution.
  - Verify cost models include all M&Q process variables
  - Provide M&Q inputs to the CARD for the appropriate cost categories
  - Provide initial M&Q inputs (cost models estimates) to the ASR

Tools

- Analogy and Parametric estimating
- Cost Analysis Requirements Description (CARD) (*See* CAPE website for tools)
- Cost/Schedule Control Systems Criteria (C/SCSC)
- Earned Value Management (EVM)
- Interactive MRL Users Guide (Checklist) for the Cost/Funding thread
- Manufacturing Cost Estimating Worksheet
- Manufacturing Maturation Plan

Resources

- CAPE website
- Cost Analysis Requirements Description (CARD) Template (*See* CAPE website for guidance)
- Cost/Schedule Control Systems Criteria Reference Guide
- DoD Directive 5105.84, Director of Cost Assessment and Program Evaluation
- DoD Instruction 5000.73, Cost Analysis Guidance and Procedures
- Guidelines for the Preparation and Maintenance of CARD Tables
- Guidelines for the Preparation and Maintenance of the Cost Analysis Requirements Description
- MIL-HDBK-766, Design to Cost
- Manufacturing Readiness Level (MRL) Deskbook
- Parametric Estimating Handbook

F.3 Prepare Initial Manufacturing and Quality Budget

Budget estimates are developed to provide the financial resources needed to improve affordability, reduce risks, mature emerging technologies for insertion, and help resolve several manufacturing-related issues. The budget estimate made near the end of the MSA phase needs to be accurate enough to support the program through TMRR. M&Q managers need to support the review and update of M&Q budgets required to support daily manufacturing and QA and to support maturing technologies and processes.

Manufacturing and Quality Tasks

- Provide M&Q cost estimates for the TMRR budget.
    - Verify that cost estimates include all M&Q cost drivers and risk estimates from the updated cost model
    - Provide updated producibility cost drivers and risk estimates to the budget process
    - Provide quantified M&Q cost driver uncertainties and associated budget impact estimates as inputs to the budget process
    - Provide investment estimates in M&Q technologies, processes, equipment, etc., as inputs to the budget process, to include:
        - Capital equipment (tooling, machines, structures, etc.)
        - Test equipment (specialized, environmental, etc.)
        - Facilities and modifications/expansion (handling, storage, transportation, disposal, etc.)
        - GFE
        - Environmental compliance (processes, facilities, equipment, etc.)
        - Manufacturing systems security (physical, cyber, etc.)
    - Use statistically based cost estimating for comparisons of M&Q aspects of the proposed system with similar systems whose costs are known
- Verify affordability cost estimates are used to establish M&Q initial thresholds.
- Identify potential ManTech investments that mitigate M&Q technology gaps.
    - Identify potential funding sources for ManTech projects (program office, Service, and/or DoD-wide funding)

Tools

- Interactive MRL Users Guide (Checklist), Cost/Funding thread
- Manufacturing Cost Estimating Worksheet
- Manufacturing Maturation Plan
- Quality Plan
- *See also* CAPE website for tools

Resources

- Cost Analysis Requirements Description (CARD) Template (*See* CAPE website for guidance)
- DoDI 5000.73, Cost Analysis Guidance and Procedures
- Manufacturing Readiness Level (MRL) Deskbook

G. MATERIALS MANAGEMENT

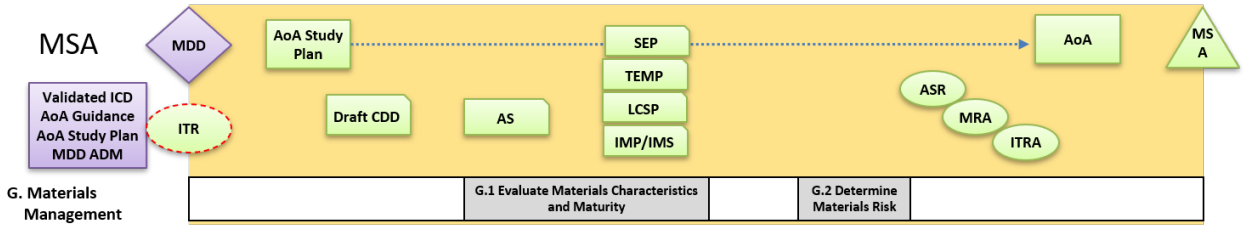


Figure 2-8. Materials Management Manufacturing and Quality Activities

Introduction

Material 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. Material 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

One of the major tasks of the MSA phase is to answer the question, "Can it be built?" (i.e., evaluate manufacturing feasibility). This task begins with materials and their capability, maturity, availability, and handling characteristics. In the early MSA phase, the characteristics of each material must be assessed for each concept chosen in the AoA. Many new and emerging materials are identified during the MSA phase, and each carry potential risks. Material capability, maturity, availability, sources, and handling characteristics are key determinates of M&Q risks. Thus, the early MSA phase is a series of trade studies to identify materiel solutions and to address gaps in capability.

Inherent in addressing M&Q risks is an analysis and understanding of the maturity of material properties, characteristics, and quality requirements. This analysis should address scale-up and lead-time requirements, as well as M&Q processes for all materials, especially those that are hazardous or difficult to obtain, process, or handle. Risks from potential counterfeit materials and parts are present at all levels of the supply chain. Additional risks can arise and need to be assessed and understood for materials that are from sole, single, fragile, or foreign sources, and those domestic sources that are vulnerable to foreign acquisition including the entire supply chain.

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. Another is the Defense Industrial Capabilities Handbook, DoD 5000.60H, which identifies alternative actions the government can take when facing material shortages to include:

- Finding foreign sources of supply
- Finding alternative or substitute parts
- Making a lifetime buy to meet all planned future needs
- Maintaining a current capability
- Developing an alternative solution

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

- Material Characteristics and Maturity
- Material Risks
- Supply Chain Management
- Critical Materials
- Special Handling Requirements
- Scale-up Requirements / De-Mil / Shutdown

G.2 Evaluate Material Characteristics and Maturity

Material characterization refers to a process by which a material's structure and properties are probed and measured so that design engineers have a better understanding of how a material performs mechanically. This understanding allows designers to make better material choices, manufacturing to make better process choices on how to form the material, and quality engineers on how to better measure the more important material properties. Material engineers need to be able to make design choices that provide the system with the best performance at the lowest costs. When materials are new or not well characterized (understood), there is greater risk of failure during production or operations.

One of the major goals of material characterization is the maturing of the material so that material characteristics and manufacturability are well understood.

Manufacturing and Quality Tasks

- Update and evaluate material maturity and availability for selected AoA concepts:
  - Determine if the materials have been produced in a laboratory (or more mature) environment
    - Evaluate research and development (R&D) and experiments for validation of material manufacturability
    - Evaluate other ongoing programs for prior use of materials under consideration (DoD, Science and Technology (S&T), commercial, government, etc.)
  - Evaluate material properties, characteristics, and quality requirements for each concept against requirements
  - If new materials emerge or are identified, evaluate needed material properties and characteristics, and quality properties
- Provide M&Q support to evaluation of the realism of projected lead times for materials (including hazardous) that are difficult to obtain or process.
- Assess M&Q requirements for material scale-up of selected AoA concepts.
- Perform M&Q volatility assessments for selected AoA concepts and identify:
  - Potential supply chain sources for critical materials
  - Hazardous materials for each concept
  - Special handling procedures that have been applied
- Determine if all M&Q special handling requirements have been identified.
  - Evaluate all materials for:
    - Potential regulatory requirements
    - Hazardous materials and handling procedures
    - Security requirements (physical, cyber, etc.)
    - Transportation, storage, and shelf life
    - GFP, GFE (tooling, test equipment, ranges, chambers, etc.)
    - Disposal

Tools

- Checklist, Section Preservation (Handling, Storage, Packaging and Delivery)
- Design for Six Sigma
- Design of Experiments Analysis
- DMSMS Product Life Cycle Assessment (consult Defense Logistics Agency website)
- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center

- Interactive MRL Users Guide (Checklist) for the Materials Management thread
- Manufacturing Maturation Plan
- Rough Cut Capacity Planning
- TRL Assessment Questionnaire

Resources

- AS9145, Advanced Product Quality Plan (APQP)/Production Part Approval Process (PPAP)
- DMSMS Guidebook, SD-22
- DoD 5000.60H, Assessing Defense Industrial Capabilities
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- ESOH in Acquisition Guide
- ISO 9001, Quality Management System
- Manufacturing Readiness Level (MRL) Deskbook
- Technology Readiness Assessment Guidebook
- Technology Readiness Assessment Guide (GAO-20-48G)

G.2 Determine Material Risk

Risk can be described as anything that has the potential to impact negatively on cost, schedule, or performance. Material risks and issues can slow or delay a program, can add costs to a program, or can create field failures because of poor material reliability. Material risks could include availability of the material, maturity of the material, or need for special handling and control. Material risks can occur anywhere in the supply chain from the prime contractor all the way down to the lowest level (dirt). M&Q managers need to support the identification and management of material risks and material maturity, especially as suppliers and vendors are brought on board and the prime contractor begins to collect and analyze actual data.

Manufacturing and Quality Tasks

- Assess materials maturity and availability M&Q risks for the AoA preferred solution that are:
    - New or critical materials in development
    - Developed in a lab environment, but are not immediately available
    - Readily available within near term (i.e., commodities)
    - Commercially available (long lead, capacity, etc.)
    - Readily available, but have environmental or health concerns
    - Have long lead times
    - Only available from a single or sole source (domestic or foreign)
    - Available within the NTIB
    - Available only from sources that are outside the NTIB
    - Vulnerable to foreign acquisition of domestic sources

  - Hazardous or difficult to obtain or process
  - Materials that are facing Diminishing Manufacturing Sources and Material Shortages (DMSMS)/Obsolescence
  - Counterfeit parts
- Assess material scale-up M&Q risks for AoA preferred solution.
- Conduct an initial risk assessment of potential supply chain capability and capacity.
  - Include material risks for delivery times, manpower, quality, fragility, availability, etc., for the entire supply chain
  - Evaluate the materials management processes for gaps throughout the entire supply chain
- Assess material capability to meet the threshold and objective requirements.
- Assess military vulnerability or gaps that could result from the lack of reasonable material alternatives.
- Identify all M&Q special handling risks including:
  - Potential regulatory requirements
    - Hazardous materials and handling procedures
    - Security requirements (physical, cyber, etc.)
    - Transportation, storage, and shelf life
    - GFP, GFE (tooling, test equipment, ranges, chambers, etc.)
    - Disposal
- Identify material risks from counterfeit electronic parts and materials (e.g., end items, components, parts, or assemblies).
- Conduct a comprehensive cost/schedule/technical risk assessment in support of the ASR and initiate mitigation plans for each risk.
- Material scale-up M&Q risks for AoA preferred solution have been assessed and documented.
- An initial risk assessment of potential supply chain capability and capacity has been conducted and documents:
  - Material risks for delivery times, manpower, quality, availability, etc., for the entire supply chain
  - The material management processes for gaps throughout the entire supply chain
- Material capability and risks to meeting the threshold and objective requirements have been assessed and documented.
- Military vulnerability or gaps that could result from the lack of reasonable material alternatives have been assessed and documented.
- All M&Q special handling risks have been identified and documented, including potential regulatory requirements for

  - Hazardous materials and handling procedures
  - Security (physical, cyber, etc.)
  - Transportation, storage, and shelf life
  - GFP, GFE (tooling, test equipment, ranges, chambers, etc.)
  - Disposal
- Material risks from counterfeit electronic parts and materials (e.g., end items, components, parts, or assemblies) have been identified and documented.
- A comprehensive cost/schedule/technical risk assessment has been conducted in support of the ASR, and mitigation plans for each risk have been documented and provided to the decision maker.

Tools

- Checklist, Section Preservation (Handling, Storage, Packaging and Delivery)
- Design of Experiments Analysis
- Diminishing Manufacturing Sources and Material Shortages (DMSMS) Product Life Cycle Assessment—consult Defense Logistics Agency (DLA)
- Industrial Base Assessment Survey Form (DCMA Industrial Analysis Center)
- Interactive MRL Users Guide (Checklist), Materials Management thread
- Long Lead Times Material Report, DI-PSSS-82201
- Manufacturing Maturation Plan
- Market Research Reporting Template
- Supply Chain Management Risk Assessment Checklist
- TRL Assessment Questionnaire

Resources

- AS9145 Advanced Product Quality Plan (APQP)/Production Part Approval Process (PPAP)
- DMSMS Guidebook, SD-22
- DoD 4140.01, DoD Supply Chain Materiel Management Regulation
- DoD 5000.60H, Assessing Defense Industrial Capabilities
- DoD Market Research Guide
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- IEEE 15288.2, Standard for Technical Reviews and Audits on Defense Programs
- DoD Systems Engineering Guidebook
- Manufacturing Readiness Level (MRL) Deskbook
- Technology Readiness Assessment Guidebook

H. PROCESS CAPABILITY AND CONTROL

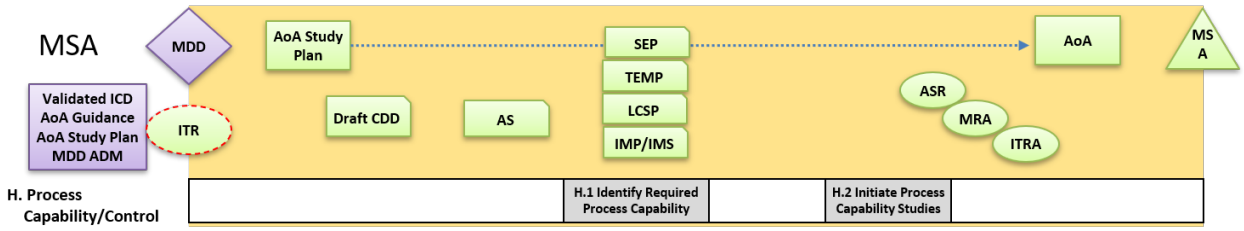


Figure 2-9. Process Capability and Control Manufacturing and Quality Activities

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.

A process is "in control" if it is stable. A stable process does not mean that the contractor is producing only good product, but it means the process is predictable. A capable process is one that is fully capable of producing product within the specification limits. Process capability is usually measured using either a Capability Index (Cp) or a Capability Index centered (Cpk). Process performance is usually measured using either Performance Index (Pp) or a Performance Index centered (Ppk). Contractors should be working to get their processes to be both capable and in control.

The next task is to initiate studies to identify any gaps in M&Q processes. These gaps should include gap in capabilities as a risk and an impact to yields, with time and resources planned to mature these critical capabilities. Manufacturing yields and rates can play a major role in manufacturing cost as they will drive decisions on what processes to use, types of tooling required, quantities to be produced, etc. Studies need to include an analysis of the impact of process capability on KCs, and therefore performance, reliability, and affordability.

Many new technologies and emerging manufacturing processes identified during the MSA phase carry risks. Failure to demonstrate materials and processes may increase the risk that the material or process may not meet the weapon system design, performance, and affordability requirements. When new or high-risk manufacturing capabilities are planned in the Acquisition Strategy, the strategy should specify how this new capability will be demonstrated in a manufacturing environment relevant for the TMRR phase.

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 Identify Required Process Capability

M&Q managers need to be working continuously on production processes to identify where variation has the most impact, reduce variation, and make the process robust to design requirements. Process control studies and other tools can be used to identify upfront and early what the design requirements are, where processes must be made to be capable, and what that capability metric or target should be.

Process capability and control is a requirement of both ISO 9001 and AS9100 quality standards and requires a process control plan, which describes the actions and activities that will demonstrate process capabilities. Process capability clarifies the inherent process variability of a given characteristic or process. Typical process capability measures include Cp/Cpk and Pp/Ppk. A capability study is generally used to assess the ability of a process to meet a drawing or specification requirement. Statistical process control tools are used to determine if a process is in a state of statistical control (predictable). Typical process control tools include the X bar and R charts, among others. For each concept being considered, a determination of the manufacturing processes capability will be completed. 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.

Advances in digital engineering including 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 to 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.

M&Q process and control should be a part of any development program and should include an assessment of current required capabilities and potential future capabilities. The first task is to identify the process capability required by the preferred concepts for the AoA. This may be accomplished by an analysis of the preferred concept for process capabilities against industry M&Q standards using manufacturing modeling and simulations.

Note: There is no one standard process capability measurement for all process and product characteristics; however, key and critical characteristics should receive the most focus on development of a standard and on the management of those characteristics during the life of the product.

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.

Manufacturing and Quality Tasks

- Identify anticipated critical manufacturing processes when possible.
- Analyze the current state of process capability for critical M&Q processes for the preferred concept, identify potential gaps, and include the information in the Acquisition Strategy and the SEP.
- Identify and analyze the state-of-the-art manufacturing and production modeling and simulation approaches that support the preferred concept and include the information in the Acquisition Strategy and the SEP.
- Identify M&Q process capability goals and risks for the preferred concept from the manufacturing feasibility assessment, including risks to:
    - Critical M&Q processes
    - Potential cost and schedule impacts
    - Producibility
    - Special tooling
    - Testing and qualification
    - Environmental
    - Management (data, security, etc.)

Tools

- ISO9001 Checklist
- AS9100 Checklist
- AS6500 Checklist
- Interactive MRL Users Guide (Checklist), Process Capability and Control Thread
- Manufacturing Maturation Plan
- Plant modeling and simulation tools (FlexSim, SimFactory, etc.)
- Process modeling tools (Siemens PLM, Delmia, etc.)
- Solid modeling and analysis software programs (e.g., NX, CATIA, Pro-Engineer, Nastran add-ins, etc.)

Resources

- MIL-HDBK-896, Manufacturing Management Program Guide
- ISO 9001 Quality Management Systems – Requirements
- AS9100 Quality Management System

- AS6500 Manufacturing Management Program
- AS9103 Variation Management of Key Characteristics
- AS9145 Advanced Product Quality Plan (APQP)/Production Part Approval Process (PPAP)
- DoD Systems Engineering Guidebook
- Manufacturing Simulation Applications
- Modeling and Simulation Guidance for the Acquisition Workforce
- Manufacturing Readiness Level (MRL) Deskbook

H.2 Initiate Process Capability Studies

A process capability study is a measure of the inherent process variability of a given characteristic. Process capability studies are conducted to assess the ability of a process to meet the contractual specification. Typically, a process capability study follows these steps:

1. Select a candidate for the study.
2. Define the process.
3. Procure resources for the study.
4. Evaluate the measurement system.
5. Prepare a control plan.
6. Select a method for the analysis.
7. Gather and analyze the data.
8. Track down and remove special causes.

Manufacturing and Quality Tasks

- Initiate M&Q process capability studies based on the data from the preferred concept.
    - If no data are available, conduct necessary studies to generate required data
    - Alternatively, use process capabilities of current or similar products to generate the required data
- Analyze the impact of M&Q process capability on KCs that impact performance, reliability, and affordability.
- Analyze M&Q studies of existing processes to determine gaps in manufacturing capabilities as a risk and an impact on yields and rates.
    - Use modeling and simulation tools to perform an analysis of process capability to support yield and rate estimates, before actual manufacturing begins
    - Determine the need for new processes to meet requirements
    - Include time and resources required to mature these critical manufacturing processes
    - Incorporate sources of variations and plans to address the variation
    - Include additional data from existing, proposed, or similar processes from other projects and programs

- Based on analyses, update yield and rate estimates for the Acquisition Strategy and the SEP.

Tools

- ISO 9001 Checklist
- AS9100 Checklist
- AS6500 Checklist
- Cause and Effect Diagram
- Cost of Quality Estimates
- First Pass Yield Estimates Worksheet
- Histograms
- Interactive MRL Users Guide (Checklist), Process Capability and Control Thread
- Manufacturing Maturation Plan
- Pareto Analysis
- Process Capability Studies (Cp and Cpk assessment)
- Statistical Process Control Charts
- Producibility Assessment Worksheet (PAW)
- Six Sigma Worksheet

Resources

- MIL-HDBK-896, Manufacturing Management Program Guide
- ISO 9001 Quality management systems – Requirements
- AS9100 Quality Management System
- AS6500 Manufacturing Management Program
- AS9103 Variation Management of Key Characteristics
- DoD Systems Engineering Guidebook
- AS9145, Advanced Product Quality Plan (APQP)/Production Part Approval Process (PPAP)
- Defense Management Guide for Program Managers, Chapter 7.6.2 Determine Process Capability
- Defense Manufacturing Guide for Program Managers, Chapter 5.5.4 Seven Quality Control Tools
- DoD Continuous Process Improvement Transformation Guide
- DoD-Wide Continuous Process Improvement (CPI/Lean and Six Sigma) Program
- NAVSO P-3687, Producibility Systems Guidelines

I. QUALITY MANAGEMENT

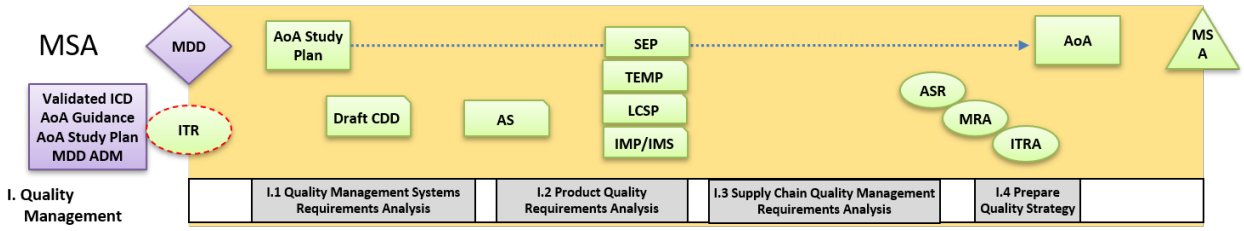


Figure 2-10. Quality Management Manufacturing and Quality Activities

Introduction

Quality management is the set of coordinated activities to direct and control an organization, including the supply chain, regarding quality policy, quality objectives, quality planning, quality assurance, and quality improvement. These activities are performed as part of the QMS, which is that part of the organization's management system that focuses on the results, in relation to the quality objectives, to satisfy the needs, expectations, and requirements. In turn, quality assurance is that part of quality management focused on providing confidence that quality requirements will be fulfilled.

A QMS compliant with industry best practices, ISO 9001 or AS9100, is the foundation for the contractor to deliver a system that meets requirements. The program must evaluate the contractor's QMS to ensure implementation of industry best practices. The program and the contractor should develop a joint government/contractor M&Q plan that specifies:

- Roles, responsibilities, and quality processes
- Tasks, schedules, and outcomes
- Standards, requirements, and metrics
- Joint risk, issue, and opportunity processes and procedures
- Quality tools such as Continuous Process Improvement (CPI)

There are many opportunities during the MSA phase of the acquisition process for M&Q personnel to make a positive impact on program execution. In addition to identifying the intended QMS, M&Q managers need to identify product quality and supply chain quality considerations as a major part of a development program. Quality considerations should be an integral part of the AoA. Therefore, quality requirements, goals, objectives, responsibilities, and authority should be defined and included in quality strategies and plans. The initial Acquisition Strategy will include the approach to quality, quality management, and quality assurance.

This thread (Quality Management) requires an analysis of the risk and management efforts to control quality and foster continuous quality improvement; it 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 System Requirements Analysis

Quality assurance managers use FAR Part 46 to down-select the appropriate contractual quality requirements. Most DoD programs will require a higher level quality clause. Often contractors will note in their proposal that they will follow a QMS, and it is up to the procuring activity (via DCMA or the ESA) to assess the contractor in its implementation. Best practice has contractors operating to either ISO 9001 Quality Management System or AS9100 Quality Management System. A typical QMS will address leadership and policy, planning, organizational support, operations, performance measurement and evaluation, and continuous improvement.

M&Q personnel should identify the potential requirements for a 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 contract clauses to include:

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

Manufacturing and Quality Tasks

- Analyze the preferred concepts for quality management system requirements, and document them in the AoA and SEP.
    - The quality management requirements should at a minimum include:
        - Quality management system requirements
        - Management responsibility requirements
        - Resource management requirements
        - Product realization requirements (e.g., risk management, design, and development, purchasing, etc.)
        - Measurement, analysis, and improvement requirements
    - Alternatively, the quality management requirements can be met by adherence to established standards (e.g., AS9100, ISO 9001, etc.)
        - Include M&Q management lessons learned
        - Include industry best practices

- Review, update, and analyze quality management metrics for the preferred concept from the AoA Study Guidance.
    - Verify that the frequency the metrics are reviewed is commensurate with quality risks
- Specify the quality management requirements to be met by the contractor or government entity as appropriate.
    - Provide requirements for quality management responsibilities and personnel within the IPT
    - Provide quality management requirements and metrics
- Contact DCMA for input on QMS evaluation of potential contractor and suppliers for the preferred concept.

Tools

- ISO 9001 Quality Management Systems – Requirements
- ISO 9001, Quality Audit Checklist
- AS9100, Quality Audit Checklist
- Assessment of Manufacturing Risk and Readiness, DI-SESS-81974
- Critical to Customer Assessment
- Critical to Quality Tree
- Interactive MRL Users Guide (Checklist), Quality Management thread
- Manufacturing Maturation Plan
- Quality Management Plan (Sample)
- Quality Management System (QMS), DI-MGMT-82184

Resources

- AFMC Instruction 63-145, Manufacturing and Quality (Draft)
- AS9100, Quality Management System – Aerospace
    - AS9102 First Article Inspection
    - AS9103 Variation Management of Key Characteristics
    - AS9133 Qualification Procedure for Aerospace Parts
    - AS9134 Supply Chain Management Guidelines
    - AS9136 Root Cause Analysis and Problem Solving
    - AS9138 Statistical Process Acceptance
- DoD Directive 5105.84, Director of Cost Assessment and Program Evaluation
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.85, Major Capability Acquisition
- ISO 9001, Quality Management Systems
- Manufacturing Readiness Level (MRL) Deskbook

I.2 Product Quality Requirements Analysis

Quality managers must be able to distinguish between a quality assurance (process) and quality control (product). Quality assurance is concerned with how a product is made, and quality control is concerned with how a product turned out. Thus, while the two are certainly interconnected, quality managers need to plan for how they are going to establish product quality requirements in the TMRR phase as the program designs and develops prototypes.

M&Q personnel need to identify the potential product quality requirements of a 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 identifies 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

M&Q personnel need to identify and manage product quality requirements:

- Analyze product quality requirements for the AoA preferred concept:
    - Identify product acceptance methods and determine sampling plans as appropriate
    - Incorporate new quality technologies and process state of the art into product quality requirements
    - Analyze the need for unique product quality requirements (i.e., specific product characteristics)
    - Analyze product quality for metrics and the frequency that the metrics should be reviewed, commensurate with M&Q risks
- Analyze potential solutions and processes that could address product quality needs:
    - Analyze identified quality technologies (i.e., metrology technologies) that could improve product quality
    - Analyze potential solutions or processes to improve the product quality of low-yield processes and components
- Contact DCMA personnel for inputs on potential contractor and supplier quality performance against quality requirements for similar products or processes.
- 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 prior to use and are traceable to national standards.

Tools

- AS9100 Quality Audit Checklist

- Assessment of Manufacturing Risk and Readiness, DI-SESS-81974
- Critical to Customer Assessment
- Critical to Quality Tree
- Interactive MRL Users Guide (Checklist) for the Quality Management thread
- ISO 9001, Quality Audit Checklist
- Lot Acceptance Testing Calculator
- Manufacturing Maturation Plan
- Quality Assurance Provisions, DI-SESS-80789A
- Quality Management Plan Samples
- Quality Program Plan, DI-QCIC-81722
- Variability Reduction Plan

Resources

- AS9100, Quality Management System – Aerospace
  - AS9103 Variation Management of Key Characteristics
  - AS9133 Qualification Procedure for Aerospace Parts
  - AS9134 Supply Chain Management Guidelines
  - AS9136 Root Cause Analysis and Problem Solving
  - AS9138 Statistical Process Acceptance
- 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
- Manufacturing Readiness Level (MRL) Deskbook
- 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 Guide

I.3 Supply Chain Quality Management Requirements Analysis

Major programs require the engagement of the entire supply chain to be successful. Program planning to include the Quality Management Plan, must be delegated down through the supply chain and evaluated on a regular basis for compliance and adequacy. AS9100 and AS9133 define principles that should be called out when qualifying products.

Manufacturing and Quality Tasks

- Analyze the impact of quality technologies and process state-of-the-art for impacts on the quality management of the supply chain.
- Analyze the supply chain quality management requirements for the preferred concept.
    - Analyze the need for focused supplier quality management requirements (e.g., a supplier Quality Assurance Plan)
    - Analyze the need for a stand-alone supplier Quality Management Plan for the supply chain
    - The quality management requirements for the supply chain should at a minimum include:
        - Quality management system requirements
        - Management responsibility requirements
        - Resource management requirements
        - Product realization requirements (e.g., risk management, design, and development, purchasing, etc.)
        - First Article Inspection if required
        - Measurement, analysis, and improvement requirements
    - Quality management requirements for the supply chain can be met by adherence to established quality standards (e.g., AS9100, ISO 9001, etc.)
        - Include M&Q management lessons learned
        - Include industry best practices
    - Analyze and update supply chain quality management metrics for the preferred concept.
- Establish supply chain quality management metrics for each of the concepts being considered for incoming quality inspection, including the identification of acceptable quality levels (AQLs).
    - Determine the frequency that the metrics should be reviewed, commensurate with M&Q risks
- Analyze potential solutions, tools, and techniques that could address quality management requirements of the supply chain.
    - Incorporate quality technologies (i.e., metrology technologies) that could improve the supply chain quality programs
    - Incorporate potential solutions (e.g., materials, machines, training, etc.) to improve low-yield processes and components and lower variability to meet supply chain quality requirements
- Contact DCMA personnel for input on the analysis of potential supply chain quality management systems.

- Ensure quality and manufacturing requirements are included in contracts of proposed suppliers and in appropriate agreements with other agencies, e.g., the DCMA.

Tools

- AS9100, Quality Audit Checklist
- AS9133, Qualification Procedure Checklist
- Assessment of Manufacturing Risk and Readiness, DI-SESS-81974
- Critical to Customer Assessment
- Critical to Quality Tree
- Interactive MRL Users Guide (Checklist), Quality Management thread
- ISO 9001, Quality Audit Checklist
- Manufacturing Maturation Plan
- Quality Management Plan
- Supplier Quality Questionnaire
- Variability Reduction Plan

Resources

- AS9100, Quality Management System – Aerospace
    - AS9102 First Article Inspection
    - AS9103 Variation Management of Key Characteristics
    - AS9133 Qualification Procedure for Aerospace Parts
    - AS9134 Supply Chain Management Guidelines
    - AS9136 Root Cause Analysis and Problem Solving
    - AS9138 Statistical Process Acceptance
- DoDI 5000.02, Operation of the Adaptive Acquisition Framework
- DoDI 5000.85, Major Capability Acquisition
- DoDI 5000.88, Engineering of Defense Systems
- Early Manufacturing and Quality Engineering Guide
- ISO 9001 Quality Management Systems
- MIL-STD-1535B Supplier QA
- Manufacturing Readiness Level (MRL) Deskbook

I.4 Prepare Quality Strategy

M&Q managers support the development and updates to the Acquisition Strategy by providing their inputs into the Systems Engineering Plan (SEP). Quality Assurance managers can look to the FAR Part 46 and 52 to understand potential contractual QA requirements and to industry best practices such as and AS9100 for implementation requirements. Manufacturing managers can look to industry best

practices such as AS6500 to help them identify manufacturing requirements. Planning is the foundation for implementation activities and to the success of a program.

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

Quality assurance and control requirements come from the FAR/DFAR. General industry guidance comes from ISO 9001 and AS9100 quality standards, which require that organizations establish a formal quality policy and submit documentation on internal processes, procedures, and standards. The following are mandatory requirements of ISO 9001:

- 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

Note: AS9100 standards includes the above.

Manufacturing and Quality Tasks

- Draft a quality management strategy based on the results of the analyses of quality management, product quality, and supply chain quality management requirements, which specifies:
    - Quality management requirements that address:
        - Management responsibility requirements
        - Quality management system requirements
        - Resource management requirements
        - Product realization requirements (e.g., risk management, design, and development, purchasing, etc.)
        - Risks, issues, and opportunities
        - Measurement, analysis, and improvement requirements
    - Alternatively, the quality management requirements met by adherence to established standards (e.g., AS9100, ISO 9001, etc.)
    - Product quality requirements that incorporate new quality technologies and process state of the art, the need for unique product quality requirements, and metrics and the review frequency
    - Supply chain quality management requirements that include:
        - The need for focused supplier quality management requirements
        - A supplier Quality Management Plan
        - Potential standards (e.g., AS9100, ISO 9001, etc.)
        - Metrics
        - Potential solutions, tools, and techniques
    - Planned use of government-furnished quality and testing equipment and assets
    - Establishing appropriate agreements, delegations, and contracts with other agencies, e.g., DCMA
        - Solicit inputs to the quality strategy from on-site government personnel
- Provide the Quality Management Strategy with appropriate language and references for inclusion in the Acquisition Strategy and the SEP.
- Draft an initial program Quality Management Plan for incorporation into the SEP that includes details from the analyses.

Tools

- AS9100 Quality Audit Checklist
- AS9137 Advanced Quality Assurance Procedure (AQAP) Checklist
- AS9145 Requirements for Advanced Product Quality Planning (APQP) and Production Part Approval Process (PPAP) Checklist
- Critical to Customer Assessment
- Critical to Quality Tree
- Interactive MRL Users Guide (Checklist), Quality Management thread
- Manufacturing Maturation Plan
- Quality Assurance Program Plan, DI-QCIC-81794
- Quality Audit Checklist
- Quality Management Plan
- Supplier Quality Questionnaire

Resources

- AS9100, Quality Management System – Aerospace
  - AS9102 First Article Inspection
  - AS9103 Variation Management of Key Characteristics
  - AS9133 Qualification Procedure for Aerospace Parts
  - AS9134 Supply Chain Management Guidelines
  - AS9136 Root Cause Analysis and Problem Solving
  - AS9138 Statistical Process Acceptance
  - AS9137 Advanced Quality Assurance Procedure (AQAP)
  - AS9145 Requirements for Advanced Product Quality Planning (APQP) and Production Part Approval Process (PPAP)
- 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

J. MANUFACTURING WORKFORCE

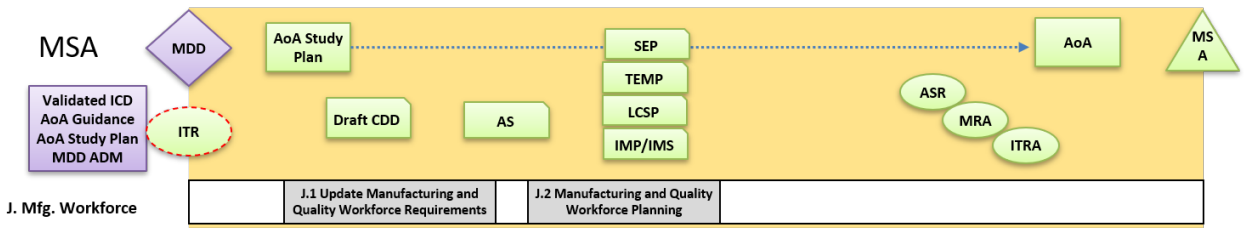


Figure 2-11. Manufacturing Workforce Manufacturing and Quality Activities

Introduction

During the MSA phase, it is essential to update the M&Q workforce requirements and begin planning for future phases. Although highly skilled and trained engineers and artisans may be the workforce used in the laboratory environment, they will not be the workforce used for production. Identification, planning for, and training of the required production workers with required skill sets must begin early. In addition to the production workforce, having a technical staff with education and experience in the relevant areas of engineering and management is key to program success.

As part of the evaluations for the AoA, the processes and planning used by the preferred concepts to determine workforce requirements need to be examined. The preferred concept M&Q processes should be evaluated, as well as a forecast of phase-by-phase requirements for M&Q skills and training.

A staffing plan should be initiated early and include personnel skills, experience and education levels, training, ramp-up, and attrition as part of identifying M&Q skill sets and production workforce requirements. Planning should address risks resulting from shortages of qualified personnel, processes that require certifications, and volatility.

This thread (Workforce) requires the assessment of the required skills and availability in required numbers of personnel to support the manufacturing effort and will focus on:

- Workforce Requirements Identification
- Workforce Planning
- Workforce Risks and Availability

J.1 Update Manufacturing and Quality Workforce Requirements

Manufacturing workforce is one of the 5Ms (manpower, machines, materials, methods, measurement) that needs to be addressed on an ongoing basis, especially early in the MSA phase as alternative solutions are identified, thus uncovering new manufacturing processes and workforce skills. Two major focus areas are:

- Workforce skills availability (are there enough people?)
- Workforce skills capability (do they have the right skills?)

Manufacturing and Quality Tasks

- Evaluate each AoA concept for appropriate industrial workforce standards.
- Evaluate the workforce processes and planning used to determine personnel skills, experience and education levels, training, ramp-up, and attrition for the preferred concepts.
- Evaluate M&Q processes for gaps in workforce skill sets, training, and manpower requirements for each AoA concept to include:
    - Workforce requirements (technical and operational)

  - Processes that require certifications (i.e., special skills)
  - Sources and shortages of qualified personnel based on processes, education, location, precision requirements, etc.
- Update requirements by phase for M&Q skills and training for preferred materiel solutions for the AoA.
  - Identify additional or new skills required
    - Include associated training requirements
  - Determine staffing requirements for skills, experience, certification levels, education levels, ramp-up, and attrition
- Include M&Q workforce requirements in the Acquisition Strategy and the SEP as appropriate.

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), Workforce thread
- Learning Curve Calculator (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/MRPII)

Resources

- Defense Manufacturing Guide for Program Managers (DAU website, various chapters)
- Manufacturing Resource Planning (MRP II)
- Manufacturing Readiness Level (MRL) Deskbook

J.2 Manufacturing and Quality Workforce Planning

As the AoA is completed and potential solutions emerge, workforce planning should be assessed and planned for. M&Q managers need to review and update workforce plans. If there are new skills, then the plan should include training and certification if required.

Manufacturing and Quality Tasks

- Initiate M&Q planning, as an input to program management planning, to address M&Q skill sets, production workforce availability requirements, and risks for the TMRR phase.
- Planning should address:
    - Mitigation needs for project ramp-up and workforce attrition
    - Mitigation of critical shortages of qualified personnel based on processes, location, precision requirements, etc.
    - Training and/or certification requirements (e.g., certified welders, skilled machine programmers or operators, etc.)
    - Plans for acquisition and training of new personnel
    - Potential impacts from labor relations, surges, competition, etc.
    - Volatility of demand and impact on workforce requirements
    - Impacts on workforce ability to address processing, testing, and acceptance of new materials and technologies
    - Impacts of regulatory requirements (e.g., special handling, security, HAZMAT, environmental needs, storage requirements, etc.) on the workforce
    - Incorporation of appropriate workforce lessons learned for processes, tools, and techniques for manufacturing workforce strategy
    - Development of M&Q metrics to measure performance
- Document workforce planning as part of the SEP and the Acquisition Strategy.

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), 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/MRPII)

Resources

- Defense Manufacturing Management Guide for Program Managers (various chapters)
- ESOH in Acquisition Guide
- Manufacturing Resource Planning (MRP II)
- Manufacturing Readiness Level (MRL) Deskbook

K. FACILITIES

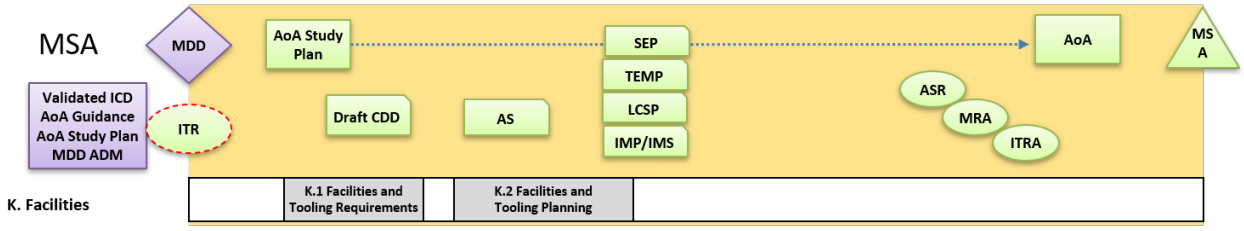


Figure 2-12. Facilities Manufacturing and Quality Activities

Introduction

During the MSA phase, it is essential for the M&Q representatives to update the facility and tooling requirements for the preferred concepts before the AoA and to initiate both a facilities plan and a tooling plan for entry into TMRR and future phases. Based on the preferred concepts, new facilities and tools may be required for new materials, new technologies, and new processes. The decision-making process will also be impacted by production rates, quantities, and capacities by the types of tooling and facilities required. Therefore, facilities and tooling planning should be integral to planning for development, funding, and scheduling.

M&Q planning efforts also define and design the special tooling and test equipment required to execute the effort. Special tooling and test equipment required for a program can be high cost and have a long lead-time to develop and procure. The planning for tooling and test equipment should be initiated during the MSA phase. The planning should include the type of tooling and test equipment to be used, investments, the transition from limited life to rate tools, the need for production and test equipment, and tooling sustainment.

This thread (Facilities) requires an analysis of the capabilities and capacity (prime, subcontractor, supplier, vendor, and maintenance repair) that are key risks in manufacturing. This thread will focus on:

- Facility and Tooling Requirements
- Facility and Tool Planning

K.1 Facilities and Tooling Requirements

Manufacturing facilities and tooling assessment includes an analysis if the capabilities and capacity of the production facilities to develop and build the prototype(s) and prepare for EMD to identify future facility and tooling requirements. Tooling assessment includes special tooling (ST), special test equipment (STE), and special inspection equipment (SIE). Facilities and tooling assessments should include facilities at the prime, subcontractor, supplier, vendor, lab, maintenance, or repair activities.

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 to use currently existing facilities, acquire new facilities, request government-furnished facilities (must be requested in the proposal), or subcontract a portion of the effort.

Manufacturing and Quality Tasks

- Update the M&Q facilities and capital equipment requirements for the AoA preferred concepts.
- Analyze the M&Q quantitative and qualitative facility demands of the preferred concepts for:
    - Availability, design, rate, and capacity capabilities of the facilities under consideration (existing, new, or redeveloped)
    - Types of processes required and the resulting impacts on facilities (e.g., specialized fixtures, test chambers, laboratories, clean rooms, waste storage and disposal, etc.)
    - Unique or special facility requirements for transportation, handling, and storage equipment being manufactured
- Update new M&Q capital equipment, tooling, and Special Test or Inspection Equipment (STE/SIE) requirements for new technology and materials for preferred concepts.
- Update the M&Q assessments of:
    - Tooling requirements for capability to produce at planned production rates and target unit costs
    - Needs for soft tooling versus hard tooling
    - Supplier and sub-tier capabilities, requirements, and investment incentives
    - STE/SIE requirements and capabilities

- Assess M&Q requirements for unique or special transportation, handling, and storage equipment to be manufactured for preferred concepts.
- Update the M&Q funding estimates required for capital equipment, tooling, and test equipment for preferred concepts.

Tools

- Bottleneck Analysis (Theory of Constraints)
- Checklist Section Preservation (Handling, Storage, Packaging, and Delivery)
- Critical Chain Project Management
- Interactive MRL Users Guide (Checklist), Facilities thread
- Manufacturing Maturation Plan
- Manufacturing Resource Planning (MRPII)
- Plant Design and Facility Layout Software Evaluation Tools

Resources

- Defense Manufacturing Management Guide for Program Managers, Chapter 6, Manufacturing Planning
- ISO 9001, Quality Management System
- Manufacturing Resource Planning (MRP II)
- Manufacturing Readiness Level (MRL) Deskbook

K.2 Facilities and Tooling Planning

Once facilities and tooling assessment have been completed and the program has identified future facility and tooling requirements, the program office needs to start planning for the development of these future needs. Facilities and tooling requirements should be planned for at the prime, subcontractor, supplier, vendor, lab, maintenance, or repair activities.

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

The Facilities and Tooling Plans are subsets of the Manufacturing Strategy, which is in turn a subset of the overall Acquisition Strategy and the SEP.

Manufacturing and Quality Tasks

- Initiate a M&Q Facilities Plan that includes:

  - Requirements for M&Q facilities for development of technologies, prototypes, and subsequent production within required lead times (existing, new, or redeveloped)
  - Addressing the rate and capacity capability requirements on the facilities and needed enhancements for M&Q
  - Mitigation of impacts on facilities from the types of M&Q processes required (e.g., acquisition of specialized fixtures, construction of test chambers, upgrading laboratories and clean rooms, upgrading waste storage and disposal equipment)
  - Addressing unique or specialized M&Q facility requirements for transportation, handling, and storage equipment
  - New facilities to be constructed to mitigate M&Q gaps in current facilities
  - Requirements for M&Q investments and funding with associated schedules
  - Assessment of and mitigation of M&Q environmental and safety factors and impacts
  - Requirements for security of M&Q facilities (physical and cyber)
- Initiate an M&Q Tooling Plan that includes:
  - Tooling requirements to meet production rates, costs, quantities, and schedule
  - Tooling sources, funding, materials impacts, maintenance impacts, etc.
  - Analysis of requirements for soft and/or hard tooling
  - M&Q test equipment including STE, SIE, and GFE
- Derive M&Q funding estimates required for capital equipment, tooling, and test equipment for the preferred concept from the facilities and tooling planning.

Tools

- Bottleneck Analysis (Theory of Constraints)
- Critical Chain Project Management
- Interactive MRL Users Guide (Checklist), Facilities thread
- Manufacturing Maturation Plan
- Manufacturing Resource Planning (MRPII)
- Plant Design and Facility Layout Software Evaluation Tools

Resources

- Defense Manufacturing Management Guide for Program Managers, Chapter 6, Manufacturing Planning
- Manufacturing Resource Planning (MRP II)
- Manufacturing Readiness Level (MRL) Deskbook

L. MANUFACTURING MANAGEMENT AND CONTROL

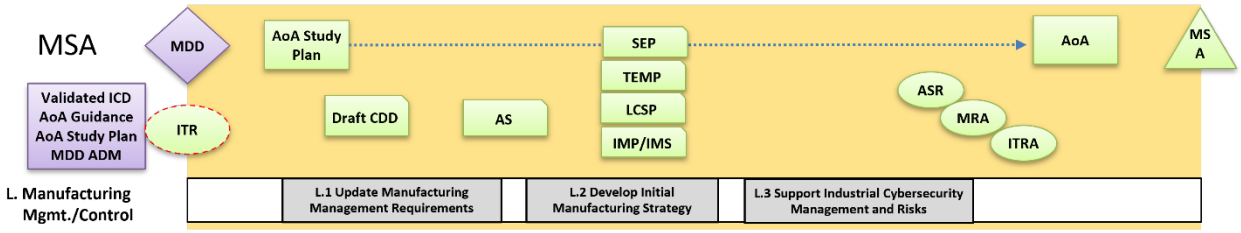


Figure 2-13. Manufacturing Management and Control Manufacturing and Quality Activities

Introduction

Programs with any manufacturing aspects will require a manufacturing management system. Refer to MIL-HDBK-896, Manufacturing Management Program Guide for best practices and definition. The timely development, production, modification, fielding, and sustainment of affordable products by managing manufacturing risks and issues throughout the program life cycle will be met only 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.

Beginning in MSA, after the preferred concept is determined, the PM and program office develop the Manufacturing Strategy and should begin detailed planning for manufacturing. Before the Materiel Development Decision, the activities managing the concept (or the program office) initiated planning for manufacturing management and control. In this phase, manufacturing management planning should be updated for the AoA. The initial Manufacturing Strategy developed during the MSA phase is a subset of the overall Acquisition Strategy and the SEP. The Manufacturing Strategy should address all aspects of manufacturing management and control from design and materials to processes, workforce, and facilities, to transition to TMRR and subsequent phases. For example, competition considerations are a major contributor to reducing weapon system cost. In addition, if a program will be dual sourced, early planning must consider the strategy required to ensure availability of data and data rights for dual sourcing. New manufacturing technologies may require specific plans for development, proofing, and transition to production. Production rates and quantities can also play a major role in driving manufacturing cost as they influence decisions on processes, tooling, make-buy, etc.

The purpose of manufacturing planning is to identify requirements and resources, to manage risk, issues, and opportunities, and to integrate manufacturing processes into a structure that provides the capability to achieve production objectives. This planning should be updated during the subsequent acquisition phases. Manufacturing planning should include:

- Manufacturing management responsibilities as an integral part of the IPT structure with assignment to specific program office personnel.
- Manufacturing metrics for the program with a specified review cycle of metrics commensurate with risks.

- Manufacturing assessments to identify and quantify risks in support of program milestone decision points and major design reviews.
- Manufacturing requirements and metrics for agreements, delegations, and contracts with other agencies (e.g., DCMA).

The initial Manufacturing Strategy, as an integral part of the Acquisition Strategy and SEP, will guide the future development program and help minimize risk.

This thread (Manufacturing Management and Control) focuses on early manufacturing management requirements and strategy, which will be documented in a manufacturing management plans and programs during later program phases.

L.1 Update Manufacturing Management Requirements

Manufacturing planning is about understanding everything it takes to produce the items required by the contract, on time, on budget, and with the right performance features. It includes considerations of all the "5Ms" (manpower, machines, materials, methods, and measurements), at the prime contractor and throughout the supply chain. During the MSA phase the program office has identified several alternative solutions and M&Q managers need to understand the M&Q impacts of these potential solutions.

Manufacturing and Quality Tasks

- Ensure each AoA preferred concept is analyzed for manufacturing management requirements (to be incorporated into the RFP, per Section B.1):
    - The manufacturing management requirements can be met by adherence to established standards (i.e., AS6500)
    - Alternatively, manufacturing management requirements should at a minimum include:
        - Manufacturing management system requirements
        - Design analysis for manufacturing requirements
        - Manufacturing risk identification requirements
        - Manufacturing planning requirements (e.g., supply chain, materials, cost, workforce)
        - Manufacturing operations management requirements
    - Analyze the impacts of technology and process state of the art on manufacturing management
    - Request DCMA inputs on manufacturing management system evaluations of potential contractors and suppliers for the preferred concept(s).
    - Analyze relevant manufacturing management lessons learned and best practices among programs and across centers

- Review, update, and analyze manufacturing management metrics for the preferred concept from the AoA Study Guidance.
    - Verify the frequency that the metrics are reviewed is commensurate with manufacturing risks
- Specify the manufacturing management requirements to be met by the contractor (in the RFP) or government entity (in the SEP) as appropriate.
    - Provide requirements for manufacturing management responsibilities and personnel within the IPT
    - Provide manufacturing management requirements and metrics
    - Metrics

Tools

- AS6500 Assessment
- Bill of Material Assessment
- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
- Interactive MRL Users Guide (Checklist), Manufacturing Management and Control Thread
- Line of Balance Assessment
- Make/Buy Decisions
- Manufacturing Maturation Plan
- Manufacturing Resource Planning (MRPII) Assessment
- Materials Requirements Planning (MRP) Assessment
- Systems Engineering Management Plan, DI-SESS-81785A
    - Manufacturing Plan Inputs
    - Manufacturing Plan, DI-MGMT-81889A
    - Quality Plan Inputs
    - Quality Assurance Program Plan, DI-QCIC-81794
- Systems Engineering Plan (SEP)
- Technology Readiness Assessment
- Work Breakdown Structure

Resources

- AFI 63-145, Manufacturing and Quality Management
- AS6500, Manufacturing Management Program
- DoDI 5000.60H, Defense Industrial Capabilities Assessment
- Manufacturing Plan, DI-MGMT-81889A
- MIL-HDBK-896, Manufacturing Management Program Guide
- Systems Engineering Management Plan, DI-SESS-81785A

- Systems Engineering Plan (SEP) Outline
- Technology Readiness Assessment Guide (GAO-20-48G)

L.2 Develop Initial Manufacturing Strategy

A Manufacturing Strategy should be developed as part of the acquisition strategy and often includes considerations such as competition. Manufacturing voids, deficiencies, and dependencies on critical foreign source materials should also be addressed. The producibility of each system design concept should be evaluated to determine if the proposed system can be manufactured in compliance with the production cost and IB goals and thresholds. The AoA identified more than one alternative, and an M&Q Strategy needs to be developed to support the development and production of an affordable program.

Manufacturing and Quality Tasks

- Develop appropriate manufacturing management strategy inputs with references based on the best practices from AS6500 for inclusion in the Acquisition Strategy and the SEP.
- Develop the initial Manufacturing Strategy, as a subset of the Acquisition Strategy, and ensure the Manufacturing Strategy addresses M&Q considerations for:
    - IB Risk Mitigation
    - Enabling/critical technologies and constraints
    - ManTech projects
    - Design and producibility
    - Rate and schedule (includes processes, tooling, make/buy, etc.)
    - Key and critical characteristics
    - Cost, affordability, and budget
    - Materials management, sourcing, and risks (including counterfeit, obsolescence, etc.)
    - Supply chain management, characteristics, and constraints (e.g., sole, single, etc.)
    - Competitive development (e.g., dual source, co-production, etc.)
    - Processes and capability control
    - Workforce planning
    - Facilities, tooling, and test equipment (including GFE and assets)
    - Environmental, safety, and occupational health
    - Cybersecurity to include industrial security
- Ensure that the Manufacturing Strategy also addresses:
    - Manufacturing assessments to support program milestone decision points and major design reviews with appropriate exit criteria
    - Manufacturing metrics for the program with a specified review cycle of metrics commensurate with risks

- Ensure the Manufacturing Strategy (and Acquisition Strategy) includes establishing appropriate agreements, delegations, and contracts with other agencies, e.g., DCMA.
- Draft an initial program Manufacturing Management Plan that addresses each key area of the strategy for incorporation into the SEP that includes details from the analyses. In accordance with AS6500, the plan should address:
    - Manufacturing Management System
    - Design Analysis for Manufacturing
    - Manufacturing Risk Identification (including mitigation)
    - Manufacturing Planning
    - Manufacturing Operations Management

Tools

- Interactive MRL Users Guide (Checklist), Manufacturing Management and Control Thread
- Manufacturing Maturation Plan
- Systems Engineering Management Plan, DI-SESS-81785A
    - Manufacturing Plan, DI-MGMT-81889A
    - Quality Plan Inputs
    - Quality Assurance Program Plan, DI-QCIC-81794
- Systems Engineering Plan (SEP)

Resources

- AS6500, Manufacturing Management Program
- MIL-HDBK-896, Manufacturing Management Program Guide
- Systems Engineering Plan (SEP) Outline

L.3 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) to support the planning, execution, and synchronization of manufacturing processes across multiple functions, distributed plants, and suppliers.
- Enterprise resource planning (ERP) system to support functional management resources and control process performance within an enterprise.

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.
- Carry the contract clause into 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 Tasks

- Assess manufacturing operation cybersecurity capabilities and cyber vulnerabilities.
- Assess OT cybersecurity approach and requirements for the preferred materiel solution considered as part of AoA.
- Assess OT cybersecurity risks in the anticipated industrial base.
- Assess cybersecurity risks on measures for manufacturing processes of preferred materiel solutions.
- Assess potential supply chain OT cybersecurity and vulnerability risks.
- Minimize and mitigate cybersecurity risks on OT infrastructure.

Tools

- Cybersecurity and Acquisition Lifecycle Integration Tool (DAU)
- Cybersecurity Strategy ADDM Template
- 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

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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https://quicksearch.dla.mil/

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https://quicksearch.dla.mil/

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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

SF 1408 Preaward Survey of Prospective Contractor – Contractor Accounting System
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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.

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

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

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

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

Acquisition Logistician's Assessment Checklist (Army)
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiRsPqKmdXtAhULlKwKHZ_lBX4QFjAAegQIAxAC&url=https%3A%2F%2Fwww.dau.edu%2Fcop%2Flog%2FDAU%2520Sponsored%2520Documents%2FArmy%2520Acquisition%2520Logistician%2520s%2520Assessment%2520Checklist%2520V5.0.doc&usg=AOvVaw2wved2qLjb0ZMNM6cyiBzL

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Acquisition Strategy Template
https://www.dau.edu/tools/t/Acquisition-Strategy-Template-v2-4

Alternative System Review (ASR) Checklist
http://acqnotes.com/acqnote/tasks/alternative-systems-review-2

Analysis of Alternatives (AoA) Study Plan Template
https://www.dau.edu/tools/t/Analysis-or-Alternatives-(AoA)-Study-Plan-Template-v2-0

AoA Study Guidance Template
https://www.dau.edu/tools/t/Analysis-or-Alternatives-(AoA)-Study-Guidance-Template-v1-0

AoA Study Plan Template
https://www.dau.edu/tools/t/Analysis-or-Alternatives-(AoA)-Study-Plan-Template-v2-0

AS5553 Counterfeit Electronic Parts: Avoidance, Detection, Mitigation, and Disposition
Internet Search

AS6500 Manufacturing Management Program Checklist
Internet Search

AS9100 Quality Management System Checklist
Internet Search

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
Internet Search

AS9145 Requirements for Advanced Product Quality Planning (APQP) and Production Part Approval Process (PPAP) Checklist
Internet Search

Assembly Chart
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Award Fee Plan Checklist
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https://www.acq.osd.mil/dpap/ccap/cc/jcchb/Files/Topical/1Restricted/award.fee.oct08.pdf

Award Fee Sample Evaluation Criteria
https://www.acq.osd.mil/dpap/ccap/cc/jcchb/Files/Topical/1Restricted/award.fee.oct08.pdf

Benchmarking
Internet Search

Bill of Material Assessment
Internet Search

Bill of Material Data Item Description - DI-PSSS-81656B
https://www.dau.edu/cop/dmsms/Lists/Tools/DispForm.aspx?ID=48&ContentTypeId=0x0100AE321BA2819FFD499A441F9A8F574C1600A3866BA66DC4B546AF0E2614A20E809A

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

Cost Analysis Requirements Description (CARD) Template
https://www.dau.edu/tools/t/Cost-Analysis-Requirements-Description-(CARD)-Template-v1-3

Cost Estimating Technique – Analogy
http://acqnotes.com/acqnote/careerfields/cost-estimating-methods

Cost Estimating Technique – Parametric
http://acqnotes.com/acqnote/careerfields/cost-estimating-methods

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http://acqnotes.com/acqnote/careerfields/cost-estimating-methods

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https://www.secnav.navy.mil/rda/OneSource/Documents/CEVM/Tools%20and%20Examples/DOD%20Guides/BowmanInterpretiveGuide1.pdf

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)

DMCA Engineering Surveillance Plan
https://www.dcma.mil/Portals/31/Documents/Policy/DCMA-INST-207.pdf

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
https://www.dcma.mil/WBT/pass/

DCMA Pre-Award Survey (SF 1403)
https://www.gsa.gov/reference/forms?search_keyword=SF%201403

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

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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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