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**DEPARTMENT OF DEFENSE
HANDBOOK
MANUFACTURING AND QUALITY
PROGRAM**



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FOREWORD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense (DoD).
2. The purpose of this handbook is to promote the timely development, production, modification, fielding, and sustainment of affordable and capable DoD systems by addressing manufacturing and quality issues throughout the program acquisition cycle. It is based upon practices developed by a joint government/industry team as part of the manufacturing development initiative, which resulted in the publication of the [Manufacturing Development Guide \(MDG\)](#).
3. This handbook is intended to be used in conjunction with the Manufacturing Readiness Levels (MRLs), as defined by DoD policy and the Defense Acquisition University (DAU). Implementation of the practices within this document will help enable successful progression through MRLs to meet program needs and milestones. The detailed requirements of this handbook are in line with the MRL matrix and threads. For additional information on MRLs, refer to the following DAU webpage: <https://acc.dau.mil/CommunityBrowser.aspx?id=18231>.
4. This document serves as a concise collection of Manufacturing and Quality best practices. It may be cited in a Request for Proposal (Section L, Instructions to Offerors; Statement of Work; or Statement of Objectives) to clearly describe to the offerors what activities they are expected to undertake. This handbook is not intended to be a detailed, "how-to" guide. The Manufacturing Development Guide, maintained by HQ AFMC (ASC/ENSM), contains additional information and details that will be helpful in the application of this handbook.
5. Comments, suggestions, or questions on this document should be addressed to the Manufacturing and Quality Branch, ASC/ENSM, Wright Patterson AFB OH 45433-7501 or emailed to engineering.standards@wpafb.af.mil. Since contact information can change, you may want to verify the currency of this address by using the ASSIST Online database at <http://assist.daps.dla.mil/>.

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1. SCOPE

1.1 Purpose. This handbook is applicable to all phases of DoD system acquisition. It describes proven manufacturing and quality related practices to promote delivery of affordable and capable weapon systems.

2. APPLICABLE DOCUMENTS

2.1 General.

The documents listed below are not necessarily all of the documents referenced herein, but are those needed to understand the information provided by this handbook.

2.2 Government documents.

2.2.1 Specifications, standards, handbooks. None.

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein.

UNITED STATES AIR FORCE

Manufacturing Development Guide

(Copies of this document are available online at <http://engineering.wpafb.af.mil/mdg/mdg.asp> or from HQ AFMC (ASC/ENSM) Wright Patterson AFB, OH 45440.)

2.3 Non-Government standards and other publications. None.

3. DEFINITIONS

3.1 Affordability. The degree to which the life cycle cost of an acquisition program is in consonance with the long range investment plans of DoD.

3.2 Critical process. A process that creates or substantially affects a *key characteristic*.

3.3 Critical safety item (CSI). A part whose failure would cause loss of life, permanent disability or major injury, loss of a system, or significant equipment damage.

3.4 First article inspection. A complete and documented physical and functional inspection process to verify that prescribed production methods have produced an acceptable item as specified by engineering drawings, planning, purchase order, engineering specifications, and/or other applicable design documents.

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3.5 Key characteristic. A feature of a material, part, assembly, or system in which variation from nominal has a significant influence on fit, performance, reliability, or cost of the part.

3.6 Material review board. A board consisting of representatives of contractor departments necessary to review, evaluate, and determine or recommend disposition of nonconforming material.

3.7 Predictive indicator. A set of internal process metrics which can provide quality and delivery forecasts, be actionable, and be indicative of the overall “health” of the prime and suppliers’ performance.

3.8 Process capability index (Cpk). The ratio between the specified design limits and the manufacturing process limits. For additional information, refer to the [Manufacturing Development Guide](#).

3.9 Producibility. The attributes of a design that allow it to be produced economically and with consistently high quality.

3.10 Risk. A measure of the potential inability to achieve overall program objectives within defined cost, schedule, and technical constraints.

3.11 Risk management. The act or practice of dealing with risk. It includes planning for risk, assessing (identifying and analyzing) risk areas, developing risk-handling options, monitoring risks to determine how risks have changed, and documenting the overall risk management program.

3.12 Statistical process control. The use of statistical methods to measure, track, and reduce the variability of manufacturing processes and products.

3.13 Variability reduction. The use of statistical and continuous improvement tools to identify and eliminate process and product variation.

4. GENERAL

4.1 Manufacturing Readiness Assessments (MRAs). The contractor should conduct MRAs periodically and prior to major program milestones to assess progress towards meeting Manufacturing Readiness Levels as they are defined in DoD Policy.

5. DETAILED GUIDELINES

5.1 Technology and industrial base.

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5.1.1 Industrial capability. Assess the capability of the industrial base to support program requirements. Identify anticipated sole sources and foreign sources and determine their risk and stability.

5.1.2 Manufacturing technology development. Identify and implement manufacturing technology development projects as needed.

5.2 Design.

5.2.1 Engineering for affordability and producibility. Establish and maintain formal affordability and producibility programs. Consider affordability and producibility constraints during cost and trade studies. For additional information, refer to the [Manufacturing Development Guide](#).

Affordability and producibility programs include, but are not limited to

- a. Consideration of current contract and entire program.
- b. Early identification of the program cost drivers and potential initiatives for reducing these costs.
- c. Use of manufacturing capabilities in design trade studies.
- d. Flow-down of affordability and producibility requirements to major/critical suppliers.

5.2.2 Key characteristics. Identify key characteristics (KCs) on the engineering drawings.

- a. Add or delete KCs as warranted due to design changes.
- b. For each KC, identify the critical manufacturing processes.
- c. Flow down KCs to the appropriate level, including to suppliers; i.e., assembly KCs should flow down to detailed part fabrication KCs.
- d. Require suppliers with design authority to identify key characteristics for their designs.
- e. Use key characteristics to control the quality of parts designated as critical safety items.

5.2.3 Design trade studies. When performing design trade studies, consider production process capabilities and manufacturing costs. During the trade studies, treat manufacturing issues as equal to product performance issues.

5.2.4 Design maturity. Assess design maturity and its impact on manufacturing process and technology development. Design maturity may be assessed through the conduct of technology readiness assessments, design reviews, and qualification testing.

5.3 Materials.

5.3.1 Maturity. Ensure that materials are sufficiently mature and available to meet program requirements.

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5.3.2 Supplier management. Establish, implement, and maintain a supplier management program to track and report supplier performance. This program should identify major/critical suppliers as well as suppliers with critical processes. It should implement processes to

- a. Communicate program requirements with all suppliers, including timely notification of changes.
- b. Assure supplier compliance with program requirements, to include sub-tier suppliers.
- c. Address risks associated with transferring work between facilities.
- d. Continuously assess overall health of the supplier management organization.
- e. Identify and manage supplier risks.

5.3.3 Diminishing manufacturing sources (DMS) and obsolescence management. Develop and maintain a comprehensive DMS management program that addresses identification and risk mitigation of all parts and material obsolescence or discontinuation. The DMS program should encompass the DoD system, including support equipment, for which the prime contractor has design responsibility.

5.3.4 Special handling. Identify special handling requirements and develop special handling procedures, as needed.

5.4 Cost. Estimate production costs for the program. Incorporate in the estimate the most recent design, manufacturing plans, program ground rules, and relevant actual manufacturing costs. During major program reviews, evaluate and present the estimated production costs and the achievability of production cost goals. Develop and execute budgets for manufacturing development and risk reduction projects.

5.5 Process capability and control.

5.5.1 Virtual manufacturing. Use virtual manufacturing techniques to evaluate the producibility and affordability of proposed design and manufacturing concepts before the product and process designs are released. Virtual manufacturing techniques should address the properties and interactions among the material, production processes, tooling, test equipment, facilities, transportation, personnel, inventory levels, and resource constraints involved in producing the product.

5.5.2 Variability reduction. Implement a variability reduction program to reduce part to part variation of key characteristics. For additional information, refer to the [Manufacturing Development Guide](#).

5.5.3 Process control plans. Develop, document, and implement process control plans for all critical processes. Keep process control plans current based on design and process changes. Plans should include, but not be limited to

- a. How key sources of variation in the manufacturing processes will be controlled using statistical process control or other techniques.
- b. Specific data to be collected, and how it will be collected, analyzed, and used.

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5.5.4 Process capabilities. Calculate the process capability index (Cpk) for each critical process.

- a. For processes with insufficient data to determine capability, data from similar in-factory processes should be used to estimate Cpk.
- b. Process capability data (where available) should be provided to design engineers to be utilized in the design of the product.
- c. The capability indices of all critical processes should be tracked and improvement actions instituted for processes with low yields or unacceptable variation. Acceptability of Cpk is based on statistically sound data, considering impacts on producibility, cost, and quality.

5.5.5 Process Failure Modes Effects and Criticality Analyses (PFMECA). PFMECAs should be performed to identify potential failures in critical and safety-related manufacturing processes, rank the criticality of the failure types and identify actions to mitigate the failures.

5.5.6 Manufacturing process control. Accomplish all production operations under controlled conditions. Examples of control techniques are

- a. Documented work instructions.
- b. Adequate production equipment.
- c. Operator certifications.
- d. Statistical process controls.

5.6 Quality management.

5.6.1 Quality systems. The primary focus of the quality management system is defect prevention and achievement of stable and capable processes, as well as continuous improvement. In case of nonconformance, conduct root cause analyses and implement corrective actions.

5.6.2 First article inspections. Perform first article inspections (FAIs) on parts that have not previously been built or on which significant design changes have been made. FAIs should only be performed on production-representative parts and processes.

5.6.3 Supplier quality. Establish and maintain a program to assess supplier quality. This program should include, as a minimum

- a. Flow down of KC requirements to suppliers.
- b. Approval of suppliers' procedures to control KCs.
- c. Flow down of first article inspection requirements to suppliers.
- d. Use of predictive indicators to provide early detection of potential quality problems at suppliers.
- e. Objective parameters to assess the overall health of the supplier quality program.
- f. The procedure for delegating Material Review Board authority to qualified suppliers.

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5.7 Manufacturing personnel. Identify workforce requirements, including special skills and training requirements.

5.8 Facilities. Identify facility requirements.

5.9 Manufacturing management.

5.9.1 Manufacturing capability assessment & risk management. A formal process is needed to identify and manage manufacturing risk issues consistent with documented program risk methodology. In identifying risks, consider the capability of planned production processes to meet anticipated design tolerances. Also consider the supplier's capacity and capabilities.

5.9.2 Factory efficiency and continuous improvement. Establish, implement, and maintain a continuous improvement program across the entire enterprise, including suppliers. This program should identify improvement opportunities both on the factory floor as well as the processes that support production, (e.g., parts and tool control, management, and white collar processes).

5.9.3 Process proofing. Develop and implement a plan to demonstrate the proposed production processes, tooling, and test equipment (including Special Tooling and Special Test Equipment) will meet program requirements.

5.9.4 Manufacturing integration. The manufacturing management function should ensure the activities described in this handbook are integrated to achieve manufacturing maturity. Manufacturing approaches should be integrated with program management, engineering, and business management strategies.

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6. NOTES

6.1 Intended use. This handbook is intended for use in the acquisition of all DoD systems for development, production, and major modification contracts. This handbook is intended to be consistent with the following commercial specifications:

- a. AS9100, “Quality Management Systems – Aerospace – Requirements”
- b. AS9102, “Aerospace First Article Inspection Requirement”
- c. AS9103, “Variation Management of Key Characteristics”

6.2 Tailoring guidance for contractual application. This standard was structured so that provisions can be readily tailored to suit program needs. For example, section 5.2.3 (Design trade studies) may be deleted for production phase contracts in which there is no development.

6.3 Keyword list.

Continuous improvement
 Critical process
 Critical safety item
 First article inspection
 Key characteristic
 Process capability
 Process
 Producibility
 Risk management
 Statistical process control
 Supplier management
 Variability reduction

Custodians:
 Army – AV
 Air Force – 11

Preparing Activity
 Air Force – 11

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NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <http://assist.daps.dla.mil>.