

- Department of Defense Manufacturing and Quality Management Body of Knowledge
- (DRAFT)
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- Systems Engineering
- 3030 Defense Pentagon
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1 Preface

- 2
- 3 This version of the DoD Manufacturing and Quality Management Body of Knowledge is a working
- 4 draft for industry and government experts to comment and to make recommended edits and/or
- 5 corrections. The long-term vision is to provide a practical guide for government manufacturing and
- 6 quality (M&Q) managers to execute their duties across the DoD acquisition lifecycle. It is further
- 7 envisioned that this document will be updated on a routine basis to reflect current policy, guidance,
- 8 tools and best practices. This document does not supersede DoD policy, guidance or law; but is a
- 9 compilation of best practices, lessons learned (backed by experience, policy and guidance).
- 10 This Body of Knowledge is structured to capture M&Q activities during each phase of the life cycle.
- 11 The document includes individual chapters to cover M&Q activities and presumptive tasks
- 12 recommended during each acquisition lifecycle phase to meet DoD Instruction 5000.02, "Operation
- 13 of the Defense Acquisition System."
- 14 The Body of Knowledge includes 6 chapters. DoD PQM managers can use the chapter that reflects
- 15 the phase of the program that they are working:
- Chapter 1: Pre-Materiel Development Decision (Pre-MDD)
- 17 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)
- 22 Each chapter breaks down the M&Q related functions for each acquisition phase into major
- 23 "Threads" and "Activities." Threads include major manufacturing and quality functions based on the
- ²⁴ "5 Ms" (Machines, Materials, Methods, Manpower, and Measurement); Manufacturing Readiness
- 25 Level criteria; and DoD unique M&Q related acquisition threads (i.e. DoD acquisition system,
- 26 defense contracting system, and surveillance system). These Threads are then broken into specific
- 27 Activities (gray boxes) as indicated on the below figure. Each Activity is numbered (i.e., A.1, A.2,
- A.3...etc.) and has a corresponding description in each chapter describing presumptive task, metrics,
- 29 resources and tools associated with this activity.

Preface

	Threads	Activities
		CBA Dráft ICD Validated ICD AoA Guidance AoA Study Plan MDD ADM
	A. DoD Acquisition System	A.1 Support Early Systems Engineering A.2 Understand User A.3 Support Tech. Reviews of Candidate Materiel Solutions A.4 Provide Mig. Input for MDD
/	B. Defense Contracting System	B.1 Support Market Research
	C. Surveillance System	C.1 Understand DCMA C.2. DCMA Support at PQM Requirements Industry & Facility Sites
	D. Manufacturing Technology & Industrial Base	D.1 Characterize Industrial Base Capabilities D.2 Support Manufacturing Technology Development
	E. Design	E.1 Support Program Producibility Requirements E.2 Evaluate Design Maturity
	F. Cost & Funding	F.1 Understand Production Cost F.2 Develop Cost Analysis F.3 Estimate Mfg. Investment Budget
	G. Materials Management	G.1 Understand Materials Maturity Requirements G.2 Characterize Material Availability Chain Mgmt. Requirements Requirements
	H. Process Capability & Control	H.1 Investigate M&S Capabilities H.2 Investigate Mfg. H.3 Develop Process Process Maturity Yield & Rate Estimates
	I. Quality	I.1 Quality Management Requirements I.2 Product Quality Requirements I.3 Supplier Quality Management Requirements
	J. Manufacturing Workforce	J.1 Identify Mfg. Workforce Requirements
	K. Facilities	K.1 Evaluate Tooling/STE/SIE Requirements Requirements
	L. Manufacturing Mgmt. & Control	L.1 Manufacturing Management Requirements L.2 Understand Mfg. Planning & L.3 Understand Materials Planning Requirements

30 As an example, Pre-MDD manufacturing and quality activities are displayed in a figure as follows:

The chapter text then includes a description of M&Q objectives for the acquisition phase; and for each activity (A.1, A.2, A.3 ...etc.) includes:

- A list of recommended tasks
- Metrics to determine if the task(s) have been accomplished
- Tools (i.e., specific tools and techniques to accomplish tasks)
- Related resources (i.e. law, policy, and guidance applicable to the activity/tasks)
- 38

31

Pre-Materiel Development Decision (Pre-MDD)

3 Introduction

- 4 The objectives of the Pre-Materiel Development Decision (Pre-MDD) efforts are to obtain a clear
- 5 understanding of user needs, identify a range of technically feasible candidate materiel solutions,
- 6 consider near-term opportunities to provide a more rapid interim response, and develop a plan for the
- 7 next acquisition phase, including the required resources. This knowledge supports the Milestone
- 8 Decision Authority's (MDA) decision to authorize entry into the acquisition life cycle and pursue a
- 9 materiel solution. The Pre-MDD manufacturing and quality activities are displayed below
- 10 (Figure 1-1).



11 12

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

- 13 An important aspect of the Pre-MDD effort is narrowing the field of possible solutions to a
- 14 reasonable set that is analyzed in the Analysis of Alternatives (AoA). Early recognition of
- 15 constraints, combined with analysis of technical feasibility, can eliminate many initial ideas because

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

- 16 they lack the potential to meet the need in a timely, sustainable, and cost-effective manner.
- 17 Conversely, the range of alternatives analyzed in the AoA need to be chosen from a sufficiently
- 18 broad solution space.
- 19 Studies have found that programs that considered a broad range of alternatives tended to have better
- 20 cost and schedule outcomes than the programs that looked at a narrow scope of alternatives (citation
- to come).

22 Manufacturing and Quality Objectives

- 23 Manufacturing is concerned with the conversion of raw materials into products based upon a detailed
- 24 design. This conversion is accomplished through a series of manufacturing and quality procedures
- and processes. It includes such major functions as manufacturing planning, cost estimating and
- scheduling; engineering; fabrication and assembly; installation and checkout; demonstration and
- 27 testing; and quality assurance. Manufacturing and quality considerations begin before the AoA in
- 28 Pre-MDD, during which the manufacturing feasibility and quality risks that are associated with each
- 29 materiel solution must be understood and incorporated into study guidance for the next acquisition
- 30 phase.
- 31 The first objective is to ensure that manufacturing and quality are part of the design process. The role
- 32 of manufacturing is to influence the design so it is producible. The role of quality is to influence the
- design so it is reliable and robust, in other words the material attributes, performance features, and
- 34 characteristics of a product satisfy a given need. The result is a design that is efficient and can be
- 35 manufactured using existing facilities, tools, equipment and people, and meets quality needs. This
- 36 role is critical because of the impact design decisions have on life cycle costs.
- The second objective is to assess manufacturing feasibility and quality risks for the various materielsolutions identified.
- 39
- 40 The next objective is to support Knowledge-Based Acquisition to include the reduction of
- 41 manufacturing and quality risks and demonstration of producibility.
- 42 To meet these objectives, manufacturing and quality strategy development must begin during the
- 43 earliest stages of concept development. The manufacturing and quality strategy should be part of the
- 44 Capabilities-Based Assessment (CBA) and the draft Initial Capabilities Document (ICD), and should
- 45 be included in the AoA Study Guidance for the Materiel Development Decision (MDD).

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

46 A. DOD ACQUISITION SYSTEM

	СВА	Draft ICD			Validated ICD AoA Guidance AoA Study Plan MDD ADM	MDE
A. DoD Acquisition System	A.1 Support Early Systems Engineering	A.2 Understand User Needs	A.3 Support Tech. Reviews of Candidate Materiel Solutions	A.4 Provide Mfg. I for MDD	nput	

47

- 48 In order to implement effective early Systems Engineering, the Joint Staff conducts a CBA, and/or
- 49 other studies as part of the Joint Capabilities Integration and Development System (JCIDS) process,
- 50 producing a draft Initial Capabilities Document (ICD). The draft ICD contains the initial Key
- 51 Performance Parameters (KPP), Key System Attributes (KSA), and Additional Performance
- 52 Attributes (APA). The draft ICD is assigned to a lead Service or Services. Prior to determining if a
- 53 materiel solution should be developed, the lead Service initiates activities to develop the AoA Study
- 54 Guidance. These activities include manufacturing feasibility, studies from the science and technology

55 (S&T) community, and other supporting studies (threat analysis, gap studies, etc.) contributing

- 56 pertinent data and information for the MDD.
- 57 Prior to the decision, manufacturing and quality studies are conducted to assist the lead Service
- 58 activities for each concept to identify potential constraints, risks, and capabilities of the concepts to
- 59 validate the draft ICD. These studies should be included in the AoA Study Guidance. After the
- 60 MDD, Department of Defense Instruction (DoDI) 5000.02, Operation of the Defense Acquisition
- 61 System, specifies that the AoA analyzes cost, schedule, sustainment, and required capabilities
- 62 associated with each proposed materiel solution, including technology maturity, integration risk,
- 63 manufacturing feasibility, and, where necessary, technology maturation and demonstration needs.
- 64 In addition, the Office of the Secretary of Defense (OSD) Defense Acquisition Program Support
- 65 (DAPS) Methodology criteria require the study plans address the System Engineering focus areas of
- 66 maturity, reliability and maintainability, space, weight, power, cooling, and feasibility.
- To understand the implications of manufacturing feasibility, studies must address the feasibility,
 maturity, and quality risks of the proposed alternatives, including the need for:
- Industrial base (IB) development and impacts
- New materials and novel processing methods
- Additional research and development
- Manufacturing technology development and capital equipment
- Special test equipment and environments, special inspection equipment, and tooling
- New or expanded facilities
- New manufacturing skill sets

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

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

81 Attention to critical Systems Engineering processes and functions is essential to ensure that programs

82 deliver capabilities on time and on budget. The effective execution of pre-MDD efforts provides

technically feasible solution options that satisfy user-driven requirements for the AoA. At the MDD,

84 the MDA not only decides whether an investment is made to fill the capability gap but also

85 determines the fundamental path the materiel development will follow. This decision should be based

86 on effective development planning.

87 A.1 Support Early Systems Engineering

88 Manufacturing and Quality Tasks

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

108 Metrics

Analysis and documentation of IB capabilities and manufacturing feasibility provided as part
 of the CBA.

 111 112 113 114 115 116 117 	•	Manufacturing feasibility study conducted to identify a range of potential technically feasible candidate materiel solutions across the entire solution space including user input as appropriate; potential solutions are documented, and provided as inputs to the Integrating Integrated Product Team (IIPT), Overarching Integrated Product Team (OIPT), and MDD. Gap analysis conducted for manufacturing feasibility to document and eliminate un-feasible candidate materiel solutions based on factors such as timeliness, sustainability, cost- effectiveness, etc.
118 119 120		• The gap analysis of manufacturing feasibility includes and documents the use of near- term, commercial, or current systems as a materiel solution for rapid fielding, and these are provided as inputs to the IIPT, OIPT, and MDD.
121 122 123 124 125 126 127 128 129 130 131 132 133	• • •	Draft top-level plan that includes scheduling, manpower, and cost projections based on the results of manufacturing feasibility analysis of candidate materiel solutions completed and documented as an input to the AoA Study Guidance process. The analysis of candidate materiel solutions includes documented technical planning with respect to performance characteristics and analysis of capability gaps in manufacturing as an input to the AoA Study Guidance process. The analysis of desired materiel solutions includes documented technical planning with respect to external dependencies and integration impacts on the industrial base as an input to the AoA Study Guidance. Results of reliability, availability, maintainability, and associated cost analysis have been documented and provided as an input to the AoA Study Guidance. Results of analysis of potential alternatives that address the feasibility of a rapid interim response to the need have been documented and provided to the OIPT.
134	Tools	
135	•	Acquisition Decision Memorandum (ADM) Template
136	•	Acquisition Strategy Outline
137	٠	AoA Study Plan Template, Sep 2009
138	•	Industrial Base Assessment Survey Form Defense Contract Management Agency (DCMA)
139		Industrial Analysis Center
140	•	Initial Technical Review Checklist
141	٠	Integrated Design Exploration and Analysis (IDEA)
142	٠	Manufacturing Feasibility Assessment Checklist (no specific tool found)
143	•	Manufacturing Readiness Level (MRL) Assessment Questionnaire
144	•	Market Research Reporting Template
145	٠	Multi-Attribute Tradespace Exploration (MATE)
146	٠	Pugn Matrix Template
147	٠	Quality Function Deployment or House of Quality Matrix
148	•	Quality Function Deployment Excel Spreadsheet

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

- Requirements Traceability Matrix Template
- 150 Requirements Verification Matrix
- Tailoring Worksheet for Materiel Solution Analysis Phase
- Technology Readiness Level (TRL) Assessment Checklist
- Theory of Inventive Problem Solving (TRIZ) Matrix

154 **Resources**

- 155 Air Force AoA Guide, Jun 2013
- 156 Air Force AoA Handbook, Jul 2008
- DoDI 5000.02,
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities
- DoD Market Research Guide, May 2012
- DSMC Acquisition Strategy Guide, Dec 1999
- 162 MRL Deskbook Version 2.5, 2016
- Pre-MDD Analysis Handbook, Jul 2010
- 164 Quality Function Deployment
- Requirements Traceability Matrix Guide, Jan 2012
- Technology Readiness Assessment Guidance, Apr 2011
- 167 A.2 Understand User Needs
- 168 Manufacturing and Quality Tasks
- In order to obtain a clear understanding of user needs,
- Participate in development of Draft Initial Capabilities Document (ICD) to provide
 manufacturing and quality inputs to development of KPPs, KSAs, and APAs, including
 inputs to Force Protection, System Survivability, Sustainment, and Energy KPPs (four of
 the six mandatory KPPs)
- Participate in the CBA or equivalent to provide manufacturing perspective on IB
 capability and manufacturing feasibility for both processes
- Identify near-term opportunities that address user needs per the draft ICD and the CBA to
 provide a more rapid interim response.
- Develop understanding of user needs as they relate to candidate materiel solutions and proactively collaborate with the user communities to:
- 180 o Support Technical Reviews of candidate materiel solutions
- 181 o Initiate characterization of trade space, risks, and mission interdependencies as input to
 182 support the AoA Study Guidance.

183	Metrics
184 185	• Provide input to the development of the Draft Initial Capabilities Document for a manufacturing and quality perspective on IB capability and manufacturing feasibility.
186 187 188	 Document manufacturing and quality inputs into the Draft Initial Capabilities Document (ICD) including KPPs, KSAs, and APAs for potential inclusion in the AoA Study Guidance
189 190	• Provide input to the CBA or equivalent for a manufacturing and quality perspective on IB capability and manufacturing feasibility.
191 192	 Document manufacturing and quality inputs into the CBA for potential inclusion in the AoA Study Guidance
193 194	• Review the User needs and document the manufacturing interpretation of these needs for inclusion in the AoA Study Guidance.
195 196	• Document near-term opportunities that address user needs per the draft ICD and the CBA that provide a more rapid interim response for inclusion in the AoA Study Guidance.
197	Tools
198	• ICD Template, Oct 2012
199	MRL Assessment Questionnaire
200	Pugh Matrix Template
201	Quality Function Deployment Excel Spreadsheet
202	Requirements Roadmap Worksheet
203	TRIZ Matrix
204	Resources
205	Capability-Based Assessment Guide, Mar 2009
206	• Defense Acquisition Guidebook (DAG) Chapter 14.3.1.3, Build Requirements Roadmap
207	• DoDI 5000.02
208	Pre-MDD Analysis Handbook, Jul 2010
209	Quality Function Deployment
210	A.3 Support Technical Reviews of Candidate Materiel Solutions
211	Manufacturing and Quality Tasks
212	• Provide manufacturing inputs to support the MDA MDD process to authorize entry into the
213	DoD acquisition process and pursue a materiel solution.

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

 214 215 216 217 218 219 220 221 222 	 Identify and provide inputs to the AoA Study Guidance that specify the minimum set of Concept of Operations (CONOPS) and ICD manufacturing and/or quality requirements that must be met for each of the candidate materiel solutions Assess each of the candidate materiel solutions for manufacturing feasibility and producibility Assess each of the candidate materiel solutions for impacts on reliability and maintainability Identify manufacturing and quality risks (technical/engineering) for each candidate material solution
223 224 225	 Identify the capability and capacity risks for rapid fielding of potential solutions. Identify source consideration risks for fragile, single, sole, domestic, and foreign sources.
226 227	 Identify manufacturing and quality scheduling impacts and constraints (risks and opportunities) for each candidate materiel solution
228 229 230 231 232 233	 Identify initial manufacturing and quality Measures of Effectiveness for each candidate materiel solution. Initiate characterization of trade space, risks, and mission interdependencies of each candidate materiel solution as input to support the AoA Study Guidance. Analyze capability and gaps of each candidate materiel solution approach to meet the need in a timely, sustainable, and cost-effective manner.
234	Metrics
235 236	• In support of the MDA MDD process, the manufacturing and quality representatives to the IIPT and the OIPT have:
237 238 239	• Evaluated the draft ICD to determine relevant manufacturing and quality metrics and values for each of the candidate materiel solutions, and provided these as documented inputs to the AoA Study Guidance and MDD processes.
240 241 242	 Reviewed the CONOPS and preliminary requirements for each of the candidate materiel solutions to provide documentation for initial definition and assessment of gaps, needs, and new technologies for the AoA Study Guidance and MDD processes.
243 244	• Assessed, evaluated, analyzed, and documented each of the candidate materiel solutions for manufacturing feasibility and producibility.
245 246	 Assessed and documented each of the candidate materiel solutions for impacts on reliability and maintainability.
247 248	 Identified, evaluated, and documented manufacturing and quality risks (technical/engineering) for each candidate materiel solution.
249 250	 Evaluated and documented the capability and capacity for Rapid Fielding of potential solutions for the AoA Study Guidance and MDD processes.

251 252	 Evaluated, assessed, and documented source considerations (sole, domestic, foreign, etc.) for the AoA Study Guidance and MDD processes.
253	• Identified, evaluated, and documented manufacturing and quality scheduling impacts and
254	constraints (risks and opportunities) for each candidate materiel solution.
255	 Identified and documented initial manufacturing and quality Measures of Effectiveness
256	for each candidate materiel solution.
257	• Document initial characterization of trade space, risks, and mission interdependencies of each
258	candidate materiel solution as input to the AoA Study Guidance.
259	• Analyze and document the capability and gaps of each candidate materiel solution approach
260	to meet the need in a timely, sustainable, and cost-effective manner for as input to the AoA
261	Study Guidance.
262	Tools
263	AoA Study Plan Template
264	Critical to Customer/Critical to Ouality Tree Template
265	Manufacturing Capability Assessment Worksheet
266	MRL Assessment Checklist
267	MDD Development Planning Templates
268	MSA Template
269	Producibility Assessment Worksheet (PAW)
270	TRIZ Matrix
271	Resources
272	• Air Force AoA Guide Jun 2013
272	Air Force AoA Handbook Jul 2008
273	 DAG Chapter 14.4.2 Performance Management
275	 Defense Manufacturing Management Guide for Program Managers, Chapter 1.3 and 2.6
275	Industrial and Manufacturing Canability Assessments in the Acquisition Lifecycle
270	DoDI 5000 02
278	MRI Deskbook Version 2.5, 2016
270	 MKL Deskoook Version 2.3, 2010 MSA Guide DAG Chapter 4.2.3 also see Air Force and Navy Guides
21)	• More Guide, Drid Chapter 4.2.5, also see rin Force and Navy Guides
280	A.4 Provide Manufacturing Input for the Materiel Development Decision
281	Manufacturing and Quality Tasks
282	• Support the MDA MDD process to authorize entry into the acquisition life cycle and pursue a
283	materiel solution.

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

284 285	• Identify a range of technically feasible candidate materiel solution approaches that address considerations of industrial production manufacturing and quality constraints
205	 Develop manufacturing inputs for the AoA Study Guidance and Study Plan planning for the
280	• Develop manufacturing inputs for the AOA Study Outdance and Study I fail plaining for the
207	 Develop droft guideness on the application and use of assessments of manufacturing readiness.
288 289	• Develop draft guidance on the application and use of assessments of manufacturing readiless on the concepts under consideration
290 291 292 293	 Identify target Manufacturing Readiness Levels (MRL) that should be achieved at key milestones and decision points for Major Defense Acquisition Programs (MDAP) Identify tools and models that may be used to assess, manage, and reduce risks that are identified in the course of MRL assessments
294 295	• Initiate characterization of trade space, risks, and mission interdependencies as input to support the AoA Study Guidance.
296 297	 Conduct a complete and rigorous manufacturing analysis/assessment of alternatives and their non-materiel implications as part of a Systems Engineering analysis.
298	• Assess alternatives for manufacturing and their non-materiel implications (cost, staffing,
299	contracting, etc.) as an input to the MDD.
300	• Assess the industrial base for production capability and capacity, and manufacturing and
301	quality constraints to eliminate non-supportable candidate materiel solutions (i.e., those that
302	are not timely, sustainable, or affordable) as an input to the AoA Study Guidance.
303	• Collaborate with the User communities to understand system performance requirements and
304	with the S&T community to identify candidate materiel solutions and potential
305	manufacturing issues as an input to the AoA Study Guidance.
306	• Support the Initial Technical Review (ITR)
307	• Assess the draft ICD, the AoA Study Guidance, and preliminary CONOPS for
308	manufacturing and quality analysis of materiel solution alternatives.
309	• Support the ITR to provide detailed manufacturing and quality information and
310	understanding of each concept or alternative for:
311	 Engineering trades
312	 Development of a Cost Analysis Requirements Description (CARD)
313	 Cost drivers, material, and process risks
314	Metrics
315	• In support of the MDA MDD process, the manufacturing and quality representatives are
316	included as active contributing members of the IIPT and the Overarching Integrated Product
317	Team (OIPT).
318	• A rigorous Systems Engineering analysis has been conducted and documented to support the
319	MDD process for entry into the next phase.

 320 321 322 323 324 325 326 327 328 329 		 Alternatives have been assessed and analyzed for manufacturing and their non-materiel implications (cost, staffing, contracting, etc.) and are documented and provided as an input to the MDD Assessment of the industrial base for production capability and capacity, and manufacturing and quality constraints to eliminate non-supportable candidate materiel solutions (i.e., those that are not timely, sustainable, or affordable) are documented and provided as an input to the AoA Study Guidance. Results of collaboration with User community's requirements for system performance and capabilities and the S&T Community for candidate materiel solutions and potential manufacturing issues are documented and provided as an input to the AoA Study
330331332	•	Guidance. Draft guidance on the application and use of assessments of manufacturing readiness on the concepts under consideration has been developed and documented and includes:
333 334 335 336		 Initial identification of target MRLs that should be achieved at key milestones and decision points for Major Defense Acquisition Programs Initial identification of tools and models that may be used to assess, manage, and reduce risks that are identified in the course of manufacturing readiness assessments
337 338	•	The designated manufacturing and quality support to the Initial Technical Review (ITR) has been specified.
339340341342343		 Assessment of the draft ICD, the AoA Study Guidance, and preliminary CONOPS for manufacturing and quality analysis of materiel solution alternatives has been conducted and results documented Detailed manufacturing and quality information has been provided to support the Initial Technical Review (ITR) and includes documentation of each concept or alternative for:
344 345 346		 Engineering trades Development of a CARD Cost drivers, material, and process risks
 347 348 349 350 351 352 353 354 355 356 	Tools • • • • • • • • • •	Acquisition Decision Memorandum (ADM) Template AoA Study Plan Template Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Initial Technical Review Checklist Manufacturing Readiness Level (MRL) Assessment Questionnaire Multi-Attribute Tradespace Exploration (MATE) Pugh Matrix Template Quality Function Deployment in excel TRIZ Matrix Template

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

357 Resources

- Air Force AoA Handbook, Jul 2008
- Defense Manufacturing Management Guide for Program Managers Chapter 12.5.1 Initial
 Technical Review
- **•** DoDI 5000.02
- DoDI 5000.60, Defense Industrial Capabilities Assessments
- MRL Deskbook Version 2.5, 2016
- Pre-MDD Analysis Handbook, Jul 2010
- Quality Function Deployment

366 **B. DEFENSE CONTRACTING SYSTEM**



368

369 Manufacturing and quality resources should be focused on the entire acquisition cycle including

areas such as production planning, transition to production, concurrent engineering, quality

371 management, continuous improvement, could cost, and manufacturing technology. A clear

372 understanding of these focus areas is key during Pre-MDD for contracting activities in the following

acquisition phases. These activities include proactively collaborating with the S&T and user

374 communities to develop understanding of candidate materiel solutions to make necessary and

375 substantive inputs to future contracts and acquisition planning.

376 **B.1 Support Market Research**

377 Manufacturing and Quality Tasks

- Work with the S&T community (across government, industry, and academia) as well as other collaborators to build the technical knowledge base for potential candidate materiel solutions.
- Survey the Industrial Base for necessary resources for the potential candidate materiel
 solutions and the current state industrial practices.
- Support requests for information and solicit industry and academia responses to warfighter
 needs.
- o Provide manufacturing and quality inputs for sources sought activity, as appropriate
- Identify and characterize candidate materiel solutions resulting from the Sources Sought to
 support Requests for Information (RFI) activities and Industry Day events.
- 387 Ensure the RFI is open to alternative solutions
- Analyze potential trade space to identify performance versus cost benefits discriminators for
 potential candidate materiel solutions.

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

390 Initiate planning for the manufacturing and quality efforts required during the next phase. • 391 Metrics 392 Results of working with the S&T community, as well as other collaborators, technical • 393 knowledge base for each candidate materiel solution is documented in the AoA Study 394 Guidance. 395 • Documentation of the availability of necessary resources for the potential candidate materiel 396 solutions and the current state industrial practices as a basis for the Sources Sought and the 397 Requests for Information. 398 • Manufacturing and quality inputs for Sources Sought activities are documented and provided, 399 as appropriate. 400 • Information from the Sources Sought documented and used to support RFI activities and 401 Industry Day events for the potential candidate materiel solutions. 402 Documentation recognizes alternative solutions in the RFI 0 403 Potential trade space identifying performance versus cost benefit discriminators for potential • 404 candidate materiel solutions have been analyzed developed and documented for subsequent 405 acquisition phases. 406 • Planning for the manufacturing and quality efforts required during the next phase initiated and documented for the future Acquisition Strategy (AS). 407 408 Tools 409 AoA Study Plan Template • Market Research Reporting Template 410 • • Pugh Matrix Template 411 412 Systems Engineering Plan (SEP) Outline • 413 **Resources** 414 Air Force AoA Handbook, Jul 2008 • 415 • DAG Chapter 14 416 • DoD Market Research Guide, May 2012 417 • SEP Outline, Jun 2015

418 C. SURVEILLANCE SYSTEM

410	C. Surveillance System	C.1 Unde PQM Re	lerstand DCMA Requirements	C.2. DCMA Support at Industry & Facility Sites	
419 L					

420 The activity managing the concept or the Program Manager should maximize the use of DCMA

421 personnel at contractor facilities where there is delegation of authority and expertise available.

422 Request DCMA Contract Management Offices jointly support development of program support plans

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

for all Acquisition Category I program contracts to ensure agreement on contract oversight needs andperspectives.

425 C.1 Understand DCMA PQM Data Inputs

426 Manufacturing and Quality Tasks

- Ensure quality and manufacturing requirements are included in contracts and in appropriate
 agreements with other agencies (e.g., DCMA).
- Request DCMA recommend the appropriate quality (i.e., ISO 9001 or AS9100) and
 manufacturing management program requirements (i.e., AS6500 or contractual)
 requirements language to be included in solicitations, requests for proposals, and
 contracts and in appropriate agreements with other agencies (e.g., DCMA).
- 433 o Request DCMA provide supporting rationale for recommendations on the emerging
 434 technology maturity.
- As part of manufacturing feasibility assessments of each concept being considered, request
 information and data input for similar products and manufacturing processes from
 DCMA on:
- 438 Manufacturing maturity of similar products and processes
- 439 Status and readiness of industrial capabilities
- 440 Current available facilities and equipment
- 441 o Workforce availability and training
- o Quality system processes and results
- Identify the manufacturing and/or production, quality, engineering and software development
 risks for similar products and processes relevant to each concept being considered for the
 AoA Study.
- 446 o Request DCMA to provide data to support analysis of the identified risks including
 447 lessons learned.

448 Metrics

449 Quality and manufacturing requirements have been documented and included in contracts • 450 and in appropriate agreements with other agencies (e.g., DCMA). 451 • Supporting rationale for recommendations on the emerging technology maturity has been 452 provided by DCMA and incorporated into the manufacturing feasibility assessment. 453 In support of and documented in the manufacturing feasibility assessments of each concept • 454 being considered, DCMA has provided information and data input for similar products and 455 manufacturing processes for: 456 • Manufacturing maturity of similar products and processes 457 Status and readiness of industrial capabilities 0

458 459 460	 Current available facilities and equipment Workforce availability and training Quality system processes and results
461 462 463 464	 Manufacturing and/or production, quality, engineering, and software development risks for similar products and processes relevant to each concept being considered for the AoA Study have been provided by DCMA, including lessons learned, and documented in the analysis of the identified risks.
465	Tools
466	AoA Study Plan Template
467	DCMA Pre-Award Survey
468	DCMA Program Support Plan
469	Industrial Base Capabilities Assessment Questionnaire
470	Manufacturing Readiness Level (MRL) Assessment Questionnaire
471	Risk Assessment Template
472	TRL Assessment Checklist
473	Resources
474	Air Force AoA Handbook, Jul 2008
475	DoDI 5000.60, Defense Industrial Capabilities Assessments
476	DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities
477	DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs,
478	Jan 2017
479	• MRL Deskbook Version 2.5, 2016
480	Technology Readiness Assessment Guidance, Apr 2011
481	C.2 DCMA Support at Industry and Facility Sites
482	Manufacturing and Quality Tasks
483 484	• Based on DCMA (when requested and agreed to by DCMA) inputs, sponsor manufacturing investment programs that support:
485 486 487 488	 Development and management of industrial base investment programs that create, expand, or preserve assured, affordable, and commercially viable production capabilities and capacities for items essential for national defense Assessment and evaluation of candidate programs
489 490 491	• Based on DCMA (when requested and agreed to by DCMA) inputs, develop recommendations to program and contracting personnel on manufacturing technology investments and Title III initiatives.

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

492 493	• Based on DCMA (when requested and agreed to by DCMA) information, develop assistance requests to DoD and/or component manufacturing technology programs that support:
494 495 496	 Identification of new manufacturing processes associated with the program and candidate components for the identified processes Identification of low-yield processes and components
497 498	 Request for manufacturing technology (ManTech) assistance for identified processes and components
499	• Development of requests for information and academia responses to warfighter needs
500 501	• Based on DCMA (when requested and agreed to by DCMA) information, evaluate and submit recommendations on an emerging manufacturing technology maturity.
502 503	 Conduct manufacturing technology assessments to evaluate an emerging manufacturing technology to determine feasibility for production
504 505	 Assess the emerging manufacturing technology to ensure it meets production requirements
506 507 508	 Develop recommendations on the emerging manufacturing technology maturity Document assessment of industrial capabilities and recommendations for applicability of emerging manufacturing technology, and provide to decision maker
509	Metrics
510 511	• Based on DCMA inputs, manufacturing investment programs have/are being sponsored that support for:
 510 511 512 513 514 515 	 Based on DCMA inputs, manufacturing investment programs have/are being sponsored that support for: Development and management of industrial base investment programs that create, expand or preserve assured, affordable, and commercially viable production capabilities and capacities for items essential for national defense have been conducted and the results documented for inclusion in the AoA Study guidance
 510 511 512 513 514 515 516 517 	 Based on DCMA inputs, manufacturing investment programs have/are being sponsored that support for: Development and management of industrial base investment programs that create, expand or preserve assured, affordable, and commercially viable production capabilities and capacities for items essential for national defense have been conducted and the results documented for inclusion in the AoA Study guidance Assessment and evaluation of candidate programs with results documented for inclusion in the AoA Study Guidance
 510 511 512 513 514 515 516 517 518 519 520 521 521 	 Based on DCMA inputs, manufacturing investment programs have/are being sponsored that support for: Development and management of industrial base investment programs that create, expand or preserve assured, affordable, and commercially viable production capabilities and capacities for items essential for national defense have been conducted and the results documented for inclusion in the AoA Study guidance Assessment and evaluation of candidate programs with results documented for inclusion in the AoA Study Guidance Based on DCMA inputs, development and documentation of recommendations for program and contracting personnel on manufacturing technology investments and Title III initiatives for the AoA Study Guidance have been completed based on DCMA inputs. Based on DCMA information, assistance requests to DoD and/or component manufacturing
 510 511 512 513 514 515 516 517 518 519 520 521 522 522 	 Based on DCMA inputs, manufacturing investment programs have/are being sponsored that support for: Development and management of industrial base investment programs that create, expand or preserve assured, affordable, and commercially viable production capabilities and capacities for items essential for national defense have been conducted and the results documented for inclusion in the AoA Study guidance Assessment and evaluation of candidate programs with results documented for inclusion in the AoA Study guidance Based on DCMA inputs, development and documentation of recommendations for program and contracting personnel on manufacturing technology investments and Title III initiatives for the AoA Study Guidance have been completed based on DCMA inputs. Based on DCMA information, assistance requests to DoD and/or component manufacturing technology programs have been developed and documented that support:
 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 	 Based on DCMA inputs, manufacturing investment programs have/are being sponsored that support for: Development and management of industrial base investment programs that create, expand or preserve assured, affordable, and commercially viable production capabilities and capacities for items essential for national defense have been conducted and the results documented for inclusion in the AoA Study guidance Assessment and evaluation of candidate programs with results documented for inclusion in the AoA Study Guidance Based on DCMA inputs, development and documentation of recommendations for program and contracting personnel on manufacturing technology investments and Title III initiatives for the AoA Study Guidance have been completed based on DCMA inputs. Based on DCMA information, assistance requests to DoD and/or component manufacturing technology programs have been developed and documented that support: Identification of new manufacturing processes associated with the program and candidate components for the identified processes
 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 	 Based on DCMA inputs, manufacturing investment programs have/are being sponsored that support for: Development and management of industrial base investment programs that create, expand or preserve assured, affordable, and commercially viable production capabilities and capacities for items essential for national defense have been conducted and the results documented for inclusion in the AoA Study guidance Assessment and evaluation of candidate programs with results documented for inclusion in the AoA Study Guidance Based on DCMA inputs, development and documentation of recommendations for program and contracting personnel on manufacturing technology investments and Title III initiatives for the AoA Study Guidance have been completed based on DCMA inputs. Based on DCMA information, assistance requests to DoD and/or component manufacturing technology programs have been developed and documented 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

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

529 530	•	Based on DCMA information, evaluate and submit recommendations on an emerging manufacturing technology maturity
531 532 533 534 535 536 537		 Manufacturing technology assessments to evaluate an emerging manufacturing technology to determine its feasibility for production have been conducted and the results documented for inclusion in the AoA Study Guidance Emerging manufacturing technology has been assessed to ensure it meets production requirements and the results documented for inclusion in the AoA Study Guidance Prepare an assessment summary on the feasibility of the manufacturing technology to meet production requirements
538	Tools	
539	•	Army Manufacturing Technology (ManTech) Proposal Rating Template
540	•	ManTech Phase I Questions
541	•	Pugh Matrix Template
542	Resou	rces
543	•	DoD Directive 4200.15, DoD ManTech Program
544	٠	ManTech Strategic Plan, Mar 2009
545	•	See Service-specific ManTech requirements

546 **D. MANUFACTURING TECHNOLOGY AND INDUSTRIAL BASE**

	D. Manufacturing		
	Technology &	D.1 Characterize Industrial Base Capabilities D.2 Support Manufacturing Technology Development	
547 I	Industrial Base (IB)		

548 Title 10 U.S.C, Section 2440, Technology and the Industrial Base, requires the "Secretary of Defense 549 to prescribe regulations requiring consideration of the national technology and industrial base in the 550 development and implementation of acquisition plans for each major defense acquisition program." 551 If programs are to be successful and meet the intent of the law, manufacturing and quality need to be 552 a major consideration in all phases of acquisition. For example, the National Environmental Policy 553 Act (NEPA) requires Federal agencies to consider the environmental impacts of proposed actions,

- 554 including actions within acquisition programs, before they are implemented.
- 555 The 5000.02 guidance provides for manufacturing assessments throughout the entire acquisition
- 556 cycle and includes such areas as production planning, transition to production, concurrent
- 557 engineering, quality management, continuous improvement, could cost, and manufacturing
- technology. The Defense Acquisition Executive (DAE) passes this policy through the respective
- 559 SAEs who are the senior acquisition executives within the DoD Component having cognizance and
- 560 management. Planning and effective investments in industrial base capabilities allow for a smooth
- transition from development to production and sustainment.

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

562 D.1 Characterize Industrial Base Capabilities

563 Manufacturing and Quality Tasks

- 564 • Conduct industrial base sector studies (i.e., capabilities and capacities) relevant to potential 565 and future needs inclusive of design, development, production, operation, and sustainment, and eventual disposal. 566 567 o Identify and understand potential industrial base sources and needs. Conduct an Industrial Base assessment to identify sources relevant to the concepts being 568 • 569 considered for the ICD, AoA Study Guidance, and the MDD. 570 Include identification of unique manufacturing capabilities that are not readily accessible 0 571 (i.e., require regeneration). 572 Include DCMA (when requested and agreed to by DCMA) data that supports the 0 573 following: 574 Industrial Capability Assessments • 575 **Analytical Products** 576 **Defense Business and Economic Analysis** • 577 Acquisition Planning Support 578 Analyze the capabilities of the identified Industrial Base sources to develop, produce, • 579 maintain, and support the concepts being considered for inclusion in the ICD, AoA Study Guidance, and the MDD: 580 581 Identify the external dependencies and integration impacts. 0 Identify the availability of essential raw materials, special alloys, composite materials, 582 0 583 components, tooling, and manufacturing and quality test equipment required to support the concepts being considered. 584 585 Identify items that are sole or single sourced, fragile source, or available only from 0 586 sources outside the National Technology Industrial Base (NTIB). 587 Analyze the effects on the sources for the concepts being considered that result from foreign acquisition of firms in the United States. 588 589 • Identify the availability of alternatives for obtaining such items from within the NTIB 590 Analyze the military vulnerability that could result from the lack of alternatives, if such items become unavailable from sources outside the NTIB. 591 592 Use appropriate models and simulations to develop required documentation for the MDD. 593 Metrics 594 As a result of industrial base sector studies, potential sources that could address potential and •
- 595 future needs have been identified and documented.

596 597		 Includes design, development, production, operation, and sustainment, and eventual disposal.
598 599	•	An assessment has been conducted and identifies sources relevant to the concepts being considered documented in the ICD, the AoA Study Guidance, and the MDD and includes:
600 601 602		 Identification of unique manufacturing capabilities that are not readily accessible (i.e., require regeneration) DCMA data on:
603 604 605 606		 Industrial Capability Assessments Analytical Products Defense Business and Economic Analysis Acquisition Planning Support
607 608 609 610	•	Capability analysis of the identified Industrial Base sources to support the design, development, production, operation, and sustainment, and eventual disposal have been conducted on the concepts being considered and provided for inclusion in the AoA Study Guidance and the MDD.
 611 612 613 614 615 616 		 The analysis identifies the external dependencies and integration impacts. Analysis identifies and documents the availability of essential raw materials, special alloys, composite materials, components, tooling, and manufacturing and quality test equipment required to support the concepts being considered The analysis identifies items that are sole or single sourced, fragile source, or available only from sources outside the NTIB.
617 618 619 620		 Analysis also identifies the effects on the sources for the concepts being considered that result from foreign acquisition of firms in the United States. Analyze the military vulnerability that could result from the lack of alternatives, if such items become unavailable from sources outside the NTIB.
621 622	•	Evidence that appropriate models and simulations have been utilized and the results have been provided as input to the AoA Study Guidance and the MDD.
623	Tools	
624 625	•	AoA Study Plan Template Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
626	•	MRL Assessment Checklist for Technology and Industrial Base thread
627	•	Army ManTech Proposal Rating Template
628	•	Numerous M&S models are available that the contractor may use, we (government) should
629		be familiar with these tools

630	Resources
 631 632 633 634 635 636 	 Air Force AoA Handbook, Jul 2008 DoDD 4200.15, Manufacturing Technology (ManTech) Program DoDI 5000.02 DoDI 5000.60, Defense Industrial Capabilities Assessments Industrial Base Capabilities Assessment MRL Deskbook Version 2.5, 2016
637	M&S Guidance for the Acquisition Workforce, Oct 2008
638	D.2 Support Manufacturing Technology Development
639	Manufacturing and Quality Tasks
640 641	• As part of industrial base sector studies, survey manufacturing and quality technologies and capabilities relevant to potential and future needs.
642	• Identify and understand potential industrial base investment needs.
643 644 645 646	 Identify the requirement for the use of advanced manufacturing and quality technology and processes for the concepts being considered. Conduct a survey of ManTech Program technology concepts that are ongoing, in development, and support the concepts being considered.
647 648 649	 Based on survey needs for Manufacturing Technology assistance identified. Based on survey provide recommendations on manufacturing and quality technology investments and Title III initiatives.
650 651 652	• Provide input to contract solicitations (sources sought, RFIs, etc.) that encourage acquisition of modern technology, production equipment, and production systems that increase the productivity and reduce life-cycle costs.
653 654	• Methods to encourage investment by U.S. domestic sources in advanced manufacturing and quality technology production equipment and processes.
655	Metrics
656 657 658 659 660 661 662 663	 A survey of manufacturing and quality technologies and capabilities relevant to potential and future needs has been conducted and the results documented and included as part of industrial base sector studies. Potential industrial base investment needs have been identified, their impact understood and documented. The requirements for the use of advanced manufacturing and quality technology and processes for the concepts being considered have been documented for the AoA Study Guidance and the MDD.

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

664 665	•	Analysis of ongoing ManTech Program technology concepts that support the concepts being considered completed and documented.
666 667 668		 Needs for Manufacturing Technology assistance documented AoA Study Guidance. Recommendations on manufacturing and quality technology investments and Title III initiatives have been documented and provided to the appropriate Service or Agency.
669 670	•	Draft language written for the future AS, sources sought, RFIs, etc. has been provided as input to AoA Study Guidance.
671	Tools	
672	•	Army ManTech Proposal Rating spreadsheet
673	•	ManTech Phase I project questionnaire
674	•	TRL Assessment Checklist
675	Resou	rces
676	•	Air Force Technology Development and Transition Strategy Guidebook, Nov 2010
677	•	Defense Manufacturing Management Guide for Program Managers, Chapter 8, Technology
678		Development and Investments
679	•	DoDI 5000.02
680	•	DoD Directive 4200.15, ManTech
681	•	MRL Deskbook Version 2.5, 2016
682	•	Technology Readiness Assessment Guidance, Apr 2011

683 **E. DESIGN**

	E. Design	E.1 Support Program Producibility Requirements	E.2 Evaluate Design Maturity	
684				

685 One of the major objectives is to evaluate manufacturing feasibility, or to answer the question "can 686 you build it?" Producibility is an engineering function directed toward generating a design which is 687 compatible with manufacturing capability and quality processes. It is often considered the most

688 important determinant of product cost, due to the effect on both production and sustainment costs.

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

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

697 Quality requirements are integral to design and development efforts as specified in industry best

- 698 practice standards for quality management systems (ISO 9001, AS9100, etc.). These standards for
- 699 systems engineering processes emphasize the importance of quality as part of program requirements
- 700 in early design. The typical processes included in the QMS and included in this document are:
- 701 • Design and Development Planning (e.g., Engineering Management, FMECA, Safety, etc.)
- 702 • Design and Development Inputs/Outputs and Reviews (e.g., Verification and Validation
- 703 (V&V), Test and Evaluation (T&E) Management, reviews and audits, etc.)
- 704 • Risk and Configuration Management

705 DoD acquisition programs may face a high risk of failure at the outset of the design process based on 706 the maturity of the design. Some level of risk associated with new concepts may be unavoidable, 707 historically this risk has been magnified by a misunderstanding of the efforts necessary to mature the 708 concept into a mature product. The government and its contractors must share equal responsibility for 709 this misunderstanding. The contractor's proposal and the government's source selection process 710 provide the most cost-effective opportunity to ensure application of these critical efforts during

- 711 design maturation.
- 712 A mature design in pre-MDD phase should begin to show these characteristics: the design meets

713 requirements and overcomes shortfalls, the design is experiencing minimal changes, and initial

714 testing and experiments indicate performance can be met. However, final design will be determined

715 at Critical Design Review (CDR), much later in the program.

716 E.1 Support Program Producibility Requirements

717 **Manufacturing and Quality Tasks**

- 718 Assess the manufacturing producibility and feasibility of the concepts being considered as • 719 materiel solutions to ensure that one or more concepts have the potential to be affordable, 720 effective, suitable, and can be developed to provide a timely solution to a need at an 721 acceptable level of risk. The assessment should include:
- 722 o Evaluation of design concepts
- 723 • Identification and determination of costs, cost drivers, and potential risks
- o Identification of manufacturing and quality processes needed and requirements 724
- 725 • Identification of design requirements
- 726 o Identification of technical risks
- 727 Additional analysis of the following areas should be conducted as the concepts mature:
- o Technology maturity 728
- 729 • Industrial Base capability
- 730 o Manufacturability
- 731 • Funding required for maturing the manufacturing and quality processes

732		• Materials availability
733		• Tests and demonstrations for new materials and processes
734		• Environmental impacts
735		• Anticipated manufacturing and quality risks including potential cost and schedule
736		impacts
737	•	Conduct trade studies that consider and incorporate alternative system designs and other
738		technical considerations.
739	Metrio	CS
740	•	Concepts being considered as materiel solutions have been assessed and documented in the
741		AoA Study Guidance for producibility and feasibility, including:
742		o Affordability
743		o Effectiveness
744		o Suitability
745		 Timeliness (including rapid deployment)
746		 Manufacturing and quality requirements and processes
747		• Design requirements
748		• Technical risks
749		• Costs, cost drivers, and potential risks
750	•	Concepts analysis has been conducted and documented as an input to the AoA Study
751		Guidance for the following:
752		• Technology maturity
753		• Industrial Base capability
754		o Manufacturability
755		• Funding required for maturing the manufacturing and quality processes
756		• Materials availability
757		 Tests and demonstrations for new materials and processes
758		 Environmental impacts
759		• Anticipated manufacturing and quality risks including potential cost and schedule
760		impacts
761	•	Trade studies have been conducted to document alternative designs considered and other
762		technical considerations and provide as input to the AoA Study Guidance.
763	Tools	
764	10013	Industrial Dass Assessment Survey Form DCMA Industrial Assessing Conter
/04 765	•	Manufacturing Droducibility Assessment Workshot (DAW)
705	•	Manufacturing Producibility Assessment worksneet (PAW)
/00	•	Market Research Reporting Template
/6/	•	MKL Assessment Checklist for Design thread

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

768	Preliminary Hazards List Developed
769	Pugh Matrix
770	TRL Assessment Checklist
771	TRIZ Matrix
772	Resources
773	• ESOH in Acquisition Guide, Apr 2009
774	• DoDI 5000.02
775	• MRL Deskbook Version 2.5, 2016
776	Producibility Systems Guidelines, NAVSO P-3687, Dec 1999
777	Technology Readiness Assessment Guidance, Apr 2011
778	E.2 Evaluate Design Maturity
779	Manufacturing and Quality Tasks
780	• Identify the manufacturing industrial base capabilities and the manufacturing technologies
781	required by candidate materiel solution approaches to evaluate the respective design
782	maturities.
783	• Identify broad performance requirements of candidate materiel solution approaches that may
784	drive manufacturing and quality options.
785	• Assess the maturity of each candidate materiel solution's design options based on
786	experiments.
787	• Identify and evaluate candidate materiel solution approaches lifecycle and technical
788	requirements.
789	• Identify and evaluate reasonable technologies that can be available in the timeframe
790	available.
791	Metrics
792	• Manufacturing industrial base capabilities and the manufacturing technologies applications
793	required by candidate materiel solution approaches and the impact on respective design
794	maturities have been documented for the AoA Study Guidance.
795	• Broad performance requirements for candidate materiel solution approaches that may drive
796	manufacturing and quality options have been identified and documented for the AoA Study
797	Guidance.
798	• Designs have been evaluated for the efforts necessary to mature the concepts into a mature
/99	product from immature technologies for inclusion in the AoA Study Guidance.
800	• Trade-offs to candidate materiel solution approaches to design have been assessed based
801	on experiments and results documented.

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

802 803 804 805		 Affordability, producibility, sustainability, and other appropriate "ilities" are documented. Analysis results document the necessary steps to mature the concept sufficiently to meet initial manufacturing and quality needs.
806 807 808 809 810	• •	Maturity is demonstrated and documented with a "bread-board" model, trade-off studies, and experiments as appropriate. Life-cycle sustainability has been evaluated and documented for the AoA Study Guidance. Technologies that can be available in the recommended timeframe have been identified and evaluated for the AoA Study Guidance.
811	Tools	
812	•	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
813	•	Market Research Reporting Template
814	•	MRL Assessment Questionnaire using design thread
815	•	Producibility Assessment Worksheet (PAW)
816	•	Pugh Matrix Template
817	•	TRL Assessment Checklist
818	•	TRIZ Matrix
819	Resou	rces
820	•	AS9100, Quality Management Systems - Requirements for Aviation, Space and Defense
821		Organizations
822	٠	DoD 5000.60, Defense Industrial Capabilities Assessments
823	•	DoDI 5000.60, Assessing Defense Industrial Capabilities
824	•	ISO 9001, Quality Management Systems
825	٠	DoD Market Research Guide, May 2012
826	•	MRL Deskbook Version 2.5, 2016
827	•	Producibility System Guidelines, NAVSO P-3687, Dec 1999
828	•	Technology Readiness Assessment Guidance, Apr 2011

829 **F. COST/FUNDING**

	F. Cost & Funding	F.1 Understand Production Cost	 F.2 Develop Cost Analysis	F.3 Estimate Mfg. Investment Budget	
830			-		
0.00					

831 Throughout the acquisition process, systems engineering provides the technical foundation for the

acquisition program. In the early stages of an acquisition, systems engineering analysis and products

are vital to the ability to assess appropriately the feasibility of addressing user needs, technology

- needs of potential solutions, and robust estimates of cost, schedule, and risk, all leading to
- 835 predictable, disciplined acquisition.

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

- 836 The government's objective is to determine the costs to develop, execute, field, and maintain each
- candidate materiel solution. Implementation of processes and systems that consider manufacturing,
- quality, and design functions in achieving a product design which meets cost, schedule, and
- 839 performance requirements with acceptable risk is required.

840 Appropriate practices for implementation will include parametric and production cost modeling

- 841 estimates. Parametric cost modeling requires identification of similar systems, products, components,
- and manufacturing processes, and other factors. Production cost modeling includes identification of
- 843 critical characteristics and Key Characteristics (KC) and critical and key manufacturing and test
- 844 processes; variability reduction; simulations of the manufacturing environment; cost/performance
- trade studies; manufacturing capability assessments; product and process validation; and key supplier
- 846 relationships. Depending on the candidate materiel solution, production cost modeling may have
- 847 limited application in this phase.
- 848 Part of the task or role for manufacturing and quality is to identify investments needed in the

849 industrial base or infrastructure for each candidate materiel solution. The needed investments may

850 include: additional industrial capacity, test equipment, workforce training, special materials handling,

- transportation, etc.
- Additionally, investments in processes and systems to assure program affordability, through product
- quality and manufacturing efficiency, may include for implementation: product improvement
- 854 initiatives, variability reduction on product and process, manufacturing process control and
- continuous improvement, key supplier relationships, and investments in manufacturing technology.
- 856 To that end, ongoing and future ManTech, Title III, etc., program investments need to be considered
- to achieve the desired performance while controlling or meeting acquisition cost objectives. This
- accomplished by developing, maturing, and transitioning advanced manufacturing technologies.
- 859 **F.1 Understand Production Cost**

860 Manufacturing and Quality Tasks

- Evaluate the Cost Analysis and Program Assessment (CAPE) parametric costs estimates for appropriateness and completeness of manufacturing considerations.
- 863 o Identify similar systems, products, components, and manufacturing and quality processes
 864 with established Average Procurement Unit Cost or Average Manufacturing Unit Cost (if
 865 available) for input to the parametric cost analysis and the study guidance.
- Support the development of cost estimates for each of the candidate materiel solutions for
 inclusion in the AoA Study Guidance.
- 868 Cost estimates should include:

869 870 871 872 873 874 875		 Identification of critical and key/critical product characteristics/features and critical and key/critical manufacturing and test processes Identification of variability reduction needs Simulations of the manufacturing environment Trade studies of cost/performance Capability assessments of manufacturing and quality, product and process validation, and key supplier relationships
876 877	•	Provide manufacturing and quality input to initial cost targets and error bands for candidate materiel solutions.
878	Metrio	CS
879 880 881 882	•	Analysis of CAPE parametric costs for manufacturing and quality cost estimates have been completed and documented with recommendations for the AoA Study Guidance. Manufacturing and quality cost estimates for the candidate materiel solutions have been evaluated and results provided for inclusion in the AoA Study Guidance.
883		• Cost estimates include documentation for:
884 885 886 887 888 889 890		 Critical and key product characteristics/features and critical and key manufacturing processes Variability reduction needs Manufacturing environment simulation results Trade study cost/performance results Capability assessment results of manufacturing and quality, product and process validation, and key supplier relationships
891 892	•	Initial cost targets and error bands reviewed and results documented for inclusion in the AoA Study Guidance.
893	Tools	
894	•	Analogy and Parametric Estimating Techniques
895	•	Cost Analysis Requirements Description Template (CARD) (see CAPE website for tools)
896	•	Manufacturing Readiness Level (MRL) Assessment Questionnaire, Cost Thread
897	•	Cost and Lead Time Estimating Worksheet
898	•	Manufacturing Cost Estimating worksheet
899	Resou	rces
900	٠	Cost Analysis Requirements Description (CARD) Template (See CAPE website for
901	-	guidance)
902	•	DAG Chapter 5.4, Cost Estimation for MDAPs

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

903	• Defense Manufacturing Management Guide for Program Managers, Chapter 9,
904	Manufacturing Cost Estimating
905	 DoDI 5000.73, Cost Analysis Guidance and Procedures, Jun 2015
906	• MRL Deskbook Version 2.5, 2016
907	• MIL-HDBK 766, Design to Cost, 1989
908	Parametric Estimating Handbook, Apr 2008
909	F.2 Develop Cost Analysis
910	Manufacturing and Quality Tasks
911	• Identify the applicable guidance for developing manufacturing and quality cost estimates
912	• Identify investments needed in the industrial base or infrastructure for each candidate
913	materiel solution
914	• Support initial document development of the CARD with the manufacturing and quality
915	inputs for the appropriate cost categories (e.g., producibility study costs).
916	• Identify any manufacturing and quality cost implications for candidate materiel solutions.
917	• Identify manufacturing and quality cost drivers of candidate materiel solutions (e.g.,
918	proposed materials and process selections that may be inherent).
919	• Conduct manufacturing and quality cost sensitivity analysis where appropriate if possible.
920	• Identify manufacturing and quality workforce and integration cost requirement implications.
921	• Part of the task or role for manufacturing and quality is to identify investments needed in the
922	industrial base or infrastructure for each candidate materiel solution. The needed investments
923	may include: additional industrial capacity, test equipment, workforce training, special
924	materials handling, transportation, etc.
925	Metrics
926	• Guidance for developing manufacturing and quality cost estimates has been documented and
927	included in the AoA Study Guidance.
928	• Manufacturing and quality cost sensitivity analysis (where appropriate) has been
929	conducted
930	• Manufacturing and quality workforce and integration cost requirement implications
931	 Process for estimating life cycle costs
932	• Manufacturing and quality inputs for the appropriate cost categories for the CARD have been
933	developed and provided.
934	• Manufacturing and quality cost implications for candidate materiel solutions have been
935	documented in the AoA Study Guidance.
936	• Manufacturing and quality cost drivers of candidate materiel solutions (e.g., proposed
937	materials and process selections that may be inherent) have been documented in the AoA
938	Study Guidance.

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

939	Tools			
940 941	• Cost/Schedule Control System Criteria (widely replaced by Earned Value Management, but could use on a small project)			
942	Manufacturing Cost Estimating Spreadsheet			
943	Manufacturing Readiness Level Assessment (MRL) Questionnaire using the Cost Thread			
944	• See CAPE website for tools			
945	Resources			
946	Cost/Schedule Control System Criteria Reference Guide, Sep 1992			
947	Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for			
948	Program Managers, Chapter 9			
949	• See CAPE website for guidance			
950	F.3 Estimate Manufacturing and Quality Investment Budget			
951	Manufacturing and Quality Tasks			
952	• Estimate investments required for candidate materiel solution approach			
953	• Capital equipment (tooling, machines, structures, etc.)			
954	• Test equipment (specialized, environmental, etc.)			
955	• Facilities and modifications/expansion (handling, storage, transportation, disposal)			
956	• Government-furnished equipment (GFE)			
957	• Identify new or high risk manufacturing and quality processes that require investments as			
958	part of a manufacturing feasibility assessment to meet concept needs			
959	 Assess ongoing ManTech, Title III, etc. program investments 			
960	o Identify future ManTech, Title III, etc. program investments			
961	Metrics			
962	• Manufacturing and quality investments for the candidate materiel solutions have been			
963	developed and evaluated with results provided for inclusion in the AoA Study Guidance.			
964	Including:			
965	• Capital equipment (tooling, machines, structures, etc.)			
966	• Test equipment (specialized, environmental, etc.)			
967	• Facilities and modifications/expansion (handling, storage, transportation, disposal)			
968	o GFE			
969	• New or high-risk manufacturing and quality processes have been identified, documented, and	d		
970	addressed in either an ongoing or future ManTech or other program budget request.			

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

971 **Tools**

- Manufacturing Cost Estimating Spreadsheet
- Manufacturing Readiness Level (MRL) Assessment Questionnaire using the Cost Thread
- See CAPE website for tools http://www.cape.osd.mil/

975 **Resources**

- MRL Deskbook Version 2.5, 2016
- See CAPE website for guidance http://www.cape.osd.mil/

978 G. MATERIALS MANAGEMENT



980 Materials management is a key focus area of manufacturing and quality tasks for the concepts being

981 considered for development. Material management will require assessment of the maturity, the

materials availability, the capability and capacity of the proposed supply chain to provide the

983 materials, and the potential need for special handling, government-furnished property (GFP), shelf

984 life, security, storage, environmental, etc. requirements.

985 The assessment will identify the need for any additional research to mature materials and identify the

986 properties, characteristics, and quality deemed necessary to support the concepts being considered.

987 Material properties, characteristics, and quality will require experiments for validation and

988 assessment for basic manufacturability.

989 The assessment will also identify materials that are available to support the concepts being

990 considered, as well as the manufacturing, quality, and scale-up risks and issues. It will also identify

those materials that are not readily available and will include identification of sources of material

992 (from the NTIB or foreign sources).

The complexity of the DoD supply chain for a weapon system is staggering with a supply chain that

994 often encompasses hundreds of vendors and subcontractors. Adding to the complexity is the fact that

995 on many large weapon system programs the prime contractor is often the integrator, with much of the 996 program content coming from subcontractor, government, and other vendors or suppliers. Thus

997 managing the supply chain, which includes the materials and the associated schedules, becomes a

998 key and critical management function.
999	G.1 Understand Materials Maturity Requirements
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1000 Manufacturing and Quality Tasks

1001 1002	•	Identify needed material properties, characteristics, and quality for each candidate materiel solution.
1003		• Identify and document appropriate metrics for evaluating materials against requirements.
1004 1005 1006 1007	•	Identify additional research and development (R&D) and experiments required for immature materials for validation and assessment of basic manufacturability Investigate ongoing programs (DoD, science and technology (S&T), commercial, government, etc.) to identify materials that address each candidate materiel solution needs.
1008		• Assess materials manufacturing maturity
1009	•	Perform volatility assessments for each candidate materiel solution:
1010 1011 1012 1013		 Potential supply chain sources for critical materials Hazardous materials Special handling procedures that were applied in the lab and include in lead time estimates
1014	Metric	CS
1015 1016	•	Material properties for candidate materiel solution approaches have been identified and documented for the AoA Study Guidance.
1017		• Identified metrics for evaluating materials have been specified and documented.
1018 1019 1020 1021	•	Required R&D and experiments for immature materials that have been developed and tested in a lab environment have been investigated and assessed and results documented. Ongoing programs (DoD, S&T, commercial, government, etc.) have been investigated and assessed for materials that support candidate materiel solution and results documented.
1022		solution
1024	•	Volatility assessments for each candidate materiel solution were conducted and document:
1025 1026 1027 1028		 Potential supply chain sources for critical materials Hazardous materials Special handling procedures that were applied in the lab and include in lead time estimates
1029	Tools	
1030	•	Market Research Reporting Template

1031 • MRL Questionnaire for Material Management thread

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

1032	• Design for Six Sigma (Tools)
1033	Design of Experiments Analysis
1034	Taguchi Loss Function Analysis
1035	Resources
1036	• MRL Deskbook Version 2.5, 2016
1037	G.2 Characterize Materiel Availability
1038	Manufacturing and Quality Tasks
1039 1040 1041 1042	 Identify the availability of essential raw materials, special alloys, composite materials, and components, required to support the concepts being considered. Assess material requirements, external dependencies, and availability for candidate materiel solutions.
1043	• Identify materials that are:
1044 1045 1046 1047	 Developed in a lab environment, but are not immediately available Readily available within near term (i.e., commodities) Commercially available, but have long lead times Readily available, but have environmental or health concerns
1048 1049 1050	 Assess material scale-up issues for candidate materiel solutions. Identify items that are sole or single sourced, fragile source, or available only from sources outside the NTIB.
1051 1052 1053 1054	 Assess the availability and lead time for of alternatives for obtaining such items from within the NTIB Conduct an analysis of any military vulnerability or gaps that could result from the lack of reasonable alternatives.
1055 1056	• Assess the effects on the NTIB that result from foreign acquisition of firms in the United States.
1057	Metrics
1058 1059 1060	• Assessment of material requirements, external dependencies, and availability for candidate materiel solutions has been conducted and documented and identifies materials, special alloys, composite materials, and components that are:
1061 1062 1063 1064	 Developed in a lab environment, but are not immediately available Readily available within near term (i.e., commodities) Commercially available, but have long lead times Readily available, but have environmental or health concerns

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1065	•	Assessment of material scale-up issues for candidate materiel solutions has been conducted				
1066		and documented.				
1067	•	Items that are sole or single sourced, fragile source, or available only from sources outside				
1068		the NTIB have been identified and documented.				
1069		• Availability and lead time for of alternatives for obtaining such items from within the				
1070		NTIB have been identified and documented				
1071		• Analysis of any military vulnerability or gaps that could result from the lack of				
1072		reasonable alternatives has been completed and documented				
1072						
1073	•	Any domestic sources that are vulnerable to foreign acquisition have been identified and				
10/4		documented.				
1075	Tools					
1076	٠	Cost and Lead Time Estimating Worksheet				
1077	•	Diminishing Manufacturing Sources and Material Sources (DMSMS) Product Life Cycle				
1078		Assessment (Consult Defense Logistics Agency (DLA))				
1079	•	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center				
1080	•	MRL Assessment Ouestionnaire for Material Management thread				
1081	•	Market Research Reporting Template				
1082	•	Technology Readiness Level Assessment Checklist				
1002	·	Technology Readiness Level Assessment Checklist				
1083	Resou	rces				
1084	•	DMSMS Guidebook, SD-22, Sep 2009				
1085	٠	MRL Deskbook Version 2.5, 2016				
1086	G.3	Understand Materials Supply Chain Requirements				
1087	Manu	facturing and Quality Tasks				
1088	•	Conduct an initial assessment of potential supply chain capability and capacity for candidate				
1089		materiel solution approaches				
1090	•	Recommend industry best practices to be followed for management of the materials supply				
1090	·	chain for the concepts being considered				
1071		chain for the concepts being considered.				
1092		• Include industry best practices for manufacturing and quality to be followed in the supply				
1093		chain for the concepts being considered.				
1094	٠	Recommend manufacturing and quality processes or standards for the procurement team to				
1095		follow to provide a basis for the team to work together and add value.				
1096	٠	Establish a threshold and objective requirements for flow down of realistic and attainable				
1097		requirements for a new concept to the supply chain as appropriate.				

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

1098		• Identify realistic material estimates (time, material, manpower, etc.) to be provided to the
1099		entire supply chain
1100		• Evaluate the flow down process for gaps throughout the entire supply chain
1101	Metri	cs
1102	٠	An initial assessment of potential supply chain capability and capacity for candidate materiel
1103		solution approaches has been conducted and documented.
1104	•	Documentation of industry best practices for management of the materials supply chain for
1105		the concepts being considered has been included in the AoA Study Guidance.
1106		• Documentation includes recommendations for manufacturing and quality best practices
1107		to be followed by the supply chain
1108	•	Supplier management manufacturing and quality processes or standards based on industry
1109		best practices have been flowed to the entire procurement team and documented in the AoA
1110		Study Guidance.
1111	٠	Threshold and objective requirements for flow down of realistic and attainable requirements
1112		for a new concept has been developed and documented.
1113		• Realistic material estimates (time, material, manpower, etc.) have been developed to be
1114		provided to the entire supply chain.
1115		• Gaps in the flow down process throughout the supply chain with recommended
1116		alternatives have been documented.
1117	Tools	
1118	•	Manufacturing Readiness Level (MRL) Assessment Questionnaire using materials thread
1119	•	Supply Chain Management Risk Assessment Checklist
1120	Resou	irces
1121	•	DoD Market Research Guide, May 2012
1122	•	MRL Deskbook Version 2.5, 2016
1123	•	DoD 4140.1-R, Supply Chain Management Regulation, May 2003
1124	•	DoDM 4140.1, DoD Supply Chain Management Procedures, Feb 2014
1125	G.4	Understand Special Requirements (e.g., Government-Furnished Property (GFP).
1126		Shelf Life, Security, Hazardous Materials, Storage Environment)
1127	Manu	facturing and Quality Tasks
1128	•	Identify the special requirements in the manufacturing processes which will be utilized to
1129		build the candidate materiel solution approaches.
1130		• Hazardous materials and handling procedures

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

1131 1132 1133 1134 1135 1136	•	 Security requirements Storage and shelf life GFP, GFE (tooling, test equipment, ranges, chambers, etc.) Disposal Identify potential regulatory requirements, handling concerns, transportation, etc. for callet materiel solution approaches.
1137	Metrio	cs
1138 1139	•	The special requirements in the manufacturing processes which will be utilized to build the candidate materiel solution approaches have been identified and documented
1140 1141 1142 1143 1144		 Hazardous materials and handling Security requirements Storage and shelf life GFP, GFE (tooling, test equipment, ranges, chambers, etc.) Disposal
1145 1146	•	Potential regulatory requirements, handling concerns, transportation, etc. for candidate materiel solution approaches have been identified and documented.
1147	Tools	
1148	٠	Cyber Security Assessment
1149	٠	DMSMS Product Life Cycle Assessment
1150	٠	Hazardous Material Assessment Template
1151	٠	ISO 9001, Checklist Section 7.5.5, Preservation (Handling, Storage, Packaging and Delivery)
1152	٠	ITAR Compliance Checklist
1153	٠	Preliminary Hazard List (PHL) See PHA checklist
1154	•	Shelf Life Calculator for Composite Materials
1155	٠	MRL Assessment Checklist for Material Management Thread
1156	Resou	rces
1157	٠	ISO 9001, Quality Management Systems
1158	٠	MRL Deskbook Version 2.5, 2016
1159	٠	ESOH in Acquisition Guide, Apr 2009
1160	•	AS9100 Supply Chain Management (SCM) Model

H. PROCESS CAPABILITY AND CONTROL 1161

H. Process Capab & Control	lity	H.1 Investigate M&S Capabilities	H.2 Investigate Mfg Process Maturity	H.3 Develop Process Yield & Rate Estimates	
52					

- 1163 Advances in digital engineering; modeling and simulation (M&S) along with continual
- 1164 improvements in computer performance have made it possible to perform comprehensive analysis of
- 1165 virtual parts and to test and assess the capability of processes before actual manufacturing begins.
- 1166 Through the use of solid modeling, finite element analysis, multi-paradigm numerical computing
- 1167 environments, and simulation software analysis tools, users are able to simulate different conditions
- that are likely to occur during manufacturing processes and model the behavior of systems under
- real-world conditions. An understanding of the capabilities to model products and processes for each
- 1170 of the concepts under consideration can be a valuable discriminator.
- 1171 The goal of manufacturing and quality is to achieve uniform, defect-free products, and it is the job of
- 1172 the manufacturing and quality team to reduce or eliminate the sources of variation and uncertainty to
- 1173 meet this goal. For each concept being considered, a determination of the manufacturing processes
- 1174 (possibly at a high level) will be completed. This assessment of manufacturing feasibility will include
- 1175 the investigation of process maturity for similar manufacturing processes. Critical and key
- 1176 manufacturing processes can also be identified during the assessment and analysis either through
- 1177 M&S or experimentation.
- 1178 The activities managing the concept and program offices must understand the "manufacturing
- 1179 feasibility" (i.e., manufacturing risks) that are associated with each potential materiel solution. For
- 1180 example, many managers are under the false perception that identical production facilities will
- 1181 experience identical problems, this is almost always not the case. Another assumption that may also
- 1182 be made is when a facility that has operated smoothly in one location, it will again operate smoothly
- 1183 if moved to another location. Again, this is almost always not the case, even if the same workforce is
- 1184 utilized; variability due to disassembly, movement, and reassembly will occur. A source of
- 1185 information for these feasibility risks comes from the "lessons learned" data captured by contractors
- as part of their systems to capture their overall capabilities, knowledge, and best manufacturing
- 1187 practices. Incorporating lessons learned from investigations of similar manufacturing processes
- 1188 maturity into the models and simulations may also increase fidelity of results and characterization of
- 1189 the items being analyzed.
- 1190 Most companies use M&S and other data analysis tools to help identify, analyze, and remove
- bottlenecks in the production process, improve yields, reduce costs, and improve quality. By
- 1192 collecting and analyzing the manufacturing and quality data, one is able to get a realistic picture of
- the entire process. A process has three features: how much variation (spread), where (centering), and
- shape (normal, skewed, bimodal, etc.). If processes are stable, then the process features, spread,
- 1195 centering, and shape, will remain constant and predictable over time. If the process is unstable, then
- these features will change, and the product output will become unpredictable. Data and information
- 1197 from similar manufacturing processes, as well as M&S processes, should be utilized to develop
- estimates of potential yields and rates of production of each concept under consideration as a
- 1199 discriminator as to which has the greatest potential to meet manufacturing and quality requirements.

1200	H.1 Investigate Modeling and Simulation (Product and Process) Capabilities
1201	Manufacturing and Quality Tasks
1202 1203	• Investigate initial product and or process models in development for candidate materiel solution approaches.
1204 1205	 Investigate manufacturing concepts or producibility modeling and simulation needs of candidate materiel solution approaches.
1206 1207 1208	• Identify modeling and simulation tools that make it possible to perform a comprehensive analysis of virtual parts and to assess the capability of processes before actual manufacturing begins.
1209 1210	• Utilize modeling and simulation software to model the behavior of candidate materiel solutions under simulated "real-world" conditions.
1211 1212	• Establish requirements and data needs for the learning curve (cost improvement curve, or experience curve).
1213	Metrics
1214 1215	• Initial product and or process models in development for candidate materiel solution approaches have been identified, assessed, and documented.
1216 1217	• Manufacturing concepts or producibility modeling and simulation needs of candidate materiel solution approaches have been identified, assessed, and documented.
1218 1219 1220	• Modeling and simulation tools that make it possible to perform a comprehensive analysis of virtual parts and to assess the capability of processes before actual manufacturing begins have been identified, evaluated, and documented.
1221 1222 1223	• Identify and document the tools and simulation software being utilized to model the behavior of candidate materiel solutions under simulated "real-world" conditions and the results (i.e., FEA).
1224 1225	 Planned learning curve and data requirements (cost improvement curve, or experience curve) have been developed and documented.
1226	Tools
1227 1228	• Solid modeling and analysis software programs (e.g., NX, CATIA, Pro-Engineer, Nastran add-ins, etc.)
1229	Process Modeling Tools (Siemens PLM, Delmia, etc.)
1230	 Plant Modeling and Simulation tools (FlexSim, SimFactory, etc.) Learning Currie Analysis Strandohoot
1231 1232	 Learning Curve Analysis Spreadsheet MRL Assessment Checklist for the Process Capability and Control Thread
1233	Resources
1234	• Modeling and Simulation Guidance for the Acquisition Workforce, Oct 2008

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1235	• MRL Deskbook Version 2.5, 2016
1236	Manufacturing Simulation Applications
1237	H.2 Investigate Manufacturing Process Maturity
1238	Manufacturing and Quality Tasks
1239 1240 1241 1242 1243	 Assess feasibility of similar materials and/or similar manufacturing process approaches, and the projected gaps based on the data collected for each concept under consideration for the AoA Study Guidance. Conduct a manufacturing feasibility assessment that identifies the manufacturing and quality risks incurred for each concept under consideration, which should include:
1244 1245 1246 1247 1248 1249 1250 1251	 Producibility of the potential design concepts Critical and key manufacturing processes Special tooling development required Demonstration, test, and qualification required for new materials, to include items, parts and components Alternate design approaches within the individual concepts Lessons learned from similar approaches Anticipated manufacturing and quality risks and potential cost and schedule impacts
1252	Metrics
1252 1253 1254 1255	 Metrics A feasibility assessment of similar material and/or similar manufacturing process approaches for the AoA Study Guidance has been conducted and documented for each concept under consideration.
1252 1253 1254 1255 1256	 Metrics A feasibility assessment of similar material and/or similar manufacturing process approaches for the AoA Study Guidance has been conducted and documented for each concept under consideration. Collect data and document the data results for the AoA Study Guidance
1252 1253 1254 1255 1256 1257 1258	 Metrics A feasibility assessment of similar material and/or similar manufacturing process approaches for the AoA Study Guidance has been conducted and documented for each concept under consideration. Collect data and document the data results for the AoA Study Guidance A feasibility assessment that identifies the manufacturing and quality risks incurred for each concept under consideration has been conducted and documents the following:
1252 1253 1254 1255 1256 1257 1258 1259 1260 1261 1262 1263 1264 1265 1266	 Metrics A feasibility assessment of similar material and/or similar manufacturing process approachess for the AoA Study Guidance has been conducted and documented for each concept under consideration. Collect data and document the data results for the AoA Study Guidance A feasibility assessment that identifies the manufacturing and quality risks incurred for each concept under consideration has been conducted and documents the following: Producibility of the potential concepts Critical and key manufacturing processes Special tooling development required Demonstration, test, and qualification required for new materials, to include items, parts and components Alternate design approaches within the individual concepts Lessons learned from similar approaches Anticipated manufacturing and quality risks and potential cost and schedule impacts
1252 1253 1254 1255 1256 1257 1258 1259 1260 1261 1262 1263 1264 1265 1266 1267	 Metrics A feasibility assessment of similar material and/or similar manufacturing process approaches for the AoA Study Guidance has been conducted and documented for each concept under consideration. Collect data and document the data results for the AoA Study Guidance A feasibility assessment that identifies the manufacturing and quality risks incurred for each concept under consideration has been conducted and documents the following: Producibility of the potential concepts Critical and key manufacturing processes Special tooling development required Demonstration, test, and qualification required for new materials, to include items, parts and components Alternate design approaches within the individual concepts Lessons learned from similar approaches Anticipated manufacturing and quality risks and potential cost and schedule impacts

1269 1270 1271 1272 1273	 MRL Assessment using Process Capability and Control Thread Process Capability Studies (Cp and Cpk assessment) Producibility Assessment Worksheet (PAW) Six Sigma Worksheet First Pass Yield Estimates Worksheet
1274	Resources
1275	• Producibility Systems Guidelines, NAVSO P-3687, Dec 1999
1276	H.3 Develop Process Yield and Rate Estimates
1277	Manufacturing and Quality Tasks
1278	• Develop and estimate yields and rates of candidate materiel solution approaches.
1279	• Conduct a manufacturing and quality study of existing processes and the need for new
1280	processes for each concept under consideration to determine if the yield meets the
1281	requirements.
1282	• Identify the sources of variations and plans to address for each concept under consideration.
1283	Metrics
1284	• Estimated yields and rates for each candidate materiel solution approach have been
1285	developed, evaluated, and documented.
1286	• A manufacturing and quality study of existing processes and the need for new processes, and
1287	corresponding process yields to meet the requirements has been conducted and documented.
1288	• Sources of variations and plans to address have been identified and recommended actions to
1289	be taken documented for each concept under consideration.
1290	Tools
1291	Cause and Effect Diagram
1292	First Pass Yield Estimates Worksheet
1293	• Histograms
1294	Pareto Analysis
1295	Process Capability Study Worksheet (Cp and Cpk Assessment)
1296	Six Sigma Worksheet
1297	Resources
1298	• DoD-Wide Continuous Process Improvement (CPI/Lean Six Sigma) Program, may 2008
1299	DoD Continuous Process Improvement Transformation Guide, May, 2006

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

1300 I. QUALITY MANAGEMENT

301	I. Quality	I.1 Quality Management Requirements	I.2 Product Quality Requirements	1.3 Supplier Quality Management Requirements	
1302	DoD has increase	ed management focus or	n manufacturing and qual	ity management during early	

program phases. Quality is the degree to which material attributes, performance features, and
characteristics of a product satisfy a given need. Quality may apply to a product, process, or system
and may be physical, sensory, behavioral, temporal, ergonomic, or functional.

- 1306 Quality management is the coordinated activities to direct and control an organization with regard to
- 1307 quality policy, quality objectives, quality planning, quality assurance and quality improvement. The
- 1308 quality of systems is significantly influenced by design and manufacturing processes and disciplines.
- 1309 These activities are performed as part of the Quality Management System (QMS), which is that part
- 1310 of the organization's management system that focuses on the results, in relation to the quality
- 1311 objectives, to satisfy the needs, expectations and requirements. In turn, Quality Assurance is that part
- 1312 of quality management focused on providing confidence that quality requirements will be fulfilled.
- 1313 Quality management is an integral part of design and development efforts. QMS standards include
- 1314 industry best practices such as ISO 9001, *Quality Management Systems-Requirements;* and AS9100,
- 1315 Quality Management Systems Requirements for Aviation, Space and Defense Organizations,
- 1316 Product Realization (clause 7) includes typical Systems Engineering tasks under sub-clause 7.3,
- 1317 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.
- 1325 Risk, Issue, and Opportunity Management.
- Corrective Action System.

DoDI 5000.02 guidance provides for manufacturing assessments through the entire acquisition cycle
and includes quality management and continuous improvement requirements. There are costs
associated with a manufacturing effort and meeting the quality levels required. These costs, to a great
degree, are inherent in and become essentially fixed as the design evolves. Given the objective of
minimizing cost, quality is a key element and needs to be instituted early, and is integral to planning
for the concepts being considered.

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

- 1333 The initial AS, developed in the next phase, will address the approach to quality, quality
- 1334 management, and quality assurance. Consideration of these items and their impact on the quality
- requirements should be an integral part of the in AoA Study Guidance and the final AoA.

1336 I.1 Quality Management Requirements

- 1337 Manufacturing and Quality Tasks
- 1338 Specify the quality management requirements to be met by the contractor or government • 1339 entity as appropriate. 1340 • Evaluate each concept being considered and identify the capability to meet quality 1341 management needs. 1342 • Evaluate each concept being considered and identify the need for focused manufacturing 1343 or quality plans (e.g., a program Quality Assurance Plan) to guide the approach. 1344 • Evaluate each concept being considered and identify the need for a standalone 1345 government manufacturing or quality assurance plan. 1346 Understand the impact of technology and process state of the art on the concepts being 1347 considered and the impacts on quality management. 1348 • Identify and understand potential solutions or systems that could address quality management 1349 needs. 1350 Identify and understand manufacturing and quality management lessons-learned and best 0 1351 practices among programs and across centers 1352 • Assess and evaluate quality technologies that could assist on candidate materiel solution 1353 programs 1354 Identify potential solutions or systems to improve low-yield processes and components. • 1355 Establish quality management metrics for each of the concepts being considered • 1356 Determine the frequency that the metrics should be reviewed, commensurate with 0 1357 manufacturing and quality risks. 1358 Evaluate potential QMSs for each of the concepts being considered. • 1359 The QMS should include: 0 1360 Management responsibility 1361 Resource management **Quality System** 1362 • 1363 **Contract Review** . 1364 Product Realization . 1365 **Design** Control 1366 **Document Control** Purchasing 1367

1368 1369 1370 1371		 Purchaser-Supplied Product Product Identification and Traceability Process Control Measurement, Analysis, and Improvement
1372		• Assess QMS audit records for frequency, compliance, and responsiveness
1373 1374 1375 1376	•	Ensure quality and manufacturing requirements are included in contracts and in appropriate agreements with other agencies, e.g., the DCMA. Contact DCMA for input on QMS evaluation of potential contractors and suppliers for each concept being considered.
1377	Metri	cs
1378 1379 1380 1381	•	Document the quality management requirements to be met by the contractor or government entity as appropriate for the AoA Study Guidance. Analyze and document the capability to meet quality management needs for each concept being considered, and
1382 1383 1384 1385 1386 1387		 Analyze and document the need for focused manufacturing or quality plans (e.g., a program Quality Assurance Plan) to guide the approach for each concept being considered and provide as input to the AoA Study Guidance. Analyze and document the need for a standalone government manufacturing or quality assurance plan for each concept being considered and provide as input to the AoA Study Guidance.
1388 1389 1390 1391	•	Document the impact of quality technology and process state of the art on the concepts being considered and the impacts on quality management. Identify and document potential solutions or systems to be included in the AoA Study Guidance that could address quality management needs to include:
1392 1393 1394 1395 1396		 An assessment of manufacturing and quality management lessons-learned and best practices among programs and across centers An assessment of quality technologies that could assist on candidate solution programs Potential solutions to improve low-yield processes and components and lower variability to meet quality management requirements
1397	٠	Identify and document quality management metrics for each of the concepts being considered
1398 1399		• The frequency that the metrics should be reviewed has been established, commensurate with manufacturing and quality risks.
1400 1401	•	Assess, analyze and document for each concept being considered, the potential QMS for inclusion in the AoA Study Guidance.
1402		• The QMS is established, based on industry best practices, and should include:

1403	 Management responsibility
1404	 Resource management
1405	 Quality System
1406	 Contract Review
1407	 Product Realization
1408	 Design Control
1409	 Document Control
1410	 Purchasing
1411	 Purchaser-Supplied Product
1412	 Product Identification and Traceability
1413	 Process Control
1414	 Measurement, Analysis, and Improvement
1415	• QMS audit records for frequency, compliance, and responsiveness
1416	• Quality and manufacturing requirements have been documented and included in contracts
1417	and in appropriate agreements with other agencies, e.g., the DCMA.
1418	• DCMA inputs on evaluation of contractor's and supplier's QMS documented and
1419	incorporated into QMS analysis for AoA Study Guidance.
1420	Tools
1421	AS9100 Quality Audit Checklist
1422	Critical to Customer Assessment
1423	Critical to Quality Tree
1424	• ISO 9001, Quality Management Systems, Quality Audit Checklist
1425	• Manufacturing Readiness Level (MRL) Assessment Questionnaire for the Quality Thread
1426	 Quality Management Plan (Sample)
1/127	Resources
1420	
1428	AFMC Instruction 63-145 Manufacturing and Quality
1429	AS9100 Quality Management System - Aerospace
1430	• DAG Chapter 14.3.1.3.6, Quality Plans
1431	• DoDI 5000.02
1432	ISO 9001, Quality Management Systems
1433	• MRL Deskbook Version 2.5, 2016
1434	I.2 Product Quality Requirements
1435	Manufacturing and Quality Tasks
1436	• Evaluate product quality requirements for each concept being considered:

1437 1438 1439 1440 1441		 Identify product quality metrics and the frequency that the metrics should be reviewed, commensurate with manufacturing and quality risks. Identify the need for focused product quality requirements (i.e., specific product characteristics) to guide the approach. Identify the need for a standalone government product quality requirements.
1442	•	Identify and understand potential solutions that could address product quality needs.
1443 1444 1445 1446		 Assess and evaluate quality technologies (e.g., metrology technologies) that could improve the candidate materiel solution's product quality. Identify potential solutions to improve low-yield processes and components for each candidate materiel solution's product quality.
1447 1448 1449 1450	•	Understand the impact of quality technology and process state of the art on the product quality requirements of the concepts being considered. Contact DCMA for inputs on potential contractor and supplier quality performance against requirements for similar products or processes.
1451	Metrio	CS
1452	•	Analyze and document in the AoA Study Guidance for each concept being considered:
1453 1454 1455 1456 1457 1458 1459		 Product quality requirements Product quality metrics and the frequency that the metrics should be reviewed, commensurate with manufacturing and quality risks that have been determined. The need for focused product quality requirements (i.e., specific product characteristics) to guide the approach for each concept being considered and provide as input. The need for standalone government product quality requirements for each concept being considered and provide as input.
1460 1461	•	Identify and document potential solutions that could address product quality needs to include (but not limited to):
1462 1463 1464		 An assessment of quality technologies that could assist on candidate solution programs Potential solutions to improve low-yield processes and components and lower variability to meet product quality requirements
1465 1466 1467	•	Document the impact of quality technology and process state of the art on the concepts being considered and the impacts on product quality requirements for the concepts being considered.
1468 1469 1470 1471	•	Inputs on potential contractor and supplier quality performance against requirements for similar products or processes provided by DCMA are incorporated into analysis of potential contractors and suppliers for each concept being considered and provide as input to the AoA Study Guidance.

1472	Tools
1473	AS9100 Quality Audit Checklist
1474	Critical to Customer Assessment
1475	Critical to Quality Tree
1476	ISO 9001, Quality Management Systems, Quality Audit Checklist
1477	Quality Management Plan (Sample)
1478	Resources
1479	• AS9100
1480	• DAG Chapter 14.3.1.3.6, Quality Plans
1481	• DoDI 5000.02
1482	ISO 9001, Quality Management Systems
1483	I.3 Supplier Quality Management Requirements
1484	Manufacturing and Quality Tasks
1485	• Understand the impact of quality technology and process state of the art for the concepts
1486	being considered and the impacts on the supply chain (i.e., supplier's) quality management.
1487	• Evaluate each concept being considered and identify supply chain quality management needs.
1488	• Evaluate each concept being considered and identify the need for focused supplier quality
1489	management requirements (e.g., a supplier Quality Assurance Plan) to guide the
1490	approach.
1491	• Evaluate each concept being considered and identify the need for a standalone
1492	government supplier quality plan for the supply chain.
1493	• Establish supply chain quality management metrics for each of the concepts being considered
1494	• Determine the frequency that the metrics should be reviewed, commensurate with
1495	manufacturing and quality risks.
1496	• Identify and understand potential solutions, tools, and techniques that could address supplier
1497	quality management requirements.
1498	• Assess and evaluate quality technologies (i.e., metrology technologies) that could
1499	improve the candidate materiel solution's supply chain programs.
1500	o Identify potential solutions (e.g., materials, machines, training, etc.) to improve low-yield
1501	processes and components and lower variability to meet supplier quality management
1502	requirements for each candidate materiel solution.
1503	• Contact DCMA for input on evaluation of potential supplier's quality management (in the
1504	lower supply chain) for each concept being considered.

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

1505 Ensure quality and manufacturing requirements are included in contracts of proposed • 1506 suppliers and in appropriate agreements with other agencies, e.g., the DCMA. 1507 Metrics 1508 • Document the impact of quality technology and process state of the art on the concepts being 1509 considered and the impacts on supply chain quality management. Analyze and document supply chain quality management needs for each concept being 1510 • 1511 considered, and 1512 • Analyze and document the need for focused supplier quality management requirements 1513 (e.g., a supplier Quality Assurance Plan) to guide the approach for each concept being 1514 considered and provide as input to the AoA Study Guidance. 1515 • Analyze and document the need for a standalone government supplier quality plan for the 1516 supply chain of each concept being considered and provide as input to the AoA Study 1517 Guidance. 1518 Analyze and document supply chain quality management metrics for each of the concepts 1519 being considered 1520 The frequency that the metrics are reviewed has been established, commensurate with 0 1521 manufacturing and quality risks. 1522 Identify and document potential solutions, tools, and techniques that could address supplier • 1523 quality management needs to include (but not limited to): 1524 An assessment of quality technologies (i.e., metrology technologies) that could assist on 0 1525 candidate solution supply chain programs 1526 • Potential solutions (e.g., materials, machines, training, etc.) to improve low-yield 1527 processes and components and lower variability to meet supplier quality management requirements 1528 1529 • DCMA inputs on evaluation of potential supplier's quality management (in the lower supply 1530 chain) for each concept being considered documented and incorporated into analysis for AoA 1531 Study Guidance. 1532 • Quality and manufacturing requirements have been documented and included in contracts of 1533 proposed suppliers and in appropriate agreements with other agencies, e.g., DCMA. 1534 Tools 1535 • AS9100 Quality Audit Checklist 1536 Critical to Customer Assessment 1537 • Critical to Quality Tree 1538 • ISO 9001, Quality Management Systems, Quality Audit Checklist 1539 Supplier Quality Questionnaire

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

• Quality Management Plan (Sample)

1541 **Resources**

- AS9100 Quality Management Systems
- DAG Chapter 14.3.1.3.6, Quality Plans
- 1544 DoDI 5000.02
- ISO 9001, Quality Management Systems

1546 J. MANUFACTURING WORKFORCE



1548 Manufacturing feasibility and industrial base analyses of the concepts being considered should

address the existing skills of the appropriate workforce. The manufacturing and quality workforce

has been ageing in recent decades, especially in many key defense sectors. Established

1551 manufacturing capabilities are becoming high risks as skills, facilities, equipment, etc. atrophy.

1552 Manufacturers have experienced a moderate to severe shortage of available, qualified production

1553 workers; a moderate to severe skills shortage in their overall workforce; and anticipate these

shortages to grow worse in the coming years; and workforce shortages and skills deficiencies in

1555 production roles are having a significant impact on their ability to expand operations or improve 1556 productivity.

1557 This trend is being addressed through increased emphasis on Science, Technology, Engineering and

1558 Math (STEM) skills to improve the current capabilities and achieve the right levels of skills. Along

1559 with education, training of personnel is key, as is having experience in the relevant areas of

1560 management. The workforce needs to be continuously improved through training and experience.

1561 The lessons learned show that manufacturing drives long-term economic prosperity and growth, and

1562 is important to the DoD mission.

1563 J.1 Identify Manufacturing Workforce (Engineering and Production) Requirements

- 1564 Manufacturing and Quality Tasks
- Identify new manufacturing and quality skills and training requirements for candidate
 materiel solution approaches.
- Identify planned personnel loadings to ensure that adequate numbers of people with the required skills are made available for each candidate material solution approach
- 1569 Define a profile of the required workforce
- 1570 o Identify workforce requirements, special skills and training requirements.
- 1571 Identify sources of personnel and their potential availability
- 1572 Plan for the acquisition and training of new personnel

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1573 1574 1575 1576 1577 1578 1579	•	Review appropriate workforce lessons learned to initiate development of tools and techniques that can be used to establish a better manufacturing workforce strategy. Understand new materials and technologies as they evolve and how the manufacturing and quality workforce will address processing, testing, and acceptance of these materials Identify potential regulatory requirements and special handling (e.g., hazardous materials, environmental needs, storage requirements, etc.) impacts to the manufacturing workforce by the candidate materiel solution approaches.
1580	Metrio	cs
1581	٠	New manufacturing skills for candidate materiel solution approaches have been identified
1582		and documented.
1583	•	Workforce requirements, including special skills and training requirements have been
1584		identified, assessed, documented for the AoA Study Guidance, and includes:
1585		• Adequacy of the planned personnel loadings, ensuring that the required people with the
1586		required skills are available
1587		• Profile of the workforce required
1588		• Workforce requirements, special skills, and training requirements
1589		• Sources of personnel with evidence of their potential availability have been determined
1590 1591		activity managing the concept or the program office
1592	٠	Workforce Lessons Learned have been reviewed and documented with appropriate Lessons
1593		Learned applied to development of tools and techniques for a better manufacturing workforce
1594		strategy.
1595	٠	Impacts of new materials and technologies on the manufacturing and quality workforce has
1596		been assessed and documented for each concept including impacts of processing, testing, and
15097		acceptance of these materials and technologies.
1598	•	environmental needs, storage requirements, etc.) impacts to the manufacturing workforce for
1600		each concept has been assessed and documented for the AoA Study Guidance.
1601	Tools	
1602	٠	Assembly Chart Analysis
1603	٠	Bottleneck Analysis (Theory of Constraints)
1604	•	Capacity Planning Worksheet
1605	•	Critical Chain Project Management
1606	•	Forecasting and Regression Analysis
1607	•	Learning Curve Estimator
1608	•	Line of Balance Template
1009	•	

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

- MRL Assessment using Manufacturing Management Thread
- Route Sheet Analysis
- Shop Floor Manufacturing Plan Analysis
- SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
- Work Measurement Analysis
- Workforce Planning Tools (SAP/Oracle/MRP II)

1616 **Resources**

- MRL Deskbook Version 2.5, 2016
- Manufacturing Resource Planning (MRP II)

1619 K. FACILITIES

1 () (K. Facilities	K.1 Evaluate Tooling/STE/SIE Requirements	K.2 Identify Facilities Requirements	
1620				

During Pre-MDD phase, the proposed industrial and manufacturing facilities should be assessed for
 resources needed by each concept being considered as a materiel solution. Assessment of facility
 needs for concepts includes real property, factory capacity and storage, special handling and special

1624 environmental requirements, storage and handling of hazardous materials, capital equipment,

1625 manufacturing processes, tooling, and materiel transportation. Utilization of new materials and

1626 technologies will often require concurrent development and procurement of new capital equipment,

1627 test equipment and facilities, and development of new quality assurance procedures and equipment.

1628 Use of test ranges and special test facilities should be listed and a notional schedule of when those

1629 government assets will be needed. Many government facilities are becoming increasingly obsolete

and constantly undergoing consolidation. The manufacturing and quality representatives should also

1631 identify any requirement for reconstitution or investment in government facilities, labs, ranges, etc.

1632 for each concept being considered.

1633 The facility includes the plant, production equipment, and waste handling and storage equipment

1634 which is to be made available to accomplish the production task. In developing the facility plan, both

1635 the quantitative and qualitative demands of the product must be considered. The quantitative analysis

1636 will determine the size of the processing departments within the facility. This analysis should

1637 consider the number of units to be delivered, and the rate of delivery. For example, the information

1638 collected in the analysis will provide a measure of the work stations, plant layout, and the floor space

- 1639 required. The qualitative analysis determines the types of processes which will be required. The
- 1640 contractor then has the option of utilizing currently existing facilities, acquiring new facilities,
- 1641 requesting government-furnished facilities (must be requested in the proposal), or subcontracting a

1642 portion of the effort.

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

1643 Funding profiles for all of the aspects of each concept being considered must provide for up front

- 1644 development of capital equipment, manufacturing processes, tooling, and verification that new
- 1645 components can be produced at production rates. A top level schedule and target costs should be
- 1646 developed. Development for each concept and installation of tooling, test equipment, and facilities
- are necessary drivers of each concept's costs and development schedule. The overall results of these
- assessments, estimates, and evaluations should be included in the AoA Study Guidance.

1649 K.1 Evaluate Tooling/Special Test and Inspection Equipment (STE/SIE) Requirements

1650	Manu

Manufacturing and Quality Tasks

1651 Identify new capital equipment and tooling required for new technology and material • manufacturing and quality processes for each concept being considered. 1652 1653 • Assess new tooling requirements for capability to produce at planned production rates 1654 and target unit costs 1655 o Assess needs for soft tooling vs. hard tooling for facility and funding impacts 1656 • Assess supplier and sub-tier capabilities and investment incentives • Assess the funding requirements and develop appropriate funding profiles 1657 1658 Evaluate each concept being considered to include alternative designs for GFE/STE/SIE 1659 • Assess the requirements for GFE/STE/SIE 1660 • Assess the capabilities of GFE/STE/SIE to meet needs 1661 • Identify requirements for unique or special transportation, handling, and storage equipment to 1662 be manufactured for each candidate materiel solution. 1663 Identify the funding required for capital equipment, manufacturing and quality processes, • 1664 tooling, and test equipment for each concept being considered. 1665 Metrics 1666 New manufacturing and quality processes requiring capital equipment and/or tooling for new • technology and materials have been identified and documented. 1667 1668 • Capital equipment and tooling requirements have been documented for inclusion in the funding profiles 1669 1670 • Capital equipment and tooling have been assessed for the capability to produce at 1671 planned production rates and target unit costs and results documented 1672 Each concept being considered including alternative designs has been assessed for STE/SIE • 1673 The requirements for STE/SIE have been evaluated and documented 0 1674 The capabilities of STE/SIE to meet needs have been evaluated and documented 0

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

1675 1676 1677	• Requirements for unique or special transportation, handling, and storage equipment to be manufactured for each candidate materiel solution have been identified and included in the AoA Study Guidance.
1678 1679 1680	• Funding required for capital equipment, manufacturing and quality processes, tooling, and test equipment for each concept being considered has been estimated and documented for the AoA Study Guidance.
1681	Tools
1682	Bottleneck Analysis (Theory of Constraints)
1683	Critical Chain Project Management
1684	Manufacturing Resource Planning (MRPII)
1685	MRL Assessment using Facilities Thread
1686	Resources
1687	• MRL Deskbook Version 2.5, 2016
1688	• Manufacturing Resource Planning (MRP II)
1689	K.2 Identify Facilities Requirements
1690	Manufacturing and Quality Tasks
1691	• Identify the facilities and capital equipment required by each of the concepts being
1692	considered
1693	• Identify the quantitative and qualitative demands of the each of the concepts being
1694	considered
1695	• Identify the availability, design, rate and capacity capabilities of the facilities under
1696	consideration (existing, new, or redeveloped)
1608	o Identify the types of processes required and the resulting impacts on facilities by each of the concents being considered (a.g., specialized fixtures, test chambers, laboratories
1699	clean rooms waste storage and disposal etc.)
1700	• Identify the unique or special facility requirements for transportation, handling, and
1701	storage equipment being manufactured for each candidate materiel solution
1702	• Identify the funding required for facilities and capital equipment for each concept being
1703	considered.
1704	Metrics
1705	• The facilities and capital equipment required by each of the concepts being considered has
1706	been identified and documented.
1707	• The quantitative and qualitative demands of the each of the concepts being considered has
1708	been identified and documented

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

1709		• The availability, design, rate and capacity capabilities of the facilities under consideration
1710		(existing, new, or redeveloped) have been evaluated and documented
1711		• The types of processes required and the resulting impacts on facilities by each of the
1712		concepts being considered (e.g., specialized fixtures, test chambers, laboratories, clean
1713		rooms, waste storage and disposal, etc.) have been evaluated and documented
1714		• Unique or special facility requirements for transportation, handling, and storage
1715		equipment being manufactured for each candidate materiel solution have been identified
1716		and documented
1717	•	Funding required for facilities and capital equipment for each concept being considered has
1718		been estimated and documented for the AoA Study Guidance.
1719	Tools	
1720	٠	Bottleneck Analysis (Theory of Constraints)
1721	•	Critical Chain Project Management
1722	•	Manufacturing Resource Planning (MRPII)
1723	•	MRL Assessment using Facilities Thread
1724	•	Manufacturing Resource Planning (MRP II)
1725	•	MRL Assessment using Facilities Thread
1726	•	Plant Design and Facility Layout Software Evaluation Tools
1727	Resou	rces
1728	•	MRL Deskbook Version 2.5, 2016

• Manufacturing Resource Planning (MRP II)

1730 L. MANUFACTURING MANAGEMENT AND CONTROL

	L. Manufacturing Management &	L.1 Manufacturing Management Requirements	L.2 Understand Mfg. Planning & Scheduling Requirements	L.3 Understand Materials Planning Requirements	
1731	Control				

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

- 1737 Beginning in this phase, the activities managing the concept (or program office) should begin the
- 1738 planning for manufacturing management and control of the concepts under consideration. This
- 1739 planning will be evolving and should be updated during the subsequent acquisition phases. The
- 1740 purpose of manufacturing planning is the identification of resources and integration into a structure
- 1741 that provides the capability to achieve production objectives. Manufacturing planning should include:

1742 1743	• Manufacturing requirements in contracts and in appropriate agreements with other agencies (e.g., DCMA)
1744 1745	 Manufacturing assessments to support program Milestone decision points and major design reviews
1746	 Manufacturing metrics and reviews at a frequency commensurate with manufacturing risks
1747	L.1 Manufacturing Management Requirements
1748	Manufacturing and Quality Tasks
1749 1750	• Identify the manufacturing management system requirements (i.e., AS6500) to be met by the contractor or government entity during subsequent phases as appropriate in the areas of:
1751 1752 1753 1754	 Design analysis for manufacturing Manufacturing risk identification Manufacturing planning Manufacturing operations management
1755 1756	• Evaluate each concept being considered and identify the capability to meet manufacturing management needs.
1757 1758 1759 1760	 Evaluate each concept being considered and identify the need for focused manufacturing or quality plans (e.g., a program Manufacturing Management Plan) to guide the approach. Evaluate each concept being considered and identify the need for a standalone government manufacturing or quality assurance plan.
1761 1762 1763 1764	 Understand the impact of technology and process state of the art on the concepts being considered and the impacts on manufacturing management. Identify and understand potential sources that could address manufacturing management needs.
1765 1766 1767 1768	 Identify and understand manufacturing and quality management lessons-learned and best practices among programs and across centers Assess and evaluate manufacturing technologies that could assist on candidate materiel solution programs.
1769	• Establish manufacturing management metrics for each of the concepts being considered
1770 1771	• Determine the frequency that the metrics should be reviewed, commensurate with manufacturing and quality risks.
1772 1773	• Contact DCMA for input on manufacturing management system evaluation of potential contractor and suppliers for each concept being considered.

1774	Metri	cs
1775 1776 1777 1778	•	The manufacturing management requirements (i.e., AS6500) to be met by the contractor or government entity as appropriate have been identified and documented. Each concept being considered has been evaluated and the capability to meet manufacturing management needs has been identified and documented.
1779 1780 1781 1782 1783		 Each concept being considered has been evaluated and the need for focused manufacturing plans (e.g., a program Manufacturing Management Plan) to guide the approach identified Each concept being considered has been evaluated and the need for a standalone government manufacturing plan identified
1784 1785 1786 1787	•	The impact of technology and process state of the art on the concepts being considered and the impacts on manufacturing management have been evaluated and documented. Potential sources that could address manufacturing management needs are understood and documented.
1788 1789 1790 1791		 Manufacturing and quality management lessons-learned and best practices among programs and across centers have been evaluated, are understood, and documented Manufacturing technologies that could assist on candidate materiel solution programs have been assessed and documented.
1792 1793	•	Manufacturing management metrics for each of the concepts being considered have been established and documented.
1794 1795		• The frequency that the metrics should be reviewed, commensurate with manufacturing and quality risks, has been determined.
1796 1797	•	Potential manufacturing management systems (i.e., AS6500) to be used in subsequent phases for each of the concepts being considered have been identified and documented.
1798		• The manufacturing management program should include:
1799 1800 1801 1802 1803		 Manufacturing management system Design analysis for manufacturing Manufacturing risk identification Manufacturing planning Manufacturing operations management
1804 1805 1806	•	Availability of DCMA personnel has been determined for input on manufacturing management systems of potential contractors and suppliers for each concept being considered with inputs collected and documented.
1807	Tools	
1808	•	MRL Assessment Questionnaire using Manufacturing Management and Control Thread

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

1809	Manufacturing Resource Planning (MRP II)
1810 1811 1812 1813	 Resources AS6500, Manufacturing Management Program MRL Deskbook Version 2.5, 2016 Manufacturing Resource Planning (MRP II)
1814	L.2 Understand Manufacturing Planning and Scheduling Requirements
1815	Manufacturing and Quality Tasks
1816	• Initiate planning for each candidate materiel solution approach to include, as a minimum:
1817 1818 1819 1820 1821 1822	 Description of the manufacturing and quality organization Describe the make or buy plan Description and initial identification of resources and manufacturing and quality capabilities Identification of manufacturing and quality data requirements for facilities, processing, and scheduling
1823 1824	 Evaluate the overall manufacturing feasibility analysis for inputs to planning and scheduling. The analysis should have included:
1825 1826 1827 1828 1829 1830 1831	 Producibility Critical and key manufacturing and quality processes Special tooling requirements Test and demonstration requirements for new materials and processes Alternate design approaches Anticipated manufacturing and quality risks and potential cost impacts and identify the needed actions to be incorporated into the initial manufacturing and quality plan.
1832	• Ensure manufacturing planning addresses transition considerations that may be impacted by:
1833 1834 1835 1836 1837 1838	 Funding constraints and phasing of money Design considerations, goals and risks Test and evaluation methods and approaches along with success criteria Production processes, methods, workforce, facilities, equipment and capabilities Life cycle logistics and sustainment criteria, approach and goals Management approach to transition risks
1839	Metrics

Inputs to be included in the AoA Study Guidance for the initial manufacturing and quality
plan document the following:

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

1842 1843		• A description of the type of manufacturing and quality organization that could produce the concept
1844		• General parameters for a make or buy plan
1845		• A description of the type of resources and manufacturing and quality capabilities needed
1846		for the concepts being considered
1847 1848		 Manufacturing and quality planning data for the quantitative and qualitative demands of the facilities and capital equipment required by each of the concepts being considered
1849 1850 1851	•	Appropriate initial manufacturing and quality planning inputs are documented from overall feasibility analysis. These planning and scheduling inputs will include requirements from the evaluations of:
1852		• Producibility
1853		• Critical and key manufacturing and quality processes
1854		• Special tooling
1855		• Test and demonstration of new materials and processes
1856		• Alternate design approaches within each concept
1857		 Potential manufacturing and quality risks and costs impacts
1858	•	Initial Manufacturing and quality planning documents, in AoA Study Guidance, address
1859		transition considerations that may be impacted by:
1860		• Funding constraints and phasing of money
1861		• Design considerations, goals and risks
1862		• Test and evaluation methods and approaches along with success criteria
1863		• Production processes, methods, workforce, facilities, equipment and capabilities
1864		 Life cycle logistics and sustainment criteria, approach and goals
1865		• Management approach to transition risks
1866	Tools	
1867	•	Assembly Chart
1868	•	Line of Balance Assessment
1869	•	MRL Assessment Questionnaire using Manufacturing Management and Control Thread
1870	٠	Operations Process Chart
1871	٠	Route Sheet
1872	•	Work Breakdown Structure
1873	•	Manufacturing Resource Planning (MRP II)
1874	Resou	irces
1875	•	AS6500, Manufacturing Management Program
1876	•	MRL Deskbook Version 2.5, 2016
1877	•	Manufacturing Resource Planning (MRP II)

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

1878 L.3 Understand Materials Planning Requirements

1879 Manufacturing and Quality Tasks

1880 1881	•	Understand feasibility and quality of materials to be used for each candidate materiel solution approach.
1882 1883 1884		 Understand the maturity (technical and characterization) of material sources, essential raw materials, special alloys, composite materials, etc. Understand alternatives to preferred materials for each candidate materiel solution
1885	•	Understanding of all aspects of tasks in materiel availability (See Section G.2)
1886 1887 1888 1889 1890		 Understand of quality, processing, ageing, handling, and transit times, etc. as an impact to lead times to include alternative materials Evaluate and assess source considerations such as quality, fragility, sole source, domestic vs. foreign, etc. for the AoA Study Guidance and MDD processes The military vulnerability that could result from the lack of alternatives
1891	Metri	CS
1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903	•	 Analyze and document the feasibility of materials and alternative materials to be used for each candidate materiel solution. Analyze the maturity both technical and characterization of material sources, essential raw materials, special alloys, composite materials, etc. and document for the AoA Study Guidance Analysis of materials availability tasks documents the impact of quality, processing, ageing, handling, and transit times, etc. to lead times including alternative materials Assessment and evaluations of source considerations for quality, fragility, sole source, domestic vs. foreign, etc. are documented and included in the AoA Study Guidance and MDD processes The above assessment includes the military vulnerability that could result from the lack of alternatives
1904	Tools	
1905 1906 1907 1908	• • •	MRL Assessment Questionnaire using Manufacturing Management Thread Production Plan (schedule) Bill of Material Assessment Make/Buy Decision
1909	•	Parts List

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

1910 **Resources**

- 1911 AS6500, MANUFACTURING MANAGEMENT PROGRAM
- MRL Deskbook Version 2.5, 2016
- 1913 Manufacturing Resource Planning (MRP II)

1 2. Materiel Solution Analysis (MSA) Phase

2 Introduction

3 As stated in Department of Defense Instruction (DoDI) 5000.02, Operation of the Defense 4 Acquisition System, the purpose of MSA phase is to "conduct the analysis and other activities 5 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 specific product or 6 7 design concept, and to commit the resources required to mature technology and/or reduce any risks 8 that must be mitigated prior to decisions committing the resources for development. This phase also 9 is an opportunity for manufacturing and quality to influence chosen system design by balancing 10 requirements against producibility, manufacturability, quality, and affordability. To support the MSA phase and the Milestone Decision Authority (MDA) decision process, manufacturing and quality 11 12 should perform and/or support activities during the phase including: 13 • Conduct and complete the Analysis of Alternatives (AoA) with manufacturing and quality 14 inputs needed to enable selection of a preferred materiel solution 15 Translate validated Key Performance Parameters (KPP) and Key System Attributes (KSA) • into Key Characteristics (KC) for manufacturing and quality 16 17 • Conducting manufacturing and quality key trades for feasibility and affordability analyses, risks, issues, and opportunities analyses, and plan for mitigations that impact cost, schedule, 18 19 and performance 20 • Develop manufacturing and quality goals for any needed development of critical enabling 21 technologies 22 Translate the Initial Capabilities Document (ICD) with manufacturing and quality validation • 23 and verification analyses results into a draft Capability Development Document (CDD) 24 • Initiation of the Test and Evaluation Master Plan (TEMP), the Systems Engineering Plan 25 (SEP), and the Acquisition Strategy (AS) with inclusion of manufacturing and quality 26 requirements 27 Figure 2-1 shows the manufacturing and quality management activities typical of the MSA phase.

28

2. Materiel Solution Analysis (MSA) Phase





Figure 2-1. MSA Phase Manufacturing and Quality Activities

31 **Phase Description**

32 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,

34 schedule, and performance. It is the role of manufacturing and quality to provide inputs to the AoA

- 35 process with respect to feasibility and industrial base (IB) analyses, performed as part of the AoA
- 36 Study Guidance, the validated ICD, and the AoA Study Plan, which guide the AoA and MSA phase

37 activities. The analyses focus on identification and analysis of alternatives; measures of

- 38 effectiveness; key trades between cost and capability; life-cycle cost, including sustainment;
- 39 schedule; concepts of operations; and overall risk. The AoA will include affordability analyses, cost
- 40 analyses, early systems engineering analyses, threat projections, and market research. Minimum
- 41 funding required for this phase includes all funding and staffing plans for the AoA and the
- 42 engineering analysis and planning for the next milestone including the milestone certification
- 43 requirements.
- 44 The AoA will address the manufacturing and quality feasibility and technology maturity of the
- 45 proposed alternatives including the risks, issues, and opportunities associated with varying

2. Materiel Solution Analysis (MSA) Phase

- 46 production rates; IB health and needs; manufacturing technology research; facilities and tooling,
- 47 special test equipment, and special inspection equipment; manufacturing skill sets; and maturity of
- 48 new materials and novel processing methods.
- 49 Prior to the completion of this phase, the DoD Component combat developer will prepare a Concept
- 50 of Operations/Operational Mode Summary/Mission Profile (CONOPS/OMS/MP) that will include
- 51 the operational tasks, events, durations, frequency, operating conditions and environment in which
- 52 the recommended materiel solution is to perform each mission and each phase of a mission. The
- 53 Systems Engineering (SE) IPT uses the outputs of the CONOPS/OMS/MP to identify and validate
- 54 capability gaps and risks, and translate these into system-specific requirements. These KPPs and
- KSAs are translated by manufacturing and quality into identified system, product, and component
 manufacturing and quality KCs. In addition, these outputs are utilized to provide manufacturing and
- 57 quality inputs to the AS, TEMP, and SEP, and ultimately the Milestone A decision. During the MSA
- 58 phase, the Component Acquisition Executive (CAE) will select a Program Manager (PM) and
- 59 establish a program office to complete the necessary actions associated with planning the acquisition
- 60 program with emphasis on the next phase.
- 61 The MSA phase ends when a DoD Component has completed the necessary analysis and the
- 62 activities necessary to support a decision to proceed to an acquisition phase. The next phase can be
- 63 Technology Maturation and Risk Reduction (TMRR), Engineering and Manufacturing Development
- 64 (EMD), or Production and Deployment (P&D), depending on the actions needed to mature the
- 65 product being acquired. Each of these phases has associated decision points to authorize entry.

66 A. DOD ACQUISITION SYSTEM



67

68 During the MSA phase, trade studies are conducted to identify materiel solutions and address gaps in 69 capability based on an AoA. At the close of the AoA, a program office is assigned ownership of the 70 approach. At this point, program management establishes the appropriate Integrated Product Team 71 (IPT) structure to support program execution. The IPT conducts systems engineering analysis to 72 support the development of the AS, the SEP, and the draft CDD. The MSA phase also provides the 73 opportunity to influence system design and plan for production by evaluating technology 74 opportunities and current practices against cost, schedule, and performance. The intent is to reduce 75 technical risk, validate designs, validate cost estimates, evaluate manufacturing processes, and refine 76 requirements. The PM will ensure manufacturing, quality, and producibility risks are identified and

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- 77 managed throughout the program life cycle. Assessments of manufacturing and quality readiness,
- risks, and mitigation plans will be developed and documented in the SEP and the AS.

79 Analysis of Alternatives (AoA)

80 From a manufacturing and quality perspective during the AoA, each competing alternative under

- 81 consideration is analyzed for its impact to industrial and manufacturing capabilities. The analysis
- 82 uses the IB assessments performed previously to determine the likelihood that a proposed solution
- 83 can be produced using existing manufacturing capabilities while meeting quality, rate, cost, and
- 84 schedule requirements. The AoA also identifies new or high-risk manufacturing capability or
- 85 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 efforts. The
- results of the analyses are used to quantify the differences between alternatives and select a preferred
- 88 solution. At the close of the AoA, the program office takes ownership of the approach and conducts
- 89 additional engineering analyses to support the development of the Acquisition Strategy and the SEP.

90 Acquisition Strategy (AS)

- Early systems engineering provides the foundation for the development of the AS. It is based on
- 92 engineering analyses, trade studies, and preliminary system functional and performance requirements
- 93 to meet a capability need. Critical thinking is required for an evaluation that focuses on determining
- 94 the correct requirements, and rigorously and objectively considers the risks, issues, and opportunities.
- 95 This requires an Acquisition Strategy that addresses all of the following program objectives:
- 96 The likely outcome is worth the investment in both resources (real costs) and schedule
 97 (opportunity costs)
- 98 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 importantaspects 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 you build it?"
- An initial manufacturing and quality strategy
- 109 The initial manufacturing and quality strategy as an integral part of the overall Acquisition Strategy
- 110 should include considerations such as:

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- 111 • Competition – Competition can be a major contributor to reducing weapon system costs, 112 however, can also be a major contributor to manufacturing and quality complexity and must 113 be carefully planned. 114 New manufacturing technologies – If required by the system concept, new manufacturing • 115 technologies will require specific plans for development, proofing, and transition of the 116 technology to the eventual producer. 117 • Production rates and quantities – These can also play a major role in driving manufacturing 118 cost as they will drive decisions on what production processes to use, types of tooling 119 required, make-buy decisions, etc. 120 • Materials sourcing – Sources that are sole, single, fragile, or foreign sources, and those 121 domestic sources that are vulnerable to foreign acquisition introduce risks to manufacturing. 122 Contracting strategies – Strategies should include manufacturing and quality technologies, • 123 facilities, investment incentives, risk mitigation efforts, etc. 124 Other manufacturing and quality considerations that should be addressed in the manufacturing and 125 quality strategy as part of the AS: The Acquisition Strategy should highlight how risk areas will be addressed and minimized in 126 127 the TMRR phase, on the path to full manufacturing capability in the P&D phase.
- The Acquisition Strategy should highlight how new manufacturing capabilities with a
 beneficial impact to the program will be addressed.
- The Acquisition Strategy should summarize the technical or manufacturing risks associated with the program, and identify any critical technologies or manufacturing processes that need to be matured and demonstrated in a manufacturing-relevant environment during the TMRR phase.

134 Systems Engineering Plan (SEP)

- 135 Manufacturing and quality input to critical systems engineering processes and functions is essential
- 136 to ensure that programs deliver capabilities on time and on budget. The effective execution of MSA
- 137 efforts provides a feasible, producible, and effective solution that satisfies user requirements. The
- 138 intent is to reduce manufacturing and quality risks, validate designs, validate cost estimates, evaluate
- 139 manufacturing processes, and refine requirements. Per DoDI 5000.02, "Program Managers will
- 140 prepare a SEP as a management tool to guide the systems engineering activities on the program. The
- 141 SEP will be submitted for approval for each milestone review, beginning with Milestone A." At each
- 142 milestone and at the Development Request for Proposal (RFP) Release Decision Point,
- 143 manufacturing and quality will support the Acquisition Strategy and SEP, including input for
- 144 interdependencies, and overall manufacturing approach to balance system performance, life-cycle
- 145 costs, and risks. The SEP should include:
- Description of the program overall technical approach, including manufacturing and quality
 inputs for key risks, processes, resources, organization, metrics, and design considerations

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148 149 150 151 152 153 154 155 156 157	 Details of the timing and manufacturing and quality criteria for the conduct of technical reviews Details for manufacturing and quality planning in order to provide effective management and control of the progress and the execution of risk mitigation activities Plans for addressing manufacturing and quality integration with existing and approved architectures and capabilities Identification of manufacturing and quality risks from external dependencies (outside the span of control) Guidance on the manufacturing and quality details in the program schedule with documentation of the planning
158 159	Finally, the SEP should be included in the RFP with an approved plan or a draft plan as either guidance or a compliance document and will be synchronized with the AS.
160	Program Management Reviews
161 162	Management reviews are a major part of the systems engineering process and are conducted by members of the IPT. Reviews serve to confirm:
163 164	 Major systems engineering efforts have been conducted and completed The program is ready to proceed to the next major schedule event
165 166 167 168 169 170 171	Technical reviews are also an important tool for program management, independent assessors, and subject matter experts including manufacturing and quality, to identify and evaluate risks early and throughout the program. If conducted in conjunction with the Materiel Development Decision (MDD), manufacturing and quality should support the Initial Technical Review (ITR), which should assess the draft ICD, the AoA Study Guidance, and preliminary CONOPS for manufacturing and quality analyses of the materiel solution alternatives. Support of the ITR will provide detailed manufacturing and quality information and understanding of each concept or alternative for:
172 173	Engineering tradesDevelopment of a Cost Analysis Requirements Description (CARD)

• Cost drivers, material, and process risks

175 The primary review during MSA is the Alternative Systems Review (ASR), which is conducted by

176 the program office prior to the Milestone A decision and entry into TMRR phase. The ASR assesses

- 177 the preferred materiel solution to ensure it has the potential to be affordable, producible,
- 178 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
- 180 trade studies that consider and incorporate alternative system designs, manufacturing and quality
- alternatives, and other technical considerations. The technical understanding, assessed at the ASR, is
- 182 sufficient and rigorous enough to support a valid cost estimate (CARD, or CARD-like Document).

2. Materiel Solution Analysis (MSA) Phase

183 A.1 Support Conduct of the AoA

184 Manufacturing and Quality Tasks

185 186	• Provide analyses of the manufacturing and quality requirements and feasibility contained in the draft ICD, the AoA Study Guidance, and the preliminary CONOPS for the AoA.
187 188	 Analyses should verify adequacy, relevance, and completeness Analyses should identify and quantify manufacturing and quality risks
189 190	• Ensure IB assessments and market analyses are updated for concepts included in the AoA (conduct if not previously accomplished).
191 192 193	 IB analyses 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 you build it?"
194 195 196 197	• 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).
198	 Identify manufacturing and quality risks
199 200	Include materials, processes, and technologyIdentify new or high-risk manufacturing processes or capacity requirements
201 202	 Identify manufacturing, quality, materials, and unique requirements that are cost drivers for the AoA
203 204	• Ensure the phase-by-phase requirements for manufacturing and quality skills and training are updated for the AoA preferred materiel solutions
205 206	• Ensure the facilities and capital equipment requirements for each AoA preferred concept are updated
200 207 208	 Ensure that each AoA preferred concept includes and is analyzed for quality management
200 209 210	 Ensure each AoA preferred concept includes and is analyzed for manufacturing management requirements
211	Metrics
212 213	• Analyses of the manufacturing and quality requirements and feasibility for were conducted and the results included in the AoA.
214 215	• Analyses addressed, quantified, and documented adequacy, relevance, and completeness of manufacturing and quality risks
216	• Assessments of IB and market analyses have been updated and include:

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 217 218 219 220 221 222 223 		 The preferred concepts for the AoA, trade studies, early prototypes, models or data, and the industrial capabilities required to design, develop, manufacture, and maintain each Quantification of the differences between alternatives based on the industrial and manufacturing capabilities and the required resources Manufacturing feasibility analyses specifically addressed and answered the question "Can you build it?"
224 225	•	Assessments of manufacturing feasibility for the AoA preferred concepts are updated and include:
226 227 228 229 230 231 232 233 234 235 236 237		 Manufacturing and quality risks for materials, processes, and technology identified and documented Analyses that identified and documented new or high-risk manufacturing processes or capacity requirements Manufacturing, quality, materials, and unique requirements that are cost drivers identified and specified for the AoA Manufacturing and quality skills requirements (phase by phase) for training updated and documented for the AoA preferred solutions Facilities and capital equipment requirements for the preferred concepts updated and documented Preferred concept analyses for quality management and manufacturing management requirements are documented
231		requirements are documented
238	Tools	requirements are documented
238 239	Tools •	Acquisition Decision Memorandum (MDD) Template
238 239 240	Tools • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline
238 239 240 241	Tools • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist
238 239 240 241 242	Tools • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist
238 239 240 241 242 243	Tools • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist
238 239 240 241 242 243 244	Tools • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist
238 239 240 241 242 243 244 245	Tools • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009
238 239 240 241 242 243 244 245 246	Tools • • • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009 Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
238 239 240 241 242 243 244 245 246 247	Tools • • • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009 Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Manufacturing Feasibility Assessment Checklist (no specific tool found)
238 239 240 241 242 243 244 245 244 245 246 247 248	Tools • • • • • • • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009 Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Manufacturing Feasibility Assessment Checklist (no specific tool found) Manufacturing Readiness Level MRL) Assessment (Questionnaire
238 239 240 241 242 243 244 245 244 245 246 247 248 249	Tools • • • • • • • • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009 Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Manufacturing Feasibility Assessment Checklist (no specific tool found) Manufacturing Readiness Level MRL) Assessment (Questionnaire Market Research Reporting Template
238 239 240 241 242 243 244 245 244 245 246 247 248 249 250	Tools • • • • • • • • • • • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009 Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Manufacturing Feasibility Assessment Checklist (no specific tool found) Manufacturing Readiness Level MRL) Assessment (Questionnaire Market Research Reporting Template Multi-Attribute Tradespace Exploration (MATE)
238 239 240 241 242 243 244 245 244 245 246 247 248 249 250 251 251	Tools • • • • • • • • • • • • • • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009 Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Manufacturing Feasibility Assessment Checklist (no specific tool found) Manufacturing Readiness Level MRL) Assessment (Questionnaire Market Research Reporting Template Multi-Attribute Tradespace Exploration (MATE) Pugh Matrix Template
238 239 240 241 242 243 244 245 244 245 246 247 248 249 250 251 252	Tools • • • • • • • • • • • • • • • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009 Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Manufacturing Feasibility Assessment Checklist (no specific tool found) Manufacturing Readiness Level MRL) Assessment (Questionnaire Market Research Reporting Template Multi-Attribute Tradespace Exploration (MATE) Pugh Matrix Template Quality Function Deployment or House of Quality Matrix
238 239 240 241 242 243 244 245 244 245 246 247 248 249 250 251 252 253	Tools • • • • • • • • • • • • • • • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009 Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Manufacturing Feasibility Assessment Checklist (no specific tool found) Manufacturing Readiness Level MRL) Assessment (Questionnaire Market Research Reporting Template Multi-Attribute Tradespace Exploration (MATE) Pugh Matrix Template Quality Function Deployment or House of Quality Matrix Quality Function Deployment Excel Spreadsheet
238 239 240 241 242 243 244 245 244 245 246 247 248 249 250 251 252 253 254	Tools • • • • • • • • • • • • • • • • • • •	Acquisition Decision Memorandum (MDD) Template Acquisition Strategy (AS) Outline AS6500 Manufacturing Management Program Checklist ISO 9000 Quality Management System Checklist AS9100 Quality Management System Checklist Alternative System Review Checklist AoA Study Plan Template, Sep 2009 Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Manufacturing Feasibility Assessment Checklist (no specific tool found) Manufacturing Readiness Level MRL) Assessment (Questionnaire Market Research Reporting Template Multi-Attribute Tradespace Exploration (MATE) Pugh Matrix Template Quality Function Deployment or House of Quality Matrix Quality Function Deployment Excel Spreadsheet Requirements Traceability Matrix Template
2. Materiel Solution Analysis (MSA) Phase

- Tailoring Worksheet for Materiel Solution Analysis Phase
- Technology Readiness Level (TRL) Assessment Checklist
- TRIZ Matrix

259 **Resources**

- Air Force AoA Guide, June 2013
- Air Force AoA Handbook, July 2008
- AS6500, Manufacturing Management Program, Nov 2014
- ISO 9000:2015, Quality Management Systems, Sep 2015
- AS9100, Quality Management Systems, Sep 2016
- Defense Acquisition Guidebook (DAG), Chapter 3-3.3.1 Alternative System Review
- DoDI 5000.02, Change 1, Jan 2017
- DoDI 5000.60, Defense Industrial Capabilities Assessments, Oct 2009
- DoD 5000.60H, Assessing Defense Industrial Capabilities, Apr 1996
- DoD Market Research Guide May 2012
- DSMC Acquisition Strategy Guide, Dec 1999
- MRL Deskbook Version 2016
- National Defense Authorization Act for FY 2017 (PL 114-328 Sect. 807) (assigns program cost and fielding targets and to conduct independent technical risk assessments)
- MDD Analysis Handbook, July 2010
- Quality Function Deployment, Akao 2004
- Requirements Traceability Matrix Guide, Jan 2012
- Technology Readiness Assessment Guidance, Apr 2011

278 A.2 Provide Manufacturing and Quality Input to the Acquisition Strategy

- 279 Manufacturing and Quality Tasks
- Provide a summary of an updated manufacturing and quality IB capability analysis for the AS, as required by DoDI 5000.02.
 Provide inputs on the capability of the IB to design, develop, produce, support, and resta
- Provide inputs on the capability of the IB to design, develop, produce, support, and restart
 the acquisition program, if appropriate
- 284oProvide inputs on IB capabilities, fragility, gaps, and risks for the Acquisition Strategy285(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 manufacturing and quality 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.)

2. Materiel Solution Analysis (MSA) Phase

 293 294 295 	Develop and provide a Manufacturing Strategy and a Quality Strategy to address the question "Can you build it?" The strategy should support the AS development and include considerations of:
296 297 298 299 300 301 302 303 304	 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), government-furnished information (GFI), special test equipment (STE), special inspection equipment (SIE), special requirements, etc.) Management (quality, manufacturing, supply chain, risks, etc.)
 305 306 307 308 	Based on IB capabilities analyses, provide manufacturing and quality inputs to Acquisition Strategy contracting strategy 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.
 309 310 311 312 313 314 315 	 Include manufacturing and quality metrics to differentiate the value of each contract type to include 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) AS, regulatory requirement for all other programs)
316 • 317 • 318 • 319 • 320 • 321 • 322 •	Develop manufacturing and quality 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 an modular open systems approach, alternative sources of supplies or services, etc.). Develop manufacturing and quality 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.
323 324 325 326 327 328 329	 Provide manufacturing and quality 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 manufacturing and quality inputs on products or components (known and/or projected) from sole, single, fragile, or foreign sources including options for:
330 331 332	 Domestic alternatives through regeneration of prior capability Creation of new capability for manufacturing products and processes Lifetime buy of items at the subsystems, and component levels

 333 334 335 	Develop plans for new or high-risk manufacturing capabilities and processes Manufacturing Technology ManTech for the Acquisition Strategy that address risks, issues, and opportunities.
336 337	• Specify how this new capability will be demonstrated in a relevant manufacturing environment for the TMRR phase
 338 339 340 	Provide manufacturing and quality 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:
341 342 343	 Requested inputs from Defense Contract Management Agency (DCMA) Materials availability (lead-time and scale-up) and maturity (characterization) Achievable rates and yields for manufacturing and quality
344 345	 Provide methodologies for determining rates and schedules (e.g., Economic Order Quantities, affordability goals, etc.)
346 347 348	 Manufacturing and quality maturity Facilities, tooling, and workforce considerations Capital equipment requirements
349350351	Based on inputs to Acquisition Strategy on required technical reviews, production decisions, events, prototypes, and deliveries, provide manufacturing and quality inputs to the initial Integrated Master Schedule including:
352 353 354 355 356 357 358 359	 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 Manufacturing and quality internal and external interdependencies and integration with existing programs, systems, and other programs in development that potentially impact the critical path
3 60 •	Develop the government manufacturing and quality management approach to:
361 362 363 364 365 366 367	 Manufacturing and quality requirements for program plans Manufacturing and quality contributions to resource management (minimizing cost, schedule, and performance risks for the product life cycle) Manufacturing and quality organization and staffing with Key Leadership Positions (KLP) and necessary skilled manpower Manufacturing and quality support organization required to meet program projected needs for TMRR and subsequent phases including:
368 369 370	 Earned Value Management requirements Cost control requirements Data collection, reporting, and management

2. Materiel Solution Analysis (MSA) Phase

371 372	•	Identify the manufacturing and quality requirements for the TMRR contractor's Manufacturing Management System (MMS) and Quality Management System (QMS).
 373 374 375 376 377 378 379 380 		 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 9000, SAE AS9100, IEEE 15288.0,1,2, etc.) If manufacturing and quality standards are not specified, develop requirements for program specific manufacturing management plan and quality management plan. Identify manufacturing and quality opportunities, initiatives, and systems that will contribute to minimizing cost, schedule, and performance risks throughout the product life cycle
381 382 383	•	Identify and assess manufacturing and quality 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.
384 385 386 387 388 389		 Identify risks from the IB, materials, facilities, workforce, interdependencies with other programs, manufacturing technology voids, quality, software and engineering-related risks etc. Identify required maturation of critical technologies and manufacturing processes to the required level Assess manufacturing and quality cost and schedule impacts from these identified risks
390 391 392 393 394 395	•	Specify the ongoing requirements for identification, analysis, mitigation, tracking, and control of manufacturing and quality 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 manufacturing and quality exit criteria metrics for MSA_TMRP_ and subsequent phase decision points.
396 397 398 399		 Metrics should include current and projected manufacturing and quality 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
400 401 402 403	•	For the Acquisition Strategy develop the manufacturing and quality support plan for the mandated independent assessment. Request DCMA inputs on strategies for quality, manufacturing, production, engineering, software development, configuration management, testing and quality.
404	Metrio	CS CS
405 406	•	Manufacturing and quality IB capability analysis updated, summarized, and documented for inclusion in the AS.
407 408		• Analyses of the capability of the IB to design, develop, produce, support, and restart the acquisition program, if appropriate, have been provided as input for the AS

409 410 411 412 413 414 415 416 417	 IB capabilities, fragility, gaps, and risks (e.g., key technologies, components, key processes, etc.) have been provided as input for the AS Impacts and interdependencies of this acquisition on the NTIB and the analyses used to make this determination have been specified and provided as input to the AS Inputs summarize the manufacturing and quality impacts, how they will be managed, and the plan for future assessment, including frequency Inputs for the government strategy and the actions necessary to preserve the IB capabilities have been identified and documented to include actions to support IB capability preservation
418 • 419	Detailed Manufacturing and Quality Strategies to address the question "Can you build it?" have been developed and are included in the AS addressing considerations of:
420 421 422 423 424 425 426 427	 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 GFE/GFI, STE/SIE, special requirements, etc.) Management (quality, manufacturing, supply chain, risks, etc.)
428 • 429 430 431	Based on IB capabilities analyses, manufacturing and quality inputs to the contracting strategy have been provided that 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.
432 433 434 435 436 437	 Inputs include manufacturing and quality metrics to differentiate the value of each contract type to include performance, capacity, functional, economic, etc. Inputs 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.) Inputs include prototyping recommendations for TMRR
438 • 439 440 441 442 • 443 444 445	Manufacturing and quality inputs for the source selection approach have been developed and documented in the Acquisition Strategy that establish and maintain access to competitive suppliers at the system, subsystem, and component levels (e.g., requiring an modular open systems approach, alternative sources of supplies or services, etc.). Manufacturing and quality inputs have been developed and documented in the Acquisition Strategy that incorporate sustainment of industrial capabilities, including manufacturing technologies and capabilities, and including the maturation required during the TMRR and subsequent phases.
446 447 448	• Manufacturing and quality 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-

2. Materiel Solution Analysis (MSA) Phase

449 450 451 452	 shelf items to required specifications at the subsystems, item, and component levels have been documented. Manufacturing and quality inputs on products or components (known and/or projected) from sole, single, fragile, or foreign sources have been documented including options for:
453 454 455	 Domestic alternatives Creation of new capability for manufacturing products and processes Lifetime buy of items at the subsystems, and component levels
456 • 457 458	Plans for new or high-risk manufacturing capabilities and processes (i.e., ManTech) have been developed and documented in the Acquisition Strategy that address risks, issues, and opportunities.
459 460	 Plans include demonstration of the new capability in a relevant manufacturing environment during the TMRR phase
 461 462 463 464 	Manufacturing and quality requirements and metrics for required technical reviews, production decisions, events, prototypes, and deliveries, including sub-tier subsystem, item, and components, have been developed and documented and provided as input to the Acquisition Strategy and incorporate:
465 466 467 468 469 470	 Inputs from DCMA Materials data including availability and maturity Estimates of achievable rates and yields including methodologies for determining Summaries of manufacturing and quality maturity assessment analyses Initial analyses of facilities, tooling, and workforce requirements Analyses of capital equipment requirements
471 • 472 473	Manufacturing and quality inputs to the initial Integrated Master Schedule have been provided based on required technical reviews, production decisions, events, prototypes, and deliveries, and included:
474 475 476 477 478 479	 Planned use of government-furnished special test equipment, government facilities/ranges, unique tooling, or other similar requirements (specific M&S, communications, restricted environment, etc.) Impacts to schedule from special materials Impact of internal and external interdependencies, and integration with existing programs, systems, and other programs in development
480 • 481	The government manufacturing and quality management approach has been developed and documented for:
482 483 484 485 486	 Manufacturing and quality requirements for program plans Manufacturing and quality contributions to resource management (minimizing cost, schedule, and performance risks for the product life cycle) Manufacturing and quality organization and staffing with KLPs and necessary skilled manpower

487 488	 Manufacturing and quality support organization required to meet projected program needs for TMRR and subsequent phases including:
489 490 491	 Earned Value Management requirements Cost control requirements Data collection, reporting, and management
492 • 493	Manufacturing and quality requirements for the TMRR contractor's MMS and QMS have been identified and documented in the AS.
494 495 496 497 498 499	 The industry standards to be used, or the requirements for program specific manufacturing and quality management, have been specified and documented (e.g., AS6500, ISO 9000, AS9100, IEEE 15288.0,1,2, etc.) Manufacturing and quality management opportunities, initiatives, or systems that contribute to minimizing cost, schedule, and performance risks throughout the product life cycle have been identified and documented
500 • 501 502	Manufacturing and quality risks, issues, and opportunities, and associated plans with key risk reduction events have been identified, assessed, and specified as inputs for the TMRR Acquisition Strategy and subsequent phases on the path to full capability.
503 504 505 506 507 508 509	 Risks, issues, and opportunities from the IB, materials, facilities, workforce, interdependencies with other programs, manufacturing technology voids, quality, software and engineering related risks,/issues etc. have been included Required maturation of critical technologies and manufacturing processes to the required level has been included Manufacturing and quality cost and schedule impacts from the identified risks have been assessed and included
510 • 511 512 513 514 • 515 516	The ongoing requirements for identification, analysis, mitigation, tracking, and control of manufacturing and quality risks, issues, and opportunities that impact performance, technical, cost, schedule, sustainment, and programmatic areas throughout the life of the program have been specified and documented in the AS. Detailed manufacturing and quality exit criteria metrics for MSA, TMRR, and subsequent phase decision points have been developed and documented as inputs to the Acquisition Strategy and include:
517 518 519	 Current and projected manufacturing quality maturity of identified critical technologies and manufacturing processes Planned MRL targets for system, subsystems, components, and items
520 • 521 522 • 523	Manufacturing and quality support plans for the mandated independent assessment have been developed, documented, and included in the AS. DCMA inputs on strategies for quality, manufacturing, production, engineering, software development, configuration management, testing, and quality have been included.

524	Tools	
525	•	Acquisition Strategy Outline
526	•	ICD Template, Oct 2012
527	٠	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
528	•	Manufacturing Readiness Level Assessment Questionnaire
529	•	Pugh Matrix Template
530	•	Quality Function Deployment Excel Spreadsheet
531	•	Requirements Roadmap Worksheet
532	•	TRIZ Matrix
533	٠	SAE AS6500 Manufacturing Management System Checklist
534	•	ISO 9000 Quality Management System Checklist
535	٠	SAE AS9100 Advanced Quality Management System Checklist
536	Reso	urces
537	•	AS6500, Manufacturing Management Program, Nov 2014
538	•	AS9100, Quality Management Systems, Sep 2016
539	•	IEEE 15288-2014, Systems and Software Engineering
540	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
541	•	IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs
542	•	ISO 9000:2015, Quality Management Systems, Sep 2015
543	•	MRL Deskbook Version 2016
544	•	PL114-328 and subsequent guidance (TBD)
545	•	Acquisition Plan Preparation Guide, Jan 2009
546	•	Capability Based Assessment Guide March 2009
547	•	DoDI 5000.02, Change 1, Jan 2017
548	•	DoDI 5000.60, Defense Industrial Capabilities Assessments, Oct 2009
549	•	DoD 5000.60H, Assessing Defense Industrial Capabilities, Apr 1996
550	•	DSMC Acquisition Strategy Guide, Dec 1999
551	•	Pre-Materiel Development Decision Analysis Handbook, July 2010
552	•	Quality Function Deployment (Reference Books)
553	A.3	Input to the Systems Engineering Plan (SEP)
554	Manu	ufacturing and Quality Tasks
555	•	Undate the assessment of manufacturing feasibility for the preferred concept, if not
556	•	completed: conduct an assessment for inclusion in the SEP
557	•	Provide manufacturing and quality inputs to the SEP on all IR design manufacturing
558	-	production, and quality risks and risk reduction and mitigation efforts.

559 560	 Identify critical technologies and manufacturing and quality process areas requiring risk reduction and mitigation efforts for the SEP, including the following activities:
561 562 563 564	 Initial manufacturing and quality approaches for system requirements and system design concepts Manufacturing and quality trade studies Potential manufacturing and quality solutions
565 566 567	 Identify manufacturing and quality risks, issues and opportunities from existing architectures, capabilities, and external dependencies Maintain up-to-date status on all key manufacturing and quality inputs to the SEP
568 • 569 570	Based on the Manufacturing and Quality Strategies in the AS, provide manufacturing and quality plans and support to assist in development of the SEP and the program schedule including:
571 572 573 574	 Inputs on required manufacturing and quality products (e.g., assessment, metrics, etc.) for all SE reviews Inputs on specific and detailed manufacturing and quality entry and exit criteria metrics for technical reviews and MSA, TMRR, and subsequent phase decision points
575 576 577 578	 Metrics should include current and projected manufacturing and quality 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
579 580 581 582 583 584 585 586 587 588 588 589	 Manufacturing and quality criteria, metrics, and frequency for SE reviews Planned significant manufacturing and quality activities and tools (i.e. modeling and simulations, manufacturing and quality assessments, long lead or advanced procurements, prototype builds, production lots/phases, etc.) Specifications for the manufacturing and quality organization, billets, and Key Leadership Positions Specification of the roles, responsibilities, and organization of the Manufacturing Working Group to support SE Manufacturing and quality roles and responsibilities within other program IPTs (e.g., Design, Risk Management, Systems Engineering, Test and Evaluation (T&E), Sustainment, Facilities, etc.)
 590 591 592 593 594 595 596 597 	Provide manufacturing and quality 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 manufacturing and quality 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 suppliers. Planned manufacturing and quality activities for the next phase

598 599 600	 Summarize key manufacturing and quality systems engineering, integration, and verification processes and activities established or modified since the previous phase, including updated
601 602 603	 Risk and risk mitigation strategies Technical and manufacturing maturity Manufacturing and quality metrics to support key management focus areas
604	Metrics
605 606 607	 The assessment of manufacturing feasibility for the preferred concept for inclusion in the SEP is up-to-date and reflects current program status. If not completed, conduct an assessment. Up to date manufacturing and quality inputs to the SEP on all IP, design, manufacturing.
608 609 610	• Op-to-date manufacturing and quality inputs to the SEP on an IB, design, manufacturing, production, and quality risks and risk reduction and mitigation efforts have been documented and provided.
611 612 613	 Critical technologies and manufacturing and quality process areas requiring risk reduction and mitigation efforts for the SEP have been identified, developed and documented, including the following activities:
614 615 616 617	 Initial manufacturing and quality approaches for system requirements and system design concepts Manufacturing and quality trade studies results Potential manufacturing and quality solutions
618 619 620 621 622	 Manufacturing and quality risks, issues and opportunities from existing architectures, capabilities, and external dependencies requiring risk reduction and mitigation efforts have been identified, developed, and documented A process to maintain up-to-date status on all key manufacturing and quality inputs to the SEP has been developed and is in place.
623 624	• Based on the Manufacturing and Quality Strategies in the AS, manufacturing and quality inputs have been documented in the SEP and include:
625 626 627 628 629	 Inputs on manufacturing and quality products (e.g., assessment, metrics, etc.) required for all SE reviews developed and documented Inputs on specific and detailed manufacturing and quality exit criteria metrics for technical reviews and MSA, TMRR, and subsequent phase decision points developed and documented
630 631 632 633	 Metrics should include current and projected manufacturing and quality maturity of identified critical technologies and manufacturing processes Metrics should also include the planned MRL target for system, subsystems, components, and items
634 635	• Manufacturing and quality criteria, metrics, and frequency for all SE reviews have been established and documented

636 637 638 639 640 641 642 643 644 645 646		 Planned significant manufacturing and quality activities and tools (i.e. modeling and simulations, manufacturing and quality assessments, long lead or advanced procurements, prototype builds, production lots/phases, etc.) have been identified and are documented in the SEP and the program schedule Manufacturing and quality organization, billets, and Key Leadership Positions have been identified and documented Specification of the roles, responsibilities, and organization of the Manufacturing Working Group to support SE have been specified and documented Manufacturing and quality roles and responsibilities within other IPTs (Design, Risk Management, Systems Engineering, T&E, Sustainment, Facilities, etc.) have been specified and documented
647 648		 Team Details – Name, Chair, Membership, Roles, Responsibility, and Authority, Products and Metrics
 649 650 651 652 653 654 655 656 657 658 659 660 	•	 Manufacturing and quality requirements, risks, issues, and opportunities (e.g., design, producibility, manufacturing technology, facilities, sustainment, cost and schedule, etc. have been provided and documented in the SEP to be addressed by all IPTs. Manufacturing and quality 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 suppliers are included and documented in the SEP and the Integrated Master Schedule. Planned manufacturing and quality SE activities for the next phase have been documented along with the appropriate metrics Key manufacturing and quality systems engineering, integration, and verification processes and activities established or modified since the previous phase, including
 661 662 663 664 665 666 		 updates have been summarized Risk and risk mitigation strategies are documented Technical and manufacturing maturity requirements are developed and documented with threshold and objectives established Manufacturing and quality metrics to support key management focus areas are established and documented
667	Tools	
668 669	•	Systems Engineering Plan (SEP) Outline
670	•	Critical to Customer/Critical to Quality Tree Template
671	•	Manufacturing Capability Assessment Worksheet
672	٠	Manufacturing Readiness Level Questionnaire (Part of MRL Users Guide)
673	٠	MDD Development Planning Templates
674	•	MSA Template

2. Materiel Solution Analysis (MSA) Phase

- Producibility Assessment Worksheet (PAWs)
- Triz Matrix

677 Resources

- 678 IEEE 15288-2014, Systems and Software Engineering
 679 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
- IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs
- SEP Outline, Jun 2015
- Air Force AoA Guide, June 2013
- Air Force AoA Handbook, Jul 2008
- DMMG for PMs, Chapter 1.3 and 2.6 Industrial and Manufacturing Capability Assessments
 in the Acquisition Lifecycle
- DoDI 5000.02, Change 1, Jan 2017
- MRL Deskbook Version 2016
- MRL Users Guide Version 2016
- MSA Guide, DAG Chapter 4.2.3, also see Air Force and Navy Guides
- 690 A.4 Support Program Management Reviews

691 Manufa	acturing and	Quality Tasks
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- Support the ITR (Initial Technical Review) (accomplish prior to AoA, if required).
- 693 o Perform manufacturing and quality analyses of the draft ICD, the AoA Study Guidance,
 694 and the preliminary CONOPS of the materiel solution alternatives
- 695oProvide detailed manufacturing and quality information to promote an understanding of696each concept or alternative for:
 - Engineering trades

697

698

699

- Cost drivers, material, and process risks, issues, and opportunities
- Development of a CARD
- Manufacturing and quality provides inputs and analyses to the ASR to support that the preferred materiel solution(s) resulting from the AoA has 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. Manufacturing and quality representatives supporting program IPTs will:
- 705oReview, evaluate, and update the manufacturing and quality producibility assessments for706the preferred system concept(s) for adequacy
- 707 o Review, evaluate, and update the comprehensive risk, issue, and opportunity assessment
 708 for completeness and adequacy of all manufacturing and quality risks and update
 709 mitigation plans (develop if not initiated)

710 711		 Complete trade studies or technical demonstrations for manufacturing concept risk reduction
712		 Incorporate producibility and manufacturing considerations which could impact
713		program decisions (e.g., critical components, materials and processes, tooling and test
714		equipment development, production testing methods, long lead items, and
715		facilities/personnel/skills requirements)
716	0	Review and evaluate the risks to manufacturing and quality associated with the use of a
717		commercial off-the-shelf (COTS)/ government off-the-shelf (GOTS)/non-developmental
718		items (NDI) solution versus a new design
719	0	Complete the manufacturing and quality input to the initial hazard analysis and/or the
720		system safety analysis for the preferred solution(s)
721	0	Assess the manufacturing and quality requirements of the draft CDD to verify that all
722		KCs are traceable to user needs through preliminary system specifications, key
723		assumptions, and constraints back to KPPs and KSAs (from JCIDS)
724	0	Assess the results of the AoA materiel solution(s) to meet manufacturing and quality cost,
725		schedule, and performance objectives
726	0	Review, evaluate, and update the comprehensive manufacturing and quality plans that
727		address critical items, parts, components, and prototypes to be developed and
728		demonstrated, along with their cost, and critical path drivers
729	0	Provide manufacturing and quality inputs on the scope and planning of competitive
730		prototyping of the materiel solution systems, subsystems, and components
731	0	Provide manufacturing and quality inputs on the scope, planning, and resources needed
732		for the initial end-item development
733	0	Review Lessons Learned for manufacturing and quality drivers of system life-cycle cost
734	0	Provide inputs to the CARD that reflect realistic materiel solutions that meet the draft
735		CDD within manufacturing and quality IB constraints including workforce estimates
736	0	Review and update manufacturing and quality inputs to the SEP and the AS, if necessary
737	Metrics	
738	• If 1	required prior to AoA, detailed manufacturing and quality information has been
739	do	cumented to support the Initial Technical Review (ITR) and documents each concept or
740	alte	ernative for:
741	0	Engineering trades
742	0	Cost drivers, material, and process risks, issues, and opportunities
743	0	Development of a CARD
744	• As	sessments of the draft ICD, the AoA Study Guidance, and preliminary CONOPS by
745	ma	inufacturing and quality analyses for materiel solution alternatives have been conducted
746	and	d results documented for the AoA.
747	• Ma	anufacturing and quality representatives designated to support the ASR have:

748 749		0	Reviewed, evaluated, and documented the updated producibility assessments for the preferred system concept(s) for adequacy with any shortfalls identified
750		0	Reviewed evaluated and documented the undated comprehensive risk issue and
751		0	opportunity assessment for completeness and adequacy of all manufacturing and quality
752			risks and that undered mitigation plans are documented and underway
152			Tisks and that updated intigation plans are documented and underway
753			 Completed trade studies or technical demonstrations for manufacturing concept risk
754			reduction have been documented
755			 Producibility and manufacturing considerations which could impact program
756			decisions (e.g., critical items, parts, components, materials and processes, tooling and
757			test equipment development, production testing methods, long lead items, and
758			facilities/personnel/skills requirements) have been identified and documented in
759			appropriate plans
760		0	Reviewed, evaluated, and documented the relative risk(s) to manufacturing and quality
761			associated with the use of a COTS/GOTS/NDI solution versus a new design
762		0	Completed and documented the manufacturing and quality inputs to the initial hazard
763			analysis and/or the system safety analysis for the preferred solution(s)
764		0	Assessed, verified, and documented that the KCs are traceable to user needs through
765			preliminary system specifications, key assumptions, constraints back to KPPs and KSAs
766			in the draft CDD
767		0	Analyzed and assessed the results of the AoA materiel solutions to meet manufacturing
768			and quality cost, schedule, and performance objectives and have documented the results
769			including shortfalls
770		0	Reviewed, evaluated, and documented the updated the comprehensive manufacturing and
771			quality plans for critical items, parts, components, and prototypes to be developed and
772			demonstrated, including cost, critical path drivers, and any shortfalls identified
773		0	Documented and provided manufacturing and quality inputs on competitive prototyping
774			(scope and planning) for the materiel solution systems, subsystems, and components
775		0	Documented and provided manufacturing and quality inputs on the scope, planning, and
776			resources needed for the initial end-item development
777		0	Reviewed and applied appropriate Lessons Learned for manufacturing and quality drivers
778			of system life-cycle cost
779		0	Developed and provided CARD inputs that reflect realistic materiel solutions that meet
780			the draft CDD requirements within manufacturing and quality IB constraints (including
781			workforce estimates)
782		0	Reviewed and updated manufacturing and quality inputs to the SEP and the AS
183	IOOIS		
784	•	Al	ternative System Review Checklist
785	Resou	rces	5
786	•	DA	AG, Chapter 3-3.3.1 Alternative System Review
-		-	

2. Materiel Solution Analysis (MSA) Phase

- IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
- IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs

789 **B. DEFENSE CONTRACTING SYSTEM**

	B. Defense Contracting System	B.1 Provide Input to TMRR RFP	B.2 Provide Inputs to TMRR SSP	B.3 Identify Potential Award Fee Criteria	
790 l					

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

797 Manufacturing and quality inputs to the RFP for TMRR should be based on the manufacturing and

quality 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 the area of manufacturing management and quality

801 management. As part of the RFP, the contractor will be required to identify and to describe their

802 proposed processes, methods, and actions to address manufacturing feasibility, producibility, and

803 manufacturing and quality risks associated with the proposed materiel solution. The RFP will require

these "ilities," risks, and other requirements to be appropriately documented in Contract Data

805 Requirements List (CDRL), Data Item Description (DIDs), and other deliverables subject to a

806 specified approval and acceptance process.

Each of the manufacturing and quality inputs to the RFP should have appropriate criteria and metrics to be met included in the SSP to ensure a fair and equitable source selection. The manufacturing and

- quality criteria and metrics should be coupled with appropriate award fee incentives, with processes,
- and procedures to reward successful management and execution, including incremental achievements

811 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

813 improvement, cost savings, etc.

814	The early inclusion of manufacturing and quality inputs into the RFP, SSP, and other program
815	processes will help guide the future development program success and help minimize risk.

816 **B.1** Provide Input to TMRR RFP

817 Manufacturing and Quality Tasks

Ensure that manufacturing and quality personnel are included in the TMRR Request for
 Proposals (RFPs) writing and review teams.

820 • 821	Analyze the manufacturing and quality results from the AoA Study Guidance and the AoA as a basis for RFP requirements.
822 823	• Results from other relevant manufacturing and quality feasibility and Industrial Base studies to be used as additional data for RFP requirements
824 • 825	Specify appropriate requirements for CDRLs, DIDs, etc. to support manufacturing and quality processes and the requisite approval process.
826 827	 Include requirements for reporting of manufacturing, quality, and supplier management metrics
828 • 829 830	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 9000, AS9100, etc.).
831 832 833	• Specify the requirements for the contractors to identify and to describe their proposed specific processes, methods, and actions to address manufacturing feasibility, producibility, and manufacturing and quality risks associated with the proposed solutions
834 • 835 836	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 addresses:
837	 Manufacturing Management System:
838 839	 Documenting how, when, and by whom each requirement of their system is to be accomplished, and define the authority and responsibility for each.
840	 Design Analysis for Manufacturing:
841842843844845	 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
846 847 848	 Identifying and managing key and critical manufacturing processes Conducting Process Failure Modes and Effects Analysis (PFMEA) on critical manufacturing processes
849	• Manufacturing Risk Identification:
850 851 852 853	 Integrating manufacturing risk management activities into the program risk, issue and opportunity management process to include the identification of manufacturing risk areas and the development and implementation of risk mitigation plans tracked to completion
854 855	 Conducting and documenting manufacturing feasibility assessments for each competing design alternative under consideration

856 857	 Identifying MRL targets and documenting manufacturing risks through the MRL assessments
858	• Manufacturing Planning:
859 860 861 862	 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.
863	 Manufacturing Operations Management including:
864 865 866 867 868 869 870 871	 Production Scheduling and Control Manufacturing Surveillance Continuous Improvement Process Control Plans Process Capabilities Production Process Verification First Article Inspections and First Article Tests Supplier Management and Quality
872 • 873	Specify industry best practices for Systems Engineering to be used (e.g., IEEE 15288, -1, -2, etc.) in the RFP.
874 875 876	 Include requirements for the contractors to identify and to describe their proposed processes, methods, and actions to address technical processes, technical management processes, and essential specialty engineering
877 •	Specify contractual manufacturing and quality requirements for:
878 879 880 881 882 883 883 884 885 886	 Conducting manufacturing and quality reviews of engineering and software (with frequency of reviews) Providing manufacturing and quality information for cost models Implementing a risk, issue, and opportunity management and mitigation program that includes manufacturing and quality (including IB risks) Implementing a manufacturing and quality variability reduction program Managing materials and subcontractors Utilizing Commercial Off The Shelf (COTS), Government Off The Shelf (GOTS), and Non-Developmental Items (NDIs)
887 •	Specify manufacturing and quality:
888 889 890 891 892	 Content for Statement of Work (SOW) and contract sections C, 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
893	improvement efforts

894		• Requirements for identification and description of producibility efforts
895		 Include cost sharing and incentive plans relevant to the solution
896 897		• Requirements for identification and description of contractor cost sharing and incentive initiatives
898 899 900 901		 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
902 903 904		 Requirements for facilities, tooling, and test equipment Requirements for workforce (e.g., training, certifications, etc.) Requirements for supply chain management
905 906 907	•	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.
908	Metric	S
909 910 911 912 913	•	Manufacturing and quality personnel have been assigned as designated members of the TMRR Request for Proposals (RFPs) writing and review teams. Results of manufacturing and quality inputs to the AoA Study Guidance and the manufacturing and quality outputs from AoA have been used for development of RFP requirements.
914 915		• Results from other relevant manufacturing and quality feasibility and IB studies have been included as additional data for RFP requirements
916 917 918 919 920	•	Appropriate manufacturing and quality CDRLs, DIDs, etc. or appropriate language and the requisite reporting and approval processes have been included in the RFP. 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 9000, AS9100, etc.) have been specified in the RFP.
921 922 923 924		• Requirements for the contractors to identify and to describe their proposed specific processes, methods, and actions to address manufacturing feasibility, producibility, and manufacturing and quality risks associated with the proposed solution(s) have been included
925 926 927 928	•	If AS6500 is not invoked in the contract, the manufacturing management requirements cited in AS6500 have been used as the basis for specific contractual requirements for a contractor plan and have been documented in the RFP. These requirements at a minimum have addressed and documented:
929 930		 The Manufacturing Management System Design Analysis for Manufacturing

2. Materiel Solution Analysis (MSA) Phase

931 932 933 934 935	 Producibility analyses Key and critical characteristics Variability reduction Manufacturing process analyses FMEA
936	• Manufacturing Risk Identification
937 938	Feasibility assessmentsManufacturing readiness assessments
939 940	 Manufacturing Planning Manufacturing Operations Management
941 • 942 943 944 • 945	If an appropriate best practices QMS is not invoked in the contract, the quality management requirements contained in ISO 9000 and/or AS9100 have been used as the basis for specific contractual requirements for a contractor QMS plan and have been documented in the RFP. Appropriate standards for Systems Engineering best practices to be used (e.g., IEEE 15288, -1, -2, etc.) have been specified in the RFP.
946 947 948	• Requirements for the contractors to identify and to describe their proposed processes, methods, and actions to address technical processes, technical management processes, and essential specialty engineering are included
949 • 950	Detailed manufacturing and quality inputs have been specified and documented in the RFP including the requirements and metrics for:
951 952 953 954 955 956 957 958 959 960	 Conducting manufacturing, quality, engineering, and software reviews (with frequency of reviews) Cost models information with associated parameters Identification and management of critical characteristics and KCs and the associated manufacturing processes Risk, issue, and opportunity management and mitigation program that includes manufacturing, quality, and IB risks Variability reduction programs Materials management processes Use of COTS, GOTS, and NDIs
961 • 962	The detailed requirements for manufacturing and quality inputs have been documented in the RFP for:
963 964 965 966 967 968	 Content for the SOW and contract sections C, L, M, and H Metrics to be met as exit criteria for TMRR phase Cost estimates that include rate, alternate materials, quantity, etc. (includes Cost of Quality data). Identification and description of manufacturing and technology capability improvement efforts
968	efforts

969		• Cost sharing and incentive plans and initiatives
970 971 972		 Incentives that encourage acquisition of modern technology, production equipment, and production systems that increase the productivity and reduce life-cycle costs Incentives that encourage investment in U.S. domestic sources
972		- Facilities tooling and test equipment
974		 Workforce planning (training, certifications, etc.)
975		• Supply chain management
976	٠	Requirements contractor support of independent risk assessments have been documented in
977		the RFP to include the requirement for identification of any critical technologies or
978		manufacturing processes that have not been successfully demonstrated in a relevant
979		environment.
980	Tools	
981	•	AS6500 Manufacturing Management Program Checklist
982	•	ISO 9000 Quality Management System Checklist
983	•	AS9100 Quality Management System Checklist
984	•	RFQ Template
985	•	SEP Outline
986	Resou	rces
986 987	Resou •	rces AS6500, Manufacturing Management Program, Nov 2014
986 987 988	Resou •	rces AS6500, Manufacturing Management Program, Nov 2014 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
986 987 988 989	Resou • •	rces AS6500, Manufacturing Management Program, Nov 2014 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs
986 987 988 989 990	Resou • •	rces AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015
986 987 988 989 990 991	Resou • • •	rces AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016
986 987 988 989 990 991 992	Resou • • • •	AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services,
986 987 988 989 990 991 992 993	Resou • • • •	AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services, Aug 2001
986 987 988 989 990 991 992 993 994	Resou • • • •	AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services, Aug 2001 MIL-HDBK-245D Handbook for Preparation of Statement of Work, Apr 1996
986 987 988 989 990 991 992 993 994 995	Resou • • • • •	AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services, Aug 2001 MIL-HDBK-245D Handbook for Preparation of Statement of Work, Apr 1996 SEP Outline, Jun 2015
986 987 988 989 990 991 992 993 994 995 996	Resou • • • • • •	AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services, Aug 2001 MIL-HDBK-245D Handbook for Preparation of Statement of Work, Apr 1996 SEP Outline, Jun 2015 10 USC § 2366b
986 987 988 990 991 992 993 994 995 996 997	Resou • • • • • • •	AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services, Aug 2001 MIL-HDBK-245D Handbook for Preparation of Statement of Work, Apr 1996 SEP Outline, Jun 2015 10 USC § 2366b FAR 46-202 Types of Contract Quality Requirements
986 987 988 989 990 991 992 993 994 995 996 997 998	Resou • • • • • • • •	AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services, Aug 2001 MIL-HDBK-245D Handbook for Preparation of Statement of Work, Apr 1996 SEP Outline, Jun 2015 10 USC § 2366b FAR 46-202 Types of Contract Quality Requirements DAG CH 3-4.3.18 Producibility, Quality and Manufacturing Readiness
986 987 988 989 990 991 992 993 994 995 996 997 998	Resou • • • • • • • • • • • • • • •	rces AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services, Aug 2001 MIL-HDBK-245D Handbook for Preparation of Statement of Work, Apr 1996 SEP Outline, Jun 2015 10 USC § 2366b FAR 46-202 Types of Contract Quality Requirements DAG CH 3-4.3.18 Producibility, Quality and Manufacturing Readiness
986 987 988 989 990 991 992 993 994 995 996 997 998 997 998	Resou	rces AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services, Aug 2001 MIL-HDBK-245D Handbook for Preparation of Statement of Work, Apr 1996 SEP Outline, Jun 2015 10 USC § 2366b FAR 46-202 Types of Contract Quality Requirements DAG CH 3-4.3.18 Producibility, Quality and Manufacturing Readiness Provide Input to TMRR SSP
986 987 988 990 991 992 993 994 995 996 997 998 997 998 999 1000	Resou	rces AS6500, Manufacturing Management Program, Nov 2014 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 9000:2015, Quality Management Systems, Sep 2015 AS9100, Quality Management Systems, Sep 2016 MIL-HDBK-29612-1A Guidance for Acquisition of Training Data Products and Services, Aug 2001 MIL-HDBK-245D Handbook for Preparation of Statement of Work, Apr 1996 SEP Outline, Jun 2015 10 USC § 2366b FAR 46-202 Types of Contract Quality Requirements DAG CH 3-4.3.18 Producibility, Quality and Manufacturing Readiness Provide Input to TMRR SSP facturing and Quality Tasks Ensure that manufacturing and quality personnel are included in the drafting of the Source

1003 1004 1005 1006		 Analyze the manufacturing and quality results from the AoA Study Guidance and the AoA as a basis for SSP requirements and metrics Results from other relevant manufacturing and quality feasibility and IB studies to be used as additional data for SSP requirements and metrics
1007 1008 1009	•	Specify the criteria and metrics for evaluating the contractor's use of best practices for Manufacturing Management, Quality Management (e.g., AS6500, ISO 9000, AS9100, etc.), and Systems Engineering management (i.e., IEEE 15288).
1010 1011 1012		• 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
1013 1014 1015	•	Specify the plan with appropriate criteria and metrics for submission, review, revision, and approval of CDRLs, DIDs, etc. to support manufacturing and quality processes. Specify manufacturing and quality criteria and appropriate metrics to be met for:
1016 1017 1018 1019 1020 1021 1022 1023 1024 1025		 All Milestone and technical reviews Manufacturing and quality 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
1026	•	Specify the criteria and metrics for evaluating the contractor's:
1027		• Manufacturing and technology capability improvement plans and efforts.
1028		 Include cost sharing and incentive plans
1029		• Producibility efforts relevant to the solution.
1030		 Include cost sharing and incentive plans
1031 1032 1033 1034		 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 the productivity and reduce life-cycle costs
1035		 Methods to encourage investment U.S. domestic sources
1036 1037 1038	•	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.

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Metrics
• Manufacturing and quality personnel have provided criteria and metrics for inclusion in the SSP.
 Results from the AoA Study Guidance and the AoA (manufacturing and quality inputs) have been analyzed the as a basis for SSP requirements and metrics Other relevant manufacturing and quality feasibility and IB studies results have been documented and used as additional data for SSP requirements and metrics
• Criteria and metrics for evaluating the contractor's use of best practices for Manufacturing Management, Quality Management, and Systems Engineering management (applicable to manufacturing and quality) have been developed and documented for the SSP.
• Criteria and metrics for evaluating the contractor's proposed processes, methods, and actions that address manufacturing feasibility, producibility, and quality risks associated with the proposed solutions are documented and specified in the SSP.
 Appropriate criteria and metrics for submission, review, revision, and approval of CDRLs, DIDs, etc. to support manufacturing and quality processes have been specified in the SSP. Manufacturing and quality criteria and metrics have been specified in the SSP for:
 All Milestone and technical reviews Conducting manufacturing and quality reviews (with frequency of reviews) Cost models and data including Cost of Quality KC management process 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
 Manufacturing and quality criteria and metrics for evaluating the contractor's plan to meet the exit criteria for TMRR phase have been specified Specified manufacturing criteria and metrics have been documented in the SSP for evaluating the contractor:
 Manufacturing and technology capability improvement plans with cost sharing and incentive plans and metrics Producibility efforts with cost sharing and incentive plans and metrics Planning for IB risk management and mitigation Strategy for acquisition of modern technology, production equipment, and production systems that increase the productivity and reduce life-cycle costs including methods to encourage investment in U.S. domestic sources
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2. Materiel Solution Analysis (MSA) Phase

1076 1077 1078	•	Criteria and metrics for contractor support of independent risk assessments to include the identification of any critical technologies and manufacturing processes that have not been successfully demonstrated in a relevant environment have been documented in the SSP.
1079	Tools	
1080	•	Source Selection Plan Template (Navy)
1081	•	AS6500 Manufacturing Management Program Checklist
1082	٠	AS9100 Quality Management System Checklist
1083	•	ISO 9001 Quality Management System Checklist
1084	Resou	rces
1085	•	Air Force Manufacturing Development Guide, Sep 2012
1086	•	AS6500, Manufacturing Management Program, Nov 2014
1087	•	AS9100, Quality Management Systems, Sep 2016
1088	٠	DAG CH 3-4.3.18 Producibility, Quality and Manufacturing Readiness
1089	٠	IEEE 15288, Systems and Software Engineering
1090	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
1091	•	IEEE 15288.2-2014, Standard for Technical Reviews and Audits on Defense Programs
1092	•	ISO 9000:2015, Quality Management Systems, Sep 2015
1093	٠	PL 114-328
1094	•	Defense Federal Acquisition Regulation Supplement, Procedures, Guidance and Information,
1095		Subpart 215.3Source Selection, March 31, 2016
1096		Source Selection Plan Guide, Dec 2008
1097	B.3	Identify Potential TMRR Award Fee Criteria
1098	Manu	facturing and Quality Tasks
1099 1100	•	Develop manufacturing and quality entrance and exit criteria for technical reviews and decision points.
1101 1102		• Specify metrics for partial achievements, incremental awards, penalties for failure to meet contract requirements, and achievement beyond expectations
1103 1104 1105	•	Incentivize early delivery of completed, comprehensive, and acceptable manufacturing and quality CDRLs, DIDs, other program documentation that meet the requirements for timely government approval.
1106 1107		• Specify metrics for partial achievement and penalties for failure to meet contract requirements
1108 1109	•	Provide incentives for achievement of manufacturing and quality specific thresholds, objectives, and sub-goals with respect to rate, schedule, performance, quality, etc.

1110 1111		• Specify metrics for partial achievements, incremental awards, and penalties for failure to meet contract requirements
1112 1113	•	Specify thresholds for the adoption and effective implementation of industry best practices in manufacturing and quality (e.g., AS6500, ISO 9000, AS9100. etc.).
1114 1115		 Develop program specific metrics that measure progress Specify incentives for exceeding thresholds
1116 1117	•	Specify thresholds and metrics for comprehensive manufacturing, quality, and subcontracting management plans.
1118 1119 1120 1121 1122 1123 1124		 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
1125 1126 1127 1128 1129 1130	•	Develop manufacturing and quality program specific criteria and metrics that include key trades for and among cost, schedule, and performance, affordability analysis, risk analysis, and risk mitigation. Develop manufacturing and quality criteria and metrics that incentivize domestic manufacturing capability improvement investments, contributing to enhanced performance, schedule improvement, cost savings, etc. Include as appropriate the following:
1131 1132 1133		 Continuous Process Improvement (CPI) Program or initiatives Cost sharing, risk reduction, cost recovery, etc. Investments in domestic advanced manufacturing equipment and processes
1134	Metrio	CS
1135 1136	•	Manufacturing and quality entrance and exit criteria requirements for technical reviews and decision points within schedule and budget are specified in the contract.
1137 1138 1139 1140 1141		 Contract specifies metrics for partial achievements, incremental awards, and awards for performance beyond expectations Contract includes penalties for partial and or failure to meet contractual requirements that are definitive and specified in terms of cost to award fee with maximum and minimum penalties
1142 1143 1144	•	Contract includes provisions and incentives with metrics for early delivery and approval of complete, comprehensive, and acceptable manufacturing and quality CDRLs, DIDs, other program documentation.
1145 1146		• Metrics for partial achievements, incremental awards, and penalties for failure to meet contract requirements are included

2. Materiel Solution Analysis (MSA) Phase

1147 1148	•	Contract includes incentives for achievement of manufacturing and quality specific thresholds, objectives, and sub-goals with respect to rate, schedule, performance, quality, etc.
1149 1150		• Metrics for partial achievements, incremental awards, and penalties for failure to meet contract requirements are included
1151 1152 1153 1154 1155	•	Contract includes appropriate manufacturing and quality criteria and metrics for enhanced performance, schedule improvement, cost savings; and specifies the potential award fee or incentive to be earned. Contract includes criteria and metrics for the adoption and implementation of industry best practices in manufacturing and quality (e.g., AS6500, ISO 9000, AS9100. etc.).
1156		• Contract specifies the metrics for measuring progress and meeting expectations
1157 1158	•	Contract includes incentives and metrics for comprehensive manufacturing, quality, and subcontracting management plans.
1159 1160 1161 1162 1163 1164 1165 1166		 Metrics for a manufacturing management plan have been included that identify: KCs and critical manufacturing processes, performing variability reduction activities, performing manufacturing capability assessments, and including a robust producibility program Metrics for a quality management plan have been included that implement an effective Quality Management System focused on defect prevention Metrics for a subcontract management plan have been included that implement a comprehensive supplier management organization that promotes exceptional performance
1167 1168 1169	•	Contract specifies criteria and metrics to evaluate trades among cost, schedule, performance, affordability, risks, risk mitigation for meeting requirements, and incentives for exceeding goals
1170 1171	•	Contract specifies manufacturing and quality criteria and metrics that encourage domestic manufacturing and quality capability improvement investments and includes the following:
1172 1173 1174 1175 1176 1177		 CPI Program or initiatives Cost savings, recovery, and sharing Risk reduction and mitigation Domestic investment in advanced manufacturing equipment and processes Performance enhancement Schedule improvement
1178	Tools	
1179 1180 1181	•	Source Selection Plan Template (Navy) Award Fee or Incentive Fee Template AS6500 Manufacturing Management Program Checklist
1182	•	AS9100 Quality Management System Checklist
1183 1184	•	ISO 9001 Quality Management System Checklist

2. Materiel Solution Analysis (MSA) Phase

1185 Resources

- 1186 Award Fee Guide (Army, Navy and Air Force all have one) • 1187 AS6500, Manufacturing Management Program, Nov 2014
- •
- AS9100, Quality Management Systems, Sep 2016 1188 •
- 1189 Defense Production Act Title III (Manufacturing Technology Programs) •
- 1190 DODD 4400.01E Defense Production Act Programs, Oct 2001 •
- 1191 ISO 9000:2015, Quality Management Systems, Sep 2015 •
- Award Fee Guide, (Army, Navy or Air Force) 1192 •
- 1193 MIL-STD-896B Manufacturing and Quality Program •

1194 C. SURVEILLANCE SYSTEM



1195

1196 The AoA authority or PM should maximize the use of Defense Contract Management Agency

1197 (DCMA) information, data, and analyses from contractor facilities where there is delegation of

1198 authority and expertise available. DCMA, utilizing a systematic approach to supplier manufacturing

- 1199 and supply chain evaluation, supply chain improvement initiatives, and best practices, is a valuable 1200 resource.
- 1201 DCMA can provide input into requirements and commitments that enable programs to have current 1202 and predictive insight into performance. Access to reliable and accurate data and process information

1203 on costs, schedule, and technical performance can assist with objective assessment of supplier plans

1204 and the verification of initial and continuing compliance with requirements. The ability to continually

1205 analyze risks and identify risk-adjusted solutions to sustain a reliable, technologically superior,

1206 efficient, cost-effective, and resilient defense IB mitigates overall program risk.

1207 C.1 Utilize DCMA Data for AoA

1208 **Manufacturing and Quality Tasks**

- 1209 As part of manufacturing feasibility assessments of AoA concepts, request information and 1210 data input for similar products and manufacturing processes from DCMA on:
- 1211 Manufacturing maturity 0
- Status and readiness of industrial capabilities 1212 0
- 1213 • Current available facilities and equipment
- Workforce availability and training 1214
- 1215 Quality system processes and results 0
- 1216 Ensure DCMA quality and manufacturing data is utilized in the analysis of the manufacturing • and quality requirements and feasibility for the AoA. 1217

1218 1219 1220 1221 1222 1223	 Utilize DCMA manufacturing and quality data relevant for emerging technology maturity to develop and provide recommendations/rationale for the AoA preferred concepts. Utilize 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 utilize DCMA manufacturing and quality data in support of the AoA to include data that supports the following analyses:
1224	 Manufacturing System Analysis
1225 1226 1227	 Supplier Surveillance Production Planning and Control System Material Management and Accounting System (MMAS)
1228	 Manufacturing Program and Product Analysis
1229 1230 1231	 Development program specific surveillance Industrial Labor Relations Past Performance
1232	 Manufacturing Continuous Improvement and Analysis
1233 1234	Surveillance of Supplier Continuous Improvement SystemSupplier Performance Measurement
1235	 Supply Chain System Analysis
1236 1237 1238 1239 1240 1241	 Materials Planning Supplier/Sub-tier Qualification/Requirements Flow Down Communication/Systems Integration Continuous Improvement Supplier Performance Measurement System and Surveillance Improvement Data Analysis, Statistics, and Sampling
1242	 Supply Chain Risk Assessment
1243 1244 1245 1246	 Risk Realization Program/Platform/Sector Analysis and Modeling Critical Item Risk Capacity/Lead Time Analysis
1247	Metrics
1248 1249 1250	• As part of manufacturing feasibility assessments of AoA concepts, DCMA provided information and data on similar products and manufacturing processes has been utilized and included specifics on:
1251 1252 1253 1254	 Manufacturing maturity Status and readiness of industrial capabilities Current available facilities and equipment Workforce availability and training

1255		• Quality system processes and results
1256 1257 1258 1259 1260 1261 1262 1263	•	 Quality and manufacturing data provided by DCMA has been utilized in the analysis of the manufacturing and quality requirements and feasibility for the AoA. DCMA data relevant emerging technology maturity has been utilized to develop and provide recommendations/rationale for the AoA preferred concept(s). DCMA data has been utilized to assist in identifying the manufacturing and/or supply chain risks for similar products and processes relevant for the AoA. DCMA data has been utilized to support the AoA to including data that supports the following analyses:
1264		 Manufacturing System Analysis
1265 1266 1267		 Supplier Surveillance Production Planning and Control System MMAS
1268		• Manufacturing Program and Product Analysis
1269 1270 1271		 Development program specific surveillance Industrial Labor Relations Past Performance
1272		 Manufacturing Continuous Improvement and Analysis
1273 1274		Surveillance of Supplier Continuous Improvement SystemSupplier Performance Measurement
1275		 Supply Chain System Analysis
1276 1277 1278 1279 1280 1281		 Materials Planning Supplier/Sub-tier Qualification/Requirements Flow Down Communication/Systems Integration Continuous Improvement Supplier Performance Measurement System and Surveillance Improvement Data Analysis, Statistics, and Sampling
1282		 Supply Chain Risk Assessment
1283 1284 1285 1286		 Risk Realization Program/Platform/Sector Analysis and Modeling Critical Item Risk Capacity/Lead Time Analysis
1287	Tools	
1288	•	DCMA Pre-Award Survey
1289	•	DCMA Program Support Plan
1290	•	AS6500 Checklist

2. Materiel Solution Analysis (MSA) Phase

- ISO 9000 Checklist
- AS9100 Checklist
- AoA Study Plan Template, Sep 2009
- SF 1404 Preaward Survey Technical
- SF 1405 Preaward Survey Production
- SF 1406 Preaward Survey Quality
- 1297

- Air Force AoA Guide, June 2013
- 1300 Air Force AoA Handbook, July 2008
- 1301 AS6500, Manufacturing Management Program, Nov 2014
- ISO 9000:2015, Quality Management Systems, Sep 2015
- AS9100, Quality Management Systems, Sep 2016
- DCMA Pre-award Survey Guide, (no date)

1305	C.2	Utilize DCMA Data for Program Manageme	nt
		0 0	

1306 Manufacturing and Quality Tasks

- Utilize the DCMA information and data provided for the AoA to support the development of manufacturing and quality inputs to program documentation, planning, and investments with respect to:
- 1310 o Manufacturing maturity
- 1311 o Industrial capability status and readiness
- 1312 o Facilities and equipment availability
- 1313 Workforce availability and training
- 1314 o Quality system processes and results
- 1315 o Manufacturing and/or supply chain risks
- Utilize DCMA data to support the manufacturing and quality inputs to systems engineering
 trade studies, design, analyses, etc. Including information from DCMA reports on:
- 1318 o Manufacturing System Analyses
- 1319 O Manufacturing Program and Product Analyses
- 1320 o Manufacturing Continuous Improvement and Analysis
- 1321 o Supply Chain System Analysis
- 1322 o Supply Chain Risk Assessment
- Based on DCMA inputs, document and develop recommendations for manufacturing investment programs mature emerging manufacturing technologies and industrial capabilities (see D.3 and D.4).

1326 1327 1328	•	Request DCMA Contract Management Offices support development of manufacturing and quality to program support plans for program contracts to ensure agreement on contract oversight needs and perspectives with respect to:
1329 1330 1331 1332		 Product support analysis Software development Counterfeit parts Cyber security
1333	Metric	S S
1334 1335 1336	•	DCMA information and data provided for the AoA have been utilized to support the development of manufacturing and quality inputs to program documentation, planning, and needed investments with respect to:
1337 1338 1339 1340 1341 1342		 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
1343 1344 1345	•	DCMA analysis data has been utilized to support the manufacturing and quality inputs to systems engineering trade studies, design, analyses, etc., which included information and results from DCMA:
1346 1347 1348 1349 1350		 Manufacturing System Analyses Manufacturing Program and Product Analyses Manufacturing Continuous Improvement and Analysis Supply Chain System Analysis Supply Chain Risk Assessment
1351 1352 1353 1354 1355 1356	•	Based on DCMA inputs, recommendations for manufacturing investment programs mature emerging manufacturing technologies and industrial capabilities have been developed and documented (see D.3 and D.4). DCMA Contract Management Offices have been requested to support development of manufacturing and quality inputs to program support plans for program contracts to ensure agreement on contract oversight needs and perspectives.
1357	Tools	
1358	٠	Army Manufacturing Technology (ManTech) Proposal Rating Template
1359	•	Industrial Base Capabilities Assessment Questionnaire
1360	•	Manufacturing Readiness Level Assessment Questionnaire
1361	•	Pugn Matrix template
1302	•	rechnology Readiness Assessment Checklist

2. Materiel Solution Analysis (MSA) Phase

1363	Resources		
1364	DoD Directive 4200.15 DoD ManTech Program		
1365	Counterfeit Parts Prevention Strategy Guide, Jun 2014		
1366	DODI 5000.60 Defense Industrial Capabilities Assessments		
1367	DOD 5000.60H Assessing Defense Industrial Capabilities		
1368	ManTech Strategic Plan, Mar 2009		
1369	MRL Deskbook Version 2016		
1370	Technology Readiness Assessment Guidance, Apr 2011		
1371	DCMA-INST-204 Manufacturing and Production		
1372	DCMA-INST-205, Major Program Support		
1373	DCMA-INST-207 Engineering Surveillance		
1374	DCMA-INST-309 Government QA Surveillance Planning		
1375	DCMA-INST-325 Technical Reviews		
1376	• DoDI 5000.02, change 1, Jan 2017		
1377	C.3 Monitor and Identify Impacts to Program Ecosystem		
1378	Manufacturing and Quality Tasks		
1379 1380	• Monitor and track external environment for potential impacts to manufacturing and quality for the program.		
1381	• Environmental impacts to supply chain (legal and natural disasters)		
1382	• Strategic and political changes/risks (domestic and foreign)		
1383	• New laws and regulations (state and federal)		
1384	• Obsolescence impacts		
1385	 New industry or updated standards (e.g., AS6500, IEEE 15288, etc.) 		
1386	• Monitor and track Industrial Base for trends, business startups, technology breakthroughs,		
1387	etc. for impacts on manufacturing and quality		
1388	• Monitor and track economic and business environment developments and impacts on		
1389	manufacturing and quality with regard to:		
1390	• Acquisitions		
1391	• Mergers		
1392	• Bankruptcies		
1393	• Market changes/disruptions		
1394	Metrics		
1395	• Changes in the external environment, the economic and business environment, or the		
1396	Industrial Base that have manufacturing and quality impacts and risks are being monitored		

and have been documented in the SEP. 1397

2. Materiel Solution Analysis (MSA) Phase

1398	٠	Acquisition Strategy has been updated to reflect changes in the external environment, the
1399		economic and business environment, or the Industrial Base that have manufacturing and
1400		quality impact.
1401	٠	Environmental, economic, and business, or Industrial Base changes that have manufacturing
1402		and quality impacts on facilities, safety, tooling, etc. have been documented and mitigation
1403		planning initiated.
1404	Tools	
1405	•	Hazardous Material Assessment Template
1406	•	ISO 9000 Checklist Section Preservation (Handling, Storage, Packaging and Delivery)
1407	•	Preliminary Hazard List (PHL) See PHA checklist
1408	Resou	rces
1409	•	ISO 9000:2015, Quality Management System, Sep 2015
1410	•	ISO 14001 Environmental Management
1411	•	MRL Deskbook Version 2016
1412	•	ESHO in Acquisition Guide, Apr 2009
1413	•	AS9100, Quality Management Systems, Sep 2016 - SCM Model

1414 D. TECHNOLOGY AND INDUSTRIAL BASE (IB)



1416 The MSA phase identifies materiel solutions to address gaps in capability based on an Analysis of

1417 Alternatives (AoA). The AoA is performed independent of the program management office and

1418 forms the basis for selecting the recommended approaches for materiel solutions. During the AoA,

1419 each competing alternative under consideration is analyzed for its impact to industrial and

1420 manufacturing capabilities. The results of the analyses are used to quantify the differences between

1421 alternatives based on the industrial and manufacturing capabilities and the resources needed.

1422 The IB assessments performed previously determine the likelihood that a proposed materiel solution

1423 can be produced. The assessments identify relevant sources and potential unique manufacturing

1424 capabilities, known gaps, risks, and potential sources, technological developments, market trends,

1425 processes, environmental factors, and policies, etc. The IB analysis focuses on availability,

1426 vulnerability, potential obsolescence, and actions necessary to mitigate.

1427 The IB assessments identify the high-risk manufacturing areas and highlight the need for investments

in manufacturing technology improvements. These gaps must be identified early to reduce

1429 acquisition costs by providing the required investments in manufacturing capabilities in time to

1430 support production. The DoD ManTech program was created to address the concerns for high-risk

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- 1431 manufacturing processes, with the objective of improving performance and reducing cost by
- 1432 developing, maturing, and transitioning advanced manufacturing technologies.
- 1433 The assessments and analyses also highlight the need to support, maintain, or enhance essential or
- 1434 fragile industrial capabilities. The IB analyses identify the IB risks incurred in selecting a particular
- 1435 design and highlight the need for mitigation of potential product or component obsolescence,
- supplier fragility, and process economic feasibility.
- 1437 Note: When industrial capabilities require an investment greater than \$10 million and affect more
- 1438 than one defense program or user, the need to support, maintain, or enhance essential or fragile
- 1439 industrial capabilities the analyses and subsequent decisions must be coordinated within and across
- 1440 the Components per DODI 5000.60.

1441 **D.1 Update Industrial Base Assessment and Analysis**

1442 Manufacturing and Quality Tasks

1443 Manufacturing and quality support the update of the IB assessments for concepts included in 1444 the AoA (conduct if not previously accomplished) by: 1445 • Ensuring identification of relevant sources including identification of unique 1446 manufacturing capabilities that are not readily accessible or available (e.g., capability is 1447 at maximum capacity, materials from a constrained source, etc.) 1448 • Determining the likelihood that a proposed material solution can be produced using 1449 existing manufacturing capabilities while meeting quality, production rate and cost 1450 requirements 1451 • Ensuring the concept requirements and capabilities assessments are updated to include: 1452 Identification of all known gaps, risks, and potential sources for key processes, . 1453 technologies, and components 1454 Identification of all potential and future manufacturing and quality needs inclusive of 1455 design, development, production, operation, and sustainment, and eventual disposal All technological developments, market trends, processes, environmental factors, and 1456 1457 policies, etc. that could potentially impact manufacturing and quality of the preferred 1458 concepts 1459 Request updated DCMA industrial analysis data to support manufacturing and quality inputs 1460 to the AoA, including data that supports the following analyses: 1461 o Industrial Capability Assessments 1462 o Analytical Products Defense Business and Economic Analyses 1463 1464 o Acquisition Planning Support 1465 Ensure the manufacturing and quality focus of the IB analyses is on the: •

1466		0	Capability to cost effectively design, develop, produce, maintain, support and restart the
1467			program (if necessary)
1468		0	Approach to making production rate and quantity changes that support a response to
1469			contingency and support objectives
1470		0	Vulnerability of supply chain (to include sole, single, fragile, foreign sources, foreign
1471			acquisition of domestic sources, and cybersecurity)
1472		0	Availability of essential raw materials, special alloys, composite materials, components,
1473			tooling, and production test equipment required to include the availability of alternatives
1474			for obtaining such items from within the NTIB
1475		0	Potential obsolescence
1476		0	Impact of external dependencies and integration
1477		0	New and unique capabilities and processes
1478		0	Actions necessary to mitigate existing IB gaps/risks and identifies when a needed
1479			industrial capability could be lost
1480	•	Pre	pare the manufacturing and quality inputs to the Industrial Base Capabilities
1481		Co	nsiderations summary report to summarize the results for inclusion in the AS:
1482		0	Recommend actions or investments that address risks to cost schedule performance and
1483		0	qualitative considerations
1484		0	Define and recommend how and when the actions would be incorporated into the budget
1485		0	and schedule and, if possible, identify budget offsets
1486		0	If the required investment is greater than \$10 million and is determined to affect more
1487		Ū	than one defense program must be coordinated within and across the Components per
1488			DODI 5000.60
1489	Metric	S	
1490	•	Th	e IB assessments for concepts included in the AoA have been updated (conduct if not
1491		pre	viously accomplished) and include manufacturing and quality inputs.
1492		0	Relevant sources have been identified and documented including identification of unique
1493			manufacturing capabilities that are not readily accessible or available (e.g., capability is
1494			at maximum capacity, materials from a constrained source, etc.)
1495		0	The likelihood that a proposed materiel solution can be produced using existing
1496		-	manufacturing capabilities while meeting quality, production rate and cost requirements
1497			has been determined and quantified
1498			 Identification of all known gaps, risks, and potential sources for key processes.
1499			technologies, and components
1500			 Identification of all potential and future manufacturing and quality needs inclusive of
1501			design development production operation and sustainment and eventual disposal
1502			 All technological developments market trends processes environmental factors and
1502			nolicies etc. that could notentially impact manufacturing and quality of the preferred
1503			concept
1004			concept

1505 1506	•	The IB assessment update included up-to-date DCMA industrial analysis data that supports the following analyses:
1507 1508 1509 1510		 Industrial Capability Assessments Analytical Products Defense Business and Economic Analyses Acquisition Planning Support
1511	•	The IB analyses focused on manufacturing and quality, and documented the following:
1512 1513 1514 1515 1516 1517 1518 1519 1520 1521 1522 1523 1524		 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 required Actions necessary to mitigate existing IB gaps/risks and identifies when a needed industrial capability could be lost
1526 1527 1528	•	The manufacturing and quality inputs to the Industrial Base Capabilities Considerations summary report, summarizing the results, have been prepared for the report and are included in the AS, including:
1529 1530 1531 1532 1533 1534		 Recommended actions or investments that address risks to cost, schedule, performance, and qualitative considerations Recommendations on actions to be incorporated into the program budget and schedule, and if possible, identify budget offsets (when and how) If the required investment was greater than \$10 million and determined to affect more than one defense program or user the following must be accomplished: The need to support, maintain, or enhance essential or fragile industrial capabilities.
1536 1537		the analyses, and subsequent decisions must be coordinated within and across the Components per DODI 5000.60.
1538	Tools	
1539	•	AoA Study Plan Template
1540	٠	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
1541	•	MRL Assessment Checklist for Technology and Industrial Base thread
1542	•	Army Man Lech Proposal Rating Template

2. Materiel Solution Analysis (MSA) Phase

1543 1544	• Numerous M&S models are available that the contractor may use, we (government) should be familiar with these tools							
1545	Resources							
1546	• Air Force AoA Handbook, Jul 2008							
1547	• DODD 4200.15 Manufacturing Technology (ManTech) Program, Sep 2002							
1548	• DoDI 5000.02							
1549	DODI 5000.60 Defense Industrial Assessments, Jul 2014							
1550	DODI 5000.60H Defense Industrial Capabilities Assessments, Apr 1996							
1551	MRL Deskbook Version 2016							
1552	• DFARS 207.105							
1553	• DoDI 5000.60							
1554	• DoDI 5000.02, Change 1, Jan 2017							
1555	• 10 USC §2440, Technology and Industrial Base Plans							
1556	D.2 Identify Critical Technology Element (CTE) Maturity and Limitations							
1557	Manufacturing and Quality Tasks							
1558	• Identify the CTEs and assess the manufacturing and quality maturity for the AoA.							
1559 1560 1561 1562	 Include necessary hardware and the associated embedded software maturity Identify mature components, subsystems, manufacturing and quality processes, and alternatives for each immature CTE, and specify a plan for increasing the manufacturing and quality maturity 							
1563 1564	• Assess the manufacturing feasibility, and manufacturing and quality processes associated with each CTE in the validated ICD, and develop a plan to improve and/or maintain maturity.							
1565 1566	 Include integration risk associated with the CTEs in trade studies and development Include CTE interdependencies and associated risks 							
1567 1568 1569 1570 1571	 For the ASR, conduct manufacturing and quality 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. Ensure that the upcoming phase RFP addresses manufacturing and quality maturation of critical technologies. 							
1572	Metrics							
1573 1574	• As part of the AoA, the CTEs have been identified, assessed, and documented for manufacturing and quality maturity.							
1575	• Necessary hardware and the associated embedded software maturity has been included							
1576 1577 1578	•	• For the AoA preferred concept(s), mature components, subsystems, processes, and alternatives for each immature CTE have been identified and documented as manufacturing and quality inputs in the appropriate program documentation (AS, SEP, etc.).						
------------------------------	-------	--	--	--	--	--	--	--
1579 1580		 Plans for increasing the manufacturing and quality maturity have been developed and documented 						
1581 1582 1583	•	The manufacturing feasibility, and manufacturing and quality processes associated with each CTEs have been documented in the draft CDD, and have been included in the AS and SEP with the plans to improve and/or maintain maturity documented.						
1584 1585 1586		 Includes manufacturing and quality integration risks associated with the CTEs in trade studies and development Includes CTE manufacturing and quality interdependencies and associated risks 						
1587 1588 1589 1590	•	As part of the ASR, analyses that document the likelihood that the CTE manufacturing and quality maturity will meet the required level of operational effectiveness and suitability with an acceptable level of risk have been provided and included.						
1590	·	documented in the RFP.						
1592	Tools							
1593	•	MRL Assessment Checklist for Technology and Industrial Base thread						
1594	٠	Producibility Assessment Worksheet (PAWs)						
1595	٠	Technology Readiness Assessment						
1596	•	TRL Calculator						
1597	Resou	rces						
1598	•	Defense Acquisition Program Support Methodology, Ver. 3.0						
1599	•	MRL Deskbook Version 2016						
1600	•	NAVSO P-3687Producibility Systems Guidelines, Dec 1999						
1601	•	Technology Readiness Assessment Guidance, Apr 2011						
1602	D.3	Identify Manufacturing Technology Gaps and Requirements						
1603	Manu	facturing and Quality Tasks						
1604 1605	•	Conduct manufacturing and quality assessments to identify gaps and high-risk in manufacturing processes needed for the preferred concept(s).						
1606 1607 1608		 Analyze identified advanced manufacturing capabilities to definitize requirements Analyze the gaps for potential manufacturing technology solutions that mitigate the risks Estimate manufacturing and quality cost, schedule, and performance impacts 						

1609 1610	•	Identify potential investments in manufacturing and quality technology that address gaps and risks.
1611 1612	•	Conduct a survey that includes both DCMA reports and analyses, and the ongoing the DoD ManTech Program projects for potential solutions to manufacturing technology gaps.
1613 1614		 Request DCMA provide relevant data Request ManTech assistance to identify processes and components
1615 1616	•	Identify and develop manufacturing and quality assistance requests to DoD and/or component manufacturing technology programs that support:
1617 1618 1619 1620 1621		 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
1622 1623	•	Identify recommendations for program and contracting personnel on emerging manufacturing and quality technology investments and Title III initiatives.
1624	Metrio	S
1625 1626	•	Manufacturing and quality assessments have identified and documented gaps and high-risk manufacturing processes required for the preferred concept(s).
1627 1628 1629 1630 1631 1632		 Advanced Manufacturing capabilities necessary for the preferred concept have been identified and documented along with associated risks. Gaps have been analyzed and results documented for potential manufacturing technology solutions that mitigate the risks Manufacturing and quality cost, schedule, and performance impacts have been identified and documented
1633 1634 1635 1636 1637 1638	•	Potential investments in manufacturing and quality technology that address gaps and risks have been identified and documented. DCMA reports and analyses and ongoing ManTech projects have been identified, assessed, and documented for potential solutions that mitigate gaps in the preferred concept. Manufacturing and quality assistance requests to DoD and/or component ManTech programs have been developed that support:
1639 1640 1641 1642		 Identification of new manufacturing processes associated with the program and candidate components Identification of low-yield processes and components Requests for information from other government agencies, industry, and academia
1643 1644	•	Recommendations for program and contracting personnel on emerging manufacturing and quality technology investments and Title III initiatives have been identified and documented.

1645	Tools	
1646	•	Army ManTech Proposal Rating spreadsheet
1647	•	ManTech Phase I project questionnaire
1648	٠	MRL Assessment Checklist for Technology and Industrial Base thread
1649	•	Pugh Matrix
1650	•	Technology Roadmap
1651	•	TRL Assessment Checklist
1652	Resou	irces
1653	•	Air Force Technology Development and Transition Strategy Guidebook, Nov 2010
1654	٠	Defense Manufacturing Management Guide for PMs, Chapter 8, Technology Development
1655		and Investments
1656	٠	DoDI 5000.02, Change 1, Jan 2017
1657	٠	DoD Directive 4200.15, ManTech, Sep 2002
1658	٠	MRL Deskbook Version 2016
1659	•	Technology Readiness Assessment Guidance, Apr 2011
1660	D.4	Plan Potential ManTech Projects
1661	Manu	facturing and Quality Tasks
1662	•	Develop plans for identified gaps and high-risk manufacturing processes that require
1663		investments in ManTech or other manufacturing programs.
1664	•	Develop a comprehensive plan for each required potential ManTech investment that
1665		mitigates manufacturing and quality technology gaps for the preferred concept.
1666		• Determine potential funding sources for ManTech projects (Program Office, Service,
1667		and/or DoD-wide funding)
1668	•	Utilize both DCMA reports and analyses and ongoing ManTech projects to support planning
1669		for potential solutions to manufacturing and quality technology gaps.
1670		• Include relevant DCMA and ManTech program data
1671		• Request manufacturing and quality planning support from DoD and/or component
1672		manufacturing technology programs for:
1673		Development of new manufacturing processes associated with the program and
1674		candidate components for the identified processes
1675		 Development and maturation of low-yield processes and components
1676		 Program and contracting personnel supporting manufacturing technology investments
1677		and Title III initiatives
1678		 Evaluating and maturing emerging manufacturing technology maturity

1679	Metri	CS
1680 1681	•	A comprehensive plan for each required potential ManTech investment that mitigates manufacturing and technology gaps for the preferred concept has been developed.
1682 1683		 Potential budget offsets and/or funding sources for ManTech projects have been determined (Program Office, Service, and/or DoD-wide funding)
1684 1685	•	Both DCMA reports and analyses and ongoing ManTech projects have been utilized to support planning for potential solutions to manufacturing and quality technology gaps.
1686 1687 1688		 Relevant DCMA and ManTech program data has been included Manufacturing and quality planning support has been requested and documented from DoD and/or component manufacturing technology programs for:
1689 1690 1691 1692 1693 1694		 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 Title III initiatives Evaluating and maturing emerging manufacturing technology maturity
1695 1696 1697 1698	•	Plans for identified high-risk manufacturing process areas that may require investments in ManTech or other manufacturing programs have been developed with recommendations documented. A comprehensive plan for each required investment has been developed for the AS.
1699	Tools	
1700 1701 1702 1703	• • •	Army ManTech Proposal Rating spreadsheet ManTech Phase I project questionnaire MRL Assessment Checklist for Technology and Industrial Base thread TRL Assessment Checklist
1704	Resou	rces
1705 1706 1707 1708 1709	•	Air Force Technology Development and Transition Strategy Guidebook, Nov 2010 Defense Manufacturing Management Guide for PMs, Chapter 8, Technology Development and Investments DoDI 5000.02, Change 1, Jan 2017 DoD Directive 4200.15, ManTech, Sep 2002
1710 1711	•	MRL Deskbook Version 2016 Technology Readiness Assessment Guidance, Apr 2011

2. Materiel Solution Analysis (MSA) Phase

1712 **D.5** Plan IB Risk Mitigation

1713 Manufacturing and Quality Tasks

- Identify all manufacturing and quality capability risks that impact the preferred concept.
- Develop a mitigation strategy and plan for each manufacturing and quality IB risk.
- Develop an IB capabilities plan with contingencies to identify and mitigate the current and future manufacturing and quality capability risks. Plan should identify and mitigate:
- All manufacturing and quality capabilities that should be maintained throughout the life
 of the program
- 1720 o Items projected to go out of production and plan for product or technology obsolescence,
 1721 lifetime replacement, or regeneration
- Fragility of unique manufacturing and quality capabilities and any facilities or
 corporations that provide unique services or products
- 1724oThe 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
- 1731 o Impact of external dependencies and integration
- 1732 o New and unique capabilities and processes

1733 Metrics

1734 All manufacturing and quality capability risks that impact the preferred concept from being • 1735 produced have been identified and documented. 1736 • A mitigation strategy and plan for each manufacturing and quality IB risk has been developed. 1737 1738 • An IB capabilities plan to address the current and future required manufacturing and quality capabilities has been developed and documented and addresses risk identification and 1739 1740 mitigation of: 1741 o All manufacturing and quality capabilities necessary should be maintained throughout the 1742 life of the program 1743 All items projected to go out of production and a plan for product or technology 0 1744 obsolescence, lifetime replacement, or regeneration • Fragility of unique manufacturing and quality capabilities and any facilities or 1745 1746 corporations that provide unique services or products 1747 • Production rate and quantity changes that support a response to contingency and support objectives 1748 1749 • Vulnerability of supply chain (to include sole, single, fragile, foreign sources, and foreign 1750 acquisition of domestic sources)

2. Materiel Solution Analysis (MSA) Phase

- 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
- 1754 o Impact of external dependencies and integration
- 1755 o New and unique capabilities and processes
- The IB capabilities plan for current and future manufacturing and quality capability risks has
 been developed and is documented in the AS and SEP.

1758 **Tools**

- Manufacturing/QA Risk Mitigation Plan (no Template available)
- MRL Assessment Checklist for Technology and Industrial Base thread
- Industrial Base Sector Plans (no specific tool)

1762 **Resources**

- DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities, Part II, Chapter 5
 Identify and evaluate Alternative Actions, Apr 1996
 DODI 5000 60 D for a labor in Labor in Laboration and the laboration of the laboration o
- DODI 5000.60 Defense Industrial Assessments, Jul 2014
- MRL Deskbook Version 2016, Chapter 5.2 Development of a Manufacturing Maturation
 Plan

1768 **E. DESIGN**

E Design E.1 Assess Mfg. E.3 Participate E.2 Initial Producibility E.4 Identify Key	
L. Designi Feasibility for AoA in IPI Planning Characteristics	
1769	

1770 The MSA phase presents the first real opportunity to influence system design and begin planning for1771 production by balancing requirements against producibility, manufacturability, and affordability. The

- 1772 AoA Team should ensure that a manufacturing feasibility assessment is accomplished as a part of the
- 1773 AoA. The feasibility assessment includes:
- Producibility of the potential design concepts
- Critical manufacturing processes and special tooling development which will be required
- Test and demonstration required for new materials
- Alternate design approaches within the individual concepts
- Anticipated manufacturing risks and potential cost and schedule impacts
- 1779 The feasibility analyses determine the likelihood that a proposed materiel solution(s) can be produced
- 1780 using existing manufacturing capabilities while meeting quality, production rate and cost
- 1781 requirements. The feasibility assessments also identify the manufacturing risks incurred and the
- 1782 manufacturing capability gaps in selecting a particular design. Without these assessments, the PM,
- 1783 once assigned, may find that the program cannot be accomplished within the defined cost and

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2. Materiel Solution Analysis (MSA) Phase

schedule thresholds as a result of incompatibilities between the system design and the manufacturingcapability available to execute it.

1786 At the close of the AoA, a program office is assigned ownership of the approach. At this point, the 1787 program management establishes the appropriate IPT structure to support program execution. The 1788 IPT structure begins with the Over-arching Program IPT (OIPT). Additional IPTs will be designated 1789 as needed to support development of the proposed materiel solution(s). The IPTs may eventually 1790 include program activities from the macro to the micro (e.g., Systems Engineering; Design; Risk, 1791 Issue, and Opportunity Management; Manufacturing and Quality; Configuration Management; 1792 Critical Subsystems, components, and items, etc.). Not all IPTs will be present at all phases of 1793 development, however, manufacturing and quality participation and inputs to all program IPTs is

1794 essential to program success.

1795 The IPTs conduct systems engineering analyses to support the development of the AS and the SEP.

1796 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.

1798 The intent is to reduce technical risk, validate designs, validate cost estimates, evaluate

1799 manufacturing processes, and refine requirements. The PM is *responsible* for manufacturing, quality,

1800 and producibility risk identification and management throughout the program's life cycle.

1801 Manufacturing and quality representatives will plan and *conduct* assessments of manufacturing and

1802 quality readiness and risk to be documented in the SEP.

As part of the IPTs, manufacturing and quality 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

1807 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 affordably over the life cycle.
- 1814 The KPPs and the KSAs should have threshold values consistent with the requirements specified in
- 1815 the ICD and the performance specified in the preliminary performance specifications. The initial
- 1816 KPPs and KSAs will be documented in the draft CDD. From the initial KPPs and KSAs,
- 1817 manufacturing and quality analyses will determine the features of a material, system, subsystem,
- 1818 item, or component whose variation has significant influence on fit, performance, service life, or
- 1819 manufacturability. These features are the KCs, which will be linked to manufacturing processes with

Manufacturing and Quality Management Body of Knowledge

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2. Materiel Solution Analysis (MSA) Phase

1820 associated risks, and should be included as manufacturing and quality considerations in the AS and1821 SEP.

1822 E.1 Assess Manufacturing Feasibility for AoA

impacts

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- 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 manufacturing and quality risks for potential cost and schedule
- 1828 o Update the producibility and manufacturability assessments for each concept 1829 • Analyze each AoA concept for manufacturing and producibility gaps and risks including: 1830 Critical and unique manufacturing process requirements 1831 . Alternate design approaches within the concepts 1832 Material requirements 1833 Supply chain requirements • 1834 Production rate requirements 1835 Facility requirements 1836 Special tooling development requirements 1837 Test and demonstration requirements for new materials • 1838 Manufacturing capability obsolescence 1839 Manufacturing capability sustainment 1840 Ensure assessments provide the data required for the initial manufacturing and producibility • 1841 inputs to KPPs and KSAs 1842 Metrics
- Manufacturing feasibility assessments for the AoA preferred concepts including the industrial capabilities required to design, develop, manufacture, and maintain each have been updated and documented.
- 1846oAnticipated manufacturing and quality risks for potential cost and schedule impacts have1847been updated
- 1848oInitial producibility and manufacturability assessment for each of concepts have been1849updated
- 1850 o Each AoA concept has been analyzed for manufacturing and producibility gaps and risks
 1851 including:
 - Critical and unique manufacturing process requirements
 - Alternate design approaches within the concepts
- 1854 Material requirements
- 1855 Supply chain requirements

2. Materiel Solution Analysis (MSA) Phase

1856	 Production rate requirements
1857	 Facility requirements
1858	 Special tooling development requirements
1859	 Test and demonstration requirements for new materials
1860	 Manufacturing capability obsolescence
1861	 Manufacturing capability sustainment
1862	• Data required for the initial manufacturing and producibility inputs to KPPs and KSAs has
1863	been documented.
1864	Tools
1865	Manufacturing Producibility Assessment Worksheet (PAWs)
1866	MRL Assessment Checklist for Design thread
1867	TRL Assessment Checklist
1868	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
1869	Market Research Reporting Template
1870	Preliminary Hazards List Developed
1871	Pugh Matrix
1872	TRIZ Matrix
1873	Resources
1874	MRL Deskbook Version 2016
1875	 Producibility Systems Guidelines, NAVSO P-3687, Dec 1999
1876	Technology Level Assessment Guidance, Apr 2011
1877	• ESOH in Acquisition Guide, Apr 2009
1878	DODI 5000.60 Defense Industrial Assessments, Jul 2014
1879	DoD Market Research Guide May 2012
1880	• DoDI 5000.02, Change 1, Jan 2017
1881	E.2 Participate in IPTs
1882	Manufacturing and Quality Tasks
1883	• Manufacturing and quality IPT(s) participants provide design inputs and design support to:
1884	• Developing initial view of system requirements and system design concepts
1885	 Formulating initial system solutions
1886	• Developing a system functional definition that incorporates the user needs
1887	 Engineering analyses
1888	 Initial design trade studies including external dependencies
1889	 Creating a system specification document
1890	• Developing preliminary system functional and performance requirements
1891	• Deriving and documenting draft KPPs and KSAs

1892		 Modeling and simulation planning
1893		• Identify critical technologies, and conduct a manufacturing maturity assessments of the
1894		hardware and embedded software options
1895		• Identify and assess manufacturing and quality risks as part of identification and
1896		assessment of system level risks
1897	٠	Manufacturing and quality IPT(s) participants provide inputs and support to:
1898		• Program management reviews
1899		• Other program IPTs (e.g., Systems Engineering, Configuration Management, Risk
1900		Management, Producibility etc.)
1901		• The AS, SEP, draft CDD, and the TEMP in preparation for and participation in the ASR
1902	Metric	S
1903	•	Manufacturing and quality IPT(s) participants have provided documented design inputs and
1904		design support to:
1905		• Developing initial view of system requirements and system design concepts
1906		• Formulating initial system solutions
1907		• Developing a system functional definition that incorporates the user needs
1908		• Engineering analyses
1909		 Initial design trade studies including external dependencies
1910		 Creating a system specification document
1911		 Developing preliminary system functional and performance requirements
1912		• Deriving and documenting draft Key Performance Parameters (KPPs) and Key System
1913		Attributes (KSAs)
1914		• Modeling and simulation planning
1915		• Identify critical technologies, and conduct a manufacturing maturity assessments of the
1916		hardware and embedded software options
1917		• Identify and assess manufacturing and quality risks as part of identification and
1918		assessment of system level risks
1919	٠	Manufacturing and quality IPT(s) participants have provided documented inputs and support
1920		to:
1921		• Program management reviews
1922		• Other program IPTs (e.g., Systems Engineering, Configuration Management, Risk
1923		Management, etc.)
1924		• The AS, SEP, draft CDD, and the TEMP which are up-to-date in preparation for and
1925		participation in the ASR
1926	Tools	
1927	•	AS Outline
1928	•	Draft CDD Template
1929	•	SEP Outline

2. Materiel Solution Analysis (MSA) Phase

1930	• TEMP Template
1931	MRL Assessment Checklist for Design thread
1932	Technology Readiness Assessment
1933	Resources
1934	• SEP Outline, 2011
1935	Acquisition Plan Preparation Guide, Jan 2009
1936	CDD-CPD Writing Guide, Feb 2015
1937	MRL Deskbook Version 2016
1938	• SEP Outline, Jun 2015
1939	Technology Level Assessment Guidance, Apr 2011
1940	• Test and Evaluation Management Guide, Dec 2012
1941	E.3 Initial Producibility Planning
1942	Manufacturing and Quality Tasks
1943	• Establish a Producibility sub-IPT.
1944	 Implement a producibility risk management process
1945	 Identify and deploy producibility design guidelines
1946	 Identify producibility best practices to be followed
1947	• Analyze potential manufacturing and quality process risks and capabilities to determine
1948	producibility goals to include:
1949	 Identification and analysis of state of the art manufacturing and production M&S
1950	approaches
1951	• Critical manufacturing and quality processes (yield and rates, if available)
1952	• Potential cost and schedule impacts
1953	• Special tooling, testing and qualification
1954	• Provide producibility planning guidance that emphasizes efficient manufacturing and product
1955	design and addresses:
1956	 Industry best practices, tools, and techniques
1957	 Design analyses that include:
1958	 Requirements validation analyses
1959	 FMEA
1960	 Trade studies on alternative product and process designs
1961	 Product complexity analyses
1962	 Manufacturing process analyses Online the line
1963	 Quality and quality process analyses Design for Manufacture and Assemble.
1904 1065	 Design for Manufacture and Assembly Tolerance analyses
1703	- Tototalice allaryses

1966		• Costs, cost drivers, and controls
1967		• Material characterization and goals
1968		o KCs
1969		• Risk and risk mitigation planning
1970		o Prototypes
1971		 Learning curve projections
1972		 Planning for product and process measurements
1973		• Statistical Process Control (SPC)
1974		• Data and database management
1975		o Testing
1976	•	Ensure producibility planning is incorporated into the Manufacturing Management Plan.
1977	Metri	CS
1978	٠	A Producibility sub-IPT has been established.
1979		• A producibility risk management process has been established
1980		• Producibility design guidelines have been identified, documented, and deployed
1981		• Producibility program best practices have been identified, and followed (e.g., standards
1982		from SAE, ISO, ASME, ANSI, etc.)
1983	•	Potential manufacturing and quality process risks and capabilities have been analyzed and
1984		producibility goals determined and documented. Analyses included:
1985		• Identification and analysis of state of the art manufacturing and production M&S
1986		approaches
1987		 Critical manufacturing and quality processes
1988		• Potential cost and schedule impacts
1989		• Special tooling, testing and qualification
1990	•	Producibility planning guidance has been developed and provided as input to the
1991		Manufacturing Management Plan, the RFP, the AS, and includes the following:
1992		• Identification and documentation of required producibility best practices, tools, and
1993		techniques
1994		• Design analyses documentation including:
1995		 Requirements validation analyses
1996		 Failure Modes and Effects Analysis
1997		 Trade studies on alternative product and process designs
1998		 Product complexity analyses
1999		 Manufacturing process analyses
2000		 Quality and quality process analyses
2001		 Design for Manufacture and Assembly
2002		 Tolerance analyses
2003		• Estimates of costs, cost drivers, and controls

2. Materiel Solution Analysis (MSA) Phase

Identification and documentation of materials characterization and goals

Identification and documentation of risk and planned risk mitigation

Identification and documentation of KCs

2004

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2007	 Requirements and plans for prototypes 						
2008	 Documentation of learning curve projections 						
2009	• Documentation of plans for product and process measurements (producibility						
2010	measurement)						
2011	• Requirements and plans for SPC						
2012	• Documentation of plans for collection of data and database management						
2013	• Requirements and plans for testing (in process and TEMP)						
2014	Tools						
2015	• Benchmarking						
2016	• Quality Functions Deployment (QFD)						
2017	• Six Sigma and Lean						
2018	• FMEA						
2019	MRL Assessment Checklist for Design thread						
2020	• Design Failure Modes and Effects Analysis (DFMEA)						
2021	• Process Failure Modes and Effects Analysis (PFMEA)						
2022	• Design for Manufacture and Assembly (DFMA)						
2023	 Design for Manufacture and Assembly (DFMA) Design of Experiments (DOE) 						
2024	Producibility Engineering and Planning (PEP) Data Item Description						
2025	Resources						
2026	Program Management Guidelines, Jan 1985						
2027	• Defense Manufacturing Management Guide for Program Managers, Chapter 7.6						
2028	Producibility Engineering and Planning (PEP)						
2029	 MRL Deskbook Version 2016 						
2030	F.4 Identify Key Characteristics (KC)						
2030							
2031	Manufacturing and Quality Tasks						
2032	• Provide manufacturing and quality inputs and support to deriving and documenting draft						
2033	KPPs, KSAs, and Additional Performance Attributes (APA).						
2034	• Perform analyses of initial KPPs, KSAs, and APAs to determine the features of a material,						
2035	system, subsystem, item, or component whose variation has significant influence on fit,						
2036	performance, service life, or manufacturability and develop initial KCs.						
2037	• Provide analysis and quantification of constraints to form, fit, and function for the						
2038	preferred concept						
2039	• Provide linkage to manufacturing and quality processes and risks						

2. Materiel Solution Analysis (MSA) Phase

2040 2041	• Provide analyses of draft KPPs, KSAs, and initial determination of KCs as manufacturing and quality inputs to program documentation.
2042	Metrics
2043 2044 2045 2046	 Manufacturing and quality inputs and support to derive and document draft KPPs, KSAs, and APAs has been provided. Analyses of KPPs, KSAs, and APAs have been performed and initial KCs have been developed and documented.
2047 2048 2049	 Analysis and quantification of constraints to form, fit, and function for the preferred concept has been provided Linkage to manufacturing and quality processes and risks has been documented
2050 2051	• Draft KPPs, KSAs, and initial KCs have been provided as manufacturing and quality inputs and documented in the AS, SEP, draft CDD, and the TEMP and maintained up-to-date.
2052	Tools
2053 2054 2055 2056	 MRL Assessment Checklist for Process Capability and Control thread Critical to Quality Tree FMEA Process Capability Analysis Worksheet
2057 2058	Producibility Assessment ChecklistTRL Assessment Checklist
2059	Resources
2060 2061 2062 2063 2064 2065	 AS6500, Manufacturing Management Program, Nov 2014 AS9103, Variation Management of KCs JCIDS Manual MRL Deskbook Version 2016 NAVSO P-3687 Producibility Systems Guidelines, Dec 1999 Technology Readiness Assessment Guidance, Apr 2011
2005	• reemology Readiness Assessment Outdance, Apr 2011

2066 **F. COST/FUNDING**

	F. Cost/Funding	F.1 Identify Mfg. and Quality Cost Drivers	F.2 Refine Cost Model	F.3 Prepare Initial Mfg.	
2067		<i>i</i>			

2068 Detailed manufacturing and quality cost estimates cannot be finalized during the MSA phase, but 2069 cost drivers can be identified and initial cost estimates developed based on proposed materials and 2070 processes that are inherent in the proposed materiel solution(s).

Producibility cost drivers can be assessed and investments in manufacturing technologies can be
 estimated. These estimates can be used to support development of the program cost estimates and the

2. Materiel Solution Analysis (MSA) Phase

2073 initial manufacturing investment budget. Cost estimates will be used to evaluate affordability (a

- 2074 discriminator) and in establishing initial thresholds for the proposed materiel solution(s). In most
- 2075 cases, the estimates will be developed by the use of statistically based cost estimating relationships or
- 2076 by comparison of the proposed systems with similar systems whose costs are known. The cost
- 2077 estimates incorporate the manufacturing and quality risks assessed during the AoA and at the ASR.
- 2078 The cost estimates will be used for evaluating and selecting a preferred system for the Milestone A
- 2079 decision and entry into the TMRR phase.

2080 **F.1** Identify Manufacturing and Quality Cost Drivers

2081 Manufacturing and Quality Tasks

2082 Identify manufacturing, quality, materials, and unique or specialized requirements and 2083 associated risks that are cost drivers for the AoA and update for the ASR. 2084 Include assumptions on process, materials, rate, supplier quality, workforce, special 0 2085 handling, environmental compliance, security, etc. and quantify the cost driver 2086 uncertainties 2087 • Estimate the cost of quality for each concept 2088 • Estimate the cost and impact of testing requirements 2089 Identify producibility cost drivers and associated risks for the AoA and update for the ASR. • 2090 Estimate impact of producibility opportunities and risks on rates, process, throughput, 0 2091 etc. 2092 o Estimate cost of implementation for producibility improvements 2093 Provide updates to the CARD with the manufacturing and quality inputs for the ASR. • 2094 Provide manufacturing and quality cost sensitivity analyses updates 0 2095 Metrics 2096 Manufacturing, quality, materials, and unique or specialized requirements cost drivers and • 2097 associated risks have been identified and documented for the AoA and updated for the ASR. 2098 Assumptions on process, materials, rate, supplier quality, workforce, special handling, 0 2099 environmental compliance, security, etc. are included 2100 • Cost driver uncertainties for appropriate assumptions have been quantified and 2101 documented 2102 • Cost of quality has been estimated and documented 2103 Cost and impact of test requirements have been documented 0 2104 Producibility cost drivers and associated risks for the AoA have been identified, documented, 2105 and updated for the ASR. 2106 • Impacts and cost of implementation have been estimated and documented 2107 Updates to the CARD have been provided with the manufacturing and quality inputs updated. • Manufacturing and Quality Management Body of Knowledge DRAFT - Coordination Copy - January 2018

2108	• Manufacturing and quality cost sensitivity analyses have been updated
2109	Tools
2110	Cost and Lead Time Estimating Worksheet
2111	Cost/Schedule Control System Criteria (see EVM)
2112	Design to Cost Estimates
2113	Manufacturing Cost Estimating Spreadsheet
2114	• MRL assessment for the Cost Thread
2115	Cost, Schedule Control Systems Criteria (CSCSC)
2116	• See CAPE website for tools
2117	Resources
2118	Cost/Schedule Control System Criteria Reference Guide, Dec 1992
2119	• Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
2120	Program Managers, Chapter 9
2121	• MIL-HDBK-766 Design to Cost, Aug 1998
2122	MRL Deskbook Version 2016
2123	• CAPE Website http://www.cape.osd.mil/
2124	o Guidelines for the Preparation and Maintenance of the Cost Analysis Requirements
2125	Description
2126	• Guidelines for the Preparation and Maintenance of CARD Tables
2127	F.2 Refine Cost Model
2128	Manufacturing and Quality Tasks
2129	• Provide manufacturing and quality inputs to update cost targets and error bands for proposed
2130	materiel solutions for the AoA.
2131	• Review the assumptions behind these targets
2132	• Prepare detailed manufacturing and quality process charts to ensure the validity behind
2133	cost targets
2134	 Identify and quantify manufacturing and quality cost variables
2135	• Quantify the uncertainties
2136	• Update the cost estimates for the proposed materiel solutions for the AoA including estimates
2137	for:
2138	• KCs and key processes
2139	• Variability reduction needs
2140	 Manufacturing environment simulations
2141	• Cost/performance trade studies
2142	 Manufacturing and quality capability requirements

2. Materiel Solution Analysis (MSA) Phase

2143 2144 2145 2146 2147		 Product and process validation requirements Key supplier management Producibility Environmental compliance Manufacturing systems security (physical, cyber, etc.)
2148 2149	•	Upon completion of the AoA, develop manufacturing and quality inputs to initial cost models for the preferred solution.
2150 2151 2152		 Verify cost models include all manufacturing and quality process variables Provide manufacturing and quality inputs to the CARD for the appropriate cost categories Provide initial manufacturing and quality inputs (cost models estimates) to the ASR
2153	Metric	CS
2154 2155	•	Manufacturing and quality inputs to update cost targets and error bands for proposed materiel solutions have been provided and documented for the AoA.
2156 2157 2158 2159 2160		 Assumptions supporting these targets are documented Detailed manufacturing and quality process charts have been developed to ensure the validity of cost targets Manufacturing and quality cost variables and uncertainties have been identified, quantified, and documented
2161 2162	•	Cost estimates for the proposed materiel solutions have been updated for the AoA and include estimates for:
2163 2164 2165 2166 2167 2168 2169 2170 2171 2172		 KCs and key processes Variability reduction needs Manufacturing environment simulations Cost/performance trade studies Manufacturing and quality capability requirements Product and process validation requirements Key supplier management Producibility Environmental compliance Manufacturing systems security (physical, cyber, etc.)
2173 2174	•	With completion of the AoA, initial cost model manufacturing and quality inputs have been developed and documented for the preferred solution.
2175 2176 2177 2178 2179		 Cost models verified and documented to include all manufacturing and quality process variables Manufacturing and quality inputs for the appropriate cost categories have been provided for CARD update Initial manufacturing and quality inputs (cost models estimates) provided to the ASR

2180	Tools
2181	Analogy and Parametric estimating
2182	• CARD - Cost Analysis Requirements Description (see CAPE website for tools)
2183	Manufacturing Readiness Level Assessment Checklist, Cost and Funding Thread
2184	Cost and Lead Time Estimating Worksheet
2185	Cost/Schedule Control Systems Criteria (C/SCSC)
2186	Manufacturing Cost Estimating Worksheet
2187	Resources
2188	• Parametric Estimating Handbook, Apr 2008
2189	• CARD - Cost Analysis Requirements Description Template (See CAPE website for
2190	guidance)
2191	Cost/Schedule Control Systems Criteria Reference Guide, Sep 1992
2192	DODI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
2193	MRL Deskbook Version 2016
2194	• MIL-HDBK 766 Design to Cost, 1989
2195	• CAPE Website
2196	Guidelines for the Preparation and Maintenance of the Cost Analysis Requirements
2197	Description
2198	Guidelines for the Preparation and Maintenance of Card Tables
2199	F.3 Prepare Initial Manufacturing and Quality Budget
2200	Manufacturing and Quality Tasks
2201	• Provide manufacturing and quality cost estimates for the TMRR budget.
2202	• Verify that cost estimates include all manufacturing and quality cost drivers and risk
2203	estimates from the updated cost model
2204	 Provide updated producibility cost drivers and risk estimates to budget process
2205	• Provide quantified manufacturing and quality cost driver uncertainties and associated
2206	budget impact estimates as inputs to the budget process
2207	• Provide investment estimates in manufacturing and quality technologies, processes,
2208	equipment, etc. as inputs to the budget process to include:
2209	 Capital equipment (tooling, machines, structures, etc.)
2210	 Test equipment (specialized, environmental, etc.)
2211	• Facilities and modifications/expansion (handling, storage, transportation, disposal,
2212	etc.)
2213	• GFE
2214	 Environmental compliance (processes, facilities, equipment, etc.) Manufacturing surface (classical and classical and
2215	 Manufacturing systems security (physical, cyber, etc.)

 Verify affordability cost estimates are utilized to establish manufacturing and thresholds. Identify potential ManTech investments that mitigate manufacturing and qualitization gaps. Identify potential funding sources for ManTech projects (program office 3) 	quality initial ity technology Service, and/or d as part of the
 Identify potential ManTech investments that mitigate manufacturing and quality gaps. Identify potential funding sources for ManTech projects (program office 3) 	ity technology Service, and/or d as part of the
 2221 gaps. 2222 o Identify potential funding sources for ManTech projects (program office statements) 	Service, and/or d as part of the
2222 O Identify potential funding sources for ManTech projects (program office S	Service, and/or d as part of the
2223 DoD-wide funding)	d as part of the
2224 Metrics	d as part of the
• Manufacturing and quality cost estimates have been provided and documente	
2226TMRR budget.	
 Cost estimates have been verified and documented to include all manufact auality cost drivers and risk estimates from the updated cost model 	turing and
2229 O Updated producibility cost drivers and risk estimates have been provided to	to the budget
2230 process	
2231 • Quantified manufacturing cost driver uncertainties and associated budget i	impact
estimates have been provided as inputs to the budget process	-
2233 o Investment estimates for manufacturing and quality technologies, processo	es, equipment,
etc. have been provided as inputs to the budget process and included:	
• Capital equipment (tooling, machines, structures, etc.)	
2236 • Test equipment (specialized, environmental, etc.)	
• Facilities and modifications/expansion (handling, storage, transportation	on, disposal,
2238 etc.)	
2239 • GFE	
• Environmental compliance (processes, facilities, equipment, etc.)	
• Manufacturing systems security (physical, cyber, etc.)	
• Statistically based cost estimating has been utilized and documents compa	risons of
2243 manufacturing and quality aspects of the proposed system to similar system	ms whose costs
are known	
• Affordability cost estimates have been utilized verified and document initial	manufacturing
2246 and quality thresholds.	
 2247 Potential ManTech investments have been identified and documented for miti 	gation of
2248 manufacturing and quality technology gaps.	Barron of
2249 • Potential offsets and funding sources determined for ManTech projects (p	rogram office,
2250 Service, and/or DoD-wide funding)	
2251 Tools	
• Manufacturing Feasibility Assessment Checklist?	

2. Materiel Solution Analysis (MSA) Phase

2253	•	See CAPE website for tools
2254	•	Manufacturing Cost Estimating Spreadsheet
2255	•	Manufacturing Readiness Level Assessment Checklist, Cost and Funding Thread
2256	Resou	irces
2257	•	See CAPE website for guidance
2258	•	MRL Deskbook Version 2016
2259	•	CARD - Cost Analysis Requirements Description Template (See CAPE website for
2260		guidance)

• DODI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015

2262 G. MATERIALS MANAGEMENT



2264 One of the major tasks of the MSA phase is to answer the question "Can you build it?" (i.e., evaluate manufacturing feasibility). Generally, this task begins with materials; their capability, maturity, 2265 availability, and handling characteristics. In early MSA phase, the characteristics of each material 2266 2267 must be assessed for each concept chosen in the AoA. Many new and emerging materials are 2268 identified during the MSA phase, and each carry potential risks. Material capability, maturity, availability, sources, and handling characteristics are key determinates of manufacturing and quality 2269 2270 risks. Thus, the early MSA phase is a series of trade studies to identify materiel solutions and to 2271 address gaps in capability.

2272 Inherent in addressing manufacturing and quality risks is an analysis and understanding of the

2273 maturity of material properties, characteristics, and quality requirements. This analysis should

address scale-up and lead-time requirements, as well as manufacturing and quality processes for all

2275 materials, especially those that are hazardous, difficult to obtain, process, and/or handle. Risks from

2276 potential counterfeit materials and parts are present at all levels of the supply chain. Additional risks 2277 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.

2280 G.1 Evaluate Materials Characteristics and Maturity

2281 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

2285 2286 2287 2288	 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.)
2289 2290 2291 2292	 Evaluate material properties, characteristics, and quality requirements for each concept against requirements If new materials emerge or are identified, identify and evaluated needed material properties and characteristics, and quality properties
2293 2294 2295 2296 2297 2298	Provide manufacturing and quality support to evaluation of the realism of projected lead times for materials (including hazardous) which are difficult to obtain or process.Assess manufacturing and quality requirements for material scale-up of selected AoA concepts.Perform manufacturing and quality volatility assessments for selected AoA concepts and identify:
2299 2300 2301	 Potential supply chain sources for critical materials Hazardous materials for each concept Special handling procedures that have been applied
2302 • 2303	Determine if all manufacturing and quality special handling requirements have been identified.
2304	• Evaluate all materials for:
2305 2306 2307 2308 2309 2310	 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
2311 Metr	ics
2312 •	Material maturity and availability has been evaluated and updated for selected AoA concepts:
2313	• Document the materials production environment
2314 2315 2316 2317	 R&D and experiments have been evaluated for validation of material manufacturability Other ongoing programs have been evaluated for prior use of materials under consideration (DoD, S&T, commercial, government, etc.)
2318 2319 2320 2321	 Material properties, characteristics, and quality requirements have been evaluated and documented for each concept against requirements Newly emerging materials have been identified, and needed material properties and characteristics, and quality properties have been evaluated and documented

2322 2323	•	Projected lead times for materials (including hazardous) which are difficult to obtain or process have been analyzed and documented with manufacturing and quality support.
2324 2325	•	Material scale-up manufacturing and quality requirements for selected AoA concepts have been assessed and documented.
2326	•	Manufacturing and quality volatility assessments for selected AoA concepts have been
2321		conducted and assessments document:
2328		• Potential supply chain sources for critical materials
2329		• Hazardous materials for each concept
2330		• Special handling procedures that have been applied
2331 2332	•	Analysis of manufacturing and quality special handling requirements have been performed and documented, and all requirements have been identified.
2333		• All materials have been evaluated for:
2334		 Potential regulatory requirements
2335		 Hazardous materials and handling procedures
2336		 Security requirements (physical, cyber, etc.)
2337		 Transportation, storage and shelf life
2338		 GFP, GFE (tooling, test equipment, ranges, chambers, etc.)
2339		 Disposal
2340	Tools	
2341	•	DMSMS Product Life Cycle Assessment (Consult DLA)
2341 2342	•	Cost and Lead Time Estimating Worksheet
2341 2342 2343	•	Cost and Lead Time Estimating Worksheet Design of Experiments Analysis
2341 2342 2343 2344	• • •	Cost and Lead Time Estimating Worksheet Design of Experiments Analysis Design for Six Sigma
2341 2342 2343 2344 2345	• • •	DMSMS Product Life Cycle Assessment (Consult DLA) Cost and Lead Time Estimating Worksheet Design of Experiments Analysis Design for Six Sigma Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
2341 2342 2343 2344 2345 2346	• • • • • • • • • • • • • • • • • • • •	DMSMS Product Life Cycle Assessment (Consult DLA)Cost and Lead Time Estimating WorksheetDesign of Experiments AnalysisDesign for Six SigmaIndustrial Base Assessment Survey Form DCMA Industrial Analysis CenterISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery)
2341 2342 2343 2344 2345 2346 2347	• • • • • • • • • • • • • • • • • • • •	DMSMS Product Life Cycle Assessment (Consult DLA)Cost and Lead Time Estimating WorksheetDesign of Experiments AnalysisDesign for Six SigmaIndustrial Base Assessment Survey Form DCMA Industrial Analysis CenterISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery)MRL Assessment Questionnaire for the Materials Thread
2341 2342 2343 2344 2345 2346 2346 2347 2348	• • • • •	DMSMS Product Life Cycle Assessment (Consult DLA)Cost and Lead Time Estimating WorksheetDesign of Experiments AnalysisDesign for Six SigmaIndustrial Base Assessment Survey Form DCMA Industrial Analysis CenterISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery)MRL Assessment Questionnaire for the Materials ThreadRough Cut Capacity Planning
2341 2342 2343 2344 2345 2346 2346 2347 2348 2349	• • • • • •	DMSMS Product Life Cycle Assessment (Consult DLA)Cost and Lead Time Estimating WorksheetDesign of Experiments AnalysisDesign for Six SigmaIndustrial Base Assessment Survey Form DCMA Industrial Analysis CenterISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery)MRL Assessment Questionnaire for the Materials ThreadRough Cut Capacity PlanningTRL Assessment Questionnaire
2341 2342 2343 2344 2345 2346 2347 2348 2349 2350	• • • • • • • • • • •	Cost and Lead Time Estimating Worksheet Design of Experiments Analysis Design for Six Sigma Industrial Base Assessment Survey Form DCMA Industrial Analysis Center ISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery) MRL Assessment Questionnaire for the Materials Thread Rough Cut Capacity Planning TRL Assessment Questionnaire
2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351	• • • • • • • • •	Cost and Lead Time Estimating Worksheet Design of Experiments Analysis Design for Six Sigma Industrial Base Assessment Survey Form DCMA Industrial Analysis Center ISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery) MRL Assessment Questionnaire for the Materials Thread Rough Cut Capacity Planning TRL Assessment Questionnaire rces DMSMS Guidebook, SD-22, Sep 2009
2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352	• • • • • • • • •	DMSMS Product Life Cycle Assessment (Consult DLA) Cost and Lead Time Estimating Worksheet Design of Experiments Analysis Design for Six Sigma Industrial Base Assessment Survey Form DCMA Industrial Analysis Center ISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery) MRL Assessment Questionnaire for the Materials Thread Rough Cut Capacity Planning TRL Assessment Questionnaire rces DMSMS Guidebook, SD-22, Sep 2009 DoDI 5000.60 Defense Industrial Capabilities Assessments, Jul 2004
2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353	e e Resou e	DMSMS Product Life Cycle Assessment (Consult DLA) Cost and Lead Time Estimating Worksheet Design of Experiments Analysis Design for Six Sigma Industrial Base Assessment Survey Form DCMA Industrial Analysis Center ISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery) MRL Assessment Questionnaire for the Materials Thread Rough Cut Capacity Planning TRL Assessment Questionnaire rces DMSMS Guidebook, SD-22, Sep 2009 DoDI 5000.60 Defense Industrial Capabilities Assessments, Jul 2004 DOD 5000.60H Assessing Defense Industrial Capabilities, Apr 1996
2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354	e e e s Resou e e e	DMSMS Product Life Cycle Assessment (Consult DLA) Cost and Lead Time Estimating Worksheet Design of Experiments Analysis Design for Six Sigma Industrial Base Assessment Survey Form DCMA Industrial Analysis Center ISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery) MRL Assessment Questionnaire for the Materials Thread Rough Cut Capacity Planning TRL Assessment Questionnaire rces DMSMS Guidebook, SD-22, Sep 2009 DoDI 5000.60 Defense Industrial Capabilities Assessments, Jul 2004 DOD 5000.60H Assessing Defense Industrial Capabilities, Apr 1996 ESHO in Acquisition Guide, Apr 2009
2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355	• • • • • • • • • • • • •	DMSMS Product Life Cycle Assessment (Consult DLA) Cost and Lead Time Estimating Worksheet Design of Experiments Analysis Design for Six Sigma Industrial Base Assessment Survey Form DCMA Industrial Analysis Center ISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery) MRL Assessment Questionnaire for the Materials Thread Rough Cut Capacity Planning TRL Assessment Questionnaire rces DMSMS Guidebook, SD-22, Sep 2009 DoDI 5000.60 Defense Industrial Capabilities Assessments, Jul 2004 DOD 5000.60H Assessing Defense Industrial Capabilities, Apr 1996 ESHO in Acquisition Guide, Apr 2009 ISO 9001 Quality Management System
2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356	e e e e s o e e s o u e s o u e s o u e s o u e s o u e s o u e s o u e s o e e s o e e s o e e e s o e e e s o e e s o e e s o e e s o e e s o e e e e	DMSMS Product Life Cycle Assessment (Consult DLA)Cost and Lead Time Estimating WorksheetDesign of Experiments AnalysisDesign for Six SigmaIndustrial Base Assessment Survey Form DCMA Industrial Analysis CenterISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery)MRL Assessment Questionnaire for the Materials ThreadRough Cut Capacity PlanningTRL Assessment QuestionnairercesDMSMS Guidebook, SD-22, Sep 2009DoDI 5000.60 Defense Industrial Capabilities Assessments, Jul 2004DOD 5000.60H Assessing Defense Industrial Capabilities, Apr 1996ESHO in Acquisition Guide, Apr 2009ISO 9001 Quality Management SystemMRL Deskbook Version 2016

2. Materiel Solution Analysis (MSA) Phase

2358 G.2 Determine Materials Risk

2359 Manufacturing and Quality Tasks

2360 • 2361	Assess materials maturity and availability manufacturing and quality risks for the AoA preferred solution that are:
2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372	 New or critical materials that are 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, difficult to obtain, or process
2373 2374	Assess materials scale-up manufacturing and quality risks for AoA preferred solution. Conduct an initial risk assessment of potential supply chain capability and capacity.
2375 2376 2377	 Include materials 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
2378 2379 2380 2381 2382	Assess materials capability to meet the threshold and objective requirements. Assess military vulnerability or gaps that could result from the lack of reasonable materials alternatives. Determine if all manufacturing and quality special handling risks have been identified including:
2383	• Potential regulatory requirements
2384 2385 2386 2387 2388	 Hazardous materials and handling procedures Security requirements (physical, cyber, etc.) Transportation, storage and shelf life GFP, GFE (tooling, test equipment, ranges, chambers, etc.) Disposal
2389 • 2390 2391 • 2392	Identify materials risks from counterfeit electronic parts and materials (e.g., end items, components, parts, or assemblies) In support of ASR, conduct a comprehensive cost/schedule/technical risk assessment and initiate mitigation plans for each risk.

2393	Metrics
2394 2395	• Materials maturity and availability manufacturing and quality risks for AoA preferred solution have been assessed and documented for materials that are:
2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406	 New or critical materials that are 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, difficult to obtain, or process
2407 2408 2409 2410	 Materials scale-up manufacturing and quality 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:
2411 2412 2413	 Materials risks for delivery times, manpower, quality, availability, etc. for the entire supply chain The material management processes for gaps throughout the entire supply chain
2414 2415 2416 2417 2418 2419	 Materials capability and risks to meeting the threshold and objective requirements has been assessed and documented. Military vulnerability or gaps that could result from the lack of reasonable material alternatives has been assessed and documented. All manufacturing and quality special handling risks have been identified and documented including:
2420	• Potential regulatory requirements
2421 2422 2423 2424 2425	 Hazardous materials and handling procedures Security requirements (physical, cyber, etc.) Transportation, storage and shelf life GFP, GFE (tooling, test equipment, ranges, chambers, etc.) Disposal
2426 2427 2428 2429 2430	 Materials risks from counterfeit electronic parts and materials (e.g., end items, components, parts, or assemblies) have been identified and documented. In support of ASR, a comprehensive cost/schedule/technical risk assessment has been conducted and mitigation plans for each risk have been documented and provided to the decision maker.

2. Materiel Solution Analysis (MSA) Phase

2431	Tools							
2432	•	Cost and Lead Time Estimating Worksheet						
2433	•	esign of Experiments Analysis						
2434	•	DMSMS Product Life Cycle Assessment (Consult DLA)						
2435	•	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center						
2436	•	ISO 9001 Checklist, Section Preservation (Handling, Storage, Packaging and Delivery)						
2437	•	Market Research Reporting Template						
2438	•	MRL Assessment Questionnaire for the Materials Thread						
2439	•	Supply Chain Management Risk Assessment Checklist						
2440	•	TRL Assessment Questionnaire						
2441	Resou	rces						
2442	•	DMSMS Guidebook, SD-22, Sep 2009						
2443	•	DoD Market Research Guide, May 2012						
2444	•	DoDI 5000.60, Defense Industrial Capabilities Assessments, Jul 2004						
2445	•	DOD 5000.60H, Assessing Defense Industrial Capabilities, Apr 1996						
2446	•	DOD 4140.1-R, Supply Chain Management Regulation, May 2003						
2447	•	DoDM 4140.01, DoD Supply Chain Management Procedures, Feb 2014						
2448	•	MRL Deskbook Version 2016						
2449	•	Technology Readiness Assessment Guidance, Apr 2011						
2450		• DoDI 5000.02, Change 1, Jan 2017						
2451		• IEEE 15288.2, Standard for Technical Reviews and Audits on Defense Programs,						
2452		May 2015						

2453 H. PROCESS CAPABILITY AND CONTROL

0 4 5 4	H. Process Capability/Control	H.1 Identify Required Process Capability	H.2 Initiate Process Capability Studies	
2454				

Manufacturing and quality process and control should be a part of any development program and 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

2459 manufacturing and quality standards using manufacturing modeling and simulations.

2460 The next task is to initiate studies to identify any gaps in manufacturing and quality processes. These

2461 gaps should include gap in capabilities as a risk and an impact to yields, with time and resources

2462 planned to mature these critical capabilities. Manufacturing yields and rates can play a major role in

2463 driving 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

2465 capability on KCs, and therefore performance, reliability, and affordability.

2. Materiel Solution Analysis (MSA) Phase

2466	Many new	technologies and	d emerging	manufacturing process	ses that are id	dentified during t	he MSA
2100	interny new	teennorogies unt	* ennerging :	manaraetaring process	ses mat are n	aominioa aaring i	

- 2467 phase carry risks. Failure to demonstrate materials and processes may increase the risk that the
- 2468 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 AS, it should be
- specified how this new capability will be demonstrated in a manufacturing environment relevant for
- the TMRR phase.

2472 H.1 Identify Required Process Capability

2473 Manufacturing and Quality Tasks

- For critical manufacturing and quality processes for the preferred concept, analyze the current state of process capability within industry and identify potential gaps.
- Identify and analyze state of the art manufacturing and production modeling/simulation
 approaches that support the preferred concept.
- Identify manufacturing and quality process capability risks for the preferred concept from the manufacturing feasibility assessment including risks to:
- 2480 o Critical manufacturing and quality processes
- 2481 Potential cost and schedule impacts
- o Producibility
- 2483 o Special tooling
- 2484 o Testing and qualification
- o Environmental
- o Management (data, security, etc.)

2487 Metrics

- The current state of process capability for the preferred concept has been analyzed and
 documented with potential gaps for critical manufacturing and quality processes within the
 industry and included in the AS and the SEP.
- Appropriate manufacturing and production modeling and simulation approaches have been identified, analyzed, and documented in the AS and the SEP.
- Manufacturing and quality process capability risks for the preferred concept have been
 updated and documented as input to the program risk management system. The updates
 should include risks to:
- 2496 Critical manufacturing and quality processes
- 0 Potential cost and schedule impacts
- 2498oProducibility
- o Special tooling
- 2500 Testing and qualification
- 2501 o Environmental
- o Management (data, security, etc.)

2. Materiel Solution Analysis (MSA) Phase

2503	Tools	
2504	٠	Solid modeling and analysis software programs (e.g., NX, CATIA, Pro-Engineer, Nastran
2505		add-ins, etc.)

- 2506 • Process Modeling Tools (Siemens PLM, Delmia, etc.)
- 2507 • Plant Modeling and Simulation tools (FlexSim, SimFactory, etc.)
- 2508 • Learning Curve Analysis Spreadsheet
- 2509 • MRL Assessment Checklist for the Process Capability and Control Thread

2510 Resources

- 2511 Defense Manufacturing Management Guide for Program Managers, Chapter 9.8 Learning 2512 Curve
- 2513 • Modeling and Simulation Guidance for the Acquisition Workforce, Oct 2008
- 2514 • MRL Deskbook Version 2016
- 2515 • Manufacturing Simulation Applications (No Date)
- 2516 See Guidance Documents •
- 2517 H.2 Initiate Process Capability Studies

2518 Manufacturing and Quality Tasks

- 2519 Initiate manufacturing and quality process capability studies based on the data from the 2520 preferred concept.
- 2521 0 If no data available, conduct necessary studies to generate required data
- 2522 Alternatively, use process capabilities of current or similar products to generate the 0 2523 required data
- 2524 • Analyze the impact of manufacturing and quality process capability on KCs that impact 2525 performance, reliability, and affordability.
- 2526 Analyze manufacturing and quality studies of existing processes to determine gaps in • manufacturing capabilities as a risk and an impact on yields and rates 2527
- 2528 Utilize modeling and simulation tools to perform an analysis of process capability to Ο 2529 support yield and rate estimates, before actual manufacturing begins
- 2530 • Determine the need for new processes to meet requirements
- 2531 Include time and resources required to mature these critical manufacturing processes
- 2532 • Incorporate sources of variations and plans to address
- 2533 • Include additional data from existing, proposed, or similar processes from other projects 2534 and programs
- 2535 Based on analyses, update yield and rate estimates for the AS and the SEP. •

2. Materiel Solution Analysis (MSA) Phase

2536	Metrie	CS
2537 2538	•	Manufacturing and quality process capability studies have been initiated based on the data from the preferred concept and results documented.
2539 2540 2541		 If no was data available, the necessary studies were conducted to generate required data Or as an alternative, the process capabilities of current or similar products were used to generate the required data
2542 2543 2544 2545 2546	•	The impact of manufacturing and quality process capability on KCs that impact performance, reliability, and affordability has been analyzed and documented including sources of variations with plans to address. Manufacturing and quality studies of existing processes have been analyzed to determine and document gaps in manufacturing capabilities as risks and an impacts to yields and rates.
2547 2548 2549 2550 2551 2552 2553 2554		 Modeling and simulation tools have been utilized to analyze process capability to support yield and rate estimates, before actual manufacturing begins The need for new processes to meet requirements has been determined, documented, and plans initiated Time and resources necessary to mature these critical manufacturing processes and sources of variation have been incorporated in planning Additional data was utilized from existing, proposed, or similar processes from other projects and programs
2555 2556	•	Yield and rate estimates for the preferred concept have been updated, and documented in the Quality and Manufacturing Strategies and incorporated in the AS and SEP.
2557	Tools	
2558 2559 2560 2561 2562 2563 2564 2565 2566 2566 2567 2568		Cause and Effect Diagram Cost of Quality Estimates Feasibility Study Checklist First Pass Yield Estimates Worksheet Histograms MRL Assessment using Process Capability and Control Thread Pareto Analysis Process Capability Studies (Cp and Cpk assessment) Producibility Assessment Worksheet (PAWs) Six Sigma Worksheet First Pass Yield Estimates Worksheet
2569	Resou	irces
2570 2571	•	Defense Management Guide for Program Managers, Chapter 7.6.2 Determine Process Capability

2. Materiel Solution Analysis (MSA) Phase

- Defense Manufacturing Guide for Program Managers, Chapter 5.5.4 Seven Quality Control Tools
- DoD-Wide Continuous Process Improvement (CPI/Lean and Six Sigma) Program, May 2008
- DoD Continuous Process Improvement Transformation Guide, May 2006
- Producibility Systems Guidelines, NAVSO P-3687, Dec 1999

2577 I. QUALITY MANAGEMENT

• • • •	I. Quality Management	I.1 Quality Management I.2 Product Quality I.3 Supply Chain Quality I.4 Prepare Requirements Analysis Requirements Analysis Management Requirements Analysis Quality I.4 Prepare	
2578			

Quality management is the coordinated activities to direct and control an organization, including the
supply chain, with regard to quality policy, quality objectives, quality planning, quality assurance and
quality improvement. These activities are performed as part of the Quality Management System
(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.

- 2586 There are many opportunities during the MSA phase of the acquisition process for manufacturing
- and quality personnel to make a positive impact on program execution. Manufacturing and quality
- considerations should be a major part of a development program. Quality considerations should be an
- 2589 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 AS will include
- the approach to quality, quality management, and quality assurance.

2592 I.1 Quality Management Requirements Analysis

2593 Manufacturing and Quality Tasks

2594 For the AoA, ensure the preferred concepts are analyzed for quality management 2595 requirements. 2596 The quality management requirements should at a minimum include: 0 2597 Quality management system requirements Management responsibility requirements 2598 • 2599 . **Resource management requirements** 2600 Product Realization requirements (e.g., risk management, design and development, 2601 purchasing, etc.) 2602 Measurement, analysis, and improvement requirements 2603 • Alternatively, the quality management requirements can be met by adherence to established standards (e.g., AS9100, ISO 9000, etc.) 2604

Manufacturing and Quality Management Body of Knowledge

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2. Materiel Solution Analysis (MSA) Phase

2605 2606	Include manufacturing and quality management lessons-learnedInclude industry best practices
2607 2608	• Review, update, and analyze quality management metrics for the preferred concept from the AoA Study Guidance.
2609	• Verify the frequency that the metrics are reviewed is commensurate with quality risks
2610 2611	• Specify the quality management requirements to be met by the contractor or government entity as appropriate.
2612 2613	 Provide requirements for quality management responsibilities and personnel within the IPT
2614	 Provide quality management requirements and metrics
2615 2616	• Contact DCMA for input on QMS evaluation of potential contractor and suppliers for the preferred concept.
2617	Metrics
2618 2619	• The preferred concepts have been analyzed for quality management requirements and documented in the AoA.
2620	• The documented quality management requirements included at a minimum:
2621 2622 2623 2624 2625 2625 2626	 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
2627 2628	 Alternatively, the documented quality management requirements were met by conformance to established standards (e.g., AS9100, ISO 9000, etc.)
2629 2630	Which includes manufacturing and quality management lessons-learnedWhich includes industry best practices
2631 2632	• Quality management metrics for the preferred concept from the AoA Study Guidance have been reviewed, updated, analyzed, and the results documented.
2633	• Review of quality management metrics is included in all program reviews
2634 2635	• Quality management requirements to be met by the government or contractor entity as appropriate have been specified for the RFP.
2636 2637	 Quality management responsibilities and personnel have been established for each IPT Quality management requirements and metrics have been established and documented
2638 2639	• Where available, DCMA input on QMS evaluation of potential contractor and suppliers for the preferred concept has been utilized and documented.

2. Materiel Solution Analysis (MSA) Phase

2640	Tools	
2641	٠	AS9100, Quality Audit Checklist
2642	•	Critical to Customer Assessment
2643	•	Critical to Quality Tree
2644	•	ISO 9001, Quality Audit Checklist
2645	•	Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality Thread
2646	•	Quality Management Plan (Sample)
2647	Resou	irces
2648	•	AFMC Instruction 63-145, Manufacturing and Quality (Draft)
2649	٠	AS9100, Quality Management Systems, Sep 2016
2650	•	DoDI 5000.02, Change 1, Jan 2017
2651	•	ISO 9000:2015, Quality Management Systems, Sep 2015
2652	٠	MRL Deskbook Version 2016
2653	1.2	Product Quality Requirements Analysis
2654	Manu	facturing and Quality Tasks
2655	•	Analyze product quality requirements for the AoA preferred concept:
2656 2657		• Incorporate new quality technologies and process state of the art into product quality requirements
2658 2659		• Analyze the need for unique product quality requirements (i.e., specific product characteristics)
2660		• Analyze product quality for metrics and the frequency that the metrics should be
2661		reviewed, commensurate with manufacturing and quality risks
2662	•	Utilize identified potential solutions and processes that could address product quality needs.
2663		• Analyze identified quality technologies (i.e., metrology technologies) that could improve
2664		product quality
2666		components product quality
2667	•	Contact DCMA personnel for inputs on potential contractor and supplier quality performance
2668		against quality requirements for similar products or processes.
2669	Metri	cs
2670	•	Product quality requirements for the AoA preferred concept have been analyzed and
2671		document:
2672 2673		• Incorporation of new quality technologies and process state of the art into product quality requirements

2. Materiel Solution Analysis (MSA) Phase

 Identified potential solutions and processes that could address product quality needs have been utilized in the analysis and documentation of: Quality technologies (i.e., metrology technologies) that could improve product quality Potential solutions or processes to improve low-yield processes and components product quality DCMA inputs on potential contractor and supplier quality performance against quality requirements for similar products or processes have been documented. DCMA inputs on potential contractor and supplier quality performance against quality requirements for similar products or processes have been documented. All of the results of product quality requirements analysis has been document in AS and SEP. Critical to Customer Assessment Critical to Quality Audit Checklist Critical to Quality Tree Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality Thread Quality Management Plan (Sample) Variability Reduction Plan Resources AAS9100, Quality Management Systems, Sep 2016 DoDI 5000.02, Change 1, Jan 2017 ISO 9000.2015, Quality Management Requirements Analysis MRL Deskbook Version 2016 I.3 Supply Chain 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 need for focused supplier quality management requirements (e.g., a supplier Quality Assurance Plan) Analyze the need for focused supplier quality management plans for the supply chain The quality management requirements for the supply chain The quality management requirements for the supply chain 	2674 2675 2676	 The need for unique product quality requirements (i.e., specific product characteristics) Product quality for metrics and the frequency that the metrics should be reviewed, commensurate with manufacturing and quality risks
 Quality technologies (i.e., metrology technologies) that could improve product quality Potential solutions or processes to improve low-yield processes and components product quality POCMA inputs on potential contractor and supplier quality performance against quality requirements for similar products or processes have been documented. All of the results of product quality requirements analysis has been document in AS and SEP. AS9100 Quality Audit Checklist Critical to Customer Assessment Critical to Customer Assessment (MRL) Questionnaire for the Quality Thread Quality Reduction Plan Quality Reduction Plan Variability Reduction Plan Variability Reduction Plan Variability Reduction Plan Dob 15000.02, Change 1, Jan 2017 Dob 15000.02, Change 1, Jan 2017 Manufacturing and Quality Management Systems, Sep 2016 ISO Supply Chain Quality Management Requirements Analysis Manufacturing and Quality technologies and process state of the art for impacts on the quality management of the supply chain. Analyze the impact of quality management requirements for the preferred concept. Analyze the need for focused supplier quality management plans for the supply chain Analyze the need for a standalone supplier quality management plans for the supply chain Chaity management requirements for the supply chain 	2677 2678	• Identified potential solutions and processes that could address product quality needs have been utilized in the analysis and documentation of:
 DCMA inputs on potential contractor and supplier quality performance against quality requirements for similar products or processes have been documented. All of the results of product quality requirements analysis has been document in AS and SEP. Tools Costical to Customer Assessment Critical to Customer Assessment Critical to Quality Audit Checklist Critical to Quality Audit Checklist Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality Thread Quality Management Plan (Sample) Variability Reduction Plan Resources AAS9100, Quality Management Systems, Sep 2016 DoDI 5000.02, Change 1, Jan 2017 ISO 9000:2015, Quality Management Systems, Sep 2015 MRL Deskbook Version 2016 L3 Supply Chain Quality Management Requirements Analysis Manufacturing and Quality Tasks Analyze the impact of 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 standalone supplier quality management plans for the supply chain Critical supply chain quality management for the supply chain should at a minimum include: Quality management requirements for the supply chain species of the supply chain should at a minimum include: 	2679 2680 2681	 Quality technologies (i.e., metrology technologies) that could improve product quality Potential solutions or processes to improve low-yield processes and components product quality
2685Tools2686• AS9100 Quality Audit Checklist2687• Critical to Customer Assessment2688• Critical to Quality Tree2689• ISO 9001, Quality Audit Checklist2690• Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality Thread2691• Quality Management Plan (Sample)2692• Variability Reduction Plan2693Resources2694• AAS9100, Quality Management Systems, Sep 20162695• DoDI 5000.02, Change 1, Jan 20172696• ISO 9000:2015, Quality Management Systems, Sep 20152697• ISO 9000:2015, Quality Management Requirements Analysis2698I.3 Supply Chain Quality Management Requirements Analysis2699• Analyze the impact of quality technologies and process state of the art for impacts on the quality management of the supply chain.2700• Analyze the need for focused supplier quality management requirements (e.g., a supplier Quality Assurance Plan)2703• Analyze the need for a standalone supplier quality management plans for the supply chain2708• Quality management requirements for the supply chain should at a minimum include:	2682 2683 2684	 DCMA inputs on potential contractor and supplier quality performance against quality requirements for similar products or processes have been documented. All of the results of product quality requirements analysis has been document in AS and SEP.
 AS9100 Quality Audit Checklist Critical to Customer Assessment Critical to Quality Tree ISO 9001, Quality Audit Checklist Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality Thread Quality Management Plan (Sample) Quality Management Plan (Sample) Variability Reduction Plan Resources AAS9100, Quality Management Systems, Sep 2016 DoDI 5000.02, Change 1, Jan 2017 ISO 9000:2015, Quality Management Systems, Sep 2015 MRL Deskbook Version 2016 Kanufacturing and Quality Management Requirements Analysis Kanufacturing and Quality Tasks Analyze the impact of quality management requirements for the preferred concept. Analyze the supply chain quality management requirements for the preferred concept. Analyze the need for focused supplier quality management plans for the supply chain Analyze the need for a standalone supplier quality management plans for the supply chain Analyze the need for a standalone supplier quality management plans for the supply chain Analyze the need for a standalone supplier quality management plans for the supply chain Analyze the need for a standalone supplier quality management plans for the supply chain Analyze the need for a standalone supplier quality management plans for the supply chain Analyze the need for a standalone supplier quality management plans for the supply chain Analyze the need for a standalone supplier quality management plans for the supply chain Quality management requirements for the supply chain should at a minimum include: Quality management system requirements 	2685	Tools
 Resources AAS9100, Quality Management Systems, Sep 2016 DoDI 5000.02, Change 1, Jan 2017 ISO 9000:2015, Quality Management Systems, Sep 2015 MRL Deskbook Version 2016 1.3 Supply Chain Quality Management Requirements Analysis 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 standalone supplier quality management plans for the supply chain. The quality management requirements for the supply chain in clude: Quality management requirements for the supply chain in should at a minimum include: 	2686 2687 2688 2689 2690 2691 2692	 AS9100 Quality Audit Checklist Critical to Customer Assessment Critical to Quality Tree ISO 9001, Quality Audit Checklist Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality Thread Quality Management Plan (Sample) Variability Reduction Plan
 AAS9100, Quality Management Systems, Sep 2016 DoDI 5000.02, Change 1, Jan 2017 ISO 9000:2015, Quality Management Systems, Sep 2015 MRL Deskbook Version 2016 1.3 Supply Chain Quality Management Requirements Analysis 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 standalone supplier quality management plans for the supply chain. The quality management requirements for the supply chain in clude: Quality management requirements for the supply chain in clude: 	2693	Resources
 1.3 Supply Chain Quality Management Requirements Analysis 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 standalone supplier quality management plans for the supply chain. The quality management requirements for the supply chain should at a minimum include: Quality management system requirements 	2694 2695 2696 2697	 AAS9100, Quality Management Systems, Sep 2016 DoDI 5000.02, Change 1, Jan 2017 ISO 9000:2015, Quality Management Systems, Sep 2015 MRL Deskbook Version 2016
 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 standalone supplier quality management plans for the supply chain The quality management requirements for the supply chain should at a minimum include: Quality management system requirements 	2698	I.3 Supply Chain Quality Management Requirements Analysis
 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 standalone supplier quality management plans for the supply chain Analyze the need for a standalone supplier quality management plans for the supply chain The quality management requirements for the supply chain should at a minimum include: Quality management system requirements 	2699	Manufacturing and Quality Tasks
 Analyze the need for focused supplier quality management requirements (e.g., a supplier Quality Assurance Plan) Analyze the need for a standalone supplier quality management plans for the supply chain The quality management requirements for the supply chain should at a minimum include: Quality management system requirements 	2700 2701 2702	 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.
 2708 Quality management system requirements 	2703 2704 2705 2706 2707	 Analyze the need for focused supplier quality management requirements (e.g., a supplier Quality Assurance Plan) Analyze the need for a standalone supplier quality management plans for the supply chain The quality management requirements for the supply chain should at a minimum include:
	2708	 Quality management system requirements

2. Materiel Solution Analysis (MSA) Phase

2709 2710 2711 2712 2713	 Management responsibility requirements Resource management requirements Product Realization requirements (e.g., risk management, design and development, purchasing, etc.) Measurement, analysis, and improvement requirements 	
2714 2715	• Alternatively, quality management requirements for the supply chain can be met by adherence to established standards (e.g., AS9100, ISO 9000, etc.)	
2716 2717	Include manufacturing and quality management lessons-learnedInclude industry best practices	
2718	• Analyze and update supply chain quality management metrics for the preferred concept.	•
2719 2720	• Analyze potential solutions, tools, and techniques that could address quality management requirements of the supply chain.	
2721 2722 2723 2724 2725	 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 	
2726 2727 2728 2729	 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. 	
2730	Metrics	
2731 2732 2733	 Impact of quality technologies and process state of the art for impacts on the quality management of the supply chain has been analyzed and the results documented. The supply chain quality management requirements have been analyzed and document: 	
2734 2735 2736 2737	 The need for focused supplier quality management requirements (e.g., a supplier Quality Assurance Plan) The need for a standalone supplier quality management plans for the supply chain The minimum quality management requirements for the supply chain including: 	7
2738 2739 2740 2741 2742 2743	 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 	
2744	• As an alternative, adherence to established standards (e.g., AS9100, ISO 9000, etc.)	

2. Materiel Solution Analysis (MSA) Phase

2745 2746	 Inclusive of manufacturing and quality management lessons-learned and industry best practices
2747 2748 2749	 Supply chain quality management metrics have been analyzed, updated, and documented. Potential solutions, tools, and techniques that could address quality management requirements of the supply chain have been analyzed, documented, and incorporate:
2750 2751 2752 2753 2754	 Quality technologies (i.e., metrology technologies) that could improve the supply chain quality programs Potential solutions (e.g., materials, machines, training, etc.) to improve low-yield processes and components and lower variability to meet supply chain quality requirements
2755 2756 2757 2758	 DCMA has been contacted for input on analysis of potential supply chain quality management systems and documented. All of the analyses and results of supply chain quality management requirements have been document in AS and SEP.
2759	Tools
2760	AS9100, Quality Audit Checklist
2761	Critical to Customer Assessment
2762	Critical to Quality Tree
2763	ISO 9001, Quality Audit Checklist
2764	Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality Thread
2765	Supplier Quality Questionnaire
2766	Quality Management Plan
2767	Variability Reduction Plan
2768	Resources
2769	AS9100, Quality Management Systems, Sep 2016
2770	• DoDI 5000.02, Change 1, Jan 2017
2771	• ISO 9000:2015, Quality Management Systems, Sep 2015
2772	MRL Deskbook Version 2016
2773	• MIL-STD-1535B Supplier QA
2774	I.4 Prepare Quality Strategy
2775	Manufacturing and Quality Tasks
2776	• Based on the results of the analyses of quality management, product quality, and supply chair
2777	quality management requirements, draft a quality management strategy that specifies:
2778	• Quality management requirements that address:
2779	 Management responsibility requirements

2780 2781 2782 2783 2783 2784 2785	 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
2786 2787 2788 2789 2790 2791	 Alternatively, the quality management requirements met by adherence to established standards (e.g., AS9100, ISO 9000, 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:
2792 2793 2794 2795 2796	 The need for focused supplier quality management requirements A supplier quality management plan Potential standards (e.g., AS9100, ISO 9000, etc.) Metrics Potential solutions, tools and techniques
2797 2798 2799	 Planned use of government-furnished quality and testing equipment and assets Establishing appropriate agreements, delegations and contracts with other agencies, e.g. the DCMA
2800 2801 2802 2803 2804	 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 AS and the SEP. Draft an initial program Quality Management Plan for incorporation into the SEP that includes details from the analyses.
2805 2806 2807 2808	 Metrics A program Quality Management Strategy, based on the results of the analyses of quality management, product quality, and supply chain quality management requirements, has been drafted that specifies:
2809	• Quality management requirements that address:
2810 2811 2812 2813 2814 2815 2816	 Quality management system requirements Management responsibility requirements Resource management requirements Product Realization requirements (e.g., risk management, design and development, purchasing, etc.) Risks and opportunities Measurement, analysis, and improvement requirements

2. Materiel Solution Analysis (MSA) Phase

2817		• Alternatively, the quality management requirements met by adherence to established
2818		standards (e.g., AS9100, ISO 9000, etc.)
2019		o Product quality requirements that incorporate new quality technologies and process state
2820		for the art, the need for unique product quality requirements, and metrics and the review
2821		Frequency
2022		o Suppry chain quanty management requirements that include.
2823		 The need for focused supplier quality management requirements
2824		 A supplier quality management plan
2825		 Potential standards (e.g., AS9100, ISO 9000, etc.)
2826		 Metrics
2827		 Potential solutions, tools and techniques
2828		• Planned use of government-furnished quality and testing equipment and assets
2829		• Appropriate agreements, delegations and contracts with other agencies, e.g. the DCMA
2830		and contains inputs from those agencies
2831	•	The Quality Management Strategy with appropriate language and references has been
2832		documented in the AS and the SEP.
2833	•	An initial program Quality Management Plan has been documented in the SEP that includes
2834		details from all of the analyses.
2835	Tools	
2836	•	AS9100 Quality Audit Checklist
2837	•	Critical to Customer Assessment
2838	•	Critical to Quality Tree
2839	•	ISO 9001 Quality Audit Checklist
2840	•	Supplier Quality Questionnaire
2841	•	Quality Management Plan
2842	Resou	rces
2843	•	AS9100, Quality Management Systems, Sep 2016
2844	•	DoDI 5000.02, Change 1, Jan 2017
2845	•	ISO 9000:2015, Quality Management Systems, Sep 2015

2846 J. MANUFACTURING WORKFORCE

	J. Mfg. Workforce	J.1 Update Manufacturing and Quality Workforce Requirements	J.2 Manufacturing and Quality Workforce Planning	
2847				

2848 During the MSA phase, it is essential to update the manufacturing and quality workforce

requirements and begin planning for future phases. Although trained highly skilled engineers and

artisans may be the workforce utilized in the lab environment, they will not be the workforce utilized

2851 for production. Identification, planning for, and training of the required production workers with
2. Materiel Solution Analysis (MSA) Phase

- required skill sets must begin early. In addition to the production workforce, having a technical staff
- 2853 with education and experience in the relevant areas of engineering and management is key to
- 2854 program success.
- As part of the evaluations for the AoA, the processes and planning utilized by the preferred concepts
- to determine workforce requirements need to be examined. The preferred concept(s) manufacturingand quality processes should be evaluated, as well as a forecast of phase-by-phase requirements for
- 2857 and quality processes should be evaluated, as well as a forecast of phase-by-phase requirements f
- 2858 manufacturing and quality 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 manufacturing and quality skill sets and production workforce requirements. Planning should address risks resulting from shortages of qualified personnel, processes that require certifications, and volatility.

2863 J.1 Update Manufacturing and Quality Workforce Requirements

2864

4 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 manufacturing and quality processes for gaps in workforce skill sets, training, and
- Evaluate manufacturing and quality processes for gaps in workforce skill sets, training, and manpower requirements for each AoA concept to include:
- 2870 Workforce requirements (technical and operational)
- 2871 o Processes that require certifications (i.e., special skills)
- 2872 o Sources and shortages of qualified personnel based on processes, education, location,
 2873 precision requirements, etc.
- Update requirements by phase for manufacturing and quality skills and training for preferred
 materiel solutions for the AoA.
- 2876 o Identify additional or new skills required
 - Include associated training requirements
- 2878oDetermine staffing requirements for skills, experience, certification levels, education2879levels, ramp-up, and attrition

2880 Metrics

2877

The workforce processes and planning used to determine personnel skills, experience and education levels, training, ramp-up, and attrition for the preferred concepts have been analyzed and documented with appropriate industrial workforce standards, criteria, and metrics applied for each AoA concept.

2885 2886 2887	•	Manufacturing and quality processes have been analyzed and documented for gaps in workforce skill sets, training, and manpower requirements and availability for each AoA concept to include:
2888 2889 2890 2891		 Production 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.
2892 2893 2894	•	Workforce requirements by phase for manufacturing and quality skills and training for preferred materiel solutions for the AoA have been analyzed, updated, and documented including:
2895 2896 2897		 Additional or new skills and associated training requirements Staffing requirements for skills, experience, certification levels, education levels, ramp- up, and attrition
2898 2899	•	All of the results of manufacturing and quality workforce requirements analyses have been documented in the AS and the SEP.
2900	Tools	
2901	•	Assembly Chart Analysis
2902	•	Bottleneck Analysis (Theory of Constraints)
2903	•	Capacity Planning Worksheet
2904	•	Critical Chain Project Management
2905	•	Forecasting and Regression Analysis
2906	•	Learning Curve Estimator
2907	•	Line of Balance Template
2908	•	Manufacturing Resource Planning (MRPII)
2909	•	MRL assessment using Manufacturing Management thread
2910	•	Route Sheet Analysis
2911	•	Shop Floor Manufacturing Plan Analysis
2912	•	SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
2913	•	Work Measurement Analysis
2914	•	Workforce Planning Tools (SAP/Oracle/MRPII)
2915	Resou	rces
2916	•	MRL Deskbook Version 2016
2917	•	Manufacturing Resource Planning (MRP II)
2918	•	Defense Manufacturing Guide for Program Managers (various chapters)

2919 J.2 Manufacturing and Quality Workforce Planning

2920 Manufacturing and Quality Tasks

- Initiate planning, as an input to program management, to address manufacturing and quality
 skill sets, production workforce availability requirements, and risks for the TMRR phase.
- Planning should address:
- 2924 Mitigation needs for project ramp-up and workforce attrition
 - Mitigation of critical shortages of qualified personnel based on processes, location, precision requirements, etc.
- 2927oTraining and/or certification requirements (e.g., certified welders, skilled machine2928programmers or operators, etc.)
- 2929 Plans for acquisition and training of new personnel
- 2930 Potential impacts from labor relations, surges, competition, etc.
- 2931 Volatility of demand and impact on workforce requirements
- 2932oImpacts on workforce ability to address processing, testing, and acceptance of new2933materials and technologies
- 2934oImpacts of regulatory requirements (e.g., special handling, security, hazardous materials,2935environmental needs, storage requirements, etc.) on the workforce
- 2936oIncorporation of appropriate workforce lessons learned for processes, tools, and2937techniques for manufacturing workforce strategy

2938 Metrics

2925

2926

2939 Planning, as input to program management, is underway that addresses manufacturing and 2940 quality skill sets, production workforce availability requirements, and risks for the TMRR 2941 phase and the results have been documented. 2942 Documented plans address and include metrics for: • 2943 • Mitigation needs for project ramp-up and workforce attrition 2944 • Mitigation of critical shortages of qualified personnel based on processes, location, 2945 precision requirements, etc. 2946 Overall training and/or certification requirements (e.g., certified welders, skilled machine 0 2947 programmers or operators, etc.) 2948 o Acquisition and training of new personnel 2949 • Potential impacts from labor relations, surges, competition, etc. 2950 • Volatility of demand and impact on workforce requirements 2951 • Impacts on workforce ability to address processing, testing, and acceptance of new 2952 materials and technologies 2953 • Impacts of regulatory requirements (e.g., special handling, security, hazardous materials, 2954 environmental needs, storage requirements, etc.) 2955 • Appropriate workforce lessons learned for processes, tools, and techniques for 2956 manufacturing workforce strategy

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2. Materiel Solution Analysis (MSA) Phase

2957 •	Workforce	planning is doo	cumented as part	of the SEP and the AS.
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2958	Tools	
2959	•	Assembly Chart Analysis
2960	•	Bottleneck Analysis (Theory of Constraints)
2961	•	Capacity Planning Worksheet
2962	٠	Critical Chain Project Management
2963	•	Forecasting and Regression Analysis
2964	٠	Learning Curve Estimator
2965	•	Line of Balance Template
2966	٠	Manufacturing Resource Planning (MRPII)
2967	•	MRL assessment using Manufacturing Management thread
2968	•	Route Sheet Analysis
2969	•	Shop Floor Manufacturing Plan Analysis
2970	•	SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
2971	•	Work Measurement Analysis
2972	•	Workforce Planning Tools (SAP/Oracle/MRPII)
2973	Resou	rces
2974	٠	MRL Deskbook Version 2016
2975	•	Manufacturing Resource Planning (MRP II)
2976	•	Defense Manufacturing Management Guide for Program Managers (various chapters)
2977	٠	ESHO in Acquisition Guide, April 2009

2978 K. FACILITIES

	K. Facilities	K.1 Facilities and Tooling Requirements	K.2 Facilities and Tooling Planning	
2979				

During the MSA phase, it is essential for the manufacturing and quality representatives to update the facility and tooling requirements for the preferred concepts prior to AoA, and 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.

2987 Manufacturing and quality planning efforts also define and design the special tooling and test

- 2988 equipment required to execute the effort. Special tooling and test equipment required for a program
- 2989 can be high cost and have a long lead-time to develop and procure. The planning for tooling and test
- 2990 equipment should be initiated during the MSA phase. The planning should include the type of tooling

2. Materiel Solution Analysis (MSA) Phase

and test equipment to be utilized, investments, the transition from limited life to rate tools, the need for production and test equipment, and tooling sustainment.

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.

2995 K.1 Facilities and Tooling Requirements

2996 Manufacturing and Quality Tasks

2997 • Update the manufacturing and quality facilities and capital equipment requirements for the 2998 AoA preferred concepts. 2999 Analyze the manufacturing and quality quantitative and qualitative facility demands of the 3000 preferred concepts for: 3001 • Availability, design, rate and capacity capabilities of the facilities under consideration 3002 (existing, new, or redeveloped) 3003 • Types of processes required and the resulting impacts on facilities (e.g., specialized 3004 fixtures, test chambers, laboratories, clean rooms, waste storage and disposal, etc.) 3005 • Unique or special facility requirements for transportation, handling, and storage 3006 equipment being manufactured 3007 • Update new manufacturing and quality capital equipment, tooling, and Special Test or 3008 Inspection Equipment (STE/SIE) requirements for new technology and materials for 3009 preferred concepts. Update the manufacturing and quality assessments of: 3010 3011 • Tooling requirements for capability to produce at planned production rates and target unit 3012 costs 3013 • Needs for soft tooling vs. hard tooling 3014 • Supplier and sub-tier capabilities and investment incentives • STE/SIE requirements and capabilities 3015 3016 Assess manufacturing and quality requirements for unique or special transportation, handling, • 3017 and storage equipment to be manufactured for preferred concepts. 3018 Update the manufacturing and quality funding estimates required for capital equipment, • 3019 tooling, and test equipment for preferred concepts. 3020 Metrics 3021 The manufacturing and quality facilities and capital equipment requirements for the AoA • 3022 preferred concepts have been updated and documented in the AoA. 3023 • Quantitative and qualitative manufacturing and quality facility demands of the preferred 3024 concepts have been analyzed and documented for:

3025 3026 3027 3028 3029 3030		 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
3031 3032 3033 3034 3035 3036	•	New manufacturing and quality capital equipment, tooling, and Special Test or Inspection Equipment (STE/SIE) requirements have been updated for new technology and materials for AoA preferred concepts. The following have been re-analyzed and re-assessed and documented by manufacturing and quality representatives as part of the AoA: • Tooling requirements for capability to produce at planned production rates and target unit
3037 3038 3039 3040		 costs Needs for soft tooling vs. hard tooling Supplier and sub-tier capabilities and investment incentives GFE/STE/SIE requirements and capabilities
3041 3042 3043 3044 3045	•	Manufacturing and quality requirements for unique or special transportation, handling, and storage equipment to be manufactured for preferred concepts have been assessed and documented. Manufacturing and quality funding estimates required for capital equipment, tooling, and test equipment for preferred concepts have been updated and included in the AoA.
3046	Tools	
3047	٠	Bottleneck Analysis (Theory of Constraints)
3048	٠	Critical Chain Project Management
3049	•	ISO 9001 Checklist Section Preservation (Handling, Storage, Packaging and Delivery)
3050 2051	•	Manufacturing Resource Planning (MRPII) MBL assessment using Engilities thread
3052	•	Plant Design and Facility Layout Software Evaluation Tools
5052		
3053	Resou	rces
3054	•	MRL Deskbook Version 2016
3055	•	Manufacturing Resource Planning (MRP II)
3030 2057	•	150 9001:2015, Quality Management System
3058	•	Manufacturing Planning

3059 K.2 Facilities and Tooling Planning

3060 Manufacturing and Quality Tasks

3061 Initiate a manufacturing and quality Facilities Plan that includes: • 3062 • Requirements for manufacturing and quality facilities for development of technologies, 3063 prototypes, and subsequent production within required lead-times (existing, new, or 3064 redeveloped) 3065 • Addressing the rate and capacity capability requirements on the facilities and needed 3066 enhancements for manufacturing and quality 3067 • Mitigation of the impacts on facilities from the types of manufacturing and quality processes required (e.g., acquisition of specialized fixtures, construction of test chambers, 3068 3069 upgrading laboratories and clean rooms, upgrading waste storage and disposal equipment, 3070 etc.) 3071 • Addressing unique or specialized manufacturing and quality facility requirements for transportation, handling, and storage equipment 3072 3073 • New facilities to be constructed to mitigate manufacturing and quality gaps in current 3074 facilities 3075 • Requirements for manufacturing and quality investments and funding with associated 3076 schedules 3077 • Assessment of and mitigation of manufacturing and quality environmental and safety 3078 factors and impacts 3079 • Requirements for security of manufacturing and quality facilities (physical and cyber) 3080 Initiate a manufacturing and quality Tooling Plan that includes: ٠ 3081 o Tooling requirements to meet production rates, costs, quantities, and schedule 3082 o Tooling sources, funding, materials impacts, maintenance impacts, etc. 3083 • Analysis of requirements for soft and/or hard tooling • Manufacturing and quality test equipment including STE, SIE, and GFE 3084 3085 Derive manufacturing and quality funding estimates required for capital equipment, tooling, • 3086 and test equipment for the preferred concept from the facilities and tooling planning. 3087 Metrics 3088 A manufacturing and quality Facilities Plan has been initiated and documents the following: 3089 • Requirements for manufacturing and quality facilities for development of technologies, 3090 prototypes, and subsequent production within required lead-times (existing, new, or 3091 redeveloped) 3092 • Addressing the rate and capacity capability requirements on the facilities and needed 3093 enhancements for manufacturing and quality 3094 • Mitigation of the impacts on facilities from the types of manufacturing and quality 3095 processes required (e.g., acquisition of specialized fixtures, construction of test chambers,

2. Materiel Solution Analysis (MSA) Phase

3096		upgrading laboratories and clean rooms, upgrading waste storage and disposal
3097		equipment, etc.)
3098		• Addressing unique or specialized manufacturing and quality facility requirements for
3099		transportation, handling, and storage equipment
3100		• New facilities to be constructed to mitigate manufacturing and quality gaps in current
3101		facilities
3102 3103		• Requirements for manufacturing and quality investments and funding with associated schedules
3104		• Assessment of and mitigation of manufacturing and quality environmental and safety
3105		factors and impacts
3106		• Requirements for security of manufacturing and quality facilities (physical and cyber)
3107	•	A manufacturing and quality Tooling Plan has been initiated and documents the following:
3108		• Tooling requirements to meet production rates, costs, quantities, and schedule
3109		 Tooling sources, funding, materials impacts, maintenance impacts, etc.
3110		 Analysis of requirements for soft and/or hard tooling
3111		• Manufacturing and quality test equipment including STE, SIE, and GFE)
3112	٠	Manufacturing and quality funding estimates required for capital equipment, tooling, and test
3113		equipment for the preferred concept have been updated and included in the AS and in the
3114		budget process.
3115	٠	Both the Facilities Plan and the Tooling Plan are incorporated into the Manufacturing and
3116		Quality Strategies and have been documented in the AS and the SEP.
3117	Tools	
3118	٠	Bottleneck Analysis (Theory of Constraints)
3119	•	Critical Chain Project Management
3120	•	Manufacturing Resource Planning (MRPII)
3121	•	MRL assessment using Facilities thread
3122	•	Plant Design and Facility Layout Software Evaluation Tools
3123	Resou	rces
3124	٠	MRL Deskbook Version 2016
3125	•	Manufacturing Resource Planning (MRP II)
3126	•	Defense Manufacturing Management Guide for Program Managers, Chapter 6,
3127		Manufacturing Planning

3128 L. MANUFACTURING MANAGEMENT AND CONTROL



2. Materiel Solution Analysis (MSA) Phase

3130 Programs with manufacturing aspects require a manufacturing management system. The timely

- 3131 development, production, modification, fielding, and sustainment of affordable products by
- 3132 managing manufacturing risks, issues, and opportunities throughout the program lifecycle require a
- 3133 comprehensive manufacturing management system. This is accomplished by including best practices
- 3134 and standards (i.e., AS6500, Manufacturing Management Program) in the contracts with industry.

3135 Beginning in MSA, after the preferred concept is determined, the PM and program office develop the

- 3136 manufacturing strategy and should begin detailed planning for manufacturing. Before the Materiel 3137 Development Decision, the activities managing the concept (or the program office) initiated planning
- 3138 for manufacturing management and control. In this phase, manufacturing management planning
- 3139 should be updated for the AoA. The initial manufacturing strategy developed during the MSA phase
- 3140 is a subset of the overall AS and the SEP. The Manufacturing Strategy should address all aspects of
- 3141 manufacturing management and control from design and materials to processes, workforce, and
- 3142 facilities, to transition to TMRR and subsequent phases. For example, competition considerations are
- 3143 a major contributor to reducing weapon system cost. In addition, if a program will be dual sourced,
- 3144 early planning must take into account the strategy required to assure availability of data and data
- 3145 rights for dual sourcing. New manufacturing technologies may require specific plans for
- 3146 development, proofing, and transition to production. Production rates and quantities can also play a
- 3147 major role in driving manufacturing cost as they influence decisions on processes, tooling, make-buy, 3148 etc.
- 3149 The purpose of manufacturing planning is to identify requirements and resources, to manage risk,
- 3150 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 3151
- acquisition phases. Manufacturing planning should include: 3152
- 3153 Manufacturing management responsibilities as an integral part of the IPT structure with 3154 assignment to specific program office personnel
- Manufacturing metrics for the program with a specified review cycle of metrics 3155 3156 commensurate with risks
- Manufacturing assessments to identify and quantify risks in support of program Milestone 3157 decision points and major design reviews 3158
- 3159 Manufacturing requirements and metrics for agreements, delegations, and contracts with • 3160 other agencies (e.g. DCMA)
- 3161 The initial Manufacturing Strategy, as an integral part of the AS and SEP, will guide the future 3162 development program and help minimize risk.

2. Materiel Solution Analysis (MSA) Phase

3163	L.1	Update Manufacturing Management Requirements
3164	Man	ufacturing and Quality Tasks
3165 3166	•	Ensure each AoA preferred concept is analyzed for manufacturing management requirements (to be incorporated into the RFP, per Section B.1):
3167 3168 3169 3170		 The manufacturing management requirements can be met by adherence to established standards (i.e., AS6500) Alternatively, the manufacturing management requirements should at a minimum include:
3171 3172 3173 3174 3175 3176		 Manufacturing management system requirements Design analysis for manufacturing requirements Manufacturing risk identification requirements Manufacturing planning requirements (e.g., supply chain, materials, cost, workforce, etc.) Manufacturing operations management requirements
3177 3178 3179 3180 3181 3182		 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
3183 3184	•	Review, update, and analyze manufacturing management metrics for the preferred concept from the AoA Study Guidance.
3185 3186		 Verify the frequency that the metrics are reviewed is commensurate with manufacturing risks
3187 3188	•	Specify the manufacturing management requirements to be met by the contractor (in the RFP) or government entity (in the SEP) as appropriate.
3189 3190 3191 3192		 Provide requirements for manufacturing management responsibilities and personnel within the IPT Provide manufacturing management requirements and metrics Metrics
3193 3194	•	Each AoA preferred concept has been analyzed and documented for manufacturing management requirements and results documented for the RFP.
3195 3196 3197 3198 3199		 The manufacturing management requirements have been met by documented adherence to established standards (i.e., AS6500) If AS6500 is not specified, the manufacturing management requirements have documented the following: Manufacturing management system requirements

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3200 3201 3202 3203 3204		 Design analysis for manufacturing requirements Manufacturing risk identification requirements Manufacturing planning requirements (e.g., supply chain, materials, cost, workforce, etc.) Manufacturing operations management requirements
3205 3206 3207 3208 3209 3210		 Impacts of technology and process state of the art on manufacturing management have been analyzed and documented DCMA inputs on manufacturing management system evaluations of potential contractors and suppliers for the preferred concept(s) have been included in the AoA. Relevant manufacturing management lessons-learned and best practices among programs and across centers have been analyzed and documented
3211 3212	•	Manufacturing management metrics for the AoA preferred concept from the AoA Study Guidance have been updated, analyzed, and documented for inclusion in the AS and the SEP
3213		• Review of manufacturing management metrics is included in all program reviews
3214 3215	•	Manufacturing management requirements to be met by the government or contractor entity as appropriate have been specified and documented.
3216 3217 3218 3219		 Manufacturing management responsibilities and personnel have been established for each government IPT and documented in the SEP Manufacturing management requirements and metrics for the contractor have been established and documented in the RFP
3220	Tools	
3221 3222 3223 3224 3225 3226 3227 3228 3229 3230 3231 3232 3233		AS6500 Assessment Bill of Material Assessment Industrial Base Capabilities Assessment Questionnaire Line of Balance Assessment Materials Requirements Planning (MRP) Assessment Manufacturing Resource Planning (MRPII) Assessment Make/Buy Decisions MRL Assessment Questionnaire for Manufacturing Management and Control Thread Systems Engineering Plan (SEP) Manufacturing Plan Inputs Quality Plan Inputs Technology Readiness Assessment Work Breakdown Structure
3234	Resou	rces

3236	• AFI63-145 Manufacturing and Quality Management, Sep 2016
3237	• MIL-HDBK-896B, Manufacturing and Quality Program, Aug 2008
3238	DODI 5000.60H Defense Industrial Capabilities Assessment, Apr 1996
3239	• Systems Engineering Plan (SEP) Outline, Jun 2015
3240	• Technology Readiness Assessment Guidance, Apr 2011
3241	L.2 Develop Initial Manufacturing Strategy
3242	Manufacturing and Quality Tasks
3243	• Develop appropriate manufacturing management strategy inputs with references based on the
3244	best practices from AS6500 for inclusion in the AS and the SEP.
3245	• Develop the initial Manufacturing Strategy, as a subset of the overall Acquisition Strategy,
3246	and ensure the Manufacturing Strategy addresses manufacturing and quality considerations
3247	for:
3248	• IB Risk Mitigation
3249	• Enabling/critical technologies and constraints
3250	 ManTech projects
3251	• Design and producibility
3252	• Rate and schedule (includes processes, tooling, make/buy, etc.)
3253	• Key and critical characteristics
3254	• Cost, affordability, and budget
3255	o Materials management, sourcing, and risks (including counterfeit, obsolescence, etc.)
3256	• Supply chain management, characteristics and constraints (e.g., sole, single, etc.)
3257	• Competitive development (e.g., dual source, co-production, etc.)
3258	• Processes and capability control
3259	• Workforce Planning
3260	• Facilities, Tooling, and Test Equipment (including GFE and assets)
3261	• Environmental, security, and safety
3262	• In addition, the Manufacturing Strategy should address:
3263	 Manufacturing assessments to support program Milestone decision points and major
3264	design reviews with appropriate exit criteria
3265	 Manufacturing metrics for the program with a specified review cycle of metrics
3266	commensurate with risks
3267	• Ensure the Manufacturing Strategy (and AS) includes establishing appropriate agreements,
3268	delegations, and contracts with other agencies, e.g. DCMA.
3269	• Draft an initial program Manufacturing Management Plan that addresses each key area of the
3270	strategy for incorporation into the SEP that includes details from the analyses. In accordance
3271	with AS6500, the plan should address:
3272	 Manufacturing Management System

3273	 Design Analysis for Manufacturing
3274	 Manufacturing Risk Identification (including mitigation)
3275	 Manufacturing Planning
3276	 Manufacturing Operations Management
3277	Metrics
3278	• Appropriate manufacturing management strategy inputs with references based on AS6500
3279	have been provided for inclusion in the AS and the SEP.
3280	• The initial Manufacturing Strategy, as a subset of the overall Acquisition Strategy, has been
3281	developed which includes and documents the considerations for:
3282	• IB Risk Mitigation
3283	• Enabling/critical technologies and constraints
3284	 ManTech projects
3285	• Design and producibility
3286	• Rate and schedule (includes processes, tooling, make/buy, etc.)
3287	• Key and critical characteristics
3288	• Cost, affordability, and budget
3289	o Materials management, sourcing, and risks (including counterfeit, obsolescence, etc.)
3290	• Supply chain management, characteristics and constraints (e.g., sole, single, etc.)
3291	• Competitive development (e.g., dual source, co-production, etc.)
3292	 Processes and capability control
3293	• Workforce Planning
3294	 Facilities, Tooling, and Test Equipment (including GFE and assets)
3295	• Environmental, security, and safety
3296	• The Manufacturing Strategy addresses and documents the following:
3297	 Use of manufacturing assessments to support program Milestone decision points and
3298	major design reviews with appropriate exit criteria
3299	 Manufacturing metrics for the program including a specified review cycle
3300	• The Manufacturing Strategy (and AS) has been established that includes appropriate
3301	agreements, delegations, and contracts with other agencies, e.g. DCMA.
3302	• An initial Manufacturing Management Plan has been developed that addresses each key area
3303	of the strategy and provided for incorporation into the SEP and includes details in accordance
3304	with AS6500 and addresses:
3305	 Manufacturing Management System
3306	 Design Analysis for Manufacturing
3307	• Manufacturing Risk Identification (including mitigation)
3308	• Manufacturing Planning
3309	 Manufacturing Operations Management

3310	Tools	
3311	•	Systems Engineering Plan (SEP)
3312 3313		 Manufacturing Plan Inputs Quality Plan Inputs
3314	Resou	rces
3315	•	MIL-STD-896B, Manufacturing and Quality Program, Aug 2008
3316	•	AS6500, Manufacturing Management Program, Nov 2014
3317	•	SEP Outline, Jun 2015
3318	•	DAG, Chapter 3-4 3.18, Producibility, Quality and Manufacturing Readiness, 2017
3319		
3320		

Technology Maturation and Risk Reduction 3. 1 (TMRR) Phase 2

Introduction 3

- As stated in Department of Defense Instruction (DoDI) 5000.02, "The purpose of this phase is to 4
- reduce technology, engineering, integration, and life cycle cost risk to the point that a decision to 5
- contract for EMD can be made with confidence in successful program execution for development, 6
- 7 production, and sustainment."
- 8 Technology Maturation and Risk Reduction (TMRR) includes a mix of activities intended to reduce
- 9 the risks associated with the product to be developed. This includes design and requirements trades,
- 10 maturation and validation of capability requirements, and finalization of affordability caps. The
- phase normally includes competing sources conducting technology maturation and risk reduction 11
- 12 activities. The phase also includes preliminary design activities, including a Preliminary Design
- 13 Review (PDR), leading to source selection for the Engineering and Manufacturing Development
- 14 (EMD) phase.





Figure 3-1. TMRR Phase Manufacturing and Quality Activities

3. Technology Maturation and Risk Reduction (TMRR) Phase

- 17 The program can exit TMRR when an affordable program or increment of militarily useful capability
- 18 has been identified, the technology and manufacturing processes for that program or increment have
- 19 been assessed and demonstrated in a relevant environment and found to be sufficiently mature,
- 20 manufacturing risks have been identified and assessed, and a system or increment can be developed
- 21 for production within a short time frame.
- 22 Key program phase reviews and documentation include:
- System Requirements Review (SRR)
- System Functional Review (SFR)
- Program Documentation
- 26 o Acquisition Strategy (AS)
- 27 o Systems Engineering Plan (SEP)
- 28 o Test and Evaluation Master Plan (TEMP)
- 29 o Capability Development Document (CDD)
- 30 Requests for Proposals (RFP)
- 31 Source Selection Plans (SSP)
- 32 Preliminary Design Review (PDR)
- 33 CDD Validation
- Milestone B (MS B) Decision

35 Manufacturing and Quality Objectives

36 Manufacturing and quality risks, issues, and opportunities are the most important factors in making

the decision to proceed within all phases of development and production. The producibility of the

design and risks are reviewed prior to the EMD phase. The TMRR phase requires assessments of the

- 39 industrial base (IB) and of the contractor(s) selected.
- 40 Programs need to specifically assess the capabilities of the industrial base in order to understand if
- 41 the base can support their program. Multiple technology development demonstrations may be
- 42 required before the operational user and the contractor can substantiate that the solution is feasible,
- 43 affordable, and supportable; satisfies capability requirements; and has acceptable risks.
- 44 By the end of the TMRR phase, manufacturing and quality processes will be assessed and
- 45 demonstrated to the extent needed to verify that risks have been reduced to an acceptable level. Some
- 46 of the mitigations may involve investments in industrial base capabilities (i.e., Title III) as well as
- 47 investments in advanced manufacturing capabilities (i.e., ManTech).
- 48 Program management is responsible for implementing effective risk, issue, and opportunity (RIO)
- 49 management and tracking to include the identification of all known risks, key assumptions,
- 50 probability of occurrence, consequences of occurrence (in terms of cost, schedule, and performance)
- 51 if not handled, analysis of risk handling options, decisions about actions to mitigate risk, and

- 52 execution of those actions. Manufacturing and quality personnel are responsible for identification,
- 53 prioritization, and mitigation of manufacturing and quality risks and issues.
- 54 Manufacturing and quality personnel participation in and support to Program Design IPTs are critical
- to success in producing a manufacturable and affordable system with acceptable risks. In TMRR,
- 56 costs need to be defined and finalized to include identified manufacturing and quality cost drivers
- 57 based on contractor-proposed materials and processes, producibility costs, required investments.
- 58 Manufacturing and quality personnel should analyze the contractor's processes, materials, make/buy
- 59 processes (hardware and software), and supply chain for capability and completeness, and
- 60 identification of single points of failure for mitigation. Process capability and control should be an
- 61 integral part of any development program and lead to a producible system with effective and efficient
- 62 manufacturing processes. Workforce skills identification and plans should provide inputs to program
- 63 planning and should identify the skills required for the scope of the technical effort needed to
- 64 develop, field, and sustain the system. Also, manufacturing and quality personnel should conduct
- assessments of contractor-proposed facilities and tooling for TMRR and subsequent phases.
- 66 During the TMRR phase the contractor will produce prototypes that will be used during tests to
- 67 validate that the design meets requirements. These prototypes will be built in a relevant
- 68 manufacturing environment, meaning that there are some elements of production realism present on
- 69 the manufacturing line. To the extent practicable, manufacturing and quality personnel will assess the
- 70 processes used for prototype build and evaluate the tests and demonstrations to better understand the
- 71 issues that will need to be resolved during the EMD phase.
- 72 Contractors must have an effective combination of people and systems in order to plan for, monitor,
- and control manufacturing and quality resources. To manage these resources, an effective
- implementation of a manufacturing management system and a quality management system is
- required during TMRR. A well-structured manufacturing management system generally employs the
- vise of industry best practices. A Quality Management System (QMS) compliant with industry best
- 77 practices is the foundation for the contractor to deliver a system that meets requirements. Assessment
- of the contractor's manufacturing management and quality systems should be performed against the
- recognized industry best practices such as AS6500, ISO 9000, AS9100, etc.
- 80 The initial manufacturing and quality strategies should have been developed during the Materiel
- 81 Solution Analysis (MSA) phase. During TMRR phase, an effective joint government/contractor
- 82 manufacturing strategy and quality strategy are required if the program is to adequately reduce risks
- and mature and deliver a design for an operationally safe, suitable, and effective weapon systems. In
- 84 addition, the program and the contractor should develop a joint government/contractor manufacturing
- and quality plans that execute the strategy for EMD.

86 A. DOD ACQUISITION SYSTEM

- 87 The TMRR phase objective is to develop and demonstrate competitive sources and prototype designs
- to reduce technical risk, validate designs and cost estimates, evaluate manufacturing processes, and
- 89 refine requirements. It is focused on maturing, prototyping, and demonstrating technologies in a
- 90 relevant environment, resulting in a preferred system concept that achieves acceptable low-risk entry
- 91 into the EMD phase.



92

93 Effective employment of systems engineering will reduce program risk. This is monitored by

- 94 meaningful technical reviews to reduce program risk, identify potential management issues in a
- 95 timely manner, and support key program decisions. Manufacturing and quality managers should be
- 96 making significant inputs into these activities and reviews. Early program reviews include the SRR
- 97 and SFR. The SRR is conducted to help ensure the level of understanding of top-level system
- 98 requirements is adequate to support further requirements analysis and design activities, and that the
- 99 system can proceed into initial system design with acceptable risk. The SFR is conducted to help
- 100 ensure that the system under review can proceed into preliminary design with acceptable risk and that
- all system requirements and functional performance requirements derived from the approved
- 102 preliminary system specification are defined and are consistent with the program budget, program
- 103 schedule, risk, and other program and system constraints.
- 104 The AS developed for the Milestone A (MS A) decision should have addressed the following105 program objectives:
- Use of industry best practices for manufacturing, quality, and systems engineering management
- 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

114 In the TMRR phase, the updated Acquisition Strategy describes the overall approach to acquiring the

115 capability to include the program schedule, risks, funding, and the business strategy.

3. Technology Maturation and Risk Reduction (TMRR) Phase

116 The pre-MS A initial manufacturing and quality strategies, as an integral part of the AS, includes

- 117 considerations of:
- 118 Competition
- 119 New manufacturing technologies
- Production rates and quantities
- 121 Materials sourcing
- Contracting strategies

For TMRR, the updated manufacturing and quality strategies are a subset of the program Acquisition
Strategy and will include these same considerations. Competition is a major contributor to reducing

125 weapon system cost. If the program will be dual sourced, the early planning must take into account

- 126 the strategy required to ensure availability of capability and data and data rights for dual sourcing.
- 127 New manufacturing technologies, if required by the system concept, will require specific plans for
- development, proofing, and transition of the technology to the eventual producer. This effort will
- 129 necessitate close coordination with the Service manufacturing technology organization to ensure
- 130 compatibility of the technology development schedule with the system development schedule.
- 131 Production rates and quantities also play a major role in driving manufacturing cost as they will drive
- 132 decisions on what production processes to use, types of tooling required, make-buy decisions, etc.
- 133 The Acquisition Strategy provides a master schedule for research, development, test, and production.
- 134 Manufacturing and quality considerations for inclusion in the strategy should include establishing
- 135 feasibility, assessing risks, identifying capable manufacturers and suppliers, manufacturing
- technology maturation, capabilities of the industrial base, availability of critical materials, and the
- 137 transition from development to production. The Acquisition Strategy and the included Manufacturing
- 138 and Quality Strategies summarize how the industrial and manufacturing risk will be addressed in the
- 139 TMRR phase to ensure that manufacturing maturity is appropriate to enter EMD, particularly for new
- 140 or high risk manufacturing endeavors.
- 141 The SEP implements the technical development and engineering aspects of the AS. The Pre-MS A
- 142 SEP requires updates based on contract award to reflect any changes due to the contractor's technical
- approach and details not available prior to contract award. Effective employment of systems
- 144 engineering with competitive prototyping, as applied through the SEP, and monitored with
- 145 meaningful technical reviews, will reduce program risk, identify potential management issues in a
- 146 timely manner, and support key program decisions. Manufacturing and quality managers should be
- 147 making significant inputs into these documents and activities. In addition, manufacturing and quality
- 148 personnel should provide a manufacturing and quality capability assessment update for the SEP
- 149 during TMRR. They should assess manufacturing and quality risks for each competing prototype
- 150 during TMRR and verify risks have been reduced to an acceptable level. Individual risks should be
- 151 identified and integrated into a cumulative assessment of the production, manufacturing, and quality
- 152 risks, issues, and opportunities.

3. Technology Maturation and Risk Reduction (TMRR) Phase

153 As the program matures, it is important to mature the requisite manufacturing requirements and

- 154 processes needed to build prototypes and production items. The SEP ensures this by providing,
- 155 updating, and planning for:
- Conducting producibility analyses with consideration of the life cycle costs of proposed manufacturing, assembly, and test processes.
- Significant activities (i.e. manufacturing assessments, long-lead or advanced procurements,
 prototype builds, production lots/phases, Production Readiness Review (PRR)) indicated on
 program schedule.
- Industrial, manufacturing, production, engineering, software, firmware, and quality risks and issues, and reduction efforts, as well as opportunities.
- Manufacturing and quality organization, billets, and Production Quality and Manufacturing
 (PQM) Key Leadership Positions (KLP).
- Manufacturing and Quality Roles and Responsibilities of IPTs (Team Details Name, Chair, Membership, Roles, Responsibility, and Authority, Products and Metrics).
- Planned activities for the next phase.
- 168 Additional considerations for the Acquisition Strategy and the SEP, based on assessments of the
- 169 contractor's cybersecurity plans, are manufacturing and quality inputs for cybersecurity that include
- technical risks, processes, industrial control systems, manufacturing and quality resources and
- 171 organizations, and design considerations. Another consideration is that the updated Program
- 172 Manufacturing and Quality Strategies include appropriate agreements, delegations, and contracts
- 173 with other agencies (e.g., Defense Contract Management Agency (DCMA), Defense Logistics
- 174 Agency (DLA), etc.).
- 175 Outputs of the SRR, SFR, and Preliminary Design Review (PDR) will create the need for substantive
- 176 updates and changes to the SEP. This phase normally includes competitive sources conducting
- 177 TMRR activities and preliminary design activities up to and including a PDR prior to source
- 178 selection for the EMD phase. A final revision and re-submission will be required for approval before
- the EMD Request for Proposal Release Decision Point (RFP RDP) and Milestone B.
- 180 The role of manufacturing and quality in the TMRR phase is to influence the design. This is critical
- 181 because of the impact design decisions have on Life Cycle Cost (LCC). Studies have shown that by
- 182 the time a PDR is held approximately 80 percent of the program's LCC is determined, even though
- 183 only a small percentage of the program's cumulative costs have been expended (citation to come). It
- 184 is also the time when a program or contractor has the most opportunity to impact life cycle cost
- 185 savings.
- 186 The PDR is a technical assessment establishing the allocated baseline to ensure that the system under
- 187 review has a reasonable expectation of being judged operationally effective and suitable, and has a
- 188 reasonable expectation of satisfying the requirements within the currently allocated budget and

3. Technology Maturation and Risk Reduction (TMRR) Phase

- 189 schedule. A successful PDR includes an assessment of the producibility of the design and an
- 190 assessment of manufacturing costs and risks.
- 191 During this phase, and timed to support CDD validation (or its equivalent), manufacturing and
- 192 quality will provide support to the Program Manager's conduct of systems engineering trade-off
- analyses showing how cost and capability vary as a function of the major design parameters. The
- analyses will support the assessment of refined Key Performance Parameters (KPP), Key System
- 195 Attributes (KSA)in the CDD. Capability requirements proposed in the CDD (or equivalent
- 196 requirements document) should be consistent with program affordability goals.
- 197 In support of program decision reviews, RFP RDP and Milestone B, manufacturing and quality will
- 198 have conducted additional requirements analyses and demonstrations including: requirements
- decomposition and allocation, definition of internal and external interfaces, design activities, and
- 200 prototypes and process demonstrations that led to a PDR. Milestone B requires final demonstration
- 201 that all sources of risk have been adequately mitigated to support a commitment to design for
- 202 production. This includes technology, engineering, integration, manufacturing, sustainment, and cost
- risks. In addition, pursuant to the NDAA for FY 2017, Sec. 807, before any decision to grant
- 204 Milestone B approval for the program (pursuant to section 2366b), manufacturing and quality
- 205 personnel are required to identify manufacturing processes that have not been successfully 206 demonstrated in a relevant environment.

207 A.1 Support Early Technical Reviews

208 Manufacturing and Quality Tasks

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- Provide manufacturing and quality support to the program's overall risk, issue, and
 opportunity management processes (e.g., industrial base, manufacturing technology gaps,
 quality, software, and engineering related risks/issues, etc.).
- Provide manufacturing and quality Program workforce requirements for Program organization, billets, and PQM Key Leadership Positions.
- Provide the manufacturing and quality management requirements (e.g., AS6500, ISO 9000,
 AS9100, IEEE 15288, etc.) to program management to be used in assessing the contractor's
 plans to meet Program cost, schedule, and performance requirements throughout the product
 life cycle (see I.1 and L.1).
- Ensure the program and contractor have a joint understanding of the system
 manufacturing and quality requirements and performance that are:
 - Consistent with the preferred materiel solution
 - Consistent with manufacturing and quality budget, schedule, risk, user, and other specific constraints
 - Feasible given available manufacturing technologies for the preferred system solution
 - Adequate and consider the maturity of interdependent system elements

225 226 227 228	 Bidirectional with traceability to the set of source documents (e.g., Key Characteristics (KC) to KPPs Verifiable with defined and agreed-upon methods Consistent with program's objectives (with manageable risk)
• 229	Provide manufacturing and quality support to the SRR:
230 231 232 233	 Provide requirements that are sufficiently detailed and understood that enable manufacturing and quality functional definitions and functional decompositions Assess manufacturing and quality feasibility of the contractor(s)' proposed (traceability to the AoA results):
234 235 236	 External interface requirements Alternative and/or competitive architectural concepts Operational and life cycle sustainment requirements
237	• Provide manufacturing and quality requirements in support of:
238 239 240 241 242 243 244 245 244 245 246 247 248 249 250 251	 Human safety and health Hazardous materials management and pollution prevention Environmental (e.g., shock, vibration, thermal, humidity, electromagnetic interference/impact, electrostatic discharge, transport, etc.) Security (physical and cyber) for both hardware and software Key Performance Parameters (i.e., KCs) Data management and software (including collection, analysis, testing, and methods of analysis, storage, retrieval of manufacturing and quality data) Supportability and sustainment Use of commercial off-the-shelf (COTS), government off-the-shelf (GOTS), and government-furnished equipment (GFE) (including diminishing manufacturing sources) Parts, materials, and processes Provide manufacturing and quality analyses of requirements that potentially impact
252	manufacturing feasibility for:
252 253 254	 System Human System Integration/interface requirements System Safety requirements
255	 System command, control, communication, computer, and intelligence (C4I)
256	requirements
257	• System security requirements (e.g., communications, cyber, program protection, anti-
258	tamper, etc.)
259	 Key Performance Parameters (e.g., mandatory and other)
260	 Interoperability requirements
261	 Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC)
262	requirements
263	 Product assurance

264 265		 Specialized manufacturing requirements (extreme complexity, multiple or very tight tolerances, precision assembly, handling of fragile components, etc.)
266 267	0	Assess and analyze the completeness and adequacy of manufacturing and quality aspects and requirements for:
268 269 270 271 272 273 274 275 276 277 278		 Contractor's plans for processes and metrics included in the System Engineering Management Plan (SEMP) Contractor's budget and schedule plans including identification of cost and schedule drivers (with impacts on the critical path) Contractor's software development strategy and development plans (to include functionality, adequacy, testing, etc.) Technology maturation plans Developmental Test and Evaluation (DT&E) approaches Development, qualification, and acceptance testing approaches including consideration for non-developmental items (NDI), COTS, and reuse items Modeling and Simulation plans to include design, production, processes, costing, etc.
 279 280 281 282 283 284 285 	0	 Provide manufacturing and quality strategies input to: The joint program/contractor risk, issue, and opportunity management system including hazards, technologies, sources of supply, etc., and mitigating courses of action The joint program/contractor configuration management system The joint program/contractor Integrated Master Plan/Integrated Master Schedule The Cost Analysis Requirements Description (CARD) for manufacturing and quality
286 287 •	Pro	should-cost inputs (See F.1)
288 289 290	eng o	Conducting manufacturing feasibility analyses including cost and schedule Providing manufacturing and quality requirements mapped to the hardware and software
290 291 292	0	functional baseline Providing traceability of manufacturing and quality requirements to the draft Capability
293 294	0	Development Document (CDD) Providing results of industrial base capabilities studies
295 296	0	Conducting assessments of risks, issues, and opportunities and associated mitigation planning
297 298	0	Manufacturing and quality inputs to the program PDR planning to include sustainment and life cycle planning
299	0	Providing analysis of the contractor's SEMP
300	0	Providing inputs to the detailed plan and schedule with inputs on sufficient resources to
301		continue design and development (i.e., Integrated Master Plan (IMP) and Integrated
302		Master Schedule (IMS)

303 304 305	0	Providing results of assessments of contractor(s) and supply chain capability to mature the proposed design(s) within the program overall cost, schedule, and performance goals (See F 2)
306	0	Providing results of manufacturing and quality design producibility analyses (See E.2)
307	0	Conducting analyses of materials availability, maturity, and characterization (See G.2)
308	0	Conducting assessments and providing estimates of process maturity and capability for
309		manufacturing and production processes (See H.1)
310	0	Assessing contractor initial Manufacturing Plans for workforce requirements, skills,
311		capabilities, training, and certifications (including for prototypes and system
312		development) (See J.1)
313	0	Providing analyses of the contractor's tooling and facilities strategies (See K.1)
314	0	Assessing the contractor's Manufacturing Management System and plans (See L.1)
315	Metrics	
316 317 318	• M m te	anufacturing and quality support to the program's overall risk, issue, and opportunity anagement processes have been provided and document the industrial base, manufacturing chnology gaps, quality, software, and engineering-related risks/issues, etc.
319	• M	anufacturing and quality Program workforce requirements have been documented and
320	pr	rovided to program management delineating manufacturing and quality billets, PQM Key
321	Le	eadership Positions, IPT membership, etc.
322	• D	ocumented manufacturing and quality management requirements have been provided to
323	pr	ogram management for use in assessment of contractor's plans to meet program cost,
324	sc	hedule, and performance requirements throughout the product life cycle. (e.g., AS6500,
325	IS	O 9000, AS9100, IEEE 15288, etc.)
326 327	0	Program and contractor joint understanding of the system manufacturing and quality requirements and performance have been agreed to and document:
328		 Consistency with the preferred materiel solution
329		• Consistency with manufacturing and quality budget, schedule, risk, user and other
330		specific constraints
331		 Feasibility of given manufacturing technologies for the preferred system solution
332		 Adequacy and maturity of interdependent system elements
333		 Bi-directional traceability to the set of source documents (e.g., KCs to KPPs)
334		 Defined and agreed-upon methods for verification
335		 Consistency with program's objectives (with manageable risk)
336	• D	ocumented manufacturing and quality support has been provided to the SRR to include:
337	0	Requirements that are sufficiently detailed and understood that enable manufacturing and
338		quality functional definitions and functional decompositions
339	0	Assessments of manufacturing and quality feasibility including contractor(s) proposed:
340		 External interface requirements
341		 Alternative and/or competitive architectural concepts
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342		 Operational and life cycle sustainment requirements
343	0	Manufacturing and quality requirements for:
344		 Human safety and health
345		 Hazardous materials management and pollution prevention
346		• Environmental parameters (e.g., shock, vibration, thermal, humidity, electromagnetic
347		interference/impact, electrostatic discharge, transport, etc.)
348		 Security parameters (physical and cyber) for both hardware and software
349		• KPPs (i.e., KCs)
350		 Data management and software (including collection, analysis, testing, and methods
351		of analysis, storage, retrieval of manufacturing and quality data)
352		 Supportability and sustainment
353		 Use of COTS, GOTS, and GFE (including diminishing manufacturing sources)
354		 Parts, materials, and processes (PM&P)
355	0	Analyses of manufacturing and quality requirements that document the impacts to
356		manufacturing feasibility by:
357		 System Human System Integration/interface requirements
358		 System Safety requirements
359		 System command, control, communication, computer, and intelligence (C4I)
360		requirements
361		• System security requirements (e.g., communications, cyber, program protection, anti-
362		tamper, etc.)
363		 KPPs (e.g., mandatory and other)
364		 Interoperability requirements
365		 EMI and EMC requirements
366		 Product assurance requirements
367		 Specialized manufacturing requirements (extreme complexity, multiple or very tight
368		tolerances, precision assembly, handling of fragile components, etc.)
369	0	Analyses have been accomplished and document the completeness and adequacy of
370		manufacturing and quality aspects and requirements included in contractor's:
371		 Plans for processes and metrics included in SEMP
372		 Plans for budget and schedule including identification of cost and schedule drivers
373		(with impacts on the critical path)
374		• Software development strategy and plans (to include functionality, adequacy, testing,
375		etc.)
376		 Technology maturation plans
377		 DT&E approaches
378		 Development, qualification, and acceptance testing approaches including
379		consideration for NDI, COTS, and reuse items
380		• Modeling and Simulation plans to include design, production, processes, costing, etc.

3. Technology Maturation and Risk Reduction (TMRR) Phase

381		• Documentation of manufacturing and quality strategy inputs to:
382 383 384		 The joint program/contractor risk, issue, and opportunity management system including hazards, technologies, sources of supply, etc., and mitigating courses of action
385 386 387		 The joint program/contractor configuration management system The joint program/contractor Integrated Master Plan/Integrated Master Schedule The CARD for manufacturing and quality should-cost inputs (See F.1)
388 389	•	Manufacturing and quality analyses and support have been provided to the program and Systems Engineering functions and for the SFR document:
390 391 392		 Manufacturing feasibility analyses to include cost and schedule Mapping of manufacturing and quality requirements to the hardware and software functional baseline
393 394		 Traceability of manufacturing and quality requirements to the draft CDD Results of Industrial Base capabilities studies
395 396 307		 Assessments of risks, issues, and opportunities and associated mitigation planning Manufacturing and quality inputs for Program PDR planning including sustainment and life quale planning
397 398		 Analysis and recommendations for the contractor's SEMP
399 400		 Inputs and recommendation on the detailed plan and schedule including inputs on sufficient resources to continue design and development (i.e., IMP/IMS)
401 402		 Results and recommendations from assessments of contractor(s) and supply chain capability to mature the proposed design(s)
403 404		 Results of manufacturing and quality design producibility analyses Analyses of materials availability, maturity, and characterization
405 406		 Results of assessments and estimates of process maturity and capability for manufacturing and production processes
407 408		• Analyses and recommendations for the contractor initial Manufacturing Plans concerning workforce requirements, skills, capabilities, training, and certifications
409 410 411		 Analyses and recommendations for the contractor's tooling and facilities strategies Analyses and recommendations for the contractor's Manufacturing Management System
411	Tools	and plans
413	•	AS6500 Manufacturing Management System Checklist
414	•	AS9100 Quality Management System Checklist
415	•	Cost Estimating Worksheet, Manufacturing
416	•	ISO 9001 Quality Management System Checklist
417	•	Manufacturing Readiness Level (MRL) Assessment Checklist
418	•	Technology Readiness Level (TRL) Assessment Checklist

419 Risk Assessment Tool •

420	•	Systems Engineering Plan (SEP) Outline
421	•	System Requirements Review (SRR) Checklist
422	•	System Functional Review (SFR) Checklist
423	•	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
424	Resou	irces
425	•	AS6500, Manufacturing Management Program, Nov 2014
426	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
427 428	•	AS9100 Quality Systems – Requirements for Aviation, Space, and Defense Organizations, Sep 2016
429	•	Cost Analysis Guide, Nov 1989
430	•	DoD 5000.60-H. DoD Handbook: Assessing Defense Industrial Capabilities. Apr 1996
431	•	DFARS 252 204-7012 Safeguarding Covered Defense Information and Cyber Incident
432		Reporting
433	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
434	٠	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
435	•	ISO 9001:2015, Quality Management System
436	•	NIST 800-171, Controls for Controlled Unclassified information, June 2015
437	•	DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017
438	•	MIL-STD-1472, DoD Design Criteria Standard: Human Engineering
439	•	DoD HCI Style Guide, Human Computer Interaction (HCI), 1994
440	•	Technology Readiness Assessment Guidance, Apr 2011
441	•	Defense Manufacturing Management Guide for Program Managers, Chapter 12 – Technical
442		Reviews and Audits, Specifically 12.5.3 System Requirements Review (SRR), 12.5.4 and
443		System Functional Review (SFR)
444	•	Guide to Environment, Safety, and Occupational Health (ESOH) in the Systems Engineering
445		Plan (SEP), no date
446	•	DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs,
447		Jan 2017
448	•	Systems Engineering Plan (SEP) Outline, Jun 2015
449	A.2	Provide Manufacturing and Quality Updates to Program Documentation
450	Manu	facturing and Quality Tasks
451	•	Based on the results, action items, and resolutions pertaining to manufacturing and quality
452		requirements and concerns from the SRR and the SFR, update the Manufacturing Strategy
453		and Quality Strategies to address development and considerations of:
454		• Competition and contracting strategies
455		• Management (quality, manufacturing, supply chain, risks, etc.)
456		 Design (feasibility, producibility, KCs, risks, etc.)

457	• New manufacturing technologies
458	 Modular Open Systems Approach (MOSA)
459	• Intellectual Property rights (including deliverables and associated license rights over the
460	entire product life cycle)
461	• Materials (characteristics, sourcing, risks, etc.)
462	• Cyber threat protection measures (See L.2)
463	 Integrated Product Support Plan
464	• Process, rates, and quantities (capabilities, control, risks, etc.) (See H.1)
465	• Facilities, Tooling, and Workforce (including GFE/GFI, STE/SIE, special requirements,
466	etc.)
467 •	Provide in the Manufacturing and Quality Strategies detailed manufacturing and quality
468	requirements for:
469	• Rates, quantities, and schedule (including reference to Economic Order Quantity and the
470	affordability targets)
471	• Manufacturing maturity and progress against manufacturing and quality goals required
472	for each technical review (SRRs, PDRs, CDRs, and at other appropriate reviews)
473	• Human safety and health
474	 Hazardous materials management and pollution prevention
475	• Environmental parameters (e.g., shock, vibration, thermal, humidity, electromagnetic
476	interference/impact, electrostatic discharge, transport, etc.)
477	• Security parameters (physical and cyber) for both hardware and software
478	• KPPs (i.e., KCs)
479	• Data management and software (including collection, analysis, testing, and methods of
480	analysis, storage, retrieval of manufacturing and quality data)
481	• Supportability and sustainment
482	• Use of priorities, allocations, and allotments, and justification
483	• Use of COTS, GOTS, and GFE (including diminishing manufacturing sources)
484	• Parts, materials, and processes (PM&P)
485 •	Update the Manufacturing Strategy and Quality Strategy to address the sustainment of
486	industrial capabilities (including manufacturing technologies and capabilities) and the
487	maturation required during the EMD and subsequent phases.
488	• Provide manufacturing and quality inputs on product or component obsolescence (known
489	and/or projected), use and replacement of limited-life items, options for unique
490	manufacturing processes and products (avoidance or regeneration), and the capability to
491	convert off-the-shelf items to required specifications at the subsystem, item, and
492	component levels.
493	• Provide manufacturing and quality inputs on products or components (known and/or
494	projected) from sole, single, fragile, or foreign sources including options for:
495	 Domestic alternatives through regeneration of prior capability
496	 Creation of new capability for manufacturing products and processes

497	 Lifetime buy of items at the subsystems, and component levels
498 • 499 500	Incorporate planning for new or high-risk manufacturing capabilities and processes Manufacturing Technology (ManTech) in the Manufacturing Strategy that addresses risks, issues, and opportunities in the EMD phase. (See D.2)
501 502 503	 If this new manufacturing capability can be demonstrated in TMRR phase in a relevant manufacturing environment, specify this demonstration in the plans Include insertion of the new manufacturing capability in planning for EMD
504 • 505	Initiate the manufacturing and quality Industrial Base (IB) capability analyses updates for inclusion in the Acquisition Strategy and the RFP to include inputs on:
506 507 508 509 510 511	 IB capabilities, fragility, gaps, and risks for the Acquisition Strategy (e.g., key technologies and key and critical processes, parts, components, etc.) Capability of the IB to design, develop, produce, support, and restart the acquisition program, if appropriate Impacts and interdependencies of this acquisition on the National Technology Industrial Base (NTIB) and the analyses used to make this determination
512 513	Include how they will be managedInclude plans for future assessments, including frequency
514 515 516	 Government strategy and actions necessary to preserve the IB capabilities (e.g., incentives for the contractor to support IB capability preservation, ManTech/Title III initiatives, etc.)
517 • 518 519	Provide manufacturing and quality inputs to Acquisition Strategy for a contracting strategy that supports selection of the best course of action through either a competitive award, a sole source award, or multiple source development to include:
520 521	• Manufacturing and quality metrics to differentiate the value of each contract type to include performance, conscitut functional economia, etc.
522 522 523 524	 Impacts and risks, issues, and opportunities that may result from different contract types (Firm Fixed Price (FFP), Fixed Price Incentive Fee (FPIF), Cost Plus Fixed Fee (CPFF), etc.)
525 526 527 528	 Prototyping approach for EMD, either competitive, single, or prototyping of critical subsystems (statutory requirement for Major Defense Acquisition Program (MDAP) AS, regulatory requirement for all other programs) Potential production approach for EMD and subsequent phases
529 • 530 531 532	Update manufacturing and quality inputs to the Acquisition Strategy for EMD with a 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.).

3. Technology Maturation and Risk Reduction (TMRR) Phase

533 534 535 536 537 538 539	 Provide updated manufacturing and quality requirements as 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: Reports and data from Defense Contract Management Agency (DCMA) Analyses materials availability (lead-time and scale-up) and maturity (characterization) Contractor data on rates and yields for manufacturing and quality Analyses of manufacturing and quality maturity and projections
540 541	 Reports on facilities, tooling, and workforce utilization Updated capital equipment requirements
 542 543 544 545 546 547 548 549 550 551 552 553 	 Provide updated manufacturing and quality inputs and plans to the IMP/IMS including: Schedule for any planned use of government-furnished special test equipment (STE), government facilities/ranges, unique tooling, or other similar requirements (specific M&S, communications, restricted environment, etc.). Schedule impacts from the requirements for special materials and allotments, and the reasons for them if applicable Manufacturing and quality internal and external interdependencies and integration with existing programs, systems, and other programs in development that potentially impact the critical path Inputs on reviews down to the sub-tier level (including PDR, CDR, PRR, etc.), documentation inputs (e.g., draft CDD, TEMP, AS, SEP, PDR, etc.), production events, and deliveries
554 • 555	Update the government Manufacturing Management and Quality Management approach for EMD to include: (See I.1 and L.2)
556 557 558 559 560 561 562	 Changes in manufacturing and quality requirements Manufacturing and quality resource management (minimizing cost, schedule, and performance risks for the product life cycle) Potential changes to manufacturing and quality organization and staffing with Key Leadership Positions (KLP) and necessary skilled manpower Changes to manufacturing and quality support organization required to meet program projected needs for EMD and subsequent phases including:
563 564 565	 Earned Value Management requirements Cost control requirements Data collection, reporting, and management
566 • 567	Update the manufacturing and quality requirements for the EMD contractor's Manufacturing Management System (MMS) and Quality Management System (QMS).
568 569 570 571	 Specify the standards to be used to promote industry best practices (e.g., AS6500, ISO 9000, AS9100, IEEE 15288.0,1,2, etc.) If manufacturing and quality standards are not specified, develop requirements for program specific manufacturing management plan and quality management plan.

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572 573 574	 Identify manufacturing and quality opportunities, initiatives, and systems that will contribute to minimizing cost, schedule, and performance risks throughout the product life cycle
575 • 576 577	Update requirements for identification, analysis, mitigation, tracking, and control of manufacturing and quality risks, issues, and opportunities that impact performance, technical, cost, schedule, sustainment, and programmatic areas throughout the life of the program.
578 579 580	 Ensure a joint manufacturing and quality comprehensive Risk, Issue, and Opportunity (RIO) Management Process that is capable of identifying and tracking risks and associated mitigation plans is in place
581 • 582 583	Analyze identified manufacturing and quality risks, issues, and opportunities, and associated mitigation plans for adequacy and completeness, and potential impacts on EMD and subsequent phases to include:
584 585 586 587 588 589 590	 Risk of industry being unable to provide program design or manufacturing capabilities at planned cost and schedule Materials, facilities, workforce, interdependencies with other programs, manufacturing technology gaps, quality, software and engineering related risks, issues etc. Required maturation of critical technologies and manufacturing processes to the appropriate level Manufacturing and quality cost and schedule impacts
591 • 592	Update manufacturing and quality exit criteria metrics for TMRR and subsequent phase decision points.
593 594 595 596	 Metrics should include current and projected manufacturing and quality maturity of identified critical technologies and manufacturing processes Metrics should also include the planned Manufacturing Readiness Level (MRL) targets for system, subsystems, components, and items
597 • 598 • 599 • 600 • 601 • 602 •	Update the manufacturing and quality support plan for an assessment of manufacturing readiness and the mandated independent assessment. Ensure other agencies are providing inputs on strategies (e.g., DCMA, Defense Logistics Agency (DLA), etc.) for quality, manufacturing, production, engineering, software development, configuration management, testing and quality. Manufacturing and quality updated inputs to the SEP and TEMP include the following:
603 604 605	 Manufacturing and quality updates and impacts on all KPPs including the mandatory KPPs (Force Protection, System Survivability, Sustainment, and Energy) Planned significant activities indicated on the up-to-date EMD program schedule
606 607 608 609	 Manufacturing assessments Long-lead or advanced procurements Prototype builds Projected lots or phases

610		 Production Readiness Review
611 612	0	Updated inputs to the program Risk, Issue, and Opportunity Management process and plans which include:
613 614 615 616 617 618 619		 Industrial risks Manufacturing risks Quality risks Engineering risks Software risks Production risks Risk reduction and mitigation efforts
620 621 622 623 624	0	Updated Program Manufacturing Management Plan addressing software development and reuse. Updated manufacturing and quality inputs from assessment of the contractor's management of and processes for Safeguarding Covered Defense Information and Cyber Incident Reporting including:
625 626 627 628 629 630 631		 Compliance with Defense Federal Acquisition Regulation Supplement (DFARS), Program Protection Plan (PPP), International Trafficking in Arms Regulation (ITAR), etc. Management of Controlled Unclassified Information Technical approaches to cybersecurity and related manufacturing and quality security, including suppliers, risks, processes, industrial control systems, resources, metrics, and design considerations
632 633	0	Updated Program Manufacturing Management Plan addressing each key area of the Manufacturing Strategy (in accordance with AS6500) to include:
634 635 636 637 638		 Manufacturing Management System Design Analysis for Manufacturing Manufacturing Risk Identification (including mitigation) Manufacturing Planning Manufacturing Operations Management
639 640	0	Updated inputs on the manufacturing and quality organization, billets and key assignments including
641 642		 Roles and Responsibilities of IPTs (Team Details – Name, Chair, Membership, Roles, Responsibility, and Authority, Products and Metrics)
643 644 645	0	Updated manufacturing and quality planning for assessments to be conducted; metrics to be tracked; progress against goals, thresholds, and objectives; entry and exit criteria for technical reviews; design considerations; etc.
646 647	0	Updated manufacturing and quality inputs to the configuration managed IMP/IMS including critical path

648	Metrics
649	Manufacturing Strategy and Quality Strategies have been updated based outputs from the
650	SRR and SFR pertaining to manufacturing and quality requirements and concerns and
651	address:
652	• Competition and contracting strategies
653	• Management (quality, manufacturing, supply chain, risks, etc.)
654	 Design (feasibility, producibility, KCs, risks, etc.)
655	 New manufacturing technologies
656	 Modular Open Systems Approach (MOSA)
657	• Intellectual Property rights (including deliverables and associated license rights over the
658	entire product life cycle)
659	• Materials (characteristics, sourcing, risks, etc.)
660	• Cyber threat protection measures (See L.2)
661	 Integrated Product Support Plan
662	• Process, rates, and quantities (capabilities, control, risks, etc.) (See H.1)
663	• Facilities, Tooling, and Workforce (including GFE/GFI, STE/SIE, special requirements,
664	etc.)
665	Manufacturing and Quality Strategies contain detailed manufacturing and quality
666	requirements for:
667	• Rates, quantities, and schedule (including reference to Economic Order Quantity and the
668	affordability targets)
669	• Manufacturing maturity and progress against manufacturing and quality goals required
670	for each technical review (SRRs, PDRs, CDRs, and at other appropriate reviews)
671	• Human safety and health requirements
672	 Hazardous materials management and pollution prevention
673	• Environmental parameters (e.g., shock, vibration, thermal, humidity, electromagnetic
674	interference/impact, electrostatic discharge, transport, etc.)
675	 Security parameters (physical and cyber) for both hardware and software
676	• KPPs and resulting KCs
677	• Data management and software which includes collection, analysis, testing, and methods
678	of analysis, storage, retrieval of manufacturing and quality data
679	• Supportability and sustainment requirements
680	• Use of priorities, allocations, and allotments, and justification
681	• Use of COTS, GOTS, and GFE (including diminishing manufacturing sources)
682	• Parts, materials, and processes (PM&P)
683	• Manufacturing Strategy and Quality Strategies have been updated to address the sustainment
684	of industrial capabilities (including manufacturing technologies and capabilities) and the
685	maturation required during the EMD and subsequent phases.
686	• Manufacturing and Quality Strategies contain plans for mitigation of product or
687	component obsolescence, use and replacement of limited-life items, unique more efficient

688 689 690 691	 manufacturing processes and products (avoidance or regeneration), and converting off- the-shelf items to required specifications at the subsystems, item, and component levels Manufacturing and Quality Strategies contain plans for mitigation of products or components from sole, single, fragile, or foreign sources including options for:
692 693 694	 Domestic alternatives through regeneration of prior capability Creation of new capability for manufacturing products and processes Lifetime buy of items at the subsystems, and component levels
695 • 696 697	Manufacturing Strategy incorporates plans for new or high-risk manufacturing capabilities and processes (ManTech) to be utilized in addressing and mitigating risks, issues, and opportunities in the EMD phase. (See D.2)
698 699 700 701	 Plans specify demonstration of new manufacturing capability TMRR phase in a relevant manufacturing environment Plans also specify insertion (how and when) of the new manufacturing capability during EMD
702 • 703 704	Manufacturing and quality Industrial Base (IB) capability analyses have been updated and provided as manufacturing and quality input for the Acquisition Strategy and the RFP and includes inputs on:
705 706 707 708 709	 IB capabilities, fragility, gaps, and risks (e.g., key technologies and key and critical processes, parts, components, etc.) Capability of the IB to design, develop, produce, support, and restart the acquisition program, if appropriate Impacts and interdependencies of this acquisition to the NTIB and the analyses used
710 711	Including how they will be managedIncluding plans for future assessments, including frequency
712 713 714	 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.)
715 • 716 717	Manufacturing and quality inputs on a contracting strategy that supports selection of the best course of action through either a competitive award, a sole source award, or multiple source development have been provided as input to the Acquisition Strategy including:
718 719	• Manufacturing and quality impacts and risks, issues, and opportunities that may result from different contract types (FFP, FPIF, CPFF, etc.)
720 721 722 723	 Manufacturing and quality metrics that differentiate the value of each contract type to include performance, capacity, functional, economic, etc. Prototyping approach for EMD, either competitive, single, or prototyping of critical subsystems (statutory requirement for MDAP AS, regulatory requirement for all other
724 725	programs)Potential production approach for EMD and subsequent phases

726 • 727 728 729 730 731 732 733 •	Manufacturing and quality inputs to the EMD source selection approach have been provided as input to the Acquisition Strategy to establish and maintain 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.). Updated manufacturing and quality requirements have been provided as inputs to both the Acquisition Strategy and the SEP for required technical reviews to be conducted, production decisions, events, prototypes, and deliveries, including sub-tier subsystem, item, and components, based on:
734 735 736 737 738 739 740	 DCMA reports and data Results of materials availability (lead-time and scale-up) and maturity (characterization) analyses Contractor data on rates and yields for manufacturing and quality Manufacturing and quality process maturity and projections Reports on utilization of facilities, tooling, and workforce Updated capital equipment requirements
741 • 742	Updated manufacturing and quality inputs and plans have been provided and incorporated in the IMP/IMS including:
743 744 745 746 747	 Schedule and plans for use of government-furnished STE, government facilities/ranges, unique tooling, or other similar requirements (specific M&S, communications, restricted environment, etc.). Schedule impacts for special materials and allotments Manufacturing and quality internal and external interdependencies and integration with
748 749 750 751 752	 o Invaluated and quarty internal and external interdependences and integration with existing programs, systems, and other programs in development that impact the critical path o Inputs on reviews that include the sub-tier level (e.g., PDR, CDR, PRR, etc.), documentation inputs (e.g., draft CDD, TEMP, AS, SEP, PDR, etc.), production events, and deliveries
753 • 754	Manufacturing Management and Quality Management Strategies for EMD have been updated and include: (See I.1 and L.2)
755 756 757 758	 Changes in manufacturing and quality requirements Manufacturing and quality resource management (minimizing cost, schedule, and performance risks for the product life cycle) Changes to menufacturing and quality argenization and staffing with KLP and performance
758 759 760 761	 Changes to manufacturing and quality organization and starting with KLP and necessary skilled manpower Changes to manufacturing and quality support organization required to meet program projected needs for EMD and subsequent phases including:
762 763 764	 Earned Value Management requirements Cost control requirements Data collection, reporting, and management

765 • 766 767	Requirements for the EMD contractor's Manufacturing Management System and Quality Management System have been updated and provided as inputs for the EMD RFP, SSP, and award fee criteria.		
768 769 770 771 772 773 774 775	 Standards have been specified to promote industry best practices (e.g., AS6500, ISO 9000, AS9100, IEEE 15288.0,1,2, etc.) If manufacturing and quality standards are not specified, requirements have been developed for program specific manufacturing management plan and quality management plan Manufacturing and quality opportunities, initiatives, and systems have been provided that contribute to minimizing cost, schedule, and performance risks throughout the product life cycle 		
776 • 777 778	Requirements for identification, analysis, mitigation, tracking, and control of manufacturing and quality risks, issues, and opportunities that impact performance, technical, cost, schedule, sustainment, and programmatic areas throughout the life of the program have been updated.		
779 780 781	 A joint manufacturing and quality comprehensive Risk, Issue, and Opportunity Management Process has been established that identifies and tracks risks and associated mitigation plans. 		
782 • 783 784	Manufacturing and quality risks, issues, and opportunities, and associated mitigation plans have been analyzed for adequacy and completeness, and impacts and results documented for EMD and subsequent phases including:		
785 786 787 788 789 790	 Risk of industry being unable to provide program design or manufacturing capabilities at planned cost and schedule Materials, facilities, workforce, interdependencies with other programs, manufacturing technology gaps, quality, software and engineering related risks, issues etc. Maturation of critical technologies and manufacturing processes to the appropriate level Manufacturing and quality cost and schedule impacts 		
791 792	Manufacturing and quality exit criteria metrics for TMRR and subsequent phase decision points have been documented in the PDR checklist for the Milestone Decision process.		
793 794 795 796	 Metrics include current and projected manufacturing and quality maturity of identified critical technologies and manufacturing processes Metrics also include the planned MRL targets for system, subsystems, components, and items 		
797 • 798 799 • 800 801 802 •	 Manufacturing and quality support plan for assessments of manufacturing readiness has been updated and documents the required support for the mandated independent assessment. Other agencies' (e.g., DCMA, DLA) support and inputs on strategies for quality, manufacturing, production, engineering, software development, configuration management, testing, and quality have been requested, received, and documented. Manufacturing and quality provided updates to the SEP and TEMP document the following: 		
803		0	Manufacturing and quality updates and impacts on all KPPs including the mandatory
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804			KPPs (Force Protection, System Survivability, Sustainment, and Energy)
805		0	Planned significant activities on the up-to-date EMD IMP/IMS including manufacturing
806			assessments, long-lead or advanced procurements, prototype builds, projected lots or
807			phases, Production Readiness Review, development testing, etc.
808		0	Updated inputs to the program Risk, Issue, and Opportunity Management process and
809			plans including industrial, manufacturing, quality, manufacturing engineering,
810			manufacturing software and firmware, production risks, issues, and opportunities and
811			associated reduction and mitigation efforts
812		0	Updated manufacturing and quality inputs to the Program Manufacturing Management
813			Plan addressing embedded software and firmware development and reuse
814		0	Updated manufacturing and quality inputs from assessment of the contractor's
815			management of and processes for Safeguarding Covered Defense Information and Cyber
816			Incident Reporting including:
817			 Compliance with DFARS, PPP, ITAR, etc.
818			 Management of Controlled Unclassified Information
819			 Technical approaches to cybersecurity and related manufacturing and quality
820			security, including suppliers, risks, processes, industrial control systems, resources,
821			metrics, and design considerations
822		0	Updated Program Manufacturing Management Plan that addresses each key area of the
823			Manufacturing Strategy (in accordance with AS6500) to include:
824			 Manufacturing Management System
825			 Design Analysis for Manufacturing
826			 Manufacturing Risk Identification (including mitigation)
827			 Manufacturing Planning
828			 Manufacturing Operations Management
829		0	Updated inputs on the manufacturing and quality organization, billets and key
830		Ū	assignments including roles and responsibilities of IPTs (Team Details – Name, Chair,
831			Membership, Roles, Responsibility, and Authority, Products and Metrics)
832		0	Updated manufacturing and quality plans for assessments to be conducted: metrics to be
833		-	tracked; progress against goals, thresholds, and objectives; entry and exit criteria for
834			technical reviews; design considerations; etc.
835		0	Updated manufacturing and quality inputs to the configuration managed IMP/IMS
836			including critical path
837	Tools		
838	•	Ac	auisition Strategy Outline
839	•	AS	6500 Manufacturing Management System Checklist
840	•	AS	9100 Quality Management System Checklist
841	•		D Template
011	-		D rempine

842	•	ISO 9001 Quality Management System Checklist
843	•	Manufacturing Readiness Level (MRL) Assessment Checklist
844	•	Technology Readiness Level (TRL) Assessment Checklist
845	•	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center Integrated
846		Master Plan/Integrated Master Schedule use MS Project
847	•	ManTech Proposal Rating Worksheet
848	•	Risk Management Plan Template
849	•	Systems Engineering Plan Outline
850	•	TEMP Outline
851	Resou	irces
852	٠	Acquisition Strategy Guide (DSMC0, Dec 1999)
853	•	AS6500, Manufacturing Management Program, Nov 2014
854	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
855	•	AS9100 Quality Systems – Requirements for Aviation, Space, and Defense Organizations,
856		Sep 2016
857	•	CDD Writing Guide, Feb 2015
858	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
859	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
860	•	Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct
861		2005
862	•	ISO 9001:2015, Quality Management System
863	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
864		Reporting
865	•	MRL Deskbook Version 2016
866	•	NIST 800-171, June 2015, Controls for Controlled Unclassified Information
867	•	Risk, Issue, and Opportunity Management Guide, Jan 2017
868	•	RFP Proposal Evaluation Guide,
869	•	Systems Engineering Plan (SEP) Outline, Jun 2015
870	•	Test and Evaluation Management Guide, Dec 2012
871	•	TRA Deskbook, Apr 2012
872	٠	DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017, Enclosure 2, 6.d.
873	•	DoDD 4200.15, Manufacturing Technology (ManTech) Program, Dec 2003
874	•	DoD 5000.60-H DoD Handbook: Assessing Defense Industrial Capabilities, Apr 1996
875	•	subpart 207.106 (S-70) of the Defense Federal Acquisition Regulation Supplement

876 A.3 Support Preliminary Design Review (PDR)

877 Manufacturing and Quality Tasks

878 • Ensure all manufacturing and quality system-level requirements, base-lined at the SRR and 879 the SFR have been correctly decomposed or directly allocated to the appropriate subsystem, 880 item, or component. 881 • Provide manufacturing and quality system, subsystem, item, and component requirements 882 and inputs for the verification and validation entry/exit criteria required for the PDR process. 883 • Provide manufacturing and quality support to system (product), subsystem, item, and 884 component design trades to finalize system requirements and configuration. 885 Provide a manufacturing and quality assessment of the preliminary system-level design and 886 margins for producibility and costs within the production budget. 887 • Assess all system (product), subsystem, item, and component physical and functional 888 interfaces and architecture for manufacturing and quality feasibility and producibility (e.g., inspectability, manufacturability, etc.) 889 890 • Include analyses of prototypes 891 Assess the design for manufacturing and quality constraints and ensure they have been • 892 captured and incorporated into the allocated requirements. 893 Provide analyses to identify all preliminary key and critical manufacturing and quality processes and characteristics to show traceability to system-level requirements and technical 894 895 performance measures (e.g., KPPs, KSAs, TPMs) through the use of Failure Modes and 896 Effects Analysis (FMEA) and similar analyses for design (DFMEA) and process (PFMEA). 897 Ensure all of the preliminary key and critical manufacturing and quality processes are 898 defined and traceable to Critical Safety Items (CSI)and/or Critical Application Items 899 (CAIs) 900 • Identify initial process capability indexes for key and critical manufacturing processes 901 • Analyze the contractor's identified major/critical sub-tier suppliers for their impact on or 902 responsibility for KCs (and therefore KPPs/KSAs) 903 Assess the preliminary system design for impacts on requirements to manufacturing and • 904 quality design, processes, and procedures, including: 905 Incomplete specifications of subsystem, items, and components (i.e., TBDs) 0 906 • Change to subsystem, items, and components from re-design based on testing 907 deficiencies or failures 908 • Results and data from building and testing prototypes 909 • Incorporation of Parts, Materials, and Processes allocated requirements 910 • Requirements for computer system Hardware Configuration Items (HWCIs) 911 • Analyses of mass properties including growth 912 o MOSA requirements 913 Tooling design, testing, and schedule (including special tooling and test equipment) 0

Manufacturing and Quality Management Body of Knowledge

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914 915 916 917 918 919 920 921 922	 Security physical and cyber (e.g., processes, industrial control systems, anti-tamper requirements, manufacturing resources and organization, etc.) Requirements for processes and procedures to control and mitigate EMI Human Machine Interface requirements ESOH requirements System safety requirements Hazardous materials and environmental controls (e.g., handling, contamination, pollution control, disposal, etc.) Supportability and maintainability requirements
923 • 924	Provide an assessment of requirements for manufacturing and quality data and data storage including:
925 926 927 928	 Analyses and post processing Availability, integrity, and maintainability Communications and processing capacity User integrity
929 • 930 931 932 • 933 934 • 935	 Provide manufacturing and quality analyses of the Software Development Plan for physical architectures, firmware integration, and physical interfaces that impact manufacturing and quality processes, procedures, and schedule. Provide an assessment of long-lead materials and production requirements (e.g., components, facilities, equipment, etc.). Provide an updated analysis of manufacturing and quality inputs to the TEMP include the following:
 936 937 938 939 940 941 942 943 944 945 946 947 948 	 Manufacturing and quality updates and impacts on all KPPs including the mandatory KPPs (Force Protection, System Survivability, Sustainment, and Energy) Planned significant activities indicated on the up-to-date EMD program schedule (e.g., manufacturing assessments, long-lead or advanced procurements, prototype builds, projected lots or phases, PRRs, etc.) Updated inputs to the program Risk, Issue, and Opportunity Management System and plans including industrial, manufacturing and production, quality, engineering, software (firmware), and risk reduction and/or mitigation efforts Results of prototype builds, demonstrations, and tests and associated data Updated manufacturing and quality inputs from the contractor's management of defense information and cyber incident reporting, compliance with DFARS, PPP, ITAR, etc. Updated planning for manufacturing and quality tests and assessments to be conducted, facilities and test equipment to be used, metrics to be tracked, progress against goals.
949 950 • 951 952	thresholds and objectives, etc. Provide an updated assessment and analysis of the manufacturing and quality processes and metrics included in the contractor's SEMP for completeness, adequacy, and alignment with those processes and metrics included in the program SEP, including

953 954 955	0	Integration of any lower-level technical reviews and audits such as SFRs, PDRs, CDRs, PCAs, FCAs, and/or PRRs Identified risks and issues to be incorporated into mitigation and/or action plans
956	0	Contractor's plan to CDR
957 • 958	Pro wo	ovide an updated assessment of Program and contractor manufacturing and quality orkforce plans and requirements for adequacy and completeness including:
959 960 961	0 0 0	Skills, capabilities, training, and certifications Manufacturing and quality human resources (staffing and staffing plans) Potential changes to organization and KLPs
962 •	Up	bdate the Manufacturing and Quality Strategies to include plans for: (See A.1, I.5, and L.4)
963 964	0	Manufacturing maturity and progress against manufacturing and quality goals required for each technical review (SRRs, PDRs, CDRs, and at other appropriate reviews)
965 966 967 968		 Definition and characterization of all manufacturing and quality processes Manufacturing technology ongoing and future projects (ManTech) Rates, yields, quantities, and schedule (including reference to Economic Order Quantity and the affordability targets)
969 970 971 972	0 0 0	KPPs (i.e., KCs) Data management and software (including collection, analysis, testing, and methods of analysis, storage, retrieval of manufacturing and quality data) Continued manufacturing and quality IB analyses on:
973 974 975 976 977 978		 IB capabilities, fragility, gaps, and risks (e.g., key technologies and key and critical processes, parts, components, etc.) IB capabilities to design, develop, produce, support, and restart the acquisition program, if appropriate Impacts and interdependencies of this acquisition program to the NTIB Government strategy and actions necessary to preserve the IB
979	0	Use of priorities, allocations, and allotments, and justification
980	0	Meeting IMP/IMS with acceptable risk for schedule and budget
981 982	0	Impacts and changes, requiring updates to the program's Configuration Items (i.e., GFE, GOTS, etc.) and contractor's supply chain (including COTS)
983 984	0	Impacts and changes, requiring updates to Program critical items and Critical Safety Items
985	0	Support of the failure reporting and corrective action system (FRACAS)
986	0	Updates and changes to the program Variability Reduction Plans
987	0	Support and inputs to the Life Cycle Sustainment Plans (LCSP)including Diminishing
988		Manufacturing Sources Materials Sources (DMSMS), PM&P, and counterfeit parts
989	0	Human safety and health
990	0	Hazardous materials management and pollution prevention

3. Technology Maturation and Risk Reduction (TMRR) Phase

991		• Environmental parameters (e.g., shock, vibration, thermal, humidity, electromagnetic
992		interference/impact, electrostatic discharge, transport, etc.)
993		• Security parameters (physical and cyber) for both hardware and software
994		• Use of COTS, GOTS, and GFE (including diminishing manufacturing sources)
995		• Products or components (known and/or projected) from sole, single, fragile, or foreign
996		sources including options for:
997		 Domestic alternatives through regeneration of prior capability
998		 Creation of new capability for manufacturing products and processes
999		 Lifetime buy of items at the subsystems, and component levels
1000	•	Update the plans for a comprehensive joint manufacturing and quality Risk, Issue, and
1001		Opportunity Management Process for EMD that has the capacity to identify, monitor, and
1002		track risks and associated mitigation plans, including plans for:
1003		• Materials, facilities, workforce, interdependencies with other programs, manufacturing
1004		technology gaps, quality, software, and engineering related risks and issues
1005		• Required maturation of critical technologies and manufacturing processes to the
1006		appropriate level
1007		 Manufacturing and quality cost and schedule impacts
1008	•	Provide analyses of demonstrations conducted in a production relevant environment to
1009		include verification of:
1010		• Prototypes (e.g., subsystems, items, and components)
1011		 Manufacturing processes with yield and rate data collected
1012		 Special Handling procedures
1013		• Workforce skills
1014		• Prototype tooling
1015		 Special test equipment/special inspection equipment (STE/SIE)
1016		• Acceptance test procedures
1017		• Modeling and Simulations (M&S)
1018		• Material maturity
1019		• Cost models
1020		o KCs
1021		• Producibility efforts
1022		 Manufacturing technology solutions
1023	•	Conduct a assessment and an analysis of Program manufacturing maturity against the MRL
1024		criteria.
1025	Metrio	CS

Manufacturing and quality system-level requirements, base-lined at the SRR and the SFR 1026 • have been verified to be correctly decomposed or directly allocated to the appropriate 1027 1028 subsystem, item, or component and documented in the appropriate management system and 1029 available as evidence for the PDR.

1030 1031 1032 1033 1034	 Finalized design trades for manufacturing and quality system requirements and configurations have completed and documented for the PDR for system (product), subsystem, item, and component All manufacturing and quality constraints have been captured, documented, and incorporated into the allocated requirements
1035 • 1036 1037	Manufacturing and quality system, subsystem, item, and component requirements and inputs for entry/exit criteria required for PDR have been documented as verified and at a minimum 50 percent have been validated for PDR.
1038 • 1039 1040	Manufacturing and quality assessments of the preliminary system-level design and margins for producibility and costs have been completed and documented for the Program Manager to be within the preliminary production budget.
1041 • 1042 1043 1044	All system (product), subsystem, item, and component physical and functional interfaces and architecture, including prototypes, for manufacturing and quality feasibility and producibility (e.g., inspectability, manufacturability, etc.) have been assessed with acceptable risk and no TBDs remain.
1045 • 1046 1047 1048 1049	Analyses, through use of failure mode effects and criticality, have been conducted that identify all preliminary key and critical manufacturing and quality processes and characteristics. Traceability to system-level requirements and technical performance measures has been demonstrated and documented in the requirements tracking system including:
1050 1051 1052 1053 1054 1055	 All of the preliminary key and critical manufacturing and quality processes are defined and traceable to Critical Safety Items and/or Critical Application Items Initial process capability indexes for key and critical manufacturing processes have been identified Contractor's identified major/critical sub-tier suppliers have been analyzed for their impact on or responsibility for KCs (ref. E.5)
1056 • 1057 1058 1059	The preliminary system design has been assessed for impacts on requirements for manufacturing and quality design (e.g., tooling, equipment, facility layouts, etc.), processes, and procedures, and plans to mitigate and/or resolve have been documented for PDR including:
1060 1061 1062	 Completed specifications of subsystem, items, and components with no TBDs Completed re-designs or modifications to subsystem, items, and components based on testing deficiencies or failures
1063 1064 1065 1066	 Prototype results and data Parts, Materials, and Processes allocations completed Requirements for computer system Hardware Configuration Items (HWCI) defined and specified
1067 1068	 Mass properties analyses completed Modular Open Systems Approach defined

3. Technology Maturation and Risk Reduction (TMRR) Phase

1069		• Tooling designs with testing and schedule completed (including special tooling and test
1070		equipment)
1071		• Security physical and cyber planning completed (e.g., processes, industrial control
1072		systems, anti-tamper requirements, manufacturing resources and organization, etc.)
1073		 Processes and procedures to control and mitigate EMI defined
1074		• Human Machine Interface requirements defined
1075		• Environmental Safety and Occupational Health requirements defined
1076		• System safety requirements and processes defined
1077		• Hazardous materials and environmental controls and processes defined and in place (e.g.,
1078		handling, contamination, pollution control, disposal, etc.)
1079		• Supportability and maintainability requirements defined
1080	•	Manufacturing and quality data and data storage requirements have been assessed and
1081		defined and are documented in the PDR documentation and integrated into the Program
1082		Management System including:
1083		• Data analyses and post processing
1084		• Data availability, integrity, and maintainability
1085		• Communications and processing capacity
1086		• User integrity and control
1087	•	Manufacturing and quality analyses of the Software Development Plan for physical
1088		architectures, firmware integration, and physical interfaces have been conducted to document
1089		the impact on manufacturing and quality processes, procedures, and schedule for systems
1090		engineering and program management.
1091	•	[check] An assessment of long-lead materials and production requirements has been
1092		conducted and documents for PDR and in the IMP/IMS ordering requirements capacity
1093		risks, issues, and opportunities (e.g., materials, facilities, and equipment) with the associated
1094		EMD budget projections.
1095	•	Manufacturing and quality inputs for the TEMP have been provided and include the
1096		following:
1097		• Manufacturing and quality updates and impacts on all KPPs including the mandatory
1098		KPPs (Force Protection, System Survivability, Sustainment, and Energy)
1099		• Planned significant activities indicated on the up-to-date EMD program schedule (e.g.,
1100		manufacturing assessments, long-lead or advanced procurements, prototype builds,
1101		projected lots or phases, PRRs, etc.)
1102		• Updated inputs to the program Risk, Issue, and Opportunity Management System and
1103		plans including industrial, manufacturing and production, quality, engineering, software
1104		(firmware), and risk reduction and/or mitigation efforts
1105		• Results of prototype builds, demonstrations, and tests and associated data
1106		• Updated manufacturing and quality inputs from the contractor's management of defense
1107		information and cyber incident reporting, compliance with DFARS, PPP, ITAR, etc.

1108 1109 1110		• Updated planning for manufacturing and quality tests and assessments to be conducted, facilities and test equipment to be used, metrics to be tracked, progress against goals, thresholds and objectives, etc.
1111 1112 1113 1114	•	Contractor's SEMP has been assessed and analyzed for PDR to determine completeness, adequacy, and alignment with manufacturing and quality processes and metrics documented in the updated Program SEP and the IMP/IMS. Recommendations provided for any shortfalls, including:
1115 1116 1117 1118		 Integration of any lower-level technical reviews and audits such as SFRs, PDRs, CDRs, PCAs, FCAs, and/or PRRs Identified risks, issues, and opportunities incorporated into mitigation and/or action plans Contractor's detailed plan to CDR
1119 1120 1121	•	Updated assessment of Program and contractor manufacturing and quality workforce plans and requirements for adequacy and completeness has been completed and documents for PDR the required:
1122 1123 1124		 Skills, capabilities, training, and certifications Manufacturing and quality human resources (staffing and staffing plans) Changes to organization and KLPs
1125 1126	•	Manufacturing and Quality Strategies for EMD have been updated for PDR and include plans for: (See A.1, I.5, and L.4)
1127 1128		• Manufacturing maturity and progress against manufacturing and quality goals required for each technical review (CDRs, PRR, and at other appropriate reviews)
1129 1130 1131		 All manufacturing and quality processes Ongoing and future manufacturing technology projects (ManTech) Rates, yields, quantities, and schedule (including EOQ and affordability)
1132 1133 1134 1135		 Managing and achieving KPPs (i.e., KCs) Data management and software (including collection, analysis, testing, and methods of analysis, storage, retrieval of manufacturing and quality data) Continued manufacturing and quality IB analyses on:
1136 1137 1138 1139 1140 1141		 IB capabilities, fragility, gaps, and risks (e.g., key technologies and key and critical processes, parts, components, etc.) IB capabilities to design, develop, produce, support, and restart the acquisition program, if appropriate Impacts and interdependencies of this acquisition program to the NTIB Government strategy and actions necessary to preserve the IB
1142 1143 1144 1145		 Use of priorities, allocations, and allotments, and justification Meeting IMP/IMS (critical path) with acceptable risks Impacts, changes, and updates to the program's CIs (i.e., GFE, GOTs, etc.) and contractor's supply chain (including COTs)

3. Technology Maturation and Risk Reduction (TMRR) Phase

1146		 Impacts, changes, and updates to Program critical items and CSIs
1147		• Support of the FRACAS
1148		 Changes and support to the program Variability Reduction Plans
1149		• Inputs and support to the LCSPs including DMSMS, PM&P, and counterfeit parts
1150		• Human safety and health
1151		• Hazardous materials management and pollution prevention
1152		• Mitigation of environmental parameters (e.g., shock, vibration, thermal, humidity,
1153		electromagnetic interference/impact, electrostatic discharge, transport, etc.)
1154		• Security parameters (physical and cyber) for both hardware and software
1155		• Use of COTS, GOTS, and GFE (including diminishing manufacturing sources)
1156		• Products or components from sole, single, fragile, or foreign sources including options
1157		for:
1158		 Domestic alternatives
1159		 Creation of new capability
1160		 Lifetime buys
1161		The comprehensive joint manufacturing and quality Pick Issue, and Opportunity
1162	•	Management Process for FMD has been undeted and documents the capacity to identify
1162		monitor and track risks issues and opportunities and associated plans
1164		Demonstrations have been conducted in a production relevant environment to varify and
1164 1165	•	document manufacturing and quality maturity for PDR, and provide status of:
1166		• Prototypes (e.g., subsystems, items, and components)
1167		• Manufacturing processes with yield and rate data collected
1168		• Special Handling procedures
1169		• Workforce skills
1170		• Prototype tooling
1171		o STE/SIE
1172		• Acceptance test procedures
1173		• Modeling and Simulations (M&S)
1174		• Material maturity
1175		• Cost models
1176		o KCs
1177		• Producibility efforts
1178		 Manufacturing technology solutions
1179	٠	MRL assessment has been conducted and an analysis of Program manufacturing maturity
1180		provided for PDR and as support to the independent program assessment.
1181	Tools	

• Preliminary Design Review Checklist

1183	Resou	rces
1184	•	AS6500, Manufacturing Management Program, Nov 2014
1185 1186		 Defense Manufacturing Management Guide for Program Managers, Chapter 12 – Technical Reviews and Audits
1187 1188 1189 1190	•	DoDI 5000.02DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017, Jan 2017 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
1191		o MIL-STD-1521B, Jun 1985 (retired)
1192	٠	MRL Deskbook Version 2016
1193		 Preliminary Design Review (PDR) Procedure, Oct 2016
1194 1195 1196 1197	•	NDAA FY 2017 (Public Law 114-328) SAE J1739, Potential Failure Mode and Effects Analysis in Design (Design FMEA), Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA), Jan 2009
1198	A.4	Support Program Decision Reviews
1199	Manu	facturing and Quality Tasks
1200 1201 1202	•	Provide manufacturing and quality inputs and updates, for both the RFP Development Release Decision and the Milestone B Decision following post-PDR assessment results, the following statutory and regulatory program required updates to:
1203		• The Acquisition Strategy
1204 1205 1206 1207 1208 1209 1210 1211 1212 1213 1214 1215 1216		 Acquisition Approach Business Strategy Contracting Strategy (type and termination liability) Cooperative Opportunities (if necessary) General Equipment Valuation Industrial Base Considerations Intellectual Property Considerations Market Research (for RFP DRD) Modular Open Systems Approach Multiyear Procurement Risk, Issue, and Opportunity Management Process Small Business Innovation Research/Small Business Technology Transfer (for RFP RDP)
1217 1218		 Acquisition Program Baseline Affordability Analysis

1219	0	Analysis of Alternatives
1220	0	Bandwidth Requirements Review
1221	0	Capability Development Document
1222	0	Cost Analysis Requirements Description (CARD), RFP Release Cost Assessment, etc.
1223	0	Exit Criteria
1224	0	Item Unique Identification Implementation Plan
1225	0	Life Cycle Sustainment Plan (LCSP)
1226	0	Low-Rate Initial Production (LRIP) Quantity
1227	0	PESHE and NEPA Compliance Schedule
1228	0	Program Protection Plan (PPP)
1229	0	Request for Proposal (RFP)
1230	0	Should Cost Target
1231	0	Spectrum Supportability Risk Assessment
1232	0	Systems Engineering Plan (SEP)
1233	0	Technology Readiness Assessment (TRA)
1234	0	Test and Evaluation Master Plan (TEMP)
1235	• P	rovide PDR documentation of conducted demonstrations in a production relevant
1236	eı	vironment of manufacturing and quality maturity (including risks and mitigation) with
1237	st	atus of:
1238	0	Prototypes (e.g., subsystems, items, and components)
1239	0	Manufacturing processes with yield and rate data collected
1240	0	Special Handling procedures
1241	0	Workforce skills
1242	0	Prototype tooling
1243	0	Special Test Equipment/Special Inspection Equipment (STE/SIE)
1244	0	Acceptance test procedures
1245	0	Modeling and Simulations (M&S)
1246	0	Material maturity
1247	0	Cost models
1248	0	KCs
1249	0	Producibility efforts
1250	0	Manufacturing technology solutions
1251	• P:	rovide results of a MRL assessment and analyses that was conducted for PDR.
1252	Metrics	
1253	• N	Ianufacturing and quality inputs and updates, for both the RFP Development Release
1254	D	ecision and the Milestone B Decision following post-PDR assessment results. have been
1255	de	ocumented and provided for the following statutory and regulatory program required
1256	111	pdates to:
1055	aj	
1257	0	The Acquisition Strategy

1258	 Acquisition Approach
1259	 Business Strategy
1260	 Contracting Strategy (type and termination liability)
1261	 Cooperative Opportunities (if necessary)
1262	 General Equipment Valuation
1263	 Industrial Base Considerations
1264	 Intellectual Property Considerations
1265	 Market Research (for RFP RDP)
1266	 Modular Open Systems Approach
1267	 Multiyear Procurement
1268	 Risk, Issue, and Opportunity Management Process
1269	 Small Business Innovation Research/Small Business Technology Transfer (for RFP
1270	RDP)
1271	• Acquisition Program Baseline
1272	• Affordability Analysis
1273	• Analysis of Alternatives
1274	 Bandwidth Requirements Review
1275	• Capability Development Document
1276	• Cost Analysis Requirements Description (CARD), RFP Release Cost Assessment, etc.
1277	o Exit Criteria
1278	o Item Unique Identification Implementation Plan
1279	• Life Cycle Sustainment Plan (LCSP)
1280	 Low-Rate Initial Production (LRIP) Quantity
1281	 PESHE and NEPA Compliance Schedule
1282	• Program Protection Plan (PPP)
1283	• Request for Proposal (RFP)
1284	• Should Cost Target
1285	 Spectrum Supportability Risk Assessment
1286	• Systems Engineering Plan (SEP)
1287	 Technology Readiness Assessment (TRA)
1288	• Test and Evaluation Master Plan (TEMP)
1289 •	Documentation of conducted demonstrations for PDR of manufacturing and quality maturity
1290	(including risks and mitigation) in a production relevant environment has been provided with
1291	status of:
1292	• Prototypes (e.g., subsystems, items, and components)
1293	• Manufacturing processes with yield and rate data collected
1294	• Special Handling procedures
1295	• Workforce skills
1296	• Prototype tooling
1297	o STE/SIE
1298	• Acceptance test procedures

3. Technology Maturation and Risk Reduction (TMRR) Phase

1299 1300 1301 1302 1303 1304 1305	•	 Modeling and Simulations (M&S) Material maturity Cost models KCs Producibility efforts Manufacturing technology solutions Results of a MRL assessment and analyses that was conducted for PDR have been provided
1306		as input to program management.
1307	Tools	
1308	•	Market Research using Pugh Template
1309	•	CARD use Cost and Lead Time Worksheet
1310	•	Life Cycle Sustainment Plan
1311	•	Technology Readiness Assessment (TRA)
1312	•	Manufacturing Readiness Level (MRL) Assessment
1313	•	Test and Evaluation Master Plan
1314	•	Integrated Master Plan/Schedule
1315	Resou	rces
1316	•	Affordability Analysis Tools, May 2015
1317	•	Life Cycle Sustainment Plan, see Product Support Manager Guide, Feb 2017
1318	•	DoD Market Research Guide, May 2012
1319	•	MRL Deskbook Version 2016
1320	•	TRA Deskbook, Apr 2012
1321	•	Test and Evaluation Management Guide, Dec 2012
1322	•	DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017
1323	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
1324	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs

1325 **B. DEFENSE CONTRACTING SYSTEM**

1326 The contracting process is a partnership between the contracting office and program personnel.

- 1327 Contracting molds and shapes the procurement process and is ultimately responsible for contract
- award and administration. However, a cohesive effort between the contracts and program
- 1329 management including the participation of both contractual and technical subject matter experts is
- 1330 essential to managing and completing the steps in this phase of the contracting process.

3. Technology Maturation and Risk Reduction (TMRR) Phase



1331

1332 The RFP is the primary opportunity to make inputs to the EMD contract and should be based on 1333 manufacturing and quality risks, issues, and opportunities discovered during TMRR. Typical areas to 1334 be included in the proposal include industry best practices for manufacturing management, quality 1335 management, and systems engineering. Other areas such as design and producibility, trade studies, 1336 manufacturing and quality technology investments, competition, materials (availability, counterfeit, 1337 and/or long-lead), data management, quality processes (capability studies), manufacturing and 1338 quality reporting and control, etc. should be addressed by manufacturing and quality. This list and 1339 other details should be addressed in the Statement of Work (SOW) and/or the Statement of

1340 Objectives (SOO).

1341 As part of implementing industry best practices and meeting regulatory requirements, certain

1342 manufacturing and quality requirements need to be incorporated in the EMD RFP. For example,

1343 when the system under development meets the definitions in Federal Acquisition Regulation (FAR)

1344 46.203 (Criteria for Use of Contract Quality Requirements, for Complexity and/or Criticality), FAR

1345 46.202-4 requires supplier compliance with higher-level quality standards that should be addressed in

the RFP. This may also require on-site government Quality Assurance personnel to perform source

1347 inspections.

Other Program requirements, often neglected during the contracting process, for manufacturing andquality input include:

- Direction for use of COTS items, GOTS items and NDIs.
- 1351 Determination of need to develop and maintain a FMECA
- Determination of intellectual property and data rights, maintenance, ownership and access for
 later phases.
- Direction for incorporation of manufacturing safety into System Safety Analyses.
- Determination of specialized system requirements, such as Flight Operations, Space
 Operations, etc.
- Determination of appropriate manufacturing and quality physical and cybersecurity
 requirements (e.g., data, information, control systems and networks, supply chain, etc.)
- Direction for inclusion of DCMA in an appropriate role to support the program

1360 Manufacturing and quality personnel should be making early and significant inputs into EMD RFP

documents and activities to ensure manufacturing and quality risks, issues, and opportunities will be

1362 considered. Having determined and provided the early and significant requirements for EMD, the

- 1363 manufacturing and quality objective for the source selection plan is to develop criteria that ensure
- 1364 selection of the proposal that represents the best value to the government. The criteria for source
- 1365 selection should be realistic and address all of the above areas, especially industry best practices.
- 1366 Award Fees can provide increased interaction of program and contractor manufacturing and quality
- 1367 management and provide the program with increased visibility into the contractor's best practices for
- 1368 manufacturing, quality, and supply chain processes and procedures. Award fees in the contract
- 1369 should be based on contractor performance to industry manufacturing and quality best practices and
- 1370 reward specific accomplishments such as:
- Producibility improvements
- Materials characterization in production relevant environment
- Manufacturing cost reduction efforts
- Manufacturing maturation plan risks burned down
- Variation and variability reduction
- Manufacturing process definition and characterization
- Progress in achieving the targeted Manufacturing Readiness Level
- Progress in maturation and demonstration of KCs (i.e., meeting KPPs/KSAs)
- Progress in achieving specific yield and rate goals
- Progress in meeting the EMD exit criteria
- 1381 Incentives in the contract should be consistent with the AS and tied to goals for exceeding contract
- 1382 requirements and program expectations. Manufacturing and quality incentives in contracts are
- 1383 designed to obtain specific manufacturing and quality objectives by establishing reasonable and
- 1384 attainable criteria that can meet the goals or targets. These criteria must be clearly communicated to
- 1385 the contractor; and include appropriate incentive arrangements that will motivate contractor efforts
- 1386 that might not otherwise be emphasized and discourage contractor inefficiency and waste.
- 1387 Important manufacturing and quality management goals and expectations to be exceeded in contract1388 incentives include:
- 1389
 Cost (e.g., cost reductions, should costs, life cycle costs)
 1390
 Schedule (e.g., expedited development or delivery, early delivery, on-time delivery, etc.)
 1391
 Technical (e.g., quality, reliability, maintainability, product improvement, etc.)
 1392
 Management commitment
 1393
 Producibility processes
 1394
 Risk, Issue, and Opportunity Management processes
 1395
 Commercial best practices
- 1396 The success of an enterprise's manufacturing and quality system is directly related to the commitment
- 1397 of the enterprise to the quality and producibility elements presented in the contract and the ability of
- 1398 the successful contractor to implement them effectively.

3. Technology Maturation and Risk Reduction (TMRR) Phase

- 1399 The learning curve (cost improvement curve, or experience curve) is a well-known approach to
- 1400 modeling many effects, such as the effect of quantity on cost. Generally, people and organizations
- 1401 learn to do things more efficiently when performing repetitive tasks. Learning curves are used as a
- 1402 measurement of progress in processes and procedures. Learning curves show that as the number of
- 1403 units produced doubles, the unit cost decreases in a predictable pattern. This technique continues as
- 1404 an industry standard today both in commercial and government applications. Manufacturing and
- 1405 quality should be developing the appropriate learning curves for the system and the plans for data
- 1406 collection to support further development.

Prior to the RFP RDP, but post manufacturing and quality analyses of the PDR, the manufacturingand quality inputs provided to the RFP should be reviewed to include:

- Overall affordability
- Competition strategy and incentive structure
- Provisions for small business utilization
- 1412 Source selection criteria
- Manufacturing and quality trades
- Capability requirements
- Security requirements
- 1416 Should Cost goals
- Risk, issue, and opportunity management
- Manufacturing and quality schedule

1419 **B.1 Provide Input to EMD Request for Proposal (RFP)**

1420	Manufacturing and Quality Tasks
1421	• Ensure that manufacturing and quality personnel are included in the EMD Request for
1422	Proposals (RFP) writing and review teams.
1423	• Specify the requirements for best practices for the contractor's Manufacturing Management
1424	System (MMS) (per Section L.2) and Quality Management System (QMS) (per Section I.1
1425	and per FAR 52.246-11, Higher-Level Contract Quality Requirement) to be used (e.g.,
1426	AS6500, ISO 9000, AS9100, etc.).
1427	• Specify the requirements for the contractors to identify and to describe their proposed
1428	specific processes, methods, and actions to address manufacturing feasibility,
1429	producibility, and manufacturing and quality risks associated with the proposed system
1430	• Specify a requirement for on-site government Quality Assurance personnel will have
1431	access to perform management system audits
1432	• Specify a requirement for on-site government Quality Assurance personnel to have
1433	access to perform source inspections and data monitoring

1434 • 1435 1436	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 addresses:
1437	 Manufacturing Management System:
1438 1439	 Documenting how, when, and by whom each requirement of their system is to be accomplished, and define the authority and responsibility for each.
1440	 Design Analysis for Manufacturing:
1441 1442 1443 1444 1445 1446 1447	 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 FMEA on critical manufacturing processes (PFMEA)
1448	• Manufacturing Risk Identification:
1449 1450 1451 1452 1453 1454 1455 1456	 Integrating manufacturing risk management activities into the program risk, issue, and opportunity management process to include 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 a competing design alternative Identifying MRL targets and documenting manufacturing risks through the MRL assessments
1457	• Manufacturing Planning:
1458 1459 1460 1461	 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.
1462	 Manufacturing Operations Management including:
1463 1464 1465 1466 1467 1468	 Production Scheduling and Control Manufacturing Surveillance Continuous Improvement Process Control Plans Process Capabilities Production Process Verification
1469	 First Article Inspections and First Article Tests
1470	 Supplier Management and Quality

3. Technology Maturation and Risk Reduction (TMRR) Phase

1471 • 1472 • 1473 • 1474 •	If ISO 9000 or AS9100 is not invoked in the contract(s), the quality management requirements cited in the standards should be the basis for specific contractual requirements for a contractor plan. The requirements, at a minimum, should specify that the contractor addresses:
1475	 Quality Management Leadership
1476 1477 1478	 Leadership and Commitment Policy Organizational Roles, Responsibilities, and Authorities
1479	o Quality Planning
1480 1481 1482	 Actions to Address Risks and Opportunities Quality Objectives and Planning Planning of Changes
1483	o Quality Support
1484 1485 1486 1487 1488	 Resources Competence Awareness Communication Documented Information
1489	• Operation
1490 1491 1492 1493 1494 1495 1496	 Operational Planning and Control Requirements for Products and Services Design and Development of Products and Services Control of Externally Provided Processes, Products, and Services Production and Service Provision Release of Products and Services Control of Non-conforming Outputs
1497	• Quality Performance
1498 1499	Monitoring, Measurement, Analyses, and EvaluationInternal Audit
1500	• Quality Improvement
1501 1502	Nonconformity and Corrective ActionsContinual Improvement
1503 • 1504	As a basis for RFP EMD requirements and inputs, analyze the TMRR manufacturing and quality output from:
1505 1506 1507	 Risk, Issue, and Opportunity Management System and processes Design producibility, feasibility, and manufacturability studies and analyses Tooling, facility, and workforce analyses

1508		• Prototype demonstrations and development tests
1509		• Materials analyses
1510		• Make/buy processes and analyses
1511		• Costs and budget analyses
1512		• Market research and analyses
1513		 Modeling and simulations analyses
1514		 Process Capability Studies
1515		 Environmental studies and risks (PESHE)
1516		 Manufacturing and quality processes and data
1517		 Work measurement/learning curve analyses
1518		 Industrial Base studies
1519 1520 1521 1522	•	Specify appropriate requirements for manufacturing and quality Contract data Requirements List (CDRL), Data Item Description (DID), etc. to support manufacturing and quality processes, include the requisite approval processes (e.g., Manufacturing Plan, Quality Assurance Plan, Producibility Plan, etc.)
1523 1524 1525		• Specify a requirement for on-site government Quality Assurance personnel will have access to perform source inspection of the plan (include on-site government Quality Assurance personnel in contractual distribution of the program Quality Plan (ref. I.1))
1526 1527	•	Specify industry manufacturing and quality best practices for Systems Engineering to be used (e.g., IEEE 15288, -1, -2, etc.) in the EMD RFP.
1528 1529 1530		 Include requirements for the contractors to identify and to describe their proposed processes, methods, and actions to address technical processes, technical management processes, and essential specialty engineering
1531	•	Specify contractual manufacturing and quality requirements for:
1532		• Content for SOW, SOO, and contract sections C, L, M, and H
1533		• Conducting manufacturing and quality reviews of engineering and software (with
1534		frequency of reviews)
1535		• Intellectual property and government technical/manufacturing data rights, maintenance,
1536		ownership, and access
1537		• Identification and description of producibility efforts including cost sharing and incentive
1538		plans relevant to the solution
1539		• Plans for facilities, tooling, test equipment, workforce (e.g., training, certifications, etc.),
1540		and supply chain management
1541		• Plans for material availability including make/buy, long-lead, sources and risks (sole,
1542		single, foreign, fragile, and critical)
1543		• Utilizing analyses of failure mode effects and criticality (e.g., FMECA, DFMEA,
1544		PFMEA) from the system level down to the component level (i.e., throughout the supply
1545		chain)
1546		 Definition and traceability of CSI and/or CAIs to all preliminary key and critical
1547		manufacturing and quality processes

3. Technology Maturation and Risk Reduction (TMRR) Phase

1548		• Conducting analyses of manufacturing system safety (in support of System Safety
1549		Assessments in accordance with MIL-STD-882)
1550		• Providing manufacturing and quality information for costs, cost models, and cost
1551		estimates that include rate, alternate materials, quantity, etc. (including Cost of Quality
1552		data)
1553		• Plans for establishing and meeting EMD required process capability (Cpk) goals
1554		• Identification and description of manufacturing technology capability improvements
1555		• Encouraging investments in advanced manufacturing technology production equipment
1556		and processes from U.S. domestic sources that increase the productivity and reduce life
1557		cycle costs
1558		• Implementing (or continuing) a joint risk, issue, and opportunity management and
1559		mitigation program that includes manufacturing and quality (including industrial base
1560		risks)
1561		• Implementing (or continuing) a manufacturing and quality variability reduction program
1562		 Appropriate cyber threat protection measures including
1563		• Safeguarding manufacturing and quality information, designed in systems protection,
1564		supply chain risks, hardware and software manufacturing network assurance
1565		(including suppliers), anti-counterfeit practices, anti-tamper (AT), and security-
1566		related activities such as physical security and industrial security
1567		 Compliance with DFARS 252.204-7012 Safeguarding Covered Defense Information
1568		and Cyber Incident Reporting
1569		 Periodic assessments to understand the risks to organizational operations,
1570		organizational assets, and individuals, resulting from the operation and the associated
1571		processing, storage, or transmission of Controlled Unclassified Information (CUI) by
1572		manufacturing information systems.
1573		 Compliance with NIST 800-82 Guide to Industrial Control Systems Security
1574		• Managing materials and subcontractors including requirements for compliance with
1575		either DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and
1576		Avoidance System, or DFARS 252.246-7008, Sources of Electronic Parts
1577		• Utilizing COTS, GOTS, GFE, and NDIs
1578		• Metrics to be met as exit criteria for EMD phase
1579	•	Provide manufacturing and quality inputs and support to specialized system requirements.
1580		such as Flight Operations Space Operations etc
1581	•	Specify the requirement that the contractor support and/or conduct as required manufacturing
1582	-	and quality.
1302		and quanty.
1583		• Technical reviews and audits including CDR, TRR, PRR, Physical Configuration Audit
1584		(PCA), Functional Configuration Audit (FCA), etc.
1585		 MRL assessments with trained personnel utilizing the MRL criteria
1586		• Independent risk assessments to include the identification of any critical technologies or
1587		manufacturing processes that have not been successfully demonstrated in a relevant
1588		environment

3. Technology Maturation and Risk Reduction (TMRR) Phase

1589 1590 1591 1592		 Performance meetings to discuss quality, manufacturing, production, supply chain, engineering, software deficiencies and issues, proposed corrective actions, and status of ongoing actions Joint risk, issue, and opportunity management meetings to manage mitigation activities
1593	Metri	CS
1594 1595 1596	•	Appropriate requirements for best practices for the contractor's MMS (Section L.2) and QMS (Section I.1) (e.g., AS6500, ISO 9000, AS9100, etc.) have been incorporated in the EMD RFP.
1597 1598 1599 1600 1601 1602		 Requirements specify that the contractors identify and describe their proposed specific processes, methods, and actions to address manufacturing feasibility, producibility, and manufacturing and quality risks associated with the proposed system Requirement specify that on-site government Quality Assurance personnel will have access to perform management system audits and access to perform source inspections and data monitoring
1603 1604 1605 1606	•	If AS6500 is not invoked in the contract(s), the manufacturing management requirements cited in AS6500 are the basis for specific contractual requirements. The requirements, at a minimum, should specify that the contractor addresses and documents plans, procedures, and processes for:
1607		 Manufacturing Management System:
1608 1609		 Documenting how, when, and by whom each requirement of their system is to be accomplished, and define the authority and responsibility for each.
1610		 Design Analysis for Manufacturing:
1611 1612 1613 1614 1615 1616 1617		 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 FMEA on critical manufacturing processes (PFMEA)
1618		• Manufacturing Risk Identification:
1619 1620 1621 1622 1623 1624 1625 1626		 Integrating manufacturing risk management activities into the program risk, issue, and opportunity management process to include 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 a competing design alternative Identifying MRL targets and documenting manufacturing risks through the MRL assessments

3. Technology Maturation and Risk Reduction (TMRR) Phase

1627	• Manufacturing Planning:
1628 1629 1630 1631	 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.
1632	 Manufacturing Operations Management including:
1633 1634 1635 1636 1637 1638 1639 1640	 Production Scheduling and Control Manufacturing Surveillance Continuous Improvement Process Control Plans Process Capabilities Production Process Verification First Article Inspections and First Article Tests Supplier Management and Quality
1641 1642 1643 1644	• If ISO 9000, AS9100, or other quality best practices standards are not invoked in the contract(s), the quality management requirements cited in the standards are the basis for specific contractual requirements. The requirements, at a minimum, should specify that the contractor addresses and documents plans, procedures, and processes for:
1645	• Quality Management Leadership
1646 1647 1648	 Leadership and Commitment Policy Organizational Roles, Responsibilities, and Authorities
1649	 Quality Planning
1650 1651 1652	 Actions to Address Risks and Opportunities Quality Objectives and Planning Planning of Changes
1653	 Quality Support
1654 1655 1656 1657 1658	 Resources Competence Awareness Communication Documented Information
1659	• Operation
1660 1661 1662 1663	 Operational Planning and Control Requirements for Products and Services Design and Development of Products and Services Control of Externally Provided Processes, Products, and Services

3. Technology Maturation and Risk Reduction (TMRR) Phase

1664 1665 1666		 Production and Service Provision Release of Products and Services Control of Non-conforming Outputs
1667		• Quality Performance
1668 1669		Monitoring, Measurement, Analyses, and EvaluationInternal Audit
1670		• Quality Improvement
1671 1672		Nonconformity and Corrective ActionsContinual Improvement
1673 1674	•	Manufacturing and quality EMD RFP requirements and inputs have been provided to the proposal team based on TMRR analyses and outputs from:
1675 1676 1677 1678 1679 1680 1681 1682 1683 1684 1685 1686 1687 1688		 Risk, Issue, and Opportunity Management System and processes Design producibility, feasibility, and manufacturability studies and analyses Tooling, facility, and workforce analyses Prototype demonstrations and development tests Materials analyses Make/buy processes and analyses Costs and budget analyses Market research and analyses Modeling and simulations analyses Process Capability Studies Environmental studies and risks (PESHE) Manufacturing and quality processes and data Work measurement/learning curve analyses Industrial Base studies
1689 1690 1691 1692 1693	•	Appropriate manufacturing and quality requirements for CDRLs, DIDs, etc. (e.g., Manufacturing Plan, Quality Assurance Plan, Producibility Plan, etc.) to support manufacturing and quality processes, including the corrective action and approval processes have been incorporated in the EMD RFP.
1694		perform source inspection of the plan (ref. I.1)
1695 1696	•	Manufacturing and quality best practices for Systems Engineering have been specified in the EMD RFP (e.g., IEEE 15288, -1, -2, etc.).
1697 1698 1699		• Requirements specify that the contractors identify and describe their proposed processes, methods, and actions to address technical processes, technical management processes, and essential specialty engineering
1700 1701	•	Contractual requirements for manufacturing and quality have been specified in EMD RFP to include:

1702	0	Content for SOW, SOO, and contract sections C, L, M, and H
1703	0	Conducting manufacturing and quality reviews of engineering and software (with
1704		frequency of reviews)
1705	0	Intellectual property and government technical/manufacturing data rights, maintenance,
1706		ownership, and access
1707	0	Identification and description of producibility efforts including cost sharing and incentive
1708		plans relevant to the solution
1709	0	Plans for facilities, tooling, test equipment, workforce (e.g., training, certifications, etc.),
1710		and supply chain management
1711	0	Plans for material availability including make/buy, long-lead, sources and risks (sole,
1712		single, foreign, fragile, and critical)
1713	0	Utilizing analyses of failure mode effects and criticality (e.g., FMECA, DFMEA,
1714		PFMEA) from the system level down to the component level (i.e., throughout the supply
1715		chain)
1716	0	Definition and traceability of CSIs and/or CAIs to all preliminary key and critical
1717		manufacturing and quality processes
1718	0	Conducting analyses of manufacturing system safety (in support of System Safety
1719		Assessments in accordance with MIL-STD-882)
1720	0	Manufacturing and quality data for costs, cost models, and cost estimates that include
1721		rate, alternate materials, quantity, etc. (including Cost of Quality data)
1722	0	Plans to meet required process capability (Cpk) EMD goals
1723	0	Identification and description of manufacturing technology capability improvements
1724	0	Investments in advanced manufacturing technology production equipment and processes
1725		from U.S. domestic sources that increase the productivity and reduce life cycle costs
1726	0	Implementation of (or continuing) a joint risk, issue, and opportunity management and
1727		mitigation program that includes manufacturing and quality (including industrial base
1728		risks)
1729	0	Implementation of (or continuing) a manufacturing and quality variability reduction
1730		program
1731	0	Cyber threat protection measures including:
1732		• Safeguarding manufacturing and quality information, designed in systems protection,
1733		supply chain risks, hardware and software manufacturing network assurance
1734		(including suppliers), anti-counterfeit practices, anti-tamper, and security-related
1735		activities such as physical security and industrial security
1736		 Compliance with DFARS 252.204-7012 Safeguarding Covered Defense Information
1737		and Cyber Incident Reporting
1738		 Periodic assessments to understand the risks to organizational operations,
1739		organizational assets, and individuals, resulting from the operation and the associated
1740		processing, storage, or transmission of Controlled Unclassified Information by
1741		manufacturing information systems.
1742		 Compliance with NIST 800-82 Guide to Industrial Control Systems Security

1743 1744 1745 1746 1747		 Management of materials and subcontractors including requirements for compliance with either DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance System, or DFARS 252.246-7008, Sources of Electronic Parts Utilization of COTS, GOTS, GFE, and NDIs Metrics to be met as exit criteria for EMD phase
1748 1749 1750 1751	•	Manufacturing and quality inputs and metrics have been provided for the EMD RFP to support specialized system requirements, such as Flight Operations, Space Operations, etc. Requirements have been specified in the EMD RFP that the contractor support and/or conduct, as required, manufacturing and quality:
1752 1753 1754 1755 1756 1757 1758 1759 1760		 Technical reviews and audits including CDR, TRR, PRR, PCA, FCA etc. MRL assessments with trained personnel utilizing the MRL criteria Independent risk assessments to include the identification of any critical technologies or manufacturing processes that have not been successfully demonstrated in a relevant environment Performance meetings to discuss quality, manufacturing, production, supply chain, engineering, software deficiencies and issues, proposed corrective actions, and status of ongoing actions Joint risk, issue, and opportunity management meetings to manage mitigation activities
1761	Tools	
1762	•	AS6500, Manufacturing Management System Checklist
1763	•	AS9100, Quality Management System Checklist, Sep 2016
1764	•	ISO 9001, Quality Management System Checklist, Sep 2016
1765	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
1766	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
1767	•	IG5315.204-5(b) Section L Guide and Template
1768	•	IG5315.204-5(c) Section M Guide and Template
1769	Resou	rces
1770	•	AS6500, Manufacturing Management Program, Nov 2014
1771	•	AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense
1772		Organizations, Sep 2016
1773	•	ISO 9001:2015, Quality Management System
1774	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
1775	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
1776	•	DFARS 246.870, Contractors' Counterfeit Electronic Part Detection and Avoidance
1777	•	DFARS 252.228-7001, Ground and Flight Risk
1778	•	DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance
1779		System
1780	•	DFARS 252.246-7008, Sources of Electronic Parts

3. Technology Maturation and Risk Reduction (TMRR) Phase

1781 1782 1783 1784 1785 1786 1786 1787 1788 1789 1790	• • • • •	DFARS 252.204-7012, Safeguarding Covered Defense Information and Cyber Incident Reporting DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017, Enclosure 14 IG5315.204-5(b) Section L Guide IG5315.204-5(c) Section M Guide MIL-STD-882, Rev. E, System Safety, May 2012 MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016 NIST 800-82 Guide to Industrial Control Systems Security NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations
1791	B.2	Provide Input to EMD Source Selection Plan (SSP)
1792	Manu	facturing and Quality Tasks
1793 1794 1795 1796 1797	•	Ensure that manufacturing and quality personnel are included in the EMD Source Selection Plan (SSP) writing and review team. Specify in the SSP metrics and scoring for application of manufacturing and quality industry best practices for the contractor's Manufacturing Management System and Quality Management System (e.g., AS6500, ISO 9000, AS9100, etc.).
1798 1799 1800 1801 1802 1803		 Plan should include metrics and scoring for preferred specific processes, methods, and actions to address manufacturing feasibility, producibility, and manufacturing and quality risks associated with the proposed system Plan should include metrics and scoring for accommodation of on-site government Quality Assurance personnel to complete required management and quality audits and data collection
1804 1805 1806 1807	•	If manufacturing management industry best practice requirements (i.e., AS6500) are not invoked in the contract(s), the requirements cited in AS6500 should be the basis for specific SSP metrics and scoring. Specify metrics that, at a minimum, include the contractor plans, processes, and procedures for:
1808 1809 1810		 Documenting how, when, and by whom each requirement of their manufacturing management system is to be accomplished, and defining the authority and responsibility for each. Conducting producibility design analyses
1817		 Identification and management of key and critical characteristics in the TDP
1812		• Implementation of VR to reduce part to part variation of key and critical characteristics
1814		 Identification and management of key and critical manufacturing processes
1815		• Conducting Process FMEA on critical manufacturing processes
1816		• Integration of manufacturing risk management activities into the program risk, issue, and
1817 1818		opportunity management process to include the identification of manufacturing risk areas and the development and implementation of risk mitigation plans tracked to completion

1819		• Conducting and documenting manufacturing feasibility assessments for any competing
1820		design alternative
1821		• Identification of MRL targets and documenting manufacturing risks through the MRL
1822		assessments
1823		• Establishing and maintaining a manufacturing plan that includes supply chain and
1824		material management, manufacturing technology development, manufacturing modeling
1825		and simulation, manufacturing costs, manufacturing system verification, manufacturing
1826		workforce, and tooling, test equipment, and facilities
1827		• Production Scheduling and Control
1828		• Manufacturing Surveillance
1829		• Continuous Improvement
1830		• Process Control Plans
1831		• Process Capabilities
1832		• Production Process Verification
1833		• First Article Inspections and First Article Tests
1834		• Supplier Management and Quality
1835	•	If ISO 9000 or AS9100 quality management industry best practices are not invoked in the
1836		contract(s), the requirements cited in the standards should be the basis for specific SSP
1837		metrics and scoring. Specify metrics that, at a minimum, include the contractor plans.
1838		processes, and procedures for:
1830		• Quality management leadership, commitment, policy, organizational roles
1840		responsibilities and authorities
1841		• Quality planning with actions to address ricks and opportunities quality objectives and
1842		planning and change management
1842		- Quality support with resources, competence, awareness, communication, and documented
1043 1844		information
1845		• Operation including operational planning and control products and services
1846		requirements and design and development
1847		• Control of externally provided processes products and services
1848		 Production and service provision
1849		 Release of products and services
1850		• Control of non-conforming outputs
1851		• Quality performance including monitoring measurement analyses evaluation and
1852		internal audits
1853		• Quality improvement including nonconformities and corrective actions, and continual
1854		improvement
1855	•	I Utilizing analyses of TMPP manufacturing and quality outputs specify metrics and scoring
1856	-	that at a minimum address the contractor(s) plans, processes, and procedures for:
1957		• Pisk issue and opportunity management
1057		 Nisk, issue, and opportunity management Design producibility, feasibility, and manufacturability.
1030		• Design productority, reastority, and manufacturating
1828		o 100ling, 1aclifty, and workforce

1860		• Prototype demonstrations and development tests
1861		• Materials management
1862		• Make/buy management
1863		• Costs and budgets
1864		• Modeling and simulations
1865		 Process capability management
1866		• Hazardous materials, environmental and safety management
1867		 Manufacturing and quality process and data management
1868		• Work measurement/learning curve management
1869		• Industrial security
1870		• Supply chain management
1871 1872 1873 1874 1875 1876	•	Specify metrics and scoring that ranks contractor(s) plans (including processes, and procedures) for timeliness, completeness, accuracy, and alignment (corrective actions, if required) for managing manufacturing and quality CDRLs, DIDs, etc., including the requisite approval processes. Specify in the SSP metrics and scoring for application of manufacturing and quality industry best practices for the contractor's Systems Engineering management (e.g., IEEE 15288, -1, -2, ata)
18//		2, etc.).
1878 1879 1880		 Include metrics and scoring for the contractors proposed processes, methods, and actions to address technical processes, technical management processes, and essential specialty engineering
1881 1882	•	Specify manufacturing and quality metrics and scoring on timeliness, completeness, accuracy, and alignment (corrective actions, if required) for:
1883 1884		• Meeting each SOW, SOO requirements, and requirements for contract sections C, L, M, and H
1885 1886		• Planning of manufacturing and quality reviews of engineering and software (with frequency of reviews)
1887		• Planning and processes for Intellectual Property management and government
1888		Technical/Manufacturing Data Rights, maintenance, ownership, and access
1889		• Planning and processes for producibility (including cost sharing and incentive plans
1890		relevant to the solution)
1891		• Plans for facilities, tooling, test equipment, workforce (e.g., training, certifications, etc.),
1892		and supply chain management
1893		• Planning and processes for materials including make/buy, long-lead, sources and risks
1894		(sole, single, foreign, fragile, and critical)
1895		• Plans for utilizing failure mode effects and criticality analyses (e.g., FMECA, DFMEA,
1896		PFMEA) from the system level down to the component level (i.e., throughout the supply
1897		chain)
1898		• Planning and processes for management of CSIs and/or CAIs, and all preliminary key
1899		and critical manufacturing and quality processes

1900		0	Planning and processes for manufacturing system safety analyses
1901		0	Planning and processes for providing manufacturing and quality information for costs,
1902			cost models, and cost estimates that include rate, alternate materials, quantity, etc.
1903			(including Cost of Quality data)
1904		0	Plans for establishing and processes for meeting EMD required process capability (Cpk)
1905			goals
1906		0	Planning for manufacturing technology capability improvements
1907		0	Plans for investments in advanced manufacturing technology production equipment and
1908			processes from U.S. domestic sources that increase the productivity and reduce life cycle
1909			costs
1910		0	Plans for implementing (or continuing) a joint risk, issue, and opportunity management
1911			and mitigation program that includes manufacturing and quality (including industrial base
1912			risks)
1913		0	Plans for implementing (or continuing) a manufacturing and quality variability reduction
1914			program
1915		0	Planning and processes for cyber-threat protection measures including:
1916			 Safeguarding manufacturing and quality information including supply chain risks
1917			 Designed in systems protection, hardware and software manufacturing network
1918			assurance (including suppliers), anti-tamper, and security-related activities such as
1919			physical security and industrial security
1920			 Anti-counterfeit practices
1921			 Periodic assessments to understand the risks to organizational operations,
1922			organizational assets, and individuals, resulting from the operation and the associated
1923			processing, storage, or transmission of Controlled Unclassified Information (CUI) by
1924			manufacturing information systems.
1925		0	Planning and processes for utilization of COTS, GOTS, GFE, NDI items
1926	•	Spe	ecify metrics and scoring that ranks contractor(s) plans (including processes, and
1927		pro	ocedures) for timeliness, completeness, accuracy, and alignment (corrective actions, if
1928		rea	uired) for managing specialized system requirements, such as Flight Operations. Space
1929		On	erations, etc.
1930	•	Sne	ecify manufacturing and quality metrics and scoring on timeliness, completeness
1931		acc	suracy and alignment (corrective actions if required) for contractor planning and
1932		pro	cesses to support and/or conduct as required manufacturing and quality.
1022		P10	Technical reviews and audits including CDP, TPP, DPP, DCA, ECA, ato
1933		0	MDL assessments with trained personnal utilizing the MDL aritaria
1934		0	Independent risk assessments to include the identification of any artical technologies or
1755		0	manufacturing processes that have not been successfully demonstrated in a relevant
1930			environment
1737		~	City in Omitician
1730		0	anging another meetings to discuss quality, manufacturing, production, supply chain,
1939			engineering, software deficiencies and issues, proposed corrective actions, and status of
1940			ongoing actions

1941		• Joint risk, issue, and opportunity management meetings to manage mitigation activities		
1942	Metrics			
1943 1944 1945 1946	•	Metrics and scoring have been specified in the SSP for contractor's application of manufacturing and quality industry best practices for the contractor's Manufacturing Management System and Quality Management System (QMS) (e.g., AS6500, ISO 9000, AS9100, etc.).		
1947 1948 1949 1950 1951		 Metrics and scoring include preferred specific processes, methods, and actions to address manufacturing feasibility, producibility, and manufacturing and quality risks Metrics and scoring include provisions for accommodation of on-site government Quality Assurance personnel to complete required management and quality audits and data collection 		
1952 1953 1954	•	If manufacturing management industry best practice requirements (i.e., AS6500) are not invoked in the contract(s), then specific metrics and scoring have been included that rank contractor plans, processes, and procedures for:		
1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968		 Documenting how, when, and by whom each requirement of their manufacturing management system is to be accomplished, and defining the authority and responsibility for each. Producibility design analyses Identification and management of key and critical characteristics in the TDP Implementation of VR to reduce part to part variation of key and critical characteristics Identification and management of key and critical manufacturing processes Conducting Process FMEA on critical manufacturing processes Integration of manufacturing risk management activities into the program risk, issue, and opportunity management process to include the identification of manufacturing risk areas and the development and implementation of risk mitigation plans tracked to completion Conducting and documenting manufacturing risks through the MRL assessments with 		
1960 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980		 conducting and documenting manufacturing fishs through the fifted assessments with trained SMEs c) 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 c) Production Scheduling and Control c) Manufacturing Surveillance c) Continuous Improvement c) Process Control Plans c) Production Process Verification c) First Article Inspections and First Article Tests 		

1981		 Supplier Management and Quality
1982 1983 1984	•	If quality management industry best practice requirements (e.g., ISO 9000, AS9100, etc.) are not invoked in the contract(s), then specific metrics and scoring have been included that rank contractor plans, processes, and procedures for:
1985		• Quality management leadership, commitment, policy, organizational roles,
1986		responsibilities, and authorities
1987		• Quality planning with actions to address risks and opportunities, quality objectives and
1988		planning, and change management
1989		• Quality support with resources, competence, awareness, communication, and documented
1990		information
1991		• Operation including operational planning and control, products and services
1992		requirements, and design and development
1993		 Control of externally provided processes, products, and services
1994		 Production and service provision
1995		• Release of products and services
1996		 Control of non-conforming outputs
1997		• Quality performance including monitoring, measurement, analyses, evaluation, and
1998		internal audits
1999		• Quality improvement including nonconformities and corrective actions, and continual
2000		improvement
2001	•	Specific metrics and scoring have been documented in the SSP that at a minimum address the
		contractor(s) plans, processes, and proceedures for
2002		contractor(s) plans, processes, and procedures for.
2002 2003		 Risk, issue, and opportunity management
2002 2003 2004		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability
2002 2003 2004 2005		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce
2002 2003 2004 2005 2006		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests
2002 2003 2004 2005 2006 2007		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management
2002 2003 2004 2005 2006 2007 2008		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management
2002 2003 2004 2005 2006 2007 2008 2009		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets
2002 2003 2004 2005 2006 2007 2008 2009 2010		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations Process capability management
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations Process capability management Hazardous materials, environmental and safety management
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2011 2012 2013		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations Process capability management Hazardous materials, environmental and safety management Manufacturing and quality process and data management
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations Process capability management Hazardous materials, environmental and safety management Manufacturing and quality process and data management Work measurement/learning curve management
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2011 2012 2013 2014 2015		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations Process capability management Hazardous materials, environmental and safety management Manufacturing and quality process and data management Work measurement/learning curve management Industrial security
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016		 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations Process capability management Hazardous materials, environmental and safety management Manufacturing and quality process and data management Work measurement/learning curve management Industrial security Supply chain management
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017	•	 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations Process capability management Hazardous materials, environmental and safety management Manufacturing and quality process and data management Work measurement/learning curve management Industrial security Supply chain management
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018	•	 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations Process capability management Hazardous materials, environmental and safety management Manufacturing and quality process and data management Work measurement/learning curve management Industrial security Supply chain management Specific metrics and scoring have been documented in the SSP that rank contractor(s) plans (including processes, and procedures) for timeliness, completeness, accuracy, and alignment
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019	•	 Risk, issue, and opportunity management Design producibility, feasibility, and manufacturability Tooling, facility, and workforce Prototype demonstrations and development tests Materials management Make/buy management Costs and budgets Modeling and simulations Process capability management Hazardous materials, environmental and safety management Manufacturing and quality process and data management Mork measurement/learning curve management Industrial security Supply chain management Specific metrics and scoring have been documented in the SSP that rank contractor(s) plans (including processes, and procedures) for timeliness, completeness, accuracy, and alignment (corrective actions, if required) for managing manufacturing and quality CDRLs, DIDs, etc.,

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2021 2022 2023	•	Specific metrics and scoring have been documented in the SSP for application of manufacturing and quality industry best practices for the contractor's Systems Engineering management(e.g., IEEE 15288, -1, -2, etc.).
2024 2025 2026		 Metrics and scoring include the contractors proposed processes, methods, and actions to address technical processes, technical management processes, and essential specialty engineering
2027 2028	•	Specific manufacturing and quality metrics and scoring have been documented in the SSP for timeliness, completeness, accuracy, and alignment (corrective actions, if required) for:
2029 2030		• Meeting each SOW, SOO requirements, and requirements for contract sections C, L, M, and H
2031 2032		• Planning of manufacturing and quality reviews of engineering and software (with frequency of reviews)
2033 2034		• Planning and processes for intellectual property management and government technical/manufacturing data rights maintenance, ownership, and access
2035 2036		 Planning and processes for producibility (including cost sharing and incentive plans relevant to the solution)
2030 2037 2038		 Plans for facilities, tooling, test equipment, workforce (e.g., training, certifications, etc.), and supply chain management
2030 2039 2040		 Planning and processes for materials including make/buy, long-lead, sources and risks (sole single foreign fragile and critical)
2040 2041		 Plans for utilizing failure mode effects and criticality analyses (e.g., FMECA, DFMEA,
2042 2043		Chain) PFMEA) from the system level down to the component level (i.e., throughout the supply chain)
2044 2045		 Planning and processes for management of CSIs and/or CAIs, and all preliminary key and critical manufacturing and quality processes
2046 2047		 Planning and processes for manufacturing system safety analyses and in support of System Safety Assessments in accordance with MIL-STD-882
2048 2049		• Planning and processes for providing manufacturing and quality information for costs, cost models, and cost estimates that include rate, alternate materials, quantity, etc.
2050 2051		 (including Cost of Quality data) Plans for establishing and processes for meeting EMD required process capability (Cpk)
2052		goals
2053		• Planning for manufacturing technology capability improvements
2054 2055		• Plans for investments in advanced manufacturing technology production equipment and processes from U.S. domestic sources that increase the productivity and reduce life cycle
2055		costs
2057		• Plans for implementing (or continuing) a joint risk, issue, and opportunity management
2058		and mitigation program that includes manufacturing and quality (including industrial base
2059		risks)
2060		• Plans for implementing (or continuing) a manufacturing and quality variability reduction
2061		program

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2062		• Planning and processes for cyber-threat protection measures including:
2063 2064 2065 2066 2067 2068 2069 2070 2071 2072		 Compliance with DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting Compliance with NIST 800-82 Guide to Industrial Control Systems Security and anti-tamper, and security-related activities such as physical security and industrial security Compliance with either DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance System, or DFARS 252.246-7008, Sources of Electronic Parts Compliance with NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations
2073		 Planning and processes for utilization of COTS, GOTS, GFE, and NDIs
2074 2075 2076 2077 2078 2079 2080 2081	•	Specific metrics and scoring have been documented in the SSP that rank contractor(s) plans (including processes, and procedures) for timeliness, completeness, accuracy, and alignment (corrective actions, if required) for managing specialized system requirements, such as Flight Operations, Space Operations, etc. Specific manufacturing and quality metrics and scoring have been documented in the SSP for timeliness, completeness, accuracy, and alignment (corrective actions, if required) of contractor planning and processes to support and/or conduct as required manufacturing and quality:
2082 2083 2084 2085 2086 2087 2088 2089 2090		 Technical reviews and audits including CDR, TRR, PRR, PCA, FCA etc. MRL assessments with trained personnel utilizing the MRL criteria Independent risk assessments to include the identification of any critical technologies or manufacturing processes that have not been successfully demonstrated in a relevant environment Performance meetings to discuss quality, manufacturing, production, supply chain, engineering, software deficiencies and issues, proposed corrective actions, and status of ongoing actions Joint risk, issue, and opportunity management meetings to manage mitigation activities
2091	Tools	
2092 2093 2094 2095 2096 2097	• • • •	AS6500, Manufacturing Management System Checklist AS9100, Quality Management System Checklist ISO 9001, Quality Management System Checklist IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs Source Selection Plan Template, USMC, Jan 2014
2098	Resou	rces
2099	٠	AS6500, Manufacturing Management Program, Nov 2014

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2100	•	AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense
2101		Organizations, Sep 2016
2102	•	ISO 9001:2015, Quality Management System
2103	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
2104	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
2105	•	DFARS 246.870, Contractors' Counterfeit Electronic Part Detection and Avoidance
2106	•	DFARS 252.228-7001, Ground and Flight Risk
2107	•	DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance
2108		System
2109	٠	DFARS 252.246-7008, Sources of Electronic Parts
2110	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
2111		Reporting
2112	•	DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017, Enclosure 14
2113	•	DoD Source Selection Procedures Memo, Mar 2011AS6500, Manufacturing Management
2114		System
2115	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016ISO 9001, Quality
2116		Management System
2117	•	MIL-STD-882, Rev. E, System Safety, May 2012
2118	•	NIST 800-82 Guide to Industrial Control Systems Security
2119	•	NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information
2120		Systems and Organizations
2121	B.3	Develop EMD Award Fee Criteria
2122	Manuf	acturing and Quality Tasks
2123	Develo	p and provide manufacturing and quality input to Award Fee Criteria appropriate to the
2124	contrac	t type and consistent with the Acquisition Strategy that specify periodic EMD phase goals
2125	address	the necessary and appropriate manufacturing and quality, including supply chain, cost,
2126	schedu	le, and performance improvements (progress against goals) in the areas of:
2127		Manufacturing and quality CDPL a DIDa at a submission and ammousl most contract
2127		o Manufacturing and quanty CDRLs, DIDs, etc. submission and approval meet contract
2120		Compliance with other threat protection and industrial security requirements
2129		• Manufacturing quality and Industrial Base risk mitigations to schedule goals (# %
2130		$(\pi, \%)$ milestones)
2131		 Manufacturing readiness progress (MRL assessments) against targets including risk
2132		mitigations
2133		• Manufacturing and producibility projects planned and completed (#/%)
2135		• Initiation, development, and progress of manufacturing and quality learning curves (% to
2136		goals) including rates, vields, variability, process times, re-work and repair etc.
-100		Bound, mersoning rates, jieras, variability, process times, re work and repair, etc.

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2137	0	System design, specifications, and documentation completion, approval, and release for
2138		prototyping/manufacturing (progress against schedule)
2139	0	Manufacturing and quality systems design (production line, tooling, equipment, ManTech
2140		insertion, etc.) completion against plans (%)
2141	0	KC development, management, maturation, and demonstration to goals (% to goal and
2142		schedule progress)
2143	0	Technical Performance Measures (TPMs) (% progress to schedule)
2144	0	Manufacturing processes and advanced manufacturing capability development,
2145		improvement, and demonstration (#/% to goals)
2146	0	Management of CSIs and CAIs to requirements
2147	0	Process Capability development and improvement (Cpk value to goals)
2148	0	Quality improvement projects planned and completed (#/% to goals)
2149	0	Variation and Variability reduction efforts (initial yield rates and trends)
2150	0	Manufacturing improvement projects identified, planned, and implemented (#/% to
2151		goals)
2152	0	Materials characterized in production relevant environment (#/%)
2153	0	Materials management, characterization, and analyses completion against appropriate
2154		quality goals (#/%)
2155	0	Facilities and equipment development, completion, and demonstration (% to plan)
2156	0	Workforce development and management to plan (e.g., hiring, training, and reductions)
2157		(#/% to plan)
2158	0	Development testing completion to schedule (% successfully completed)
2159	0	Manufacturing costs and cost reduction with minimum periodic thresholds (#/%)
2160		 Cost sharing when goals are not met must also be specified.
2161	0	Quality costs and cost reduction with minimum periodic thresholds (#/%)
2162	0	Manufacturing Plan progress against completion (cost and schedule)
2163	0	Quality Plan progress against completion (cost and schedule)
2164	0	Manufacturing and quality safety system requirements (% compliance)
2165	0	Manufacturing Management System compliance to best practices and/or contract
2166		requirements (# to standard)
2167	0	Quality Management System compliance to best practices and/or contract requirements
2168		(# to standard)
2169	0	System Engineering management compliance to best practices for manufacturing and
2170		quality technical processes, technical management processes, and essential specialty
2171		engineering (# to standard)
2172	0	Progress toward meeting EMD exit criteria

2173 Metrics

- 2174 Manufacturing and quality inputs to Award Fee Criteria consistent with the Acquisition Strategy
- 2175 have been documented and specify periodic EMD phase goals that require manufacturing and quality
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2176 2177	cost, schec against goa	lule, and performance improvements including the supply chain, measured as progress als, for:
2178 2179 2180 2181 2182 2183 2183 2184 2185		 Manufacturing and quality CDRLs, DIDs, etc., submission, approval, and corrective actions, meeting contract requirements (schedule) Compliance with cyber-threat protection and industrial security requirements Manufacturing, quality, and Industrial Base risk mitigations (#,%, milestones) Manufacturing readiness progress (MRL assessments against targets, including risk mitigations) Manufacturing and producibility projects (planned and completed, #/%) Manufacturing and quality learning curves (% to goals)
2186 2187		Include rates, yields, variabilityInclude process times, re-work and repair, scrap, etc.
2188 2189 2190	0	Prototype/manufacturing design specifications, drawings and documents completion, approval, and release (#/%) Manufacturing and quality systems design completion (#/%)
2191		 Production line, tooling, equipment, ManTech insertion, etc.
2192 2193 2104	0	Development, management, maturation, and demonstration of manufacturing and quality KCs and processes (#/%)
2194 2195 2196	0	Advanced manufacturing capability development, improvement, and demonstration (#/%/schedule)
2197 2198	0	Monitoring and management of CSIs and CAIs to requirements (%) Development and improvement of manufacturing processes
2199 2200 2201 2202		 Process Capability development and improvement (Cpks) Quality improvement projects (#/%/schedule) Variation and Variability reduction (yield, rates and trends) Manufacturing improvement projects (#/%/schedule)
2203 2204 2205 2206	0 0 0	Materials characterized in production relevant environment (#/%) Management and characterization of materials completion (rate/#/%) Completion and/or demonstration of facilities and equipment (%) Plans for, development, and management of the workforce (#/%)
2207		 Hiring, training, reductions, etc.
2208 2209	0 0	Development testing completion (% successfully completed) Manufacturing costs and cost reduction with minimum periodic thresholds (#/%)
2210		 Cost sharing when goals are not met must also be specified
2211 2212 2213	0 0 0	Quality costs and cost reduction with minimum periodic thresholds (#/%) Manufacturing Plan progress (cost and schedule) Quality Plan progress (cost and schedule)

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2214		• Manufacturing and quality safety system progress (% compliance and schedule)
2215		 Manufacturing Management System compliance to best practices and/or contract
2216		requirements (# to standard)
2217		• Quality Management System compliance to best practices and/or contract requirements
2218		(# to standard)
2219		• System Engineering management compliance to best practices for manufacturing and
2220		quality technical processes, technical management processes, and essential specialty
2221		engineering (# to standard)
2222		 Progress toward meeting EMD exit criteria (#/%/schedule/cost)
2223	Tools	
2224		Amore Fee Template LICAE
2224	•	Aware Fee Template, USAF
2225	Resou	rces
2226	•	Air Force Award Fee Guide, Oct 2008 (Army and Navy guides available)
2227	•	AS6500. Manufacturing Management Program, Nov 2014
2228	•	AS9100 Quality Management Systems - Requirements for Aviation Space and Defense
2220	-	Organizations Sen 2016
222)	•	ISO 9001:2015 Quality Management System
2230	•	MPL Deskbook Version 2016
2231	•	WIRL Deskoook version 2010
2232	B.4	Develop EMD Manufacturing Incentive Criteria
2233	Manu	facturing and Quality Tasks
2234	•	Develop and provide manufacturing and quality inputs to EMD Incentives Criteria
2235		appropriate to the contract type and consistent with the Acquisition Strategy that are tied to
2236		early investments with goals of exceeding contract requirements and program expectations.
2237		These should address appropriate manufacturing and quality cost, schedule, and performance
2238		improvements (including supply chain) in the areas of:
2239		• Strong management commitment to success through effective communications, team
2240		empowerment, and visibility in manufacturing and quality planning, teamwork, and
2241		execution
2242		• Assessments of lower tier supply chain for manufacturing readiness and maturity in
2243		advance of the System maturity targets (#/%)
2244		• Manufacturing cost (Δ \$), cost reduction (%/\$), and cost avoidance
2245		• Schedule improvements (such as increased slack time, expedited development, early
2246		delivery, or just-in-time implementation, etc.)
2247		• Technical enhancements beyond contract requirements in quality, reliability,
2248		maintainability, product improvement, yield, rates, etc.
2249		• Testing and reliability improvements positive trends (%)
2250		• Testing and demonstration beyond contract requirements (include test reductions)
		-

2251	0	Quality improvement positive trends (acceleration of improvements %)
2252	0	Exceeding quality improvement goals
2253	O	Key and critical manufacturing process variation reduction (Cpk improvements on key
2254		and critical products beyond contract)
2255	0	Investments in modern manufacturing methods, software, and equipment including
2256		ManTech (cost share %)
2257	C	Materials characterization schedule improvements in additional environments beyond
2258		contract requirements (time)
2259	O	Variation and Variability reduction efforts exceeding contract requirements (yields, rates,
2260		and trends)
2261	0	Qualification and investments in additional sources within the U.S. IB (\$)
2262	Metrics	
2263	• N	Ianufacturing and quality inputs to EMD Incentives Criteria consistent with the Acquisition
2264	S	trategy have been documented are traceable to early investments that exceed contract
2265	re	equirements and program expectations. These incentives specify manufacturing and quality
2266	C	ost, schedule, and performance improvements (including supply chain) in the areas of:
2267	0	Strong management commitment to success through effective communications, team
2268	0	empowerment and visibility in manufacturing and quality planning teamwork and
2269		execution
2270	0	Progress of Manufacturing Maturation Plan for lower tier supply chain manufacturing
2270	0	readiness and maturity against program goals (risk reductions to cost and schedule)
2271	0	Manufacturing cost (Λ \$) cost reduction (%/\$) and cost avoidance
2272	0	Schedule improvements (such as increased slack time, expedited development, early
2273	0	delivery or just-in-time implementation etc.)
2275	0	Technical enhancements beyond contract requirements in quality reliability
2276	0	maintainability product improvement yield rates etc
2270	0	Testing and reliability improvements positive trends (%)
2278	0	Testing and demonstration beyond contract requirements (include test reductions)
2279	0	Quality improvement positive trends (acceleration of improvements %)
2280	0	Exceeding quality improvement goals
2280	0	Manufacturing processes against process canability (Cnk) (appropriate positive progress)
2201	0	Key and critical manufacturing process variation reduction (Cpk improvements on key
2282	0	and critical products beyond contract)
2203	0	Investments in modern manufacturing methods, software, and equipment including
2204	0	ManTech (cost share %)
2205		Producibility enhancement and project completion $(\#/\%)$ above contract requirements
2200	0	Materials characterization schedule improvements in additional environments beyond
2201	0	contract requirements (time)
2200 2280	~	Variation and Variability reduction afforts avagading contract requirements (vields, retes
2209	0	and trends)
2290	~	and using) Qualification and investments in additional sources within the U.S. \mathbb{R} (\mathfrak{C})
2271	0	Quantication and investments in additional sources within the U.S. $ID(\phi)$

2292	Tools	
2292		Award Eac/Incentive Eac Dian
2293	•	Award Pee/ incentive Pee Flair
2294	Resou	irces
2295		• FAR Subpart 16.4 Incentive Contracts
2296		 DoD/NASA Incentive Contracting Guide
2297		 AS6500, Manufacturing Management Program, Nov 2014
2298		o AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense
2299		Organizations, Sep 2016
2300		• ISO 9001:2015, Quality Management System
2301		• MRL Deskbook Version 2016
2302	B.5	Update RFP Post-PDR
2303	Manu	facturing and Quality Tasks
2304	•	If needed, update manufacturing and quality inputs to the RFP based on post-PDR
2305		assessment results (see A.3) and updates made to the following (see A.4):
2306		• The Acquisition Strategy
2307		 Acquisition Approach
2308		 Business Strategy
2309		 Contracting Strategy (type and termination liability)
2310		 Cooperative Opportunities (if necessary)
2311		 General Equipment Valuation
2312		 Industrial Base Considerations
2313		 Intellectual Property Considerations
2314		 Market Research (for RFP RDP)
2315		 Modular Open Systems Approach
2316		 Multiyear Procurement Did Lange 10 and its Manager 10
2317		 Risk, Issue, and Opportunity Management Process Small Dusiness Inneutrien Descende/Small Dusiness Technology Transfer
2318		• Small Business Innovation Research/Small Business Technology Transfer (for PED PDD)
2319		$(101 \text{ K}1^{\circ}\text{F} \text{ K}\text{D}\text{F})$
2320		• Acquisition Program Baseline
2321		• Affordability Analysis
2322		Analysis of Alternatives Devices
2325		o Bandwildin Kequirements Keview
2324 2325		 Capability Development Document Cost Analysis Paguirements Description (CAPD), PEP Palassa Cost Assessment, etc.
2323		• Cost Analysis Requirements Description (CARD), RFP Release Cost Assessment, etc.
2320 2327		• Exit Citicita
2321		• Life Cycle Sustainment Plan (LCSP)
2520		6 Ene Cycle Sustainment I fan (LCSI)

3. Technology Maturation and Risk Reduction (TMRR) Phase

2329 2330 2331 2332 2333 2334 2335 2336		Low-Rate Initial Production (LRIP) Quantity PESHE and NEPA Compliance Schedule Program Protection Plan (PPP) Should Cost Targets Spectrum Supportability Risk Assessment Systems Engineering Plan (SEP) Technology Readiness Assessment (TRA) Test and Evaluation Master Plan (TEMP)
2337	Metrics	
2338 2339 2340	• M do fo	anufacturing and quality updated inputs for changes to the RFP (post-PDR) have been ocumented and provided to program management for recommended potential changes in llowing:
2341	0	The Acquisition Strategy
2342 2343		Acquisition ApproachBusiness Strategy
2344		 Contracting Strategy (type and termination liability)
2345		 Cooperative Opportunities (if necessary)
2346		 General Equipment Valuation
2347		 Industrial Base Considerations
2348		 Intellectual Property Considerations
2349		 Market Research (for RFP DRD)
2350		 Modular Open Systems Approach
2351		 Multiyear Procurement
2352		 Risk, Issue, and Opportunity Management Process
2353		 Small Business Innovation Research/Small Business Technology Transfer (for RFP)
2354		DRD)
2355	0	Acquisition Program Baseline
2356	0	Affordability Analysis
2357	0	Analysis of Alternatives
2358	0	Bandwidth Requirements Review
2359	0	Capability Development Document
2360	0	Cost Analysis Requirements Description (CARD), RFP Release Cost Assessment, etc.
2361	0	Exit Criteria
2362	0	Item Unique Identification Implementation Plan
2363	0	Life Cycle Sustainment Plan (LCSP)
2364	0	Low-Rate Initial Production (LRIP) Quantity
2365	0	PESHE and NEPA Compliance Schedule
2366	0	Program Protection Plan (PPP)
2307	0	Should Cost 1 argets
2308	0	spectrum supportability Kisk Assessment

3. Technology Maturation and Risk Reduction (TMRR) Phase

2369 2370 2371 2372	 Systems Engineering Plan (SEP) Technology Readiness Assessment (TRA) Test and Evaluation Master Plan (TEMP) TBD
2373	Tools
2374	AS6500, Manufacturing Management System Checklist
2375	 AS9100, Quality Management System Checklist, Sep 2016
2376	 ISO 9001, Quality Management System Checklist, Sep 2016
2377	 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
2378	 IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
2379	• IG5315.204-5(b) Section L Guide and Template
2380	• IG5315.204-5(c) Section M Guide and Template
2381	Resources
2382	 AS6500, Manufacturing Management Program, Nov 2014
2382 2383	 AS6500, Manufacturing Management Program, Nov 2014 AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense
2382 2383 2384	 AS6500, Manufacturing Management Program, Nov 2014 AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations, Sep 2016
2382 2383 2384 2385	 AS6500, Manufacturing Management Program, Nov 2014 AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations, Sep 2016 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
2382 2383 2384 2385 2386	 AS6500, Manufacturing Management Program, Nov 2014 AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations, Sep 2016 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
2382 2383 2384 2385 2386 2386	 AS6500, Manufacturing Management Program, Nov 2014 AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations, Sep 2016 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs ISO 9001:2015, Quality Management System
2382 2383 2384 2385 2386 2387 2388	 AS6500, Manufacturing Management Program, Nov 2014 AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations, Sep 2016 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs ISO 9001:2015, Quality Management System IG5315.204-5(b) Section L Guide
2382 2383 2384 2385 2386 2387 2388 2388	 AS6500, Manufacturing Management Program, Nov 2014 AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations, Sep 2016 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs ISO 9001:2015, Quality Management System IG5315.204-5(b) Section L Guide IG5315.204-5(c) Section M Guide
2382 2383 2384 2385 2386 2386 2387 2388 2389 2390	 AS6500, Manufacturing Management Program, Nov 2014 AS9100, Quality Management Systems - Requirements for Aviation, Space, and Defense Organizations, Sep 2016 IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs ISO 9001:2015, Quality Management System IG5315.204-5(b) Section L Guide IG5315.204-5(c) Section M Guide MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016

2392 C. SURVEILLANCE SYSTEM

2397

- 2393 The Program Manager should maximize the use of DCMA information, data, and analyses from
- 2394 contractor facilities where there is delegation of authority and expertise available. DCMA, utilizing a
- 2395 systematic approach to supplier manufacturing and supply chain evaluation, supply chain
- 2396 improvement initiatives, and best practices, is a valuable resource.



3. Technology Maturation and Risk Reduction (TMRR) Phase

- 2398 Effective quality management is required if the contractor is to deliver an operationally safe, suitable
- and effective system. The Quality Management System (QMS) assures the as-delivered configuration
- 2400 is the same as the as-designed and as-tested configuration. The QMS serves as the control function
- within the systems engineering process, requiring control over requirements reviews, design inputs,
- 2402 verification and validation of design outputs, and control of design changes. The QMS also requires
- 2403 monitoring and measuring of processes and products to ensure they conform to requirements.
- 2404 DCMA provides access to reliable and accurate QMS data and process information on costs,
- schedule, and technical performance and can assist with objective assessment of supplier plans and
- the verification of initial and continuing compliance with requirements. The ability to continually
- 2407 analyze risks and identify risk-adjusted solutions to sustain a reliable, technologically superior,
- 2408 efficient, cost-effective, and resilient defense industrial base mitigates overall program risk.
- 2409 Manufacturing and quality should provide information, data, plans for the requirement to obtain
- 2410 DCMA analyses, supporting information, and recommendations as inputs to the program
- 2411 management and technical reviews.
- 2412 A pre-award survey can focus on virtually every facet of the contractor's business operations from
- 2413 technical capability to financial stability, from quality assurance to plant safety. DCMA conducts
- 2414 nearly all pre-award surveys required by government buying activities. Manufacturing and quality
- 2415 should provide recommendations and inputs to program management for the pre-award survey
- 2416 requirements to be addressed by DCMA.
- 2417 The process begins with a program request for a survey and concludes with a program decision based
- 2418 on a recommendation by a DCMA Contract Management Office (CMO) survey team. A pre-award
- 2419 survey can focus on virtually every facet of the contractor's business operations from technical
- 2420 capability to financial stability, from quality assurance to plant safety. In a sense, the survey process
- is the contractor's opportunity to provide evidence (i.e., Plan of Performance) that they can
- 2422 successfully fulfill the terms of the contract.

2423 C.1 Utilize DCMA data for Program Management Inputs

2424 Manufacturing and Quality Tasks

2429

- Utilize the DCMA information and data to support manufacturing and quality inputs to the
 SRR to include:
- 2427 Assessments of manufacturing and quality feasibility
- 2428 Contractor(s) capability to meet manufacturing and quality requirements for:
 - Manufacturing Management System best practices (i.e., AS6500)
- Quality Management System best practices (e.g., AS9100, ISO 9000, etc.)
- Risk, Issues, and Opportunities Management System capabilities
- Human safety and health

Manufacturing and Quality Management Body of Knowledge

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2433	 Environmental and hazardous materials management (pollution prevention)
2433	 Environmental and nazardous materials management (ponution prevention) Security (physical and cyber) for both hardware and software (a.g. communications)
2434	- Security (physical and cyber) for both hardware and software (e.g., communications,
2433	 Management of KCs
2430	 Management of data and software (including collection, analysis, testing, and
2437	- Management of data and software (including conection, analysis, testing, and methods of analysis, storage, retrieval of manufacturing and quality data)
2430	Supportability and sustainment
2439	 Supportability and sustainment Use of COTS_COTS_NDIs_ and CEE (including diminishing manufacturing sources)
2440	 Use of COTS, GOTS, NDIS, and GFE (including diminishing manufacturing sources) Management of parts, materials, and processors (DM & D)
2441	 Management of parts, materials, and processes (PM&P) Configuration Management System conchilities
2442	Configuration Management System capabilities
2443	• Specialized manufacturing requirements (extreme complexity, multiple or very tight
2444	tolerances, EMI protection, precision assembly, handling of fragile components and
2445	Electrostatic Discharge protection, etc.)
2446	 Process capabilities and manufacturing operations
2447	 Modeling and Simulation tools and capabilities
2448	 Testing processes, equipment, and facilities capabilities
2449	 Earned Value Management System capabilities
2450	 Cost, Scheduling, and Control System capabilities
2451	 Systems Engineering Management capabilities (i.e., IEEE 15288)
2452	 Performance to plans and schedules (IMP/IMS)
2453	• Provide information, data, plans for manufacturing and quality requirements to obtain
2454	DCMA analyses, supporting information, and recommendations as inputs to the System
2455	Functional Review to include DCMA:
2456	\circ Analyses and results of contractor(s) and supply chain capabilities
2457	• Analyses and results of Industrial Base canability studies
2458	• Recommendations from assessments of contractor(s) supply chain capability, if available
2459	• Analyses of contractor(s)' capability to procure mature and characterize materials
2460	• Analyses and recommendations for contractor(s)' producibility and continuous
2460	improvement processes
2461	• Recommendations for the contractor(s) tooling and equipment strategies
2462	• Recommendations for the Manufacturing and Quality Plans, the TEMP, and the
2403	IMP/IMS
2404	\sim Analyses and recommendations for the contractor's SEMP
2466	• Recommendations for the contractor(s) workforce requirements skills capabilities
2400 2467	training and certifications
2468	Δ = Δ nalyses of contractor(s) manufacturing and production process varifications and Process
2400	Consolitions (Coles)
2409	Capabilities (CpKS)
	a Analysis and recommandations for the contractor(a) Quality Management System and
2470	• Analyses and recommendations for the contractor(s) Quality Management System and

3. Technology Maturation and Risk Reduction (TMRR) Phase

2472 Based on DCMA inputs, develop recommendations for manufacturing investment programs • 2473 that mature emerging manufacturing technologies and industrial capabilities (see D.2 and 2474 D.4). 2475 Metrics 2476 • DCMA information and data has been utilized to develop and document manufacturing and 2477 quality inputs for the SRR, including: 2478 Results of manufacturing and quality feasibility assessments 0 2479 • Reports on contractor(s) capability to meet manufacturing and quality requirements for: 2480 Manufacturing Management System best practices (i.e., AS6500) 2481 Quality Management System best practices (e.g., AS9100, ISO 9000, etc.) 2482 • Risk, Issues, and Opportunities Management System capabilities 2483 Human safety and health • 2484 Environmental and hazardous materials management (pollution prevention) 2485 Security (physical and cyber) for both hardware and software (e.g., communications, 2486 cyber, program protection, anti-tamper, etc.) 2487 Management of KCs 2488 Management of data and software (including collection, analysis, testing, and 2489 methods of analysis, storage, retrieval of manufacturing and quality data) 2490 Supportability and sustainment Use of COTS, GOTS, NDIs, and GFE (including diminishing manufacturing sources) 2491 2492 Management of parts, materials, and processes (PM&P) 2493 Configuration Management System capabilities 2494 Specialized manufacturing requirements (extreme complexity, multiple or very tight tolerances, EMI protection, precision assembly, handling of fragile components and 2495 2496 Electrostatic Discharge protection, etc.) 2497 • Process capabilities and manufacturing operations 2498 Modeling and Simulation tools and capabilities Testing processes, equipment, and facilities capabilities 2499 Earned Value Management System capabilities 2500 • 2501 Cost, Scheduling, and Control System capabilities 2502 Systems Engineering Management capabilities (i.e., IEEE 15288) 2503 Performance to plans and schedules: Integrated Master Plan(IMP), Integrated Master 2504 Schedule (IMS) 2505 DCMA analyses, supporting information, and recommendations have been obtained and • 2506 document inputs to the System Functional Review including the contractor(s): 2507 • Capabilities including supply chain capabilities and recommendations 2508 • Capability to procure, mature, and characterize materials 2509 • Producibility and continuous improvement processes 2510 Tooling and equipment strategies 0

Manufacturing and Quality Management Body of Knowledge

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2511 2512 2513 2514		 Manufacturing Plans, Quality Plans, the TEMP, the IMP/IMS, and the SEMP Workforce requirements, skills, capabilities, training, and certifications Manufacturing and production process verifications and Process Capabilities (CpKs) Quality Management System and processes
2515 2516 2517 2518 2519	•	DCMA analyses, supporting information, and recommendations have been obtained and document inputs to the System Functional Review for Industrial Base capability studies. Recommendations for manufacturing investment programs have been developed and documented based on DCMA recommendations that mature emerging manufacturing technologies and industrial capabilities (see D.2 and D.4).
2520	Tools	
2521	•	DCMA inputs to the following documents, go/no-go (either is or is not included)
2522	•	Manufacturing Readiness Level (MRL) Assessment
2523	•	Technology Readiness Assessment (TRA)
2524	•	Integrated Master Plan/Schedule (IMP/IMS)
2525	•	Test and Evaluation Master Plan (TEMP)
2526	•	Systems Engineering Plan (SEP)
2527	Resou	rces
2528	•	DCMA-INST-204, Manufacturing and Production
2529	•	DCMA-INST-205, Major Program Support
2530	•	DCMA-INST-207, Engineering Surveillance
2531	•	DCMA-209, Pre-award Surveys
2532	•	DCMA-INST-323, Data Collection and Analysis
2533	•	DCMA-INST-325, Technical Reviews
2534	•	DCMA-INST-1201, Corrective Action
2535	C.2	Conduct Pre-Award Survey
2536	Manu	facturing and Quality Tasks
2537	•	Develop manufacturing and quality requirements for DCMA pre-award surveys requests.
2538	•	Manufacturing and quality provide recommendations and inputs to program management for
2539		the pre-award type survey requirements (e.g., formal general purpose, formal on-site with
2540		solicitation requirements, or short form).
2541		• Identify manufacturing and quality management systems (MMS/OMS) specific contract
2542		clauses and work statements within the acquisition planning documents
2543		• Identify MMS/QMS risk areas during pre-award and post-award conferences, and follow-

and critical suppliers:	veys of the contractor and key
2547 • Technical capability	
2548 o Production capability	
2549 o Quality assurance	
2550 o Risk identification	
2551 o Supply chain management	
2552 o Finance and accounting	
2553 o Government property control	
2554 o Transportation and packaging	
2555 o Security, physical and cyber	
2556 o Plant safety	
2557 o Hazardous materials/environmental/energy/regulatory con	pliance
2558 o Flight, space, and/or operations and safety	
2559 o Software capability	
2560 o Technical documentation	
2561 o Configuration management	
• Review DCMA audit results for manufacturing and quality im	pacts and make
2563 recommendations to the source selection personnel, the Procur	rement Contracting Officer
2564 (PCO), the program Systems Engineer, and the Program Mana	iger.
2565 Metrics	
 2565 Metrics 2566 • Manufacturing and quality requirements for DCMA pre-award 	l surveys requests have been
 2565 Metrics 2566 Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 	l surveys requests have been t.
 2565 Metrics 2566 Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and provided to program management 	l surveys requests have been t. provided recommendations to
 2565 Metrics 2566 Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement 	l surveys requests have been t. provided recommendations to ents (e.g., formal general
 2565 Metrics 2566 Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement 2570 purpose, formal on-site with solicitation requirements, or shore 	l surveys requests have been it. provided recommendations to ents (e.g., formal general t form).
 2565 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement 2569 program management for the pre-award type survey requirement 2570 o Specific contract clauses and work statements within the a 	I surveys requests have been t. provided recommendations to ents (e.g., formal general t form). cquisition planning documents
 2565 Metrics 2566 Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement 2570 program management for the pre-award type survey requirement 2570 o Specific contract clauses and work statements within the a have been identified for formal survey 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents
 2565 Metrics 2566 Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement 2569 program management for the pre-award type survey requirement 2570 o Specific contract clauses and work statements within the a have been identified for formal survey 2573 o MMS/QMS risk areas have been documented 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents
 2565 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement 2569 program management for the pre-award type survey requirement 2570 o Specific contract clauses and work statements within the a have been identified for formal survey 2573 o MMS/QMS risk areas have been documented 2574 The following factors were included and survey results documented 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents
 2565 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement purpose, formal on-site with solicitation requirements, or shor Specific contract clauses and work statements within the a have been identified for formal survey MMS/QMS risk areas have been documented The following factors were included and survey results documentes were and critical suppliers: 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents
 2565 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement purpose, formal on-site with solicitation requirements, or shor Specific contract clauses and work statements within the a have been identified for formal survey MMS/QMS risk areas have been documented The following factors were included and survey results documents, were and critical suppliers: 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents
 2565 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement 2569 program management for the pre-award type survey requirement 2570 o Specific contract clauses and work statements within the a have been identified for formal survey 2573 o MMS/QMS risk areas have been documented 2574 The following factors were included and survey results docum key and critical suppliers: 2576 o Technical Capability (e.g., plans, processes, and systems) 2577 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents
 2565 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2568 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement purpose, formal on-site with solicitation requirements, or shor 2571 • Specific contract clauses and work statements within the a have been identified for formal survey 2573 • MMS/QMS risk areas have been documented 2574 • The following factors were included and survey results docum key and critical suppliers: 2576 • Technical Capability (e.g., plans, processes, and systems) 2577 • Orduction Capability (e.g., facilities, tooling, rates, etc.) 2578 • Quality Assurance (e.g., audits compliance processes place) 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents ented for the contractor and
 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement Specific contract clauses and work statements within the a have been identified for formal survey MMS/QMS risk areas have been documented The following factors were included and survey results docum key and critical suppliers: Technical Capability (e.g., plans, processes, and systems) Production Capability (e.g., audits, compliance, processes, plans, monitoring, etc.) Risk identification (e.g., processes, plans, monitoring, etc.) 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents ented for the contractor and
 2565 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management 2567 Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement purpose, formal on-site with solicitation requirements, or shor 2570 • Specific contract clauses and work statements within the a have been identified for formal survey 2573 • MMS/QMS risk areas have been documented 2574 • The following factors were included and survey results docum key and critical suppliers: 2576 • Technical Capability (e.g., plans, processes, and systems) 2578 • Quality Assurance (e.g., audits, compliance, processes, plans, monitoring, etc. 2580 • Supply Chain Management (i.e., qualification processes) 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents mented for the contractor and uns, monitoring, etc.)
 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management Manufacturing and quality have developed, documented, and program management for the pre-award type survey requirement purpose, formal on-site with solicitation requirements, or shor Specific contract clauses and work statements within the a have been identified for formal survey MMS/QMS risk areas have been documented The following factors were included and survey results docum key and critical suppliers: Technical Capability (e.g., plans, processes, and systems) Production Capability (e.g., audits, compliance, processes, plas, monitoring, etc. Supply Chain Management (i.e., qualification processes) Finance and Accounting 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents ented for the contractor and uns, monitoring, etc.)
 Metrics Manufacturing and quality requirements for DCMA pre-award developed, documented, and provided to program management for the pre-award type survey requirement purpose, formal on-site with solicitation requirements, or shor Specific contract clauses and work statements within the and have been identified for formal survey MMS/QMS risk areas have been documented The following factors were included and survey results docume key and critical suppliers: Technical Capability (e.g., plans, processes, and systems) Production Capability (e.g., facilities, tooling, rates, etc.) Quality Assurance (e.g., audits, compliance, processes, plans, monitoring, etc. Supply Chain Management (i.e., qualification processes) Finance and Accounting Government Property Control 	I surveys requests have been it. provided recommendations to ents (e.g., formal general t form). cquisition planning documents mented for the contractor and uns, monitoring, etc.)

3. Technology Maturation and Risk Reduction (TMRR) Phase

2584	• Security, physical and cyber
2585 2586 2587	 Security standards including Industrial Control Security ITAR compliance Cyber-security
2588 2589 2590	 Plant Safety (i.e., compliance audits) Hazardous Materials/Environmental/Energy/Regulatory Compliance Flight, Space, and/or Operations and Safety
2591 2592 2593 2594 2595	 Airworthiness Seaworthiness Combat operations readiness Space-worthiness Cyber-readiness
2596 2597 2598	 Software Capability Technical documentation, status, and reporting (e.g., CDRLs, SEMPs, TEMPs, etc.) Configuration Management
2599 2600 2601	• DCMA audit results have been reviewed for manufacturing and quality impacts and recommendations have been documented and provided to the source selection personnel, the PCO, the program Systems Engineer, and the Program Manager.
2602 Too	bls
2603 2604 2605 2606	 SF 1404 Pre-Award Survey – Technical SF 1405 Pre-Award Survey – Production SF 1406 Pre-Award Survey – Quality Assurance SF 1407 Pre-Award Survey – Financial Capability
2607 Res	sources
2608 2609 2610 2611 2612	 DCMA-INST-204, Manufacturing and Production DCMA-INST-205, Major Program Support DCMA-INST-207, Engineering Surveillance DCMA-209, Pre-Award Surveys DCMA Pre-Award Survey Guide (old version)

2613 D. TECHNOLOGY AND INDUSTRIAL BASE (IB)

2614 TMRR phase IB considerations should include a thorough evaluation of the IB to understand how the

2615 IB capability and availability will impact the program. DoD Directives (DoDD) and Public Law

requires each major program to conduct assessments of the IB throughout the acquisition cycle. The

2617 phase assessments help determine the capabilities of the IB to develop, produce, maintain, and

support all defense acquisition programs. The program will document the source availability,

- 2619 producibility, supportability, and maintainability risks and technology needs associated with the
- 2620 materials and components needed.



- 2621
- The update of earlier phase assessments will serve as a baseline as the design evolves. It will document the manufacturing capabilities required for the AS and facilitate the updates of manufacturing and quality inputs to the Systems Engineering Plan (SEP) and Request for Proposal (RFP) documents. The IB topic areas that should be assessed include:
- Industrial base sources relevant to the program, the contractor, and the contractor's supply
 chain
- Manufacturing and quality processes and techniques
- Design producibility risks, issues, and opportunities
- Cyber risks and vulnerabilities to manufacturing and quality information and data
- Impacts of materials (e.g., critical, long-lead, etc.)
- Supply disruption risks, issues, and program impacts from critical and strategic materials
- Availability and capability of production machinery, equipment, and tooling
- IB analysis is a continuing process that gathers program specific information and provides feedbackthroughout the program life cycle. Earlier IB analyses require updating for the following:
- Development requirements and planned production rates
- Industrial capabilities risks, issues and opportunities (e.g., single points of failure, fragile
 suppliers, sole and single sources, etc.)
- Resilience of critical defense industrial base capabilities
- Procurement surges and contractions
- 2641 Much of the technology that will be incorporated into the system is matured during phase for
- 2642 inclusion or insertion. Manufacturing and quality should be working closely with the design
- 2643 engineers to evaluate the maturity and feasibility of each new system technology. New system
- technologies are prone to producibility issues that make them high risk and these technologies may
- require new manufacturing technologies. Manufacturing technology gaps should be addressed with
- 2646 plans and budget for development, initiation, and insertion points identified along with cost,
- schedule, and performance impacts. Contractor agreements to utilize completed or successful
- 2648 manufacturing technology projects are essential.

3. Technology Maturation and Risk Reduction (TMRR) Phase

2649 While all new technologies need to be monitored, certain technologies will be critical to the success

- 2650 of the program these critical technologies deserve special considerations. If a system depends on
- 2651 specific technologies to meet operational thresholds in development, production, operation, and
- sustainment, and if the technology or its application is either new or novel, then that technology is
- 2653 considered a critical or enabling technology. These Critical Technology Elements should have been
- identified and evaluated in the MSA phase for maturity of the technology, in preparation for a formal
- 2655 Technology Readiness Assessment (TRA).

Additionally, CTEs were identified in the previous phase and assessed for feasibility, affordability, and supportability and for manufacturing and quality maturity. Plans to increase maturity were incorporated into the draft CDD, AS, SEP, and the RFP for the MSA phase. For TMRR, the identified manufacturing and quality process areas and process limitations requiring risk mitigation will be updated, including the hardware and the associated embedded software maturity and the cybersecurity risks and vulnerabilities to software and firmware. Implementation of risk reduction efforts in these areas should be initiated in this phase.

2663 Technology risks that are critical to the success of the program are candidates for new Manufacturing 2664 Technology (ManTech) projects. However these types of projects will have their own risks, costs, 2665 and schedule impacts that must be factored into the program. The objective of the ManTech program 2666 is to improve performance while reducing acquisition cost by developing, maturing and transitioning advanced manufacturing technologies. The ManTech program impacts all phases of acquisition. It 2667 aids in achieving reduced acquisition and total ownership costs by developing, maturing, and 2668 2669 transitioning key manufacturing technologies in support of new system technologies. Plans from the previous provide the basis for investments and should be initiated in this phase to find and implement 2670 affordable, low-risk solutions. 2671

- 2672 During TMRR phase program management is responsible for incorporating industrial base analyses,
- 2673 to include capacity and capability considerations, into acquisition planning and execution. Having
- 2674 documented industrial base considerations in the Acquisition Strategy and identified industrial
- 2675 capability problems, the program should initiate an IB mitigation plan that addresses current and
- 2676 future manufacturing and quality risks. The plan should address manufacturing and quality
- 2677 capabilities that should be maintained throughout program life cycle; mitigate obsolescence, business
- 2678 fragility, supply chain vulnerability, material availability; and address impacts of external
- 2679 dependencies, new and unique capabilities, military vulnerabilities, and rate and quantity changes.
- Additionally, public law requires major defense acquisition programs to conduct an analysis of the capabilities of the national technology and industrial base to develop, produce, maintain, and support the program, including consideration of the following factors related to foreign dependency:
- The availability of essential raw materials, special alloys, composite materials, components,
 tooling, and production test equipment for the sustained production of systems fully capable

3. Technology Maturation and Risk Reduction (TMRR) Phase

of meeting the performance objectives established for those systems; the uninterrupted

maintenance and repair of such systems; and the sustained operation of such systems.

The identification of major systems and items available only from sources outside the

2685 2686

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2688		national technology and industrial base.	
2689	•	The availability of alternatives for obtaining such items from within the national technology	
2690		and industrial base if such items become unavailable from sources outside the national	
2691		technology and industrial base; and an analysis of any military vulnerability that could result	
2692		from the lack of reasonable alternatives.	
2693	•	The effects on the national technology and industrial base that result from foreign acquisition	
2694		of firms in the United States.	
2695	During	TMRR, management of industrial base and technology considerations to reduce technology,	
2696	engineering, integration, and life cycle risks must be an integral part of program management and are		
2697	key to	the success of the program through development, production, and sustainment.	
2698	D.1	Update Industrial Base Capabilities Assessment and Analyses	
2699	Manu	facturing and Quality Tasks	
2700	•	Update the analyses of Industrial Base Capabilities Considerations (from previous phase or	
2701		conduct if not previously accomplished) of the national technology and industrial base to	
2702		develop, produce, maintain, and support the program, including foreign dependency. The	
2703		updated analyses will consider the following:	
2704		• Identification of relevant sources including identification of:	
2705		 Unique manufacturing capabilities 	
2706		 Capabilities not readily accessible or available (e.g., capability is at maximum 	
2707		capacity, materials from a constrained source, etc.)	
2708		 Major systems and items available only from sources outside the national technology 	
2709		and industrial base	
2710		 Alternatives for obtaining such items from within the national technology and 	
2711		industrial base if such items become unavailable from sources outside the national	
2712		technology and industrial base	
2713		• Vulnerabilities of and effect on the supply chain including sole, single, fragile, or foreign	
2714		sources, cyber exploitation, and foreign acquisition	
2715		• Capability of the materiel solution to be produced using existing manufacturing	
2716		capabilities and capacities while meeting quality, production rate and cost requirements.	
2717		• Capability of the IB to protect digitized program and system information including	
2718		system definition, design and test, contracting, and competitive prototyping.	
2719		• Capability to cost effectively design, develop, produce, maintain, and support the	
2720		program, including:	
2721		 Tooling 	

2722		 Production test equipment
2723		 Operation of systems
2724		 Maintenance and sustainment of systems
2725	0	Capability to make production rate and quantity changes that support a response to
2726		contingency and support objectives (surges and contractions)
2727	0	Availability of essential raw materials, special alloys, composite materials, components,
2728		tooling, and production test equipment required to include the availability of alternatives
2729		for obtaining such items from within the NTIB
2730	0	Potential obsolescence of components, parts, and materials
2731	0	Impacts of external dependencies and integration
2732	0	New and unique capabilities and processes
2733	0	Assessed requirements and capabilities which include:
2734		 Identified sources for key technologies, components, and processes, including known
2735		gaps and risks
2736		 Identified needs including design, development, production, operation, and
2737		sustainment, and eventual disposal
2738		 All technological developments, market trends, processes, environmental factors, and
2739		policies, etc. that could potentially impact the program
2740	0	Updated DCMA industrial analysis data and reports to include:
2741		 Industrial Capability Assessments
2742		 Appropriate Analytical Products
2743		 Defense Business and Economic Analysis
2744		 Acquisition Planning Support
2745	• Pr	epare the updated Industrial Base Capabilities Considerations summary report for inclusion
2746	in	the Acquisition Strategy and appropriate updates to the SEP:
2747	0	Include recommended actions or investments that address risks to cost, schedule,
2748		performance, and qualitative considerations that define and recommend how and when
2749		the actions would be incorporated into the budget and schedule and, if possible, identify
2750		budget offsets
2751		• Note: If the required investment is greater than \$10 million and is determined to
2752		affect more than one defense program must be coordinated within and across the
2753		Components and approved by the Under Secretary Of Defense For Acquisition,
2754		Technology, And Logistics per DODI 5000.60.
2755	Metrics	
2756	• A1	nalyses of Industrial Base Capabilities Considerations of the national technology and
2757	in	dustrial base to develop, produce, maintain, and support the program, including foreign
2758	de	pendency have been updated or conducted including consideration of the following:
2759	0	Relevant source(s) identification including identification of:

2760 2761 2762 2763 2764 2765 2766 2767	 Unique manufacturing capabilities Capabilities not readily accessible or available (e.g., capability is at maximum capacity, materials from a constrained source, etc.) Major systems and items available only from sources outside the national technology and industrial base Alternatives for obtaining such items from within the national technology and industrial base if such items become unavailable from sources outside the national technology and industrial base
2768 2769 2770 2771 2772 2773 2774 2775 2776	 Vulnerabilities and the effect on the supply chain from sole, single, fragile, or foreign sources, cyber exploitation, and foreign acquisition Capability to produce the system, subsystem, items, and components using existing manufacturing capabilities and capacities, and meet requirements (e.g., quality, production rate and cost requirements) Capability of the IB to protect digitized program and system information (cybersecurity) including system definition, design and test, contracting, and competitive prototyping Capability to cost effectively design, develop, produce, maintain, and support the program, including:
2777 2778 2779 2780	 Tooling Production test equipment Operation of systems Maintenance and sustainment of systems
2781 2782 2783 2784 2785 2786 2787 2788 2789	 Capability to make production rate and quantity changes that support a response to contingency and support objectives (surges and contractions) 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 of components, parts, and materials Impacts of external dependencies and integration New and unique capabilities and processes Assessed requirements and capabilities:
2790 2791 2792 2793 2794 2795	 Sources for key technologies, components, and processes, including known gaps and risks Needs including design, development, production, operation, and sustainment, and eventual disposal Program impacts including technological developments, market trends, processes, environmental factors, and policies, etc.
2796 2797 2798 2799	 Updated DCMA industrial analysis data and reports to include: Industrial Capability Assessments Appropriate Analytical Products Defense Business and Economic Analysis

3. Technology Maturation and Risk Reduction (TMRR) Phase

2800		 Acquisition Planning Support
2801 2802	•	The updated Industrial Base Capabilities Considerations Summary Report has been prepared manufacturing and quality input to the Acquisition Strategy and updates for the SEP:
2803 2804		• Recommended actions or investments to address risks to cost, schedule, performance, and qualitative considerations have been included
2805 2806 2807 2808		 Note: If the required investment is greater than \$10 million and is determined to affect more than one defense program must be coordinated within and across the Components and approved by the Under Secretary Of Defense For Acquisition, Technology, And Logistics per DOD 5000.60.
2809	Tools	
2810 2811		 Industrial Base Assessment Survey Form, DCMA Industrial Analysis Center MRL Assessment Checklist for Technology and Industrial Base thread
2812	Resou	rces
2813 2814		 DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017 DODI 5000.60H, Defense Industrial Capabilities Assessments
2815		• MRL Deskbook Version 2016 • 10 USC 2440. Teshnology and Industrial Dags
2810		 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and
2817		Industrial Base
2819		 10 USC 2503, Analysis of the Technology and Industrial Base
2820	D.2	Update Manufacturing Technology Gaps and Requirements
2821	Manu	facturing and Quality Tasks
2822 2823	•	Update assessments and analyses of emerging technologies to determine capability of current manufacturing technology, processes, and infrastructure to support system development.
2824 2825 2826		 Analyze the need (determine gaps) for new manufacturing technologies, processes, and infrastructure Identify required risk mitigation efforts with cost and schedule impacts
2827 2828 2829	•	Perform manufacturing technology trade studies that includes an assessment of how new and emerging technology might impact product design requirements, affordability, and manufacturing capabilities.
2830 2831	•	Update the assessment of identified high risk manufacturing process areas necessary for the program that require investments in ManTech programs.
2832		• Estimate cost, schedule, and performance impacts
2833 2834	•	Update current ManTech project plans with survey data from ongoing ManTech projects and DCMA reports and analyses for solutions to manufacturing technology gaps.

2835		• Request DCMA provide up-to-date data
2836		• Update the comprehensive plan for each required ManTech investment
2837		 Ensure the DoD/Service ManTech POC membership in appropriate IPT
2838		 Request information from other government agencies, industry, and academia
2839		responses to needs
2840	Metrio	cs
2841	•	Assessments and analyses of emerging technologies to determine capability of current
2842		manufacturing technology, processes, and infrastructure to support system development have
2843		been updated and documented for program management and reviews (e.g., SFR, AS, budget,
2844		PMRs, etc.) including:
2845		• Gaps requiring new manufacturing technologies, processes, and infrastructure
2846		• Required risk mitigation planning efforts with cost, budget, and schedule impacts
2847	•	Manufacturing technology trade studies have been performed and documented that includes
2848		assessment new and emerging technology impacting product design requirements,
2849		affordability, and manufacturing capabilities.
2850	•	ManTech project plans have been updated based on the assessment of high-risk
2851		manufacturing process areas, the ongoing ManTech projects, DCMA inputs from reports and
2852		analyses, information from Services and agencies, industry, and academia; and quantify the
2853		required investments in ManTech programs including cost, schedule, budget, and
2854		performance impacts.
2855	Tools	
2856	•	MRL Assessment Checklist for Technology and Industrial Base thread
2857	•	Producibility Assessment Worksheet (PAWs)
2858	•	Pugh Matrix
2859	•	Technology Readiness Assessment
2860	Resou	rces
2861	•	MRL Deskbook Version 2016
2862	•	NAVSO P-3687 Producibility Systems Guidelines, Dec 1999
2863	•	Technology Transition Managers Guide, June 2005
2864	D.3	Address Critical Technology Element (CTE) Process Limitations
2865	Manu	facturing and Quality Tasks
2866	•	Update and assess the identified CTEs for feasibility, affordability, and supportability and for
2867		manufacturing and quality maturity.
2868		• Identify mature alternative components or subsystems for each immature CTE
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2869 2870		• Develop plans for increasing CTEs manufacturing and quality maturity and mitigating associated risks and include:
2871 2872 2873 2874 2875 2876		 Update plans to improve and/or maintain maturity from the draft CDD, AS, and SEP (if available) If manufacturing processes need to be updated or developed, plan and budget for the effort to mitigate manufacturing risk Include integration risks associated with the updated CTEs from trade studies Include updates for CTE interdependencies and associated risks
2877 2878	•	Update the identified manufacturing and quality process areas and process limitations requiring risk mitigation
2879 2880		 Include necessary hardware and the associated embedded software maturity Include cybersecurity risks and vulnerabilities (software and firmware)
2881	•	Support the Technology Readiness Assessments that benchmark technology risks.
2882 2883 2884 2885 2886		 Determine the degree of manufacturing and quality risks in development Conduct in depth analyses of the manufacturing and quality risks associated with the design as needed Develop plans for recommended manufacturing and quality risk mitigations to be conducted
2887		• Implement plans to improve CTE manufacturing and quality maturity
2888 2889 2890	•	Manufacturing and quality support definition of the required Technology Readiness Levels (TRLs) to be achieved for each CTE at each systems engineering milestone (e.g., Systems Requirements Review (SRR), Test Readiness Review (TRR), etc.).
2891	Metri	cs
2892 2893	•	Identified CTEs have been assessed for feasibility, affordability, and supportability and for manufacturing and quality maturity and results documented for:
2894 2895 2896		 Mature alternative components or subsystems for each immature CTE Plans for increasing CTEs manufacturing and quality maturity and mitigating associated risks which included:
2897 2898 2899 2900 2901		 Plans to improve and/or maintain maturity from the draft CDD, AS, and SEP (if available) have been updated Budget for the effort to mitigate manufacturing risk has been updated and submitted Integration risks from trade studies Updates for CTE interdependencies and associated risks
2902 2903	•	Manufacturing and quality process areas and process limitations requiring risk mitigation have been updated and documented in the SEP to include:
2904 2905		 Necessary hardware and the associated embedded software maturity Cybersecurity risks and vulnerabilities (software and firmware)

3. Technology Maturation and Risk Reduction (TMRR) Phase

2906	•	Technology Readiness Assessments that benchmark technology risks have been conducted.
2907 2908		 The degree of manufacturing and quality risks in development has been documented In depth analyses of the manufacturing and quality risks associated with the design has
2909		been conducted and risks quantified
2910		• Recommended plans for manufacturing and quality risk mitigations to be conducted has
2911		Deen documented in the SEP, the AS, and the budget and schedule Plans to improve CTE manufacturing and quality maturity have been implemented
2912		o Thans to improve CTE manufacturing and quarty maturity have been impremented
2913	•	Manufacturing and quality has provided input for determination of the required TRLs to be
2914		achieved for each CTE at each systems engineering milestone (e.g., Systems Requirements
2913		Review, Test Readiness Review, etc.).
2916	Tools	
2917	•	MRL Assessment Checklist for Technology and Industrial Base thread
2918	٠	Producibility Assessment Worksheet
2919	•	Technology Readiness Assessment
2920	•	TRL Calculator
2921	Resou	rces
2922	•	DoDI 5000.02, Feb 2017, 5d(4)(b)3. and 5d(4)(c)
2923	٠	Defense Acquisition Program Support Methodology, Ver. 3.0
2924	٠	MRL Deskbook Version 2016
2925	٠	NAVSO P-3687, Producibility Systems Guidelines, Dec 1999
2926	•	Technology Readiness Assessment Deskbook, Jul 2009
2927	D.4	Initiate ManTech Projects
2928	Manut	facturing and Quality Tasks
2929	•	Review Service ManTech portfolios for projects with potential application to program gaps
2930		to:
2931		• Determine if the program/contractor should participate in the project
2932		• Determine if the program/contractor should support bridging of the project to the next
2933		phase Determine how the results of the project can be implemented in the program
2934		o Determine now the results of the project can be implemented in the program
2935	•	Review current Title III, IBAS, and other government investment program portfolios for
2936		projects with potential application to program gaps.
2937 2938	•	based on Service portiono reviews, update program Man Lech plan and submit proposals for funding, which should include:
2020		- Identified high right manufacturing process areas that require investments in state of the
2939 2940		art manufacturing technology

2941 2942 2943 2944 2945 2946		 Identification of manufacturing technology development efforts to be funded by the program or other alternative sources Justification of benefit to industry, industry sector, or other DoD systems Determination if required manufacture technology efforts will be completed in time to support program needs Relevant data from DCMA and other sources to support plan
2947	Metric	CS
2948 2949	•	Service ManTech portfolios for projects with potential application to program gaps have been reviewed and document the need for:
2950 2951 2952		 Program/contractor participation in the project Program/contractor support to bridge the project to the next phase Project implementation in the program
2953 2954 2955 2956	•	Current Title III, IBAS, and other government investment program portfolios have been reviewed for projects and the results document potential application to the program. Program ManTech plans have been updated and proposals submitted for funding. Proposals included:
2957 2958 2959		 Investments in state of the art manufacturing technology Investments efforts to be funded by the program or other alternative sources Justification of benefit to industry, industry sector, or other DoD systems
2960	Tools	
2961 2962 2963 2964	• • •	Army ManTech Proposal Rating spreadsheet ManTech Phase I project questionnaire MRL Assessment Checklist for Technology and Industrial Base thread TRL Assessment Checklist
2965	Resou	rces
2966 2967 2968 2969 2970 2971		 Defense Production Act, Title III DoDI 5000.02, Feb 2017 DoDD 4200.15, ManTech Defense Manufacturing Management Guide for PMs, Chapter 8, Technology Development and Investments MRL Deskbook Version 2016
2972 2973 2974		 Technology Readiness Assessment Guidance, Apr 2011 Service ManTech guidance, e.g. Air Force Technology and Transition Strategy Guidebook, Nov 2010

2975	D.5	Initiate Industrial Base (IB) Risk Mitigation	n
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2976 Manufacturing and Quality Tasks

- Initiate mitigation plans that address current and future manufacturing and quality Industrial Base risks. Plans should:
 Address all manufacturing and quality capabilities required that should be maintained
- 2980 throughout the life of the program
 2981 o Mitigate product or technology obsolescence, lifetime replacement, or regeneration of
 2982 items projected to go out of production
- 2983 o Mitigate business fragility of any facilities or corporations that provide unique services or 2984 products or unique manufacturing and quality capabilities
- 2985 o Address the approach to making production rate and quantity changes that support a 2986 response to contingency and support requirements including surges
- 2987oMitigate the vulnerability of the supply chain (to include sole, single, fragile, foreign2988sources, cyber exploitation, and foreign acquisition of domestic sources)
- 2989oAddress the availability of essential raw materials, special alloys, composite materials,2990components, tooling, and production test equipment (required to include the availability2991of alternatives for obtaining such items from within the NTIB)
 - Address the impacts of external dependencies and integration
 - Address the risks introduced by new and unique capabilities and processes

2994 Metrics

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- Mitigation plans have been initiated that document and address manufacturing and quality
 Industrial Base risks. Plans should address and mitigate risks to:
- 2997oManufacturing and quality capabilities that are required throughout the life of the2998program
- 2999oProduct or technology obsolescence including lifetime replacement or regeneration of3000items projected to go out of production
- 3001oFacilities or corporations that provide unique services or products, or unique3002manufacturing and quality capabilities
- 3003 Adapting to production rate and quantity changes including surge requirements
- 3004oSupply chain vulnerability to include sole, single, fragile, foreign sources, cyber3005exploitation, and foreign acquisition of domestic sources
- 3006oAvailability of essential raw materials, special alloys, composite materials, components,3007tooling, and production test equipment
- 3008 Program from the impacts of external dependencies and integration
- 3009 Program by introduction of new and unique capabilities and processes

3010 **Tools**

3011 o Manufacturing/QA Risk Mitigation Plan (no Template available)

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3. Technology Maturation and Risk Reduction (TMRR) Phase

3012 Resources 3013 DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities, Part II, Chapter 5 Identify and evaluate Alternative Actions, Apr 1996 3015 MRL Deskbook Version 2016, Chapter 5.2 Development of a Manufacturing Maturation Plan

3017 E. DESIGN

3018 Manufacturing and quality personnel participation in and support to Program Design IPTs is critical 3019 to success in producing a manufacturable and affordable system with acceptable risks. Manufacturing 3020 and quality industry best practices are integral to design and development efforts in both 3021 Manufacturing Management System (MMS) and Quality Management System (QMS) requirements 3022 (e.g., AS6500, ISO 9001, AS9100, etc.). The program should integrate manufacturing and quality 3023 into the product design and development process and engage manufacturing and quality expertise as 3024 early as possible. Analyses of design alternatives through trade studies, producibility analyses, and 3025 manufacturing feasibility based on program requirements need to be conducted with results 3026 incorporated into the design. To accomplish program objectives, these need to be performed 3027 throughout the supply chain (e.g., failure mode analyses, Key Characteristics (KC), quality 3028 capabilities, test processes, etc.), enabling appropriate visibility and accountability through 3029 collection, recording, and communication of technical and programmatic data to all levels.



3030

During the TMRR phase, the manufacturing and quality capabilities should be assessed for each
competing design under consideration. The assessments should baseline needed industrial,
manufacturing, and quality capabilities and identify required investments. While it is not expected
that contractors have a complete factory and supply chain established at this point, program
understanding of key and critical manufacturing and quality processes, scale-up efforts, and supply
chain risks and issues is critical. This understanding for TMRR phase should include:

- Manufacturing processes and techniques not currently available
- Design producibility risks, issues, and opportunities
- Probability of meeting milestones
- Potential impacts of critical, strategic, and long-lead materials including disruptions
- Manufacturing and quality equipment and tooling availability
- Cost models and goals realism
- Estimates for support of management reviews

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3. Technology Maturation and Risk Reduction (TMRR) Phase

- Analyses and rationale for manufacturing and quality feasibility, cost, and schedule trade-offs
 of alternative approaches
- Anticipated manufacturing and quality processes testing and demonstration efforts

3047 Producibility criteria should reflect a blending of general criteria and specific criteria applicable to 3048 the system being developed. Producibility analyses will be effective if the design engineers 3049 understand and apply the producibility design criteria. Producibility is more than a design 3050 engineering function requiring manufacturing and quality engineer participation to generate a design 3051 which is compatible with the manufacturing and quality capabilities of the contractors. Producibility 3052 is the most important determinant of product cost, due to the impacts on EMD, Production and 3053 Deployment (P&D), and Operations and Support (O&S) costs. Ignoring producibility may lock the 3054 acquisition program into design solutions which can only be accomplished at unnecessarily high 3055 costs and/or designs which can entail substantial technical, cost and schedule risk. The TMRR 3056 contract should have required that the contractor develop, execute, and maintain a Producibility Plan 3057 and criteria to guide the design and development efforts. The plan should describe specifically what 3058 activities will be accomplished in each phase, the responsible organization, and the management 3059 controls that will be established to ensure successful accomplishment. Manufacturing and quality 3060 should review the plan with a focus on the completeness, clarity, adequacy, and realism of the 3061 planning accomplished by the contractor. Results of these analyses will support the development of

3062 specific contractual provisions for the EMD phase.

DOD policy on major system acquisitions makes producibility risk considerations a requirement in
 the Acquisition Program Baseline (APB) prior to the start of technology development. Producibility
 assessments should be an integral part of the on-going systems engineering process. Design
 processes should have included producibility assessments as part of the design decisions, however
 producibility is not limited to design.

- 3068 Effective measurement is critical to accuracy producibility assessments. Measurement is a tool for
- 3069 evaluating the effectiveness of producibility performance and for determining the degree to which
- 3070 improvements need to be made to ensure that future products are producible. Producibility
- 3071 assessments are conducted on system, subsystem, item, and component levels. Manufacturing and
- 3072 quality processes must be monitored and controlled with measurements, to ensure repeatable and
- 3073 consistent production of accurate, high-quality products. Process variability results in product
- 3074 variability, and product variability, when outside of design limits, means unacceptable quality. As a
- 3075 general rule, reducing process variability improves product quality and, therefore, producibility.
- 3076 In general, to assess program producibility, the organization must evaluate producibility on a
- 3077 product-by-product basis. Analysis of producibility on a per product basis allows the organization to
- 3078 better understand the strengths and weaknesses of the system, so that enhancements can be identified.
- 3079 Other producibility considerations include:
- Minimizing costs and schedule while maximizing performance

3. Technology Maturation and Risk Reduction (TMRR) Phase

• Infrastructure – cyber-security, software tools, design guides, training, and policies

Trade studies for design principles, reducing part counts, using of common parts, ease of
 assembly, simplicity of fabrication, safety, etc.

Key and critical product characteristics and features are the output of key and critical manufacturing
and quality processes. Consequently, to achieve program goals it is important for the contractor to
identify and control these characteristics early in the system design and development effort.

- 3087 According to AS9100D, KCs (Key Characteristics) are defined as an attributes or features whose 3088 variation have a significant effect on product fit, form, function, performance, service life or
- 3089 producibility, that require specific actions for the purpose of controlling variation. A critical
- 3090 characteristic is defined by AS6500 as a characteristic that is likely, if defective, to create or increase
- a hazard to human safety, or to result in failure of a system to perform a required function.
- 3092 Additionally, AS6500 defines a critical manufacturing process as a process that creates or
- 3093 substantially affects a key or critical characteristics. Some KCs and critical characteristics and the
- associated manufacturing processes may be produced or accomplished at a sub-tier supplier. By the
- 3095 end of the TMRR phase, the contractor and the program office should have a top-level understanding
- 3096 of KCs. Products perform better when there is less variation on the key and critical characteristics.
- Based on design and manufacturing feasibility and capability analyses, producibility assessments,
 and KC identification process, manufacturing and quality will assess design maturity in accordance
 with industry best practices. It must be economically feasible to manufacture a quality product at a
 specified rate and to deliver end items capable of achieving the performance and reliability inherent
 in the design. A strong emphasis early in the design phase on:
- Configuration control,
- Key and critical characteristics processes,
- Risks, issues, and opportunities management,
- Manufacturing and quality capabilities, feasibility, and producibility,
- 3106 will minimize the time and cost required for successful transition to production.

Design maturity occurs when a product design meets the requirements, as well as cost, schedule, and reliability targets. It is a best practice to achieve design completion at the system-level critical design review in the EMD phase. Consequently design completion should include a ramp-up during TMRR to meet Preliminary Design Review exit criteria.

- 3111 The PDR is a technical assessment establishing the physically allocated baseline and the functional
- 3112 baseline to ensure that the system under review has a reasonable expectation of being judged
- 3113 operationally effective and suitable, and has a reasonable expectation of satisfying the requirements
- 3114 within the currently allocated budget and schedule. A successful PDR should include an assessment
- of the producibility of the design and an assessment of manufacturing costs and risks.

3. Technology Maturation and Risk Reduction (TMRR) Phase

3116 3117	Manuz aspect	facturing and quality is responsible for inputs, per industry best practices, to almost every of PDR. Manufacturing and quality inputs include:
 3118 3119 3120 3121 3122 3123 3124 3125 3126 3127 	• • • •	Entry/exit criteria for the preliminary PDR process Results of MRL assessments Reviews, analyses, assessments, and contractor deliverables that support sufficient maturity of the allocated baseline Results of the assessments establishing the system functional baseline Inputs and documentation to the technical planning process Manufacturing Plans and Quality Plans Inputs to the program risk, issue, and opportunity assessment process for identification and mitigation of manufacturing and quality cost, schedule, and technical risks Inputs to the program life cycle cost estimates
3128	E.1	Participate in Design IPT
3129	Manu	facturing and Quality Tasks
 3130 3131 3132 3133 3134 	•	 Manufacturing and quality Design IPT participants ensure adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.). Provide manufacturing and quality requirements based on analyses of system requirements and design concepts. Identify capabilities and constraints based on the system specifications
3135 3136 3137		 Establish the required manufacturing and quality capabilities baseline Identify manufacturing and quality affordability cost drivers and impact on schedule and performance
3138 3139	•	Manufacturing and quality provide input to design trade studies (i.e., functional and performance requirements) that include criteria concerning:
3140 3141 3142 3143 3144 3145 3146 3147 3148 3149		 KPPs, KSAs, APAs, and evolving KCs Manufacturing process capabilities, limitations, and concerns Software and firmware development and re-use Safety, handling, storage, and disposal considerations and restrictions Quality constraints and costs (measurements, destructive/non-destructive tests, process capabilities, limitations, etc.) Manufacturing costs, materials, special tooling, and test equipment Cost-effective and affordable designs to achieve performance and schedule while minimizing cost Manufacturing capacity, workforce, and schedule impacts
3150	•	Manufacturing and quality participation in the design producibility process provides:
3151 3152		 Identification products and processes that would benefit from producibility analyses (i.e., Design for Manufacturing (DFM)/Design for Assembly (DFA)

3153 3154 3155 3156 3157 3158 3159 3160 3161 3162 2162	•	 Monitoring and reporting on producibility process activities with respect to risks, issues, and opportunities Integration of producibility with other design activities including software and firmware development and re-use Participation in producibility design trade studies to include process capabilities, manufacturing costs, tooling, test equipment, materials, manufacturing capacity, workforce training, schedule impacts, etc. Identification of innovative manufacturing technology opportunities Manufacturing and quality Design Integrated Product Team (IPT)participants provide monitoring, reviewing, analyses, and reporting on multiple analyses as part of the FMECA
3164	•	For the Design and Development planning process, manufacturing and quality shall provide:
3165 3166 3167 3168 3169 3170 3171 3172		 Planning inputs that establish, implement, and maintain appropriate processes to manage key and critical subsystems, components, and items including process controls for KCs Requirements for design, production process verification, test, inspection, verification, and product acceptance (statistical techniques) Inputs for monitoring and managing the development process through frequency, data, and metrics for design reviews Criteria for manufacturing and quality evaluation of design outputs (product) Requirements for manufacturing and quality verification, validation, and change control
3173	•	Provide manufacturing and quality impacts and interdependencies of design activities to
3174 3175		other functional areas or activities (e.g., engineering, producibility, costs, safety, manpower, schedule, etc.).
3176 3177 3178 3179 3180	•	Manufacturing and quality performs assessments and identification of manufacturing and quality risks, issues, and opportunities (e.g., technology, manufacturing, cybersecurity, software development, and sustainment) including mitigation. Provide manufacturing and quality support to program reviews (e.g., PMRs, SRR, SFR, and PDR)
3180 3181 3182	•	Provide manufacturing and quality support to the program level TRA and MRL assessment (as required).
3183 3184	•	Provide manufacturing and quality support to the specified program configuration control process for the design.
3185 3186	•	Evaluate the design for the impacts on manufacturing and quality requirements with respect to GFE (e.g., subsystems, components, test ranges, facilities, etc.).
3187 3188	•	Provide manufacturing and quality inputs to program documentation (e.g., SEP, TEMP, AS, CDD, etc.)
3189 3190 3191		 Include inputs and support for CDD validation efforts Include inputs for manufacturing plan updates (including design changes, investments, etc.)

3192 3193	•	Provide support to other IPTs as required (e.g., Systems Engineering, Costs, Proposal Team, etc.)
3194 3195	•	Provide manufacturing and quality input in support of congressionally mandated assessments and reports.
3196 3197		 Inputs on manufacturing and quality risks associated with the program Inputs on manufacturing and quality processes that need to be matured.
3198	Metri	cs
3199 3200	•	Manufacturing and quality Design IPT participants have documented compliance with manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.).
3201 3202		 Documentation includes Lessons Learned Includes DCMA reports, program reviews, and deliverables
3203 3204	•	Manufacturing and quality analyses of system requirements, design concepts, and capabilities baseline have been included and documented in the design including:
3205 3206 3207		 Capabilities and constraints based on the system specifications Required manufacturing and quality capabilities baseline Affordability cost drivers and impact on schedule and performance
3208 3209	•	Manufacturing and quality inputs to design trade studies (i.e., functional and performance requirements) have been provided and include criteria for:
3210 3211		 KPPs, KSAs, APAs, and evolving KCs Manufacturing process capabilities, limitations, risks, issues, and opportunities
3212		• Software and firmware development and re-use
3213 3214 3215		 O Safety, halding, storage, and disposal requirements Quality requirements and costs (measurements, destructive/non-destructive tests, process canabilities limitations at a)
3213 3216 3217 3218		 Manufacturing costs, materials, special tooling, and test equipment requirements Cost-effective and affordable designs to achieve performance and schedule while minimizing cost
3218		 Manufacturing capacity, workforce, and schedule requirements
3220	•	Documented manufacturing and quality support to the design producibility processes include:
3221		• Products and processes producibility analyses (i.e., DFM/DFA)
3222		 Producibility process analyses with respect to risks, issues, and opportunities
3223		• Producibility integration with other design activities including software and firmware
3224 3225		o Design trade studies that have included process capabilities, manufacturing costs, tooling
3226		test equipment, materials, manufacturing capacity, workforce training, schedule impacts
3227		etc.
3228		• Opportunities for use of innovative manufacturing technology

3. Technology Maturation and Risk Reduction (TMRR) Phase

3229 3230 3231 3232 3233	•	Manufacturing and quality Design IPT participants have provided monitoring, reviewing, analyses, and documentation on multiple FMEAs (e.g., DFMEA, PFMEA, etc.) as part of the FMECA process.Manufacturing and quality, as part of the Design and Development planning process, has documented and provided:
3234 3235 3236 3237 3238 3239 3240 3241 3242		 Planning inputs to establish, implement, and maintain appropriate processes and management of key and critical subsystems, components, and items (including process controls for KCs) Requirements for design, production process verification, inspection, verification, product acceptance and test (statistical techniques) Inputs for monitoring and management of the manufacturing and quality development process through the frequency, data, and metrics required for design reviews Manufacturing and quality metrics for the evaluation of design outputs (e.g., verification, validation, change control, etc.)
3243 3244 3245 3246 3247 3248 3249 3250	•	Manufacturing and quality design activity impacts and interdependencies to other functional areas or activities (e.g., engineering, producibility, costs, safety, manpower, schedule, etc.) has been documented and provided as inputs to and in support of the Acquisition Strategy and SEP. Assessments, identification, tracking, and mitigation of manufacturing and quality risks, issues, and opportunities (e.g., technology, manufacturing, cybersecurity, software development, and sustainment) have been documented as inputs to the SEP. Manufacturing and quality participants have documented and provided support to:
3251 3252 3253 3254		 Program reviews (e.g., PMRs, SRR, SFR, and PDR) to include action items, entry/exit criteria, metrics, documentation, etc. Program configuration control process for the design Program-level TRA and MRL assessment (as required)
3255 3256 3257 3258	•	Documentation of the impacts on manufacturing and quality design requirements has been provided for GFE (e.g., subsystems, components, test ranges, facilities, etc.). Manufacturing and quality inputs have been documented for inclusion in program documentation (e.g., SEP, TEMP, AS, CDD, etc.), including:
3259 3260		 Inputs and support for CDD validation efforts Inputs for manufacturing plan updates (including design changes, investments, etc.)
3261 3262 3263 3264	•	Manufacturing and quality participants have provided documented support to other IPTs as required (e.g., Systems Engineering, Costs, Proposal Team, etc.). Manufacturing and quality inputs to support of congressionally mandated assessments and reports have been provided.
3265 3266		 Inputs on manufacturing and quality risks associated with the program Inputs on manufacturing and quality processes that need to be matured

3267	Tools	
3268	•	Design for Manufacturing and Assembly (DFMA)
3269	٠	SRR checklist
3270	•	SFR checklist
3271	•	TRA checklist
3272	•	MRL assessment checklist
3273	٠	PDR checklist
3274	•	Acquisition Plan Preparation Guide template
3275	•	SEP template
3276	•	TEMP template
3277	•	Life Cycle Sustainment Plan template
3278	٠	CDD template
3279	Resou	rces
3280	•	10 USC 144B, Sec 2366 and 2448
3281	٠	AS6500, Manufacturing Management Program, Nov 2014
3282	٠	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
3283	•	AS9100 Quality Systems – Requirements for Aviation, Space, and Defense Organizations,
3284		Sep 2016
3285	٠	AS 9103, Variation Management of Key Characteristics
3286	٠	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
3287	٠	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
3288	٠	ISO 9001:2015, Quality Management Program
3289	٠	Acquisition Strategy Guide, DSMC, Dec 1999
3290	٠	Systems Engineering Plan (SEP) Outline, Jun 2015
3291	٠	TEMP Guide, Dec 2012 and DAG Chapter 8-4.1
3292	٠	LCSP memo, Sep, 2011 and DAG Chapter 4-3.1
3293	٠	CDD-CPD writing Guide, Feb 2015
3294	٠	System Requirements Review (SRR), DAG Chapter 3-3.3.2
3295	٠	System Functional Review (SFR), DAG Chapter 3-3.3.3
3296	٠	Preliminary Design Review (PDR), DAG Chapter 3-3.3.4
3297	٠	Technology Readiness Assessment (TRA) Guidance 2011
3298	•	Manufacturing Readiness Level (MRL) Deskbook 2016
3299	E.2	Evaluate Design and Manufacturing Capability
3300	Manu	acturing and Quality Tasks
3301	•	Perform a manufacturing and quality assessments of the contractor(s) and supply chain
3302		capability to mature the proposed design(s) within the program overall cost, schedule, and
3303		performance goals.

3304		0	Identify risks, issues, opportunities and mitigation plans
3305		0	Include competing technologies, prototypes, etc.
3306		0	Include capabilities with respect to environmental and hazardous processes
3307	•	Co	nduct analyses to:
3308 3309		0	Determine shortfalls (risks) to the required baseline manufacturing and quality capability and mitigation required
3310 3311		0	Identify manufacturing and quality processes and techniques that require development (including for special and hazardous)
3312 3313		0	Identify materials, producibility, equipment, and schedule risks, issues, and opportunities (including availability, hazardous, and long-lead)
3314 3315		0	Develop manufacturing and quality inputs to production unit cost and schedule (realism) estimates
3316 3317		0	Provide manufacturing and quality comparisons of competing and/or alternative approaches
3318		0	Provide manufacturing and quality recommendations for anticipated manufacturing and
3319			quality process testing and demonstration efforts for each competing and alternative
3320			approach
3321		0	Identify required manufacturing and quality capability investments (e.g., ManTech, GFE,
3322			facilities, capital equipment, tooling, test equipment, and processes, Modeling and
2222			Simulation (M&S) at a)
3323			Simulation (Mas), etc.)
3323 3324	Metric	s	Simulation (M&S), etc.)
332333243325	Metric •	s Ma	unufacturing and quality assessments of contractor in-house and supply chain
 3323 3324 3325 3326 	Metric •	s Ma ma	unufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to
 3323 3324 3325 3326 3327 	Metric •	s Ma ma me	inufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented.
 3323 3324 3325 3326 3327 3328 	Metric •	s Ma ma me	unufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc.
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 3323 3324 3325 3326 3327 3328 3329 3330 	Metric	s Ma ma me o	unufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.)
3323 3324 3325 3326 3327 3328 3329 3330 3331	Metric	s Ma ma o o	 Initiation (Wees), etc.) Initiation (Wees), etc.) Initiation (Wees), etc.) Initiation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes
3323 3324 3325 3326 3327 3328 3329 3330 3331 3332	Metric •	s Ma ma o o Ma	unufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes unufacturing and quality analyses have been conducted and documented that:
3323 3324 3325 3326 3327 3328 3329 3330 3331 3332 3333	Metric •	s Ma ma o o Ma o	unufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes unufacturing and quality analyses have been conducted and documented that: Determine shortfalls (risks) to the required baseline manufacturing and quality capability
3323 3324 3325 3326 3327 3328 3329 3330 3331 3332 3333 3334	Metric •	s Ma ma o o Ma o	 Initiation (M&S), etc.) Initiation (M&S), etc.) Initiation (M&S), etc.) Initiation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes Inufacturing and quality analyses have been conducted and documented that: Determine shortfalls (risks) to the required baseline manufacturing and quality capability and mitigation required
3323 3324 3325 3326 3327 3328 3329 3330 3331 3332 3333 3334 3335	Metric •	s Ma ma o o Ma o	nufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes mufacturing and quality analyses have been conducted and documented that: Determine shortfalls (risks) to the required baseline manufacturing and quality capability and mitigation required Identify manufacturing and quality processes and techniques that require development
3323 3324 3325 3326 3327 3328 3329 3330 3331 3332 3333 3334 3335 3336	Metric •	s Ma me o o Ma o o	nufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes mufacturing and quality analyses have been conducted and documented that: Determine shortfalls (risks) to the required baseline manufacturing and quality capability and mitigation required Identify manufacturing and quality processes and techniques that require development Identify materials, producibility, equipment, and schedule risks, issues, and opportunities
3323 3324 3325 3326 3327 3328 3329 3330 3331 3332 3333 3334 3335 3336 3337	Metric •	s Ma me o o Ma o o o	 Inufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes mufacturing and quality analyses have been conducted and documented that: Determine shortfalls (risks) to the required baseline manufacturing and quality capability and mitigation required Identify manufacturing and quality processes and techniques that require development Identify materials, producibility, equipment, and schedule risks, issues, and opportunities (including availability and long-lead)
3323 3324 3325 3326 3327 3328 3329 3330 3331 3332 3333 3334 3335 3336 3337 3338	Metric •	s Ma me o o Ma o o o	 Initiation (WeCS), etc.) anufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes anufacturing and quality analyses have been conducted and documented that: Determine shortfalls (risks) to the required baseline manufacturing and quality capability and mitigation required Identify manufacturing and quality processes and techniques that require development Identify materials, producibility, equipment, and schedule risks, issues, and opportunities (including availability and long-lead) Develop manufacturing and quality inputs to production unit cost and schedule (realism)
3323 3324 3325 3326 3327 3328 3329 3330 3331 3332 3333 3334 3335 3336 3337 3338 3339	Metric •	s Ma me o o Ma o o o o	 anufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes anufacturing and quality analyses have been conducted and documented that: Determine shortfalls (risks) to the required baseline manufacturing and quality capability and mitigation required Identify manufacturing and quality processes and techniques that require development Identify materials, producibility, equipment, and schedule risks, issues, and opportunities (including availability and long-lead) Develop manufacturing and quality inputs to production unit cost and schedule (realism) estimates
3323 3324 3325 3326 3327 3328 3329 3330 3331 3332 3333 3334 3335 3336 3337 3338 3339 3340	Metric •	s Ma me o o Ma o o o o	anufacturing and quality assessments of contractor in-house and supply chain nufacturing maturation processes and capabilities, with risk and issue mitigation plans to et program cost, schedule, and performance goals have been documented. Include competing technologies, prototypes, etc. Include manufacturing and quality capability investments (e.g., ManTech, GFE, facilities, capital equipment, tooling, test equipment, and processes, M&S, etc.) Include capabilities with respect to environmental and hazardous processes mufacturing and quality analyses have been conducted and documented that: Determine shortfalls (risks) to the required baseline manufacturing and quality capability and mitigation required Identify manufacturing and quality processes and techniques that require development Identify materials, producibility, equipment, and schedule risks, issues, and opportunities (including availability and long-lead) Develop manufacturing and quality inputs to production unit cost and schedule (realism) estimates Provide manufacturing and quality comparisons of competing and/or alternative

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3342 3343	 Provide manufacturing and quality recommendations for anticipated process testing and demonstration efforts for each competing and alternative approach 		
3344	Tools		
3345 3346	MRL assessmentQuality system audit		
3347	Resources		
3348 3349 3350 3351 3352	 AS6500, Manufacturing Management Program, Nov 2014 MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016 AS9100 Quality Systems – Requirements for Aviation, Space, and Defense Organizations, Sep 2016 MRL Deskbook Version 2016 		
3353	E.3 Update Producibility Plan		
3354	Manufacturing and Quality Tasks		
3355 3356 3357	• Review and analyze the contractor(s) plans for specific processes, methods, and actions to address manufacturing feasibility, producibility, and manufacturing and quality risks associated with the proposed solutions.		
3358 3359 3360 3361 3362 3363	 Include schedule, responsibilities, and management controls Review the plan for purpose, realism, completeness, and clarity Identify interdependencies and integration factors Identify risks, issues, and opportunities Identify manufacturing technology requirements Include technology insertion opportunities 		
3364	• Ensure plan describes how the design engineers apply the producibility design criteria.		
3365 3366	• If a competitive approach is used, describe how each competing design will be evaluated from a producibility standpoint		
3367 3368	• Update identified and potential manufacturing and quality process risks, issues, and capabilities to include:		
3369 3370 3371 3372 3373	 Validated and updated producibility goals and metrics Updated Modeling and Simulation (software) approaches (manufacturing and production) Critical manufacturing and quality processes (yield, rates, and variability, if available) Impacts to cost, schedule, and performance Facilities, tooling, testing, and qualification 		
3374 3375	• Merge the identified contractor and government manufacturing and quality risks, issues, and opportunities into a consolidated government/contractor program plan and process.		

3376 3377	• Ensure producibility planning for design includes manufacturing and quality considerations for and/or address the following:
3378 3379 3380 3381 3382 3383 3384 3385 3386 3386 3387	 Security (physical and cyber) System safety and hazardous materials management criteria Interdependencies and integration Modular Open Systems Approach (MOSA) (includes interfaces and subsystems) Benchmarking Costing Data management systems Design for Manufacture/Assembly Design of Experiments (DOE) Failure Modes and Effects Analysis (FMEA)
3388 3389 3390	 Design Failure Modes and Effects Analysis (DFMEA) System Failure Modes and Effects Analysis (SFMEA) Process Failure Modes and Effects Analysis (PFMEA)
3391 3392 3393 3394	 Prototyping approaches Design for Six Sigma Tools (Quality Functions Deployment (QFD), Root Cause Analyses, Statistical Process Control (SPC), Tolerance Analyses, etc.)
3395	Metrics
3396 3397 3398 3399	• Contractor(s) plans for processes, methods, and actions to address manufacturing feasibility, producibility, and manufacturing and quality risks associated with the proposed solutions have been reviewed, analyzed for adequacy, and documented for formal IPT/program reviews (PDR, etc.) to include:
3400 3401 3402 3403 3404 3405 3406 3407	 Contractually required documentation (Contract Data Requirements List (CDRLs), Data Item Description (DIDs), etc.) have been approved or corrective actions initiated Schedule, responsibilities, management controls, and costs Review of purpose, realism, completeness, and clarity Interdependencies and integration factors Risks, issues, and opportunities Manufacturing technology requirements Technology insertion opportunities
3408 3409 3410 3411 3412	 Documented planning describes how producibility is incorporated into the system design. In a competitive development approach, competing design plans have been evaluated from a producibility standpoint with comparative planning results documented. Identified and potential manufacturing and quality process risks, issues, and capabilities have been documented to include:
3413	 Validated and updated producibility goals and metrics

3. Technology Maturation and Risk Reduction (TMRR) Phase

3414 3415 3416 3417	 Updated Modeling and Simulation (software) approaches (manufacturing and production) Critical manufacturing and quality processes (yield, rates, and variability, if available) Impacts to cost, schedule, and performance Facilities, tooling, testing, and qualification
3418 • 3419 • 3420 • 3421 • 3422 •	Identified contractor and government manufacturing and quality risks, issues, and opportunities have been documented and incorporated for the consolidated government/contractor program plan and process. Producibility planning for design included manufacturing and quality considerations for and/or addressed and documented the following:
3423 3424 3425 3426 3427 3428 3429 3430 3431 3432	 Security (physical and cyber) System safety and hazardous materials management criteria Interdependencies and integration Modular Open Systems Approach (MOSA) (includes interfaces and subsystems) Benchmarking Costing Data management systems Design for Manufacture/Assembly (DFMA) Design of Experiments (DOE) Failure Modes and Effects Analysis (FMEA)
3433 3434 3435	 DFMEA SFMEA PFMEA
3436 3437 3438 3439	 Prototyping approaches Design for Six Sigma Tools (Quality Functions Deployment (QFD), Root Cause Analyses, Statistical Process Control (SPC), Tolerance Analyses, etc.)
3440 •3441	Evidence that the producibility plan delineates activities to be accomplished in TMRR phase to include:
3442 3443 3444 3445 3446	 Organizational responsibilities Specific management controls by function Establishes methodology for application of producibility design criteria Establishes methodology for evaluation of producibility between competing design concepts
3447 Tools	Producibility Engineering and Planning (PEP) Data Item Description
3449 Resourt 3450 •	rces IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs

3. Technology Maturation and Risk Reduction (TMRR) Phase

 3451 3452 3453 3454 3455 3456 	• • •	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs MIL-STD-882E DoD Standard Practice: System Safety, May 2012 NAVSO P-3687 Producibility System Guidelines, Dec 1999 Producibility System Guidelines, Missile Defense Agency, Apr 2009 Defense Manufacturing Management Guide for Program Managers, Chapter 7.6 Producibility Engineering and Planning
3457	E.4	Perform Producibility Assessments
3458	Manu	facturing and Quality Tasks
 3459 3460 3461 3462 3463 3464 2465 	•	 Manufacturing and quality Design IPT participants perform and/or support producibility assessments utilizing approved contractual documentation (CDRLs, DIDs, etc.) and other programmatic information and data including the following factors in the assessments: Planned producibility goals and metrics Management responsibilities and controls Design analyses (between and among competitive designs)
3465 3466 3467 3468 3469 3470 3471 3472 3473 3474 3475 3476 3477		 Cost and schedule Key Characteristics Interdependencies and integration Modular Open Systems Approach (MOSA) (includes interfaces and subsystems) Risks, issues, and opportunities Manufacturing technology requirements (including innovative and advanced) Technology insertion opportunities Review of goals, realism, completeness, and clarity Implementation of industry best practices, tools, and techniques System safety design and hazardous materials management criteria Security (physical and cyber) Facilities, tooling, testing, and qualification Government-furnished equipment (GFE), etc.
3478 3479 3480	•	 Utilize producibility tools, techniques, procedures, and associated metrics that include: State-of-the-art Modeling and Simulation software Failure Modes and Effects Analyses (FMEA)
3481 3482 3483		DFMEASFMEAPFMEA
3484 3485 3486 3487 3488		 Design for Manufacture and Assembly (DFMA) Design of Experiments (DOE) Design for Six Sigma Quality Function Deployment (QFD) Benchmarking
3. Technology Maturation and Risk Reduction (TMRR) Phase

3489		0	Design guides
3490		0	Interdependencies and integration analyses
3491		0	Tolerance analyses
3492		0	Requirements validation analyses
3493		0	Trade studies on alternative product and process designs
3494		0	Product complexity analyses
3495		0	Safety analyses
3496		0	Manufacturing process analyses
3497		0	Quality and quality process analyses
3498		0	Costs, cost drivers, and controls analyses
3499		0	Materials characterization and availability
3500		0	Prototyping of component, item, subsystem, competitive, etc.
3501		0	Learning curve goals and projections
3502		0	Product and process measurements utilizing Statistical Process Control (SPC)
3503		0	Data and database management
3504		0	Testing
3505	٠	Pro	ovide manufacturing and quality support to design producibility analyses including:
3506		0	Process capabilities
3507		0	Manufacturing costs
3508		0	Tooling and test equipment
3509		0	Materials availability and characterization
3510		0	Manufacturing capacity and capability
3511		0	Workforce availability and training
3512		0	Schedule impacts
3513		0	Manufacturing and quality cybersecurity (including all digital communications and
3514			connectivity for design, facilities, equipment, etc.)
3515		0	System safety and vulnerability
3516	Metric	S	
3517	•	Ma	unufacturing and quality Design IPT participants have conducted and/or supported
3518		pro	ducibility analyses and assessments that have addressed and document the following
3519		fac	tors (adequacy, validity, completeness, etc.):
3520		0	Producibility goals and metrics
3521		0	Management responsibilities and controls
3522		0	Design analyses (between and among competitive designs)
3523		0	Cost and schedule
3524		0	Key Characteristics
3525		0	Interdependencies and integration
3526		0	Modular Open Systems Approach (MOSA) (includes interfaces and subsystems)
3527		0	Risks, issues, and opportunities
3528		0	Manufacturing technology requirements (including innovative and advanced)

3. Technology Maturation and Risk Reduction (TMRR) Phase

3529 3530 3531 3532 3533 3534 3535	 Technology insertion opportunities Review of goals, realism, completeness, and clarity Implementation of industry best practices, tools, and techniques System safety design and hazardous materials management criteria Security (physical and cyber) Facilities, tooling, testing, and qualification GFE), etc.
3536 3537 3538	• Evidence for use of tools, techniques, procedures, with associated metrics to improve producibility has been documented in assessments and analyses to support program reviews and milestones decisions. These included:
3539 3540	 State of the art Modeling and Simulation software Failure Mode & Effects Analyses (FMEA)
3541 3542 3543	 DFMEA SFMEA PFMEA
3544 3545 3546 3547 3548 3549 3550 3551 3552 3553 3554 3555 3556 3557 3558 3559 3560 3561 3562	 Design for Manufacture and Assembly (DFMA) Design of Experiments (DOE) Design for Six Sigma Quality Function Deployment (QFD) Benchmarking Design guides Interdependencies and integration analyses Tolerance analyses Requirements validation analyses Trade studies on alternative product and process designs Product complexity analyses Safety analyses Quality and quality process analyses Costs, cost drivers, and controls analyses Materials characterization and availability Prototyping of component, item, subsystem, competitive, etc. Learning curve goals and projections Product and process Control (SPC)
3564	 Data and database management Testing
3565 3566	• Manufacturing and quality design producibility analyses and support included and documented:
3567 3568	 Process capabilities Manufacturing costs Manufacturing and Quality Management Body of Knowledge
	DDAET Coordination Conv. Jonuy of Knowledge

3. Technology Maturation and Risk Reduction (TMRR) Phase

3569		• Tooling and test equipment
3570		• Materials availability and characterization
3571		• Manufacturing capacity and capability
3572		• Workforce availability and training
3573		• Schedule impacts
3574 2575		• Manufacturing and quality cybersecurity (including all digital communications and
3373 2576		System sofety and vulnerability
5570		System safety and vulnerability
3577	Tools	
3578	•	Producibility Assessment Worksheet
3579	•	Taguchi Loss Function Sheet
3580	•	Design of Experiments (DOE)
3581	•	Quality Function Deployment (QFD) method
3582	•	Trade Studies
3583	Resou	rces
3584	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
3585	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
3586	•	SAE J1739, Potential Failure Mode and Effects Analysis in Design (Design FMEA),
3587		Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes
3588		(Process FMEA), Jan 2009
3589	•	MIL-STD-882E DoD Standard Practice: System Safety, May 2012
3590	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
3591	•	Producibility Engineering Standard Practice Manual, US Army Belvoir R&D Center, Sep
3592		1993
3593	•	NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy, Dec 1999
3594	E.5	Identify Key Characteristics (KCs)
3595	Manu	facturing and Quality Tasks
3596	•	Manufacturing and quality Design IPT participants provide monitoring evaluation and
3597	-	analyses from multiple FMEA activities (e.g. FMECA DFMEA PFMEA etc.) for the
3598		derivation of KCs, critical characteristics, and Critical Safety Items (CSIs), where possible.
2500		
3599 3600		• Provide manufacturing and quality support to the System Safety Assessment (SAR) to assist in CSI identification with supporting rationale
3601	•	Guide and ensure identification, derivation, and justification of KCs and critical
3602		characteristics from identified KPPs, KSAs, and APAs (including all mandatory KPPs).
2602		- Undete initial manufacturing and quality draft KDDs KSAs and ADAs and associated
3604		O Optice minimization in an equality or an KPrs, KSAS, and APAS, and associated
3004		

3605 3606 3607	 Provide manufacturing and quality inputs on development and management processes to establish, implement, and maintain management of key and critical subsystems, components, items, and software including process controls for KCs
3608 3609 3610	 Provide inputs on development and management processes to be evaluated Include identification of manufacturing and quality processes to be matured Specify, as applicable, specific actions to be taken (e.g., mitigation, investments, etc.)
3611 3612	• Develop a preliminary list, which includes where produced or accomplished and a rationale for inclusion (see G.6), of:
3613 3614 3615 3616 3617 3618	 Key Characteristics Critical characteristics Critical Application Items (CAIs) (e.g., systems, subsystems, software, materials, components, etc.) Key manufacturing and quality processes Critical Safety Items (CSIs)
 3619 3620 3621 3622 2622 	Manufacturing and quality IPT participants provide outputs of and updates to key and critical characteristic identification, derivation, justification, and management processes to the SEP, AS, CDD validation process, RFP development process, TRA, MRL assessment, and PDR entry/exit criteria development process.
3623	
3623 3624 Metr	ics
3623 3624 Metr 3625 • 3626	ics Manufacturing and quality Design IPT participants have provided documented evaluations and analyses of multiple FMEA activities (e.g., FMECA, DFMEA, PFMEA,).
3623 3624 Metr 3625 • 3626 3627 3628 3629 3630	 ics Manufacturing and quality Design IPT participants have provided documented evaluations and analyses of multiple FMEA activities (e.g., FMECA, DFMEA, PFMEA,). Manufacturing and quality has provided these as inputs to the derivation processes for KCs, critical characteristics, and CSIs Manufacturing and quality has provided documented input in support of the SAR to assist in CSI identification
3623 3624 Metr 3625 • 3626 • 3627 • 3628 • 3629 • 3631 • 3632 • 3633 •	 ics Manufacturing and quality Design IPT participants have provided documented evaluations and analyses of multiple FMEA activities (e.g., FMECA, DFMEA, PFMEA,). Manufacturing and quality has provided these as inputs to the derivation processes for KCs, critical characteristics, and CSIs Manufacturing and quality has provided documented input in support of the SAR to assist in CSI identification Manufacturing and quality has provided documented guidance to support identification, derivation, and justification of KCs and critical characteristics from identified KPPs, KSAs, and APAs.
3623 3624 Metr 3625 • 3626 • 3627 • 3628 • 3629 • 3630 • 3631 • 3632 • 3633 • 3634 • 3635 • 3636 • 3637 • 3638 • 3639 •	 Manufacturing and quality Design IPT participants have provided documented evaluations and analyses of multiple FMEA activities (e.g., FMECA, DFMEA, PFMEA,). Manufacturing and quality has provided these as inputs to the derivation processes for KCs, critical characteristics, and CSIs Manufacturing and quality has provided documented input in support of the SAR to assist in CSI identification Manufacturing and quality has provided documented guidance to support identification, derivation, and justification of KCs and critical characteristics from identified KPPs, KSAs, and APAs. Draft manufacturing and quality KPPs, KSAs, and APAs (with associated CTEs) have been updated and documented including those with impact on mandatory KPPs (Force Protection, System Survivability, Sustainment, and Energy at a minimum) Manufacturing and quality has provided documented inputs for development and management processes that establish, implement, and maintain management of key and critical subsystems, components, items, and software including process controls for KCs

3642 3643 3644 3645		 Inputs included identification of manufacturing and quality processes requiring maturation with recommended metrics Specific actions have been documented with recommended metrics (e.g., mitigation, investments, etc.)
3646 3647 3648 3649		• A preliminary list of KCs and Critical characteristics, CAIs(e.g., systems, subsystems, software, materials, components, etc.), key manufacturing and quality processes, and CSIs has been created and documented, including where produced or accomplished information with supporting rationale
3650 3651 3652 3653 3654 3655 3655 3656 3657	•	The program office and the contractor manufacturing and quality IPT participants have jointly identified ninety percent KPPs; and have analyzed, linked, and documented these KPPs to key and critical characteristics in the appropriate management systems for tracking and status. Manufacturing and quality IPT participants have documented and provided outputs/updates to key and critical characteristic identification, derivation, justification, and management processes as inputs to the AS, SEP, CDD validation process, RFP development process, TRA, MRL assessment, and PDR entry/exit criteria development process.
3658	Tools	
3659	•	MRL Matrix Version 2016
3660 3661 3662 3663 3664		 Critical to Quality Tree Failure Mode and Effects Analysis Process Capability Analysis Worksheet Producibility Assessment Checklist Technology Readiness Level Assessment Checklist
3665	Resou	rces
3666 3667 3668 3669 3670 3671 3672 3673 3674 3675	• • • • • •	AS6500, Manufacturing Management Program, Nov 2014 DoDI5000.02, change 1, IEEE 15288.1,2 JCIDS Manual SAE J1739, Potential Failure Mode and Effects Analysis in Design (Design FMEA), Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA), Jan 2009 MIL-STD-882E DoD Standard Practice: System Safety, May 2012 • MRL Deskbook Version 2016 • NAVSO P-3687 Producibility System Guidelines, Dec 1999
3676		 Technology Level Assessment Guidance, April 2011

3. Technology Maturation and Risk Reduction (TMRR) Phase

3677 E.6 Assess Design Maturity

3678 Manufacturing and Quality Tasks

3679 Based on design and manufacturing feasibility and capability analyses, producibility • 3680 assessments, and KC identification process, manufacturing and quality will assess design 3681 maturity in accordance with industry best practices (e.g., AS6500, AS9100, etc.) and readiness for the PDR (per IEEE 15288). 3682 3683 Update prior or conduct manufacturing and quality assessments of capability and 0 3684 feasibility based on contracted system concept(s). 3685 Assess lower level performance requirements to determine sufficiency to proceed to 3686 preliminary design 3687 Assess completeness of product data required for component manufacturing 3688 Update the producibility and manufacturability assessments for gaps and risks including: Ο 3689 Critical and unique manufacturing process requirements including software • 3690 Alternate design approaches within the concepts 3691 • Material requirements 3692 Supply chain requirements 3693 Production rate and yield requirements 3694 Facility requirements Special tooling development requirements 3695 3696 Test and demonstration requirements for new materials System safety and hazardous materials management 3697 Economic feasibility 3698 • 3699 Manufacturing capability obsolescence 3700 Manufacturing capability sustainment 3701 • Assess adequacy and robustness of the contractor configuration control processes with 3702 respect to design, engineering, software changes o Assess updates and status of key and critical characteristic processes 3703 3704 Assess manufacturing and quality engineering and management activities for 3705 adequacy and completeness (e.g., documentation, drawings, data collection and 3706 management, etc.) 3707 Assess for adequacy and completeness of manufacturing and quality inputs on 3708 mandatory KPPs 3709 • Provide inputs and plans for manufacturing and quality risks, issues, and opportunities to the government/contractor Risk, Issue, and Opportunity (RIO) Management Process 3710 3711 Update and status known 3712 Identify and develop plans for new 3713 Evaluate adequacy and completeness of mitigation activities

Manufacturing and Quality Management Body of Knowledge

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3714	C	Provide manufacturing and quality inputs for product level engineering/design
3/15		requirements definition and support the validation activities.
3716 3717	C	 Assess and validate product requirements and features as well enough defined to support PDR
3718	C	Identify manufacturing and quality components of Technical Performance Measures
3719	-	(TPMs) to support tracking of design maturity
3720	C	Assess and validate if product data essential for system/subsystem prototyping is ready
3721	-	for release
3722	C	Assess completion status of physical and functional interface definitions for the product
3723	-	(system)
3724	C	Assess and validate prototype demonstrations in a relevant environment for all
3725		enabling/critical items, parts and components including relevant software
3726	C	Assess percentage completion of subsystem design (with schedule for completion) and
3727		component and item maturity (percentage in current production) for PDR
3728	Metrics	
3729	• 1	Anufacturing and quality assessments of capability and feasibility based on contracted
3730	S	vstem concept(s) have been conducted, evaluated, and the results documented for
3731	r	equirements and completeness.
3732		Lower level performance requirements have been assessed as sufficient to support
3733		required preliminary design activities
3734	<i>.</i>	Product data has been assessed as complete to support component manufacturing
5754	(³ Troduct data has been assessed as complete to support component manufacturing
3735	• F	Producibility and manufacturability assessments have been reviewed, identified and/or
3736	υ	pdated for gaps and risks with documentation that includes:
3737	C	Critical and unique manufacturing processes including software
3738	C	Alternate design approaches within the concepts
3739	C	Materials
3740	C	Supply chain
3741	C	Production rates and yields
3742	C	> Facilities
3743	C	Special tooling
3744	C	> Tests and demonstrations
3745	C	System safety and hazardous materials management
3746	C	Economic feasibility
3747	C	Manufacturing obsolescence and sustainment
3748	C	New or emerging risks, issues, or opportunities
3749	• (Contractor configuration control processes with respect to design, engineering, software
3750	C	hanges has been assessed and validated for adequacy, robustness, accuracy, and compliance
3751	v	vith contract.

3752 • 3753	Assessments of key and critical characteristic processes have been conducted, updates and status documented, and shortfalls and corrective actions identified.
3754 3755 3756 3757 3758	 Manufacturing and quality engineering and management activities have been assessed and document adequacy and completeness (e.g., documentation, drawings, data collection and management, etc.) Manufacturing and quality inputs for mandatory KPPs (CDD validation process) have been assessed for adequacy and completeness
3759 • 3760	Manufacturing and quality inputs and plans for risks, issues, and opportunities have been assessed and documented in the government/contractor RIO Management Process:
3761 3762 3763 3764	 Updates and status have been included Plans for new and emerging risks, issues, and opportunities have been identified and developed Adequacy and completeness of mitigation activities has been documented
3765 • 3766	Manufacturing and quality inputs for product level engineering/design requirements definition have been provided and support validation activities.
3767 3768 3769 3770 3771 3772 3773 3774 3775 3776 3777	 Product requirements and features have been defined and documented to support PDR Manufacturing and quality components of Technical Performance Measures have been identified to support tracking of design maturity Product data required for subsystem/system prototype manufacturing is under configuration control and has been documented and released with all enabling/critical items, parts and components prototyped including software Physical and functional interfaces for the product (system) have been eighty percent defined and documented Prototype demonstrations in a relevant environment for all enabling/critical items, parts and components software have been assessed and validated Subsystems designs have been assessed and documented to be seventy-five percent
3778 3779	complete and ninety percent of components and items have been assessed and documented as proven designs ready for production
 3780 3781 3782 3783 	Based on industry best practices for design and manufacturing feasibility and capability analyses, producibility assessments, and KC identification process, manufacturing and quality has assessed and documented design maturity and readiness (IAW: AS6500, AS9100, etc.).
3784 3785 3786 3787 3788	 Documented inputs have been provided for the AS, SEP, and other program documentation Appropriate documentation has been provided for CDD validation, TRA and MRL assessment activities, RFP release Documentation has been provided for the PDR entry/exit criteria

3789	Tools	
3790	•	Design for Six Sigma
3791	Resou	rces
3792	•	AS6500, Manufacturing Management Program, Nov 2014
3793	•	AS9100 Quality Systems - Requirements For Aviation, Space, And Defense Organizations,
3794		Sep 2016
3795	•	DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017, Enclosure 2, 6.d.,
3790 3707	•	Jan 2017 ICIDS Manual Enclosure D. Dec 2015
3798	•	MIL-STD-882F DoD Standard Practice: System Safety May 2012
3799	•	References to Public Law, 114-328, etc.
3800	•	Risk, Issue, and Opportunity Management Program Guide
3801	E.7	Support Preliminary Design Review (PDR)
3802	Manu	facturing and Quality Tasks
3803	•	Provide manufacturing and quality inputs to the entry criteria for the preliminary PDR
3804		process per industry best practices (i.e., IEEE 15288) including:
3805		• Acceptability criteria for technical review outputs
3806		• Preparatory actions for the specific program
3807		 Inputs to allocated baseline and budget Devices of leaves leave and experimentary DDPs
3808		o Review of lower level subsystem PDRs
3809	•	Provide manufacturing and quality inputs to the exit criteria for the PDR process per industry
3810		best practices (i.e., IEEE 15288) that include addressing:
3811		• Adequacy, accuracy, and completeness of required manufacturing and quality PDR
3812		criteria Closure of manufacturing and quality action items with appropriate corrective action
3813		o Closure of manufacturing and quarty action terms with appropriate corrective action plans
3815		 Risk and issue mitigation and opportunity planning
3816		• Adequacy of the allocated and functional baselines
3817	•	Manufacturing and quality support the PDR to ensure, by inputs provided from results of a
3818		MRL assessment(s), that the manufacturing system will meet expectations for effectiveness
3819		and suitability (quality) within the allocated budget and schedule includes:
3820		• Manufacturing equipment, tooling, and software (including ManTech)
3821		• Processes, process control, and process capabilities (C _{pk} s)
3822		 Include initial data analyses
3823		• Interfaces and interface requirements

3. Technology Maturation and Risk Reduction (TMRR) Phase

3824	o Materials management (including hazardous)	
3825	> Workforce (personnel, skill sets, training, etc.)	
3826	 Supply chain (includes industrial base alternatives) 	
3827	o Facilities (including GFE)	
3828 •	Provide manufacturing and quality design inputs for reviews, analyses, assessments, and	
3829	contractor deliverables that support sufficient maturity of the allocated baseline per	
3830	contractual requirements to conduct a PDR including:	
3831	Analyses of system-level performance, producibility, growth allocations, and traceability	7
3832	 Design trade studies to the lowest level 	
3833	o Software development and re-use	
3834	 Allocation of interoperability performance requirements 	
3835	 Preliminary long-lead production requirements 	
3836	Requirements for parts, materials, and processes incorporated in the preliminary design	
3837	including risks, issues, and opportunities (e.g., obsolescence; fragile, sole, single, foreign	l
3838	sources, hazardous, etc.)	
3839	Manufacturing and quality control processes and procedures (e.g., Electromagnetic	
3840	Interference, hazardous, environmental, etc.)	
3841	> Meeting the Mandatory KPPs and system performance/functional KPPs and KSAs	
3842	(including supply chain)	
3843	> Key Characteristics and key processes management	
3844	 Include critical characteristics and critical processes (including Critical Technologies) 	5
3845	List of CTEs with CSIs and CAIs included) analyses (See E.5 and G.6)	
3846	o DT&E requirements	
3847	System safety requirements	
3848	c Environmental Safety, Occupational Health (ESOH) requirements and preliminary	
3849	hazards list	
3850	o Manufacturing security and access (physical and cyber)	
3851	O Quality assurance requirements (including tolerances/design margin analyses for a robus	t
3852	design)	
3853	Modular Open Systems Approach (MOSA) (includes interfaces and subsystems)	
3854 •	Provide the manufacturing and quality inputs to the assessment establishing the system	
3855	functional baseline, including inputs for:	
3856	> Preliminary designs of hardware, software, and procedures including interfaces is	
3857	complete, satisfies all requirements in the system functional baseline and is under	
3858	Configuration Management without any major To Be Determined (TBD) or open items	
3859	System, segment, subsystem, and component-level interfaces	
3860	> Manufacturing and quality aspects of C4I equipment, interfaces, processes, and	
3861	procedures across segments, subsystems, and components	
3862	> Implication of the threat scenario to manufacturing and quality processes and	
3863	environments (traceable to all segments, subsystems, and components)	

3. Technology Maturation and Risk Reduction (TMRR) Phase

3864 3865		 Manufacturing and quality data collected to date, including test data, on the subsystems, items, and components for the preliminary design
3866 3867 3868 3869		 Data should be traceable to requirements via specifications and verification cross-reference matrix (from SFR) Data should support bidirectional traceability between functional and allocated baselines
3870 3871	•	Provide the manufacturing and quality inputs and documentation to the technical planning process to include:
3872 3873 3874 3875 3876 3877		 Manufacturing and quality analyses of the Supplier(s) SEMP to determine adequacy and alignment with the manufacturing and quality provisions in the SEP Manufacturing and quality analyses of lower-level PDRs to identify risks and issues and determination of actions required A review of the Manufacturing Management and Quality Management plans in the SEMP and the SEP for adequacy to meet proposed EMD requirements
3878 3879		 Include requirements for sub-tier SE reviews and audits such as PDR, CDR, PRR, etc.
3880		• The assessment of design maturity for the manufacturing and quality components of
3881		TPMs for the technical planning process
3882		• Manufacturing Management Plan and Quality Management Plan approaches to support
3883		program Validation and Verification (V&V) processes as part of design, development,
3884		test, data acquisition, etc.
3885		• Manufacturing and quality inputs to the hazardous materials management and pollution
3886		prevention processes and procedures
3887		• Inputs on adequacy of facilities chosen to perform design verification (includes facilities, equipment GEE etc.)
3889		• Status of ongoing system producibility and trade studies
3890		 Identification of long-lead materials and supply chain elements (including multi-sourcing
3891		of items, parts, and components)
3892		 Inputs to the requirements for software development plans
3893 3894		 Coordination, scheduling, and availability of assets (e.g., facilities, labs, equipment, etc.) for test and integration
3895		 Hardware/software interfaces and integration
3896		 Data storage, handling, and security (physical and cyber)
3897		 Built-in test and performance
3898	•	Review manufacturing and quality plans for completeness and adequacy to include
3899		\circ $$ Analyses, demonstrations, and prototypes to confirm the design/development approach in
3900		a relevant environment
3901		• Trade studies that address COTS, re-use, and other related issues
3902		• A draft Bill of Materials for the system

3. Technology Maturation and Risk Reduction (TMRR) Phase

3903 3904		• An updated IMP and IMS that includes all major phases with acceptable risks and executable budget
3905		\circ Use of computer modeling design tools and test and integration labs
3906		• Identification definition and characterization of critical manufacturing processes
3907		metrics and the management process
3908		• Collection of manufacturing and quality data for Reliability and Maintainability
3909		processes
3910		\circ A failure reporting and corrective action system (FRACAS) process
3911		• Inputs to the TEMP components and items facilities equipment fixtures and interfaces
3912		 Capability to meet rate and schedule
3913	•	Provide manufacturing and quality support to the Life Cycle Support Plan.
3914	•	Provide inputs to the program risk, issue, and opportunity assessment process for
3915		identification and mitigation of manufacturing and quality cost, schedule, and technical risks.
3916	•	Provide inputs to the program life cycle cost estimates for manufacturing and quality.
3917	Metri	cs
3918	•	Evidence that manufacturing and quality inputs to the entry criteria for the preliminary PDR
3919		process per industry best practices (i.e., IEEE 15288) have been provided to include:
3920		• Acceptability criteria for technical review outputs
3921		• Preparatory actions for the specific program
3922		• Inputs to allocated baseline and budget
3923		• Review of lower level subsystem PDRs
3924	•	Evidence that manufacturing and quality inputs to the exit criteria for the PDR process per
3925		industry best practices (i.e., IEEE 15288) have been documented and address:
3926		• Adequacy, accuracy, and completeness of required manufacturing and quality PDR
3927		criteria
3928		• Closure of manufacturing and quality action items with appropriate corrective action
3929		plans
3930		• Risk and issue mitigation and opportunity planning
3931		• Adequacy of the allocated and functional baselines
3932	•	Manufacturing and quality has conducted MRL assessment(s) and provided documented
3933		results to support the PDR that the manufacturing system meets expectations for
3934		effectiveness and suitability (quality) within the allocated budget and schedule including
3935		inputs on:
3936		• Manufacturing equipment, tooling, and software (including ManTech)
3937		• Processes, process control, and process capabilities (C _{pk} s)
3938		 Included initial data analyses
3939		• Interfaces and interface requirements
3940		 Materials management (including hazardous)

3941 3942 3943	 Workforce (personnel, skill sets, training, etc.) Supply chain (includes industrial base alternatives) Facilities (including GFE)
 3944 3945 3946 3947 	Manufacturing and quality has participated in and provided documented design inputs for reviews, analyses, assessments, and contractor deliverables to support the determination that the allocated baseline is mature and meets contractual entry requirements for a PDR including:
3948 3949 3950 3951 3952 3953 3954 3955 3956	 Completed analyses of system-level performance, producibility, growth allocations, and traceability Completed Design trade studies to the lowest level Completed analyses of software and firmware development and re-use Performance requirements for interoperability allocated Preliminary long-lead production requirements documented Documented requirements for parts, materials, and processes incorporated in the preliminary design including recommended mitigations of risks and issues (e.g., obsolescence; fragile, sole, single, foreign sources, hazardous, etc.)
3957	 Documented recommendations for opportunities
3958 3959 3960 3961 3962 3963	 Documented manufacturing and quality control processes and procedures (e.g., EMI, hazardous, environmental, etc.) Documented design verifications that the Mandatory KPPs and system performance/functional KPPs and KSAs (including supply chain) have been met for PDR entrance criteria Documented Key Characteristics, key processes, and management processes
3964 3965	 Including critical characteristics and critical processes (including Critical Technologies List of CTEs with CSIs and CAIs included) documentation
3966 3967 3968 3969 3970 3971 3972 3973	 Documented inputs to DT&E requirements analyses Documented inputs System safety requirements analyses Documented inputs to ESOH requirements and preliminary hazards list analyses Manufacturing security and access (physical and cyber) requirements analyses Quality assurance requirements analyses (including tolerances/design margin for a robust design) Documented inputs to Modular Open Systems Approach (includes interfaces and subsystems) requirements analyses
3974 • 3975	Manufacturing and quality has provided documented inputs to the system functional baseline, which included inputs for:
3976 3977 3978	 Completed preliminary designs of hardware, software, and procedures (including interfaces), which satisfied all requirements in the system functional baseline and are under CM

 3979 3980 3981 3982 3983 3984 3985 3986 3987 3988 	0 0 0	 System, segment, subsystem, and component-level interfaces which are under configuration control Manufacturing and quality requirements for C4I equipment, interfaces, processes, and procedures across segments, subsystems, and components Implications of the threat scenario to manufacturing and quality processes and environments (traceable to all segments, subsystems, and components) Analyses of manufacturing and quality data collected to date, including test data, on the subsystems, items, and components for the preliminary design Data traceability to requirements via specifications and verification cross-reference matrix (from SFR)
3989		 Data bidirectional traceability between functional and allocated baselines
39903991	Ma pro	anufacturing and quality has provided inputs and documentation to the technical planning ocesses to include:
3992 3993 3994 3995 3996 3997	0 0 0	Analyses of the Supplier(s) SEMP for adequacy and alignment with the manufacturing and quality provisions in the SEP Analyses of risks and issues and mitigation actions required from lower-level PDRs (subsystems, items, and components) Review of the Manufacturing Management and Quality Management plans in the SEP and the SEMP for accuracy and adequacy to meet proposed EMD requirements
3998 3999		 Include requirements for sub-tier SE reviews and audits such as PDR, CDR, PRR, etc.
4000 4001	0	Design maturity assessment results for the manufacturing and quality components of TPMs
4002 4003	0	To the program, V&V processes as part of design, development, test, data acquisition, etc.
4004 4005	0	To the hazardous materials management and pollution prevention processes and procedures
4006 4007	0	Analysis results on adequacy of facilities chosen to perform design verification (includes facilities, equipment, GFE, etc.)
4008	0	Status and adequacy of ongoing system producibility and trade studies
4009	0	Validated list of long-lead materials and supply chain elements (including multi-sourcing
4010		of items, parts, and components)
4011	0	Validated list of manufacturing and quality requirements for software development plans:
4012 4013 4014		 Coordination, scheduling, and availability of assets (e.g., facilities, labs, equipment, etc.) for test and integration Hardware/software interfaces and integration
4014		 Inarcovare for the interfaces and integration Data storage handling and security (physical and cyber)
4016		 Built-in test and performance

3. Technology Maturation and Risk Reduction (TMRR) Phase

4017 4018	•	Manufacturing and quality plans have been reviewed for accuracy and adequacy with results documented for PDR, to include:
4019		• Analyses, demonstrations, and prototypes to confirm the design/development approach in
4020		a relevant environment
4021		• Trade studies that address COTS, re-use, and other related issues
4022		• A draft Bill of Materials for the system
4023		• An updated IMP and IMS that includes all major phases with acceptable risks and
4024		executable budget
4025		• Use of computer modeling, design tools, and test and integration labs
4026		• Identification, definition, and characterization of critical manufacturing processes,
4027		metrics, and the management process
4028		• Collection of manufacturing and quality data for Reliability and Maintainability
4029		processes
4030		• A failure reporting and corrective action system (FRACAS) process
4031		• Inputs to the TEMP components and items, facilities, equipment, fixtures, and interfaces
4032		• Capability to meet rate and schedule
4033	•	Manufacturing and quality has provided documented inputs to the Life Cycle Support Plan.
4034	•	Manufacturing and quality have documented and provided manufacturing and quality risks,
4035		issues, and opportunities for inclusion and mitigation as part of the program RIO Process.
4036	٠	Manufacturing and quality life cycle cost estimates have been provided for the PDR.
4037	Tools	
4038	٠	Preliminary Design Review checklist
4039	Resou	rces
4040	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
4041	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
4042	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
4043	•	MIL-STD-882E DoD Standard Practice: System Safety, May 2012
4044	•	Preliminary Design Review, DAG Chapter 3-3.3.4
4044	•	Preliminary Design Review, DAG Chapter 3-3.3.4

4045 **F. COST/FUNDING**

4046 Detailed manufacturing cost estimates could not be developed during the MSA phase, but cost 4047 drivers should have been identified based on proposed materials and process selections that were 4048 inherent in the proposed material solutions. In addition, producibility cost could be assessed and 4049 investments in manufacturing technologies could be estimated. In TMRR, costs need to be defined 4050 and finalized.

3. Technology Maturation and Risk Reduction (TMRR) Phase



4051

4052 Cost estimates should be used to evaluate affordability and establish initial program thresholds. In

4053 most cases, the estimates in MSA were developed through the use of statistically based cost

4054 estimating relationships or by comparison of the proposed systems with similar systems whose costs

4055 are known. The cost estimates will be used as the initial basis for concept costs in the TMRR phase.

4056 Manufacturing and quality cost estimating is a process used to predict life cycle manufacturing costs

4057 based upon the capabilities and processes to produce and support the components of a system.

4058 Manufacturing and quality specialists within the program predict system costs using the results of

trade studies and probable process yields. Manufacturing and quality should-cost inputs should be

4060 provided to the Cost Analysis Requirements Document (CARD) to update it for consistency with the

4061 approved system specification.

Within any program there will be certain systems, subsystems, items, and components the cost of
which will dramatically impact the overall system cost which are the cost drivers. Any analysis of
manufacturing and quality risks and producibility issues will generally identify a cost driver.
Manufacturing and quality focuses on producibility planning and risk and issue mitigation for
identification and reduction of cost drivers. Areas that are ripe for discovering and eliminating
manufacturing cost drivers include the following areas:

- 4068 Emerging technologies
- 4069 Industrial base
- Design/producibility
- Funding for maturing the manufacturing and quality processes
- Materials availability and environmental impacts
- 4073 Supply chain management
- Process capability and control
- Manufacturing and quality management/supplier quality management
- 4076 Workforce
- Facilities, capital equipment, tooling, and test equipment
- 4078 After identifying manufacturing cost drivers a concerted effort should be initiated to reduce these
- 4079 drivers and the overall costs wherever possible. There are several cost tools that can be used within
- 4080 the program that can help identify and achieve overall cost reductions.

3. Technology Maturation and Risk Reduction (TMRR) Phase

4081 A should-cost review uses an integrated team to conduct coordinated, in-depth cost analyses of a 4082 contractor's plans and ongoing efforts. The purpose of the review is to identify inefficient and 4083 uneconomical contractor practices, to quantify the impact of these practices on system cost, and to 4084 use the findings to develop a realistic price objective. The approved cost reduction efforts or 4085 initiatives are used to incentivize contractor performance towards achievement of the new should-4086 cost target. The should-cost analysis is intended to not only evaluate proposed contractor costs, but to 4087 then track and monitor those costs and to identify further savings opportunities that will lead to 4088 further cost reductions.

- Will-cost estimates should be verified by an office that is external to and independent of the program office. Additionally, it is DOD policy that programs actively manage the budget baseline using the current will-cost estimates for all acquisition, budget and program execution decisions (e.g. sourceselection, contract negotiations, major reviews, etc.). The programs budget baseline is based on a will-cost estimate and is sometimes referred to as the Independent Cost Estimate (ICE) or verified Program Office Estimate. This estimate is historical in nature and aims to provide sufficient funds to execute the program under normal conditions (average program risks). This will-cost estimate is used
- 4096 to support the budget and ensures sufficient funding.
- 4097 Program Managers will employ Earned Value Management (EVM). The purpose of EVM is to
- 4098 ensure sound planning and resourcing of all tasks required for contract performance. EVM provides a
- 4099 disciplined, structured, objective, and quantitative method to integrate technical work scope, cost,
- 4100 and schedule objectives into a single cohesive contract baseline plan called a Performance
- 4101 Measurement Baseline for tracking contract performance.
- 4102 Manufacturing and quality personnel must analyze contractor data in order to develop, update, and
 4103 support plans for mitigation and/or maturation of cost drivers.

As the program matures the manufacturing budget will become more refined and accurate. During
the TMRR phase, as the design matures, the contractor and the program should be able to create
budgets based upon specific design characteristics and knowledge of the manufacturing and quality
capabilities and processes which will be used to produce the system. The budget should include:

- Manufacturing and quality cost reduction initiatives.
- Accurate costs based on analyses and assessments of cost data against cost targets and trends.
- 4110
 Manufacturing and quality funding estimates for emerging requirements including investment opportunities and investment roadmaps
- Budgeting for manufacturing and quality initiatives and manufacturing technology investment programs.
- 4114 When budgeting for manufacturing and quality, interaction with the contractor will enable the
- 4115 program to understand the significant cost impacts experienced by the contractor. Interaction
- 4116 increases the program's understanding of the contractor's manufacturing and quality operations and

3. Technology Maturation and Risk Reduction (TMRR) Phase

4117 manufacturing and quality costs, as well as the factors that can impact manufacturing and quality4118 operations.

4119 **F.1 Identify Manufacturing Cost Drivers** 4120 **Manufacturing and Quality Tasks** 4121 Analyze and update manufacturing and quality should-cost inputs and provide these to the • 4122 Cost Analysis Requirements Document (CARD) update for consistency with the approved 4123 system specification and budget for the SRR. 4124 0 Include updates to the will-cost model based on industry best practices 4125 Include updates to manufacturing and quality cost sensitivity analyses 0 4126 Analyze and update manufacturing and quality cost drivers from manufacturing, quality, • 4127 materials, and unique or specialized requirements and associated risks and issues for the SRR. 4128 4129 Include contractor descriptions and plans for processes, materials, rates, supplier quality, 0 4130 workforce, special handling, environmental compliance, security (physical and cyber), 4131 etc. 4132 • Include identified subsystems, parts, items, and components 4133 • Include "should-cost" analyses 4134 Quantify the cost driver uncertainties 4135 • Update the estimate for the cost of quality • Update the estimate for the cost and impact of testing 4136 4137 Analyze and update the contractor producibility planning for cost drivers and associated risks • 4138 for the SRR to include: 4139 o Emerging technologies 4140 • Design producibility 4141 • Cost reduction and avoidance 4142 • Manufacturing processes 4143 o Materials availability 4144 • Environmental compliance 4145 • Supply chain • Process capability and control 4146 • Quality and supplier quality 4147 4148 • Workforce training 4149 Security, required special handling, cyber protection 4150 • Facilities, capital equipment, tooling, and test equipment 4151 Analyze the contractor initial manufacturing and quality risk assessment for mitigation plan • 4152 costs and drivers within budget and schedule for the SRR.

4153 4154	• Include risks from sole, sing acquisition of domestic source	le, fragile, foreign sources, cyber exploitation, and foreign ces
4155 4156 4157 4158 4159 4160 4161 4162	 Analyze the contractor manufact allocation of cost drivers for the Update manufacturing and qualit design for consistency with prog Analyze and update manufacturing demos and validations contribution Ensure manufacturing and qualitic consistent with the allocated basis 	uring and quality cost planning for realistic and appropriate SRR. ty cost estimates for predicted life cycle costs of the evolving ram affordability constraints for the SRR. ng and quality cost estimates and budget for prototype ng to cost drivers for the SRR. y cost should-cost estimates (inputs) to the CARD are eline for the PDR.
4163	• Include manufacturing and q	uality cost sensitivity analyses validation
4164 4165 4166	 Update manufacturing and quali- unique or specialized requirement and the PDR including: 	ty cost drivers from manufacturing, quality, materials, and nts and associated risks and issues for the MRL assessment
4167 4168 4169 4170 4171 4172	 Contractor processes, materi environmental compliance, s Subsystems, parts, items, and Quantified cost drivers Cost of quality estimates Estimates for the cost of test 	als, rates, supplier quality, workforce, special handling, ecurity (physical and cyber), etc. l components
4173 4174 4175	Validate the contractor producib plans for the MRL assessment an above.	ility cost drivers and associated risks, issues, and mitigation and the PDR including SRR producibility planning areas
4176 4177	Update status of contractor manu drivers (budget and schedule) for	facturing and quality risks and issues mitigation costs and r the MRL assessment and the PDR.
4178 4179 4180	 Include risks and issues from foreign acquisition of domes Cost, schedule, and technical 	n sole, single, fragile, foreign sources, cyber exploitation, and tic sources I risks are identified, and mitigation plans are in place
4181 4182	Validate the contractor manufact allocation of cost drivers for the	uring and quality costs and cost planning for realism and MRL assessment and the PDR.
4183 4184	Update manufacturing and quali- assessment and the PDR.	ty cost estimates for predicted life cycle costs for the MRL
4185 4186	Validate manufacturing and qual validation costs for cost drivers f	ity cost estimates and budget for prototype actual costs and for the MRL assessment and the PDR.
4187 4188	Update manufacturing and quali- schedule for the MRL assessmer	ty hardware estimates for quantity, effort (costs), and and the PDR.
4189 4190 4191	Update manufacturing and quality allocations to lower system elem model for the MRL assessment a	ty inputs to the system cost model and budget including ent levels, tracking against targets, and the production cost and the PDR.

4192	Metrics
4193 4194 4195	• Manufacturing and quality should-cost inputs have been analyzed for consistency with the approved system specification and budget for the SRR and the documented results provided as input to the Cost Analysis Requirements Document (CARD) including:
4196 4197	 Updated will-cost model based on industry best practices Updated manufacturing and quality cost sensitivity analyses
4198 4199 4200	• Manufacturing and quality cost drivers from manufacturing, quality, materials, and unique or specialized requirements and associated risks and issues have been updated, documented, and provided for the SRR including:
4201 4202 4203 4204 4205 4206 4207 4208	 Contractor descriptions and plans for processes, materials, rates, supplier quality, workforce, special handling, environmental compliance, security (physical and cyber), etc. Identified subsystems, parts, items, and components "Should-cost" analyses Quantified the cost driver uncertainties Estimated cost of quality Estimated cost of testing
4209 4210 4211	• Manufacturing and quality have analyzed the contractor producibility plans for cost drivers and associated risks and provided the documented results for the SRR to including the required aspects of:
4212 4213 4214 4215 4216 4217 4218 4219 4220	 Emerging technologies Design producibility Cost reduction and avoidance Manufacturing processes Materials availability Environmental compliance Supply chain Process capability and control Quality and supplier quality
4221 4222 4223	 Workforce training Security, required special handling, cyber protection Facilities, capital equipment, tooling, and test equipment
4224 4225 4226	• Contractor initial manufacturing and quality risk assessments and mitigation plans have been analyzed and results documented for costs and cost drivers against budget and schedule for the SRR including:
4227 4228	• Risks from sole, single, fragile, foreign sources, cyber exploitation, and foreign acquisition of domestic sources

4229 4230 4231	•	Contractor manufacturing and quality planning has been analyzed and documented for realistic and appropriate allocation of cost drivers for the SRR. Manufacturing and quality cost estimates for predicted life cycle costs of the evolving design
4232 4233	•	have been documented and provided for the SRR, and are consistent with program affordability constraints.
4234 4235	•	Manufacturing and quality cost estimates and budget for prototype demos and validations to confirm cost drivers have been analyzed and documented for the SRR.
4236 4237	•	Manufacturing and quality should-cost cost estimates (documented inputs) to the CARD have been validated and are consistent with the allocated baseline for the PDR.
4238		• Included manufacturing and quality cost sensitivity analyses validation
4239 4240 4241	•	Manufacturing and quality cost drivers from manufacturing, quality, materials, and unique or specialized requirements and associated risks and issues have been updated and documented to support the MRL assessment and the PDR including:
4242 4243 4244 4245 4246 4247		 Contractor processes, materials, rates, supplier quality, workforce, special handling, environmental compliance, security (physical and cyber), etc. Subsystems, parts, items, and components Quantified cost drivers Cost of quality estimates Estimates for the cost of testing
4248 4249 4250 4251 4252 4253	•	Contractor producibility cost drivers and associated risks, issues, and mitigation plans have been validated and results provided for the MRL assessment and the PDR (included the SRR producibility planning areas above). Contractor manufacturing and quality risks and issues mitigation costs and drivers (budget and schedule) have been analyzed, updated, and results provided for the MRL assessment and the PDR, which included:
4254 4255 4256		 Risks and issues from sole, single, fragile, foreign sources, cyber exploitation, and foreign acquisition of domestic sources Identified costs, schedule, and technical risks and issues with mitigation plans in place
4257 4258 4259	•	Contractor manufacturing and quality costs and cost plans have been validated and documented for realism and appropriate allocation of cost drivers for the MRL assessment and the PDR.
4260 4261	•	Manufacturing and quality cost estimates for predicted life cycle costs have been updated and documented to support the MRL assessment and the PDR.
4262 4263	•	Manufacturing and quality cost estimates and budget updated and documented with prototype actual costs and validated cost drivers for the MRL assessment and the PDR.
4264 4265	•	Manufacturing and quality hardware estimates for quantity, effort (costs), and schedule have been updated and documented for the MRL assessment and the PDR.

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4266 4267 4268 4269 4270 4271 4272	•	Manufacturing and quality inputs to the system cost model and budget including allocations to lower system element levels, tracking against targets, and the production cost model have been updated and documented for the MRL assessment and the PDR. Documented evidence that cost models have been updated with design requirements, material specifications, tolerances, integrated master schedule, results of system/subsystem simulations and production relevant prototype demonstrations have been provided for the MRL assessment and the PDR.		
4273	Tools			
4274	•	Cost Analysis Requirements Description (CARD) template		
4275	•	Cost and Lead Time Estimating Worksheet		
4276	•	Cost/Schedule Control System Criteria (see EVM)		
4277	•	Design to Cost Estimates		
4278	•	Manufacturing Cost Estimating Spreadsheet		
4279	•	MRL assessment for the Cost Thread		
4280	•	Cost, Schedule Control Systems Criteria (CSCSC)		
4281	•	See CAPE website for tools		
4282	Resou	rces		
4283	•	Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for		
4284		Program Managers, Chapter 9		
4285	•	Should-cost and Affordability Memo, Aug 2011		
4286	•	DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015		
4287	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs		
4288	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs		
4289	•	MRL Deskbook Version 2016		
4290	•	CARD Website and process		
4291	F.2	Develop Manufacturing Cost Mitigation/Maturation Plan		
4292	Manuf	facturing and Quality Tasks		
4293	•	Utilizing the outputs (SRR/SFR) from the should-cost and will-cost analyses, develop cost		
4294		reduction (i.e., mitigation) plans.		
4295		• Conduct a coordinated, in-depth should-cost review on the contractor(s) planning and		
4296		ongoing efforts against best practices		
4297		 Incorporate identified cost drivers 		
4298		• Conduct will-cost analyses on the results		
4299		• Plans include tracking and monitoring costs to identify further savings opportunities and		
4300		reductions		
4301		• Plans address manufacturing and quality cost risks and issues mitigation plans		

3. Technology Maturation and Risk Reduction (TMRR) Phase

4302 4303		 Plans include completion of major cost and performance trades, and risk and issue reduction efforts to support the CDD Validation Decision prior to PDR
4304 4305	•	If an Independent Cost Estimate (ICE) or verified Program Office Estimate is requested, provide manufacturing and quality inputs and support.
4306 4307 4308 4309		 Provide validated manufacturing and quality capability requirements Provide manufacturing and quality inputs on required funding for the FYDP Verify manufacturing and quality compliance with affordability goals for production and sustainment
4310 4311 4312	•	Analyze the contractor manufacturing and quality Earned Value Management (EVM) plan to include the critical path documentation. Update the cost model to include cost targets and include:
4313 4314		 Design/Producibility analyses considerations and results Manufacturing and quality costs
4315 4316 4317 4318 4319 4320 4321 4322 4323 4324 4325		 New manufacturing and quality processes implementation Materials availability and maturity Environmental management and disposal impacts Process capability and throughput (setup, yield, scrap, rework, Work In Progress) Quality (including supplier quality) issues Workforce issues Facilities costs Security, required special handling, cyber protection Special Tooling and Test Equipment Equipment availability, capacity, and constraints New Technologies analyses and impacts
4326 4327		 Support of Finance and Contracting processes (such as independent program estimates, proposal preparation, fact-finding and negotiations, budgeting, and what-ifs.)
4328 4329	•	Update the manufacturing and quality cost models to support mitigation/maturation planning to include the capability for the models to support:
4330 4331		 Design trades to assess the cost impacts of specific design changes Alternative production processes or process improvements
4332 4333 4334 4335	•	Incorporation of the current estimates and actual (if available) manufacturing costs into the cost estimates Planning for EMD, production, developmental and operational test, and life cycle sustainment of proposed products.
4336		• The CDD Validation Decision process
4337 4338	•	Develop cost maturation and mitigation plans to support independent evaluations (MRL assessments)

3. Technology Maturation and Risk Reduction (TMRR) Phase

4339 4340	 Manufacturing Maturation Plan incorporates and document the costs associated for maturing manufacturing capability that does not meet required maturity levels
4341 Metric	S
4342 • 4343 4344	Manufacturing and quality cost risks and cost issues mitigation plans utilizing should-cost and will-cost analyses have been completed, documented, and are being executed with progress tracked and reported on a recurring basis (PMRs, etc.).
4345 4346 4347 4348 4349 4350 4351 4352	 A coordinated, in-depth should-cost review on the contractor(s) planning and ongoing efforts against best practices has been conducted Identified cost drivers have been incorporated Tracking and plans to monitor costs to identify further savings opportunities and reductions have been included Manufacturing and quality cost risks and issues mitigation plans have been addressed Completion of major cost and performance trades, and risk and issue reduction efforts have been included to support the CDD Validation Decision prior to PDR
4353 • 4354	Manufacturing and quality inputs and support have been provided to an Independent Cost Estimate (ICE) or verified Program Office Estimate (if requested) and includes:
4355 4356 4357 4358	 Validated manufacturing and quality capability requirements Manufacturing and quality inputs on required funding for the FYDP Manufacturing and quality verified compliance with affordability goals for production and sustainment
4359 • 4360 4361 • 4362	Contractor manufacturing and quality EVM plan is in place, has been reviewed for adequacy and completeness, documents the critical path, and is up-to-date. Evidence that an updated, robust cost model is documented and maintained, to include cost targets and includes:
4363 4364	 Design/Producibility analyses considerations and results Manufacturing costs
4365 4366 4367 4368 4369 4370 4371 4372 4373	 New manufacturing processes implementation Materials availability and maturity Environmental management and disposal impacts Process capability and throughput (setup, yield, scrap, rework, Work In Progress) Quality (including supplier quality) issues Workforce issues Facilities costs Security, required special handling, cyber protection Special Tooling and Test Equipment
4374 4375	 Equipment availability, capacity, and constraints New Technologies analyses and impacts

4376 4377		• Support of Finance and Contracting processes (such as independent program estimates, proposal preparation, fact-finding and negotiations, budgeting, and what-ifs)
4378 4379 4380	•	The updates to manufacturing and quality cost models have been documented to support mitigation/maturation planning which included the capability for the models to support: Design trades to assess the cost impacts of specific design changes
4381 4382 4383 4384 4385 4385 4386		 Alternative production processes or process improvements Incorporation of the current estimates and actual (if available) manufacturing costs into the cost estimates Planning for EMD, production, developmental and operational test, and life cycle sustainment of proposed products The CDD Validation Decision process
4387 4388	•	Cost maturation and mitigation plans have been developed and are in place to support independent evaluations (MRL assessments)
4389 4390		• Manufacturing Maturation Plan incorporates and documents the costs associated for maturing manufacturing capability that does not meet required maturity levels.
4391	Tools	
4392 4393 4394	• •	Parametric, Engineering and Actual estimating CARD - Cost Analysis Requirements Description (see CAPE website for tools) Manufacturing Readiness Level Assessment Checklist, Cost and Funding Thread
4395 4396 4397 4398	• • •	Cost and Lead Time Estimating Worksheet Cost/Schedule Control Systems Criteria (C/SCSC) Manufacturing Cost Estimating Worksheet Manufacturing Maturation Plan (no template available)
4399	Resou	rces
4400 4401 4402	•	10 USC Sec. 2334 Independent Cost Estimation and Cost Analysis CARD - Cost Analysis Requirements Description Template (See CAPE website for guidance)
4403 4404 4405 4406	•	DODI 5000.73 Cost Analysis Guidance and Procedures NDAA DY 2017 (Public Law 114-328), §807, Cost, Schedule and performance of major defense acquisition programs JCIDS Manual
4407 4408 4409	•	MRL Deskbook Version 2016 Cost/Schedule Control Systems Criteria Reference Guide, Sep 1992 DoDI 5000.73, Cost Analysis Guidance and Procedures, Jun 2015
4410	•	DoDI 5000.02, Feb 2017, Change 1, Jan 2017

3. Technology Maturation and Risk Reduction (TMRR) Phase

4411 **F.3 Develop Learning Curve**

4412 Manufacturing and Quality Tasks

4413 4414	•	Manufacturing and quality defines appropriate learning curves for the system and subsystems to include initiation and reporting requirements.
4415		• Include the basis for the slope (quantity and schedule) for the learning curves
4416	•	Define requirements for the baseline data and data collection to include:
4417 4418 4419 4420 4421 4422		 Costs for quality, processes, personnel, out-sourcing, re-work, scrap, etc. Timing for processes, kitting, idle, takt, cycle, re-work, etc. Labor efficiency Improvements in methods, equipment, tools, automation Standardization and common processes Design changes (producibility/manufacturability)
4423 4424	•	Plan for collection of data to support learning curves development that includes the following factors and improvements, at a minimum:
4425 4426 4427 4428 4429 4430 4431 4432 4433 4434 4435 4436		 Workforce learning, worker and supervisor Process, line, and workstation Machinery, equipment, and tooling Design producibility changes Work methods and processes Planning and scheduling processes Lot and batch sizing and optimization (just-in-time) Engineering and test activities and changes Quality inspections/tests sampling requirements Inventory, storage, re-work, and scrap levels Operation sequencing and synchronization Pre-Planned Product Improvement program and processes
4437	Metric	CS
4438 4439	•	Manufacturing and quality has defined the learning curves for the system and subsystems and documented them in the program management system for technical and program reviews
4440 4441 4442		 Initiation (system and subsystems) and reporting requirements with frequency of review and goals have been included Basis for the slope has been defined as appropriate and realistic
4443 4444	•	Baseline data and data collection requirements have been defined, documented, and distributed to the appropriate IPT including:
4445 4446		 Costs for quality, processes, personnel, out-sourcing, re-work, scrap, etc. Timing for processes, kitting, idle, takt, cycle, re-work, etc.

4447		• Labor efficiency
4448		• Improvements in methods, equipment, tools, automation
4449		• Standardization and common processes
4450		 Design changes (producibility/manufacturability)
4451	•	Collection of data to support learning curve development has been planned, documented, and
4452		distributed and includes the following factors and improvements, at a minimum:
4453		• Workforce learning, worker and supervisor (%/time)
4454		 Skill improvements (#)
4455		 Tooling improvements (#/% throughput)
4456		 Workstations efficiency improvements (#)
4457		• Process, line, and workstation (% throughput)
4458		• Machinery, equipment, and tooling (% throughput)
4459		 Design producibility changes (#/%)
4460		• Work methods and processes (% throughput)
4461		 Planning and scheduling processes (% throughput)
4462		• Lot and batch sizing and optimization (just-in-time) (\$)
4463		• Engineering and test activities and changes (#/\$/time)
4464		• Quality inspections/tests sampling requirements (#/time)
4465		• Inventory, storage, re-work, and scrap levels $(\#/\$)$
4466		• Operation sequencing and synchronization (% throughput)
4467		• Pre-Planned Product Improvement program and processes (#/\$)
4468	Tools	
4469	•	Learning Curve Worksheet in Excel
4470	Resou	rces
4471	•	Application of Learning Curve Theory to Systems Acquisition. Defense Acquisition
4472		University (DAU) Teaching Note. Feb 2011
4473	•	Defense Manufacturing Management Guide for Program Managers Chapter 9.8 Learning
4474	-	Curve
4475	F.4	Prepare Initial Manufacturing Budget
4476	Manu	facturing and Quality Tasks
4477	•	Update the manufacturing and quality cost estimates from MSA to validate and update the
4478	-	TMRR budget to include fact-of-life changes.
4479 4480		• Verify that cost estimates include all manufacturing and quality cost drivers and risk estimates from the updated cost model

4481	0	Verify manufacturing and quality quantification of cost driver uncertainties and
4482		associated budget impact estimates as inputs to the budget process
4483	0	Verify the producibility costs (cost drivers and risks) are included in budget process
4484	0	Update investment estimates in manufacturing and quality technologies, processes,
4485		equipment, etc. (including ManTech) as inputs to the budget process to include:
4486		 Capital equipment (tooling, machines, structures, etc.)
4487		 Test equipment (specialized, environmental, etc.)
4488		 Facilities and modifications/expansion (handling, storage, transportation, disposal,
4489		etc.)
4490		• GFE
4491		 Environmental compliance (processes, facilities, equipment, etc.)
4492		 Manufacturing systems security (physical, cyber, etc.)
4493	0	Update cost estimating (should-cost and will-cost) with contractor data on manufacturing
4494		and quality aspects of the proposed system (include similar systems whose costs are
4495		known)
4496	0	Validate established manufacturing and quality targets (from initial thresholds)
4497		affordability cost estimates (should-cost and will-cost) for TMRR based on contractor
4498		data
4499	0	Update identified ManTech investments to mitigate manufacturing and quality
4500		technology gaps in TMRR for implementation
4501		 Contact and coordinate with potential funding sources for ManTech projects
4502		(program office, Service, and/or DoD-wide funding)
4503	0	Provide analyses of the adequacy, reasonableness, and necessity of contractor-proposed
4504		manufacturing labor hours and material costs and determine the adequacy of the
4505		manufacturing budget for TMRR
4506 •	Al	l outstanding manufacturing and quality risks and issues understood for the SRR and the
4507	SF	R with approved TMRR budget for mitigation plans to achieve PDR entrance criteria
4508	inc	luding:
4509	0	Technology
4510	0	Industrial Base
4511	0	Design
4512	0	Cost and Funding
4513	0	Materials
4514	0	Process and Capability Control
4515	0	Quality Management
4516	0	Manufacturing Workforce
4517	0	Facilities
4518	0	Manufacturing Management

3. Technology Maturation and Risk Reduction (TMRR) Phase

4519 4520 4521	•	Analyze the manufacturing and quality TMRR budget sufficiency for the capability to produce a prototype system or subsystem in a production relevant environment prior to Milestone B.
4522 4523		• Assess each TMRR prototype requirements (system or subsystem) for manufacturing and quality process needs, risks and issues, and affordability analyses with budget impacts.
4524 4525	•	Evaluate the ongoing manufacturing technology investments (ManTech programs) for sufficiency to meet program objectives (e.g., EMD, P&D, and O&S).
4526		• Include sponsored initiatives in the program budget and from other sources
4527 4528	•	Monitor the execution of the TMRR program, and evaluate for impacts to recommend appropriate changes to the manufacturing and quality budget.
4529 4530 4531 4532 4533 4534 4535		 Assess the affordability and executability of the manufacturing processes Recommend quality and manufacturing cost reduction initiatives Analyze the quality, manufacturing, and production cost data (if available) down to the component level against cost targets, and identify trends Identify quality and manufacturing emerging issues Identify manufacturing investment opportunities and develop investment roadmaps to further the manufacturing development efforts
4536 4537	•	Identify budget resources to support an MRL assessment and a TRA prior to PDR. Develop manufacturing and quality budget inputs for EMD.
4538 4539		• Ensure program management includes required support by manufacturing and quality to program processes and technical and programmatic reviews for:
4540 4541 4542 4543 4544 4545 4546 4547 4548 4549 4550 4551 4552		 Producibility Key Characteristics Manufacturing Risks Material and supply chain management Manufacturing Technology Manufacturing Surveillance and Audits Manufacturing Security (physical and cyber) GFE Continuous improvement Process control and capability First article inspection and test Provide an assessment of requirements for manufacturing processes, risks and issues, and affordability analyses with budget impacts
4553 4554		• Perform analyses of proposed manufacturing labor hours and material costs for adequacy, reasonableness, and necessity for a budget estimate
4555 4556		 Utilize data from contractor reported manufacturing labor hours and material costs, if available

4557 4558	0	Perform analyses of proposed manufacturing and quality cost reduction initiatives and incentives for a budget estimate
4559	0	Analyze manufacturing and quality FMD cost estimates and supporting TMRR
4560	0	performance data to develop appropriate budget requests that include:
4561		 Monitoring and managing Key Characteristics (includes critical characteristics, and
4562		all KPPs)
4563		 Assessment of identified trends
4564		 Emerging quality and manufacturing initiatives
4565		 Cost/funding estimates and recommendations on emerging requirements
4566		 Investment opportunities with associated roadmaps
4567	0	Provide manufacturing and quality EMD phase budget inputs that include comprehensive
4568		manufacturing and quality planning for EMD, production, developmental and operational
4569		test, life cycle sustainment, and disposal of proposed products including:
4570		 Investments for quality and test (e.g., training, equipment, personnel, process
4571		improvement, etc.)
4572		 Quantities and rates through Low-Rate Initial Production (LRIP), Production, and
4573		Sustainment
4574		 Materials (e.g., obsolescence, long-lead purchase, storage and handling,
4575		transportation, etc.)
4576		 Capital equipment requirements (e.g., production equipment, facilities, etc.)
4577		 Facilities (e.g., production, storage, handling, waste disposal, etc.)
4578		 Risk and issue identification and mitigation
4579		 Technology investment programs including emerging quality and manufacturing
4580		initiatives
4581		 Manufacturing workforce (e.g., availability, training, etc.)
4582		 Manufacturing processes (e.g., existing and new, scale-up, modifications, process
4583		capability and control, corrective actions, etc.)
4584		 Manufacturing management and control
4585		 Manufacturing Security (physical and cyber)
4586		 Resources to support contractor, sub-tier, and supplier MRL assessments prior to
4587		CDR and PRR.
4588		 Resources to support an MRL assessment and a TRA prior to Milestone C
4589		 Demonstration of pilot line capability and readiness to begin LRIP
4590	Al	l outstanding manufacturing and quality risks and issues understood for the Milestone B
4591	De	ecision with approved EMD budget for mitigation plans to achieve CDR and LRIP entrance
4592	cri	iteria including:
4593	0	Technology
4594	0	Industrial Base
4595	0	Design
4596	0	Cost and Funding

4597	0	Materials
4598	0	Process and Capability Control
4599	0	Quality Management
4600	0	Manufacturing Workforce
4601	0	Facilities
4602	0	Manufacturing Management
4603	Metrics	
4604 4605	• M do	ISA Manufacturing and quality cost estimates have been updated to validate and ocumented in the TMRR budget to include fact-of-life changes.
4606 4607	0	Cost estimates have been verified and included all manufacturing and quality cost drivers and risk estimates from the updated cost model
4608 4609	0	Manufacturing and quality cost driver uncertainty quantification and associated budget impact estimates have been verified and provided as inputs to the budget process
4610	0	Producibility costs (cost drivers and risks) have been verified and included in budget
4011	0	process Manufacturing and quality technologies, processes, equipment, etc. (including ManTech)
4012	0	investment estimates have been updated and provided as inputs to the hudget process to
4614		include:
4615		 Capital equipment (tooling machines structures atc.)
4015		 Capital equipment (specialized environmental etc.)
4617		 Facilities and modifications/expansion (handling storage transportation disposal
4618		etc.)
4619		• GFE
4620		 Environmental compliance (processes, facilities, equipment, etc.)
4621		 Manufacturing systems security (physical, cyber, etc.)
4622	0	Cost estimates (should-cost and will-cost) utilizing contractor data on manufacturing and
4623		quality aspects of the proposed system (include similar systems whose costs are known)
4624		have been updated and validated and utilized to update the budget
4625	0	Manufacturing and quality targets established from initial thresholds have been validated
4626		utilizing affordability cost estimates (should-cost and will-cost) based on contractor data
4627		for the budget process
4628	0	ManTech investments identified to mitigate manufacturing and quality technology gaps
4629		during TMRR have been identified for implementation
4630		 Potential funding sources for ManTech projects (program office, Service, and/or
4631		DoD-wide funding) have been identified and contacted
4632	0	Analyses of the adequacy, reasonableness, and necessity of contractor-proposed
4633		manufacturing labor hours and material costs have been completed and adequacy
4634		validated for the TMRR manufacturing budget

4635 4636 4637	•	All outstanding manufacturing and quality risks and issues have been evaluated and documented for the SRR and the SFR with allocated TMRR budget for mitigation plans to achieve PDR entrance criteria including:
4637 4638 4639 4640 4641 4642 4642 4643 4644 4645 4645 4646 4647 4648 4649	•	 Technology Industrial Base Design Cost and Funding Materials Process and Capability Control Quality Management Manufacturing Workforce Facilities Manufacturing Management Manufacturing Management
4650 4651 4652 4653		 Milestone B. Each TMRR prototype (system or subsystem) has been assessed for manufacturing and quality process needs, risks and issues, and affordability with required budget documented
4654 4655 4656 4657 4658 4659	•	Manufacturing and quality technology investments (ManTech programs) have been evaluated as sufficient to meet program objectives including sponsored initiatives in the program budget and from other sources. The execution of the TMRR program budget is being monitored and evaluated for impacts to the manufacturing and quality budget and budget changes and updates have been provided that include:
4660 4661 4662 4663 4664 4665 4666		 Affordability and executability of the manufacturing processes Quality and manufacturing cost reduction initiatives Quality, manufacturing, and production cost data analyses (down to the component level) against cost targets, and identified trends Quality and manufacturing emerging issues Manufacturing investment opportunities and investment roadmaps to improve manufacturing
4667 4668 4669 4670 4671 4672 4673	•	Resources to support an MRL assessment and a TRA prior to PDR have been documented in the budget Manufacturing and quality budget estimates have been provided for the EMD budget. • Manufacturing and quality have documented and provided budget inputs on required support by manufacturing and quality to program processes and technical and programmatic reviews to include support for: • Producibility
4672 4673		programmatic reviews to include support for:Producibility

3. Technology Maturation and Risk Reduction (TMRR) Phase

4674 4675 4676 4677 4678 4679 4680 4681 4682 4683		 Key Characteristics Manufacturing Risks Material and supply chain management Manufacturing Technology Manufacturing Surveillance and Audits Manufacturing Security (physical and cyber) GFE Continuous improvement Process control and capability First article inspection and test
4684 4685 4686 4687	0	An assessment of requirements for EMD manufacturing processes, risks and issues, and affordability analyses has been provided with required budget estimates Analyses of proposed manufacturing labor hours and material costs for adequacy, reasonableness, and necessity has been conducted and budget estimate provided
4688 4689		 Contractor reported data for manufacturing labor hours and material costs has been utilized, if available
4690 4691 4692 4693	0	Analyses of proposed manufacturing and quality cost reduction initiatives and incentives has been conducted and budget estimate provided Budget requests have been developed based on manufacturing and quality EMD cost estimates and supporting TMRR performance data and include:
4694 4695 4696 4697 4698 4699		 Monitoring and managing Key Characteristics (includes critical characteristics, and all KPPs) Assessment of identified trends Emerging quality and manufacturing initiatives Cost/funding estimates and recommendations on emerging requirements Investment opportunities with associated roadmaps
4700 4701 4702	0	Manufacturing and quality EMD phase budget inputs have been provided that include comprehensive manufacturing and quality planning for EMD, production, developmental and operational test, life cycle sustainment, and disposal of proposed products including:
4703 4704 4705 4706 4707 4708 4709 4710 4711 4712 4713		 Investments for quality and test (e.g., training, equipment, personnel, process improvement, etc.) Quantities and rates through LRIP, Production, and Sustainment Materials (e.g., obsolescence, long-lead purchase, storage and handling, transportation, etc.) Capital equipment requirements (e.g., production equipment, facilities, etc.) Facilities (e.g., production, storage, handling, waste disposal, etc.) Risk and issue identification and mitigation Technology investment programs including emerging quality and manufacturing initiatives Manufacturing workforce (e.g., availability, training, etc.)

3. Technology Maturation and Risk Reduction (TMRR) Phase

4714	 Manufacturing processes (e.g., existing and new, scale-up, modifications, process
4715	capability and control, corrective actions, etc.)
4716	 Manufacturing management and control
4717	 Manufacturing Security (physical and cyber)
4718	 Resources to support contractor, sub-tier, and supplier MRL assessments prior to
4719	CDR and PRR.
4720	 Resources to support an MRL assessment and a TRA prior to Milestone C
4721	 Demonstration of pilot line capability and readiness to begin LRIP
4722	• All outstanding manufacturing and quality risks and issues have been evaluated and
4723	documented for the Milestone B Decision with approved EMD budget for mitigation plans to
4724	achieve CDR and LRIP entrance criteria including:
4725	o Technology
4726	 Industrial Base
4727	0 Design
4728	 Cost and Funding
4729	• Materials
4730	 Process and Capability Control
4731	 Quality Management
4732	 Manufacturing Workforce
4733	o Facilities
4734	 Manufacturing Management
4735	Tools
4736	Manufacturing Cost Estimating Spreadsheet
4737	Manufacturing Readiness Level Assessment Checklist, Cost and Funding Thread
4738	Technology Readiness Level Assessment Checklist
4739	Resources
4740	AS6500, Manufacturing Management Program, Nov 2014
4741	• DoDI5000.02
4742	• IEEE 15288.2
4743	MRL Deskbook Version 2016
4744	• Public Law 114-328, §807
4745	G. MATERIALS MANAGEMENT
4746	Material cost like manufacturing cost is estimated early in the program and turns to actual cost when
4747	production begins. As the program matures and the design becomes stable the estimates become

4748 more actual costs. Material cost drivers can vary from the cost of the material itself to the cost of the

4749 material and processing it into an end item. Selecting the most producible materials for their

3. Technology Maturation and Risk Reduction (TMRR) Phase

- 4750 capability, maturity, availability, and handling characteristics during the TMRR phase will reduce
- 4751 costs and benefit program on cost and schedule.





4753 Based on contractor data, manufacturing and quality personnel must assess all materials for all 4754 manufacturing and quality risks, issues, and opportunities. This begins with an update of the 4755 evaluation of material maturity and availability from the previous phase including an assessment of 4756 the validity and maturity of emerging materials. Material availability should consider lead times with 4757 associated impacts to schedule, budget, and critical path, etc. The assessment should also include 4758 analyses for fluctuations, rarity, availability, capacity, regulatory issues, ITAR, anti-tamper, and 4759 military vulnerability. The contractor may have proposed alternate materials which will require the 4760 same rigorous assessment for properties, characteristics, and quality requirements applicable to this 4761 system. There may be other opportunities for alternate materials that address known risks and issues 4762 that should be included. Finally, manufacturing and quality risks, issues, and opportunities based on 4763 potential materials obsolescence and lack of availability based on the business climate (e.g., business 4764 failures, market changes, political, etc.) should be incorporated for the SRR and the SFR, and updates 4765 for the PDR.

4766 During the TMRR phase, while it is not expected that contractors would have a complete factory and 4767 supply chain established, key knowledge must be obtained to determine requirements for EMD scale-4768 up efforts, and the resulting supply chain issues. Scale up for EMD considerations should include:

- Manufacturing processes and techniques not currently available
- Probability of meeting delivery dates
- Potential impacts from critical and long-lead time materials
- Facility, equipment, tooling availability (acquisition and/or scheduling)
- Trade-offs among manufacturing and quality materials alternatives
- Anticipated in-process testing and demonstration
- 4775 Methods for conserving critical and strategic materials and mitigating supply disruption risks
 4776 and associated impacts
- Transportation and security including ITAR considerations
- 4778 TMRR presents the first opportunity to assess the contractor's Supply Chain Management (SCM)
- 4779 program. Ideally, the contractor chosen adheres to industry manufacturing and quality best practices
- 4780 for manufacturing management, quality management, systems engineering, sourcing, and
- 4781 configuration management (CM) with strong contracts and supplier interactions including processes,

3. Technology Maturation and Risk Reduction (TMRR) Phase

- 4782 plans, scheduling, variability reduction, and lead times with associated impact on the critical path. If
- 4783 not, it can be extremely difficult to effectively manage a program's supply chain.
- 4784 Alternate source options are a technique for risk mitigation due to material availability risks. If
- 4785 availability of materials or components, subsystems or systems is at risk, qualifying an alternative
- 4786 source may be a viable solution. Having an alternate source will mitigate issues with diminishing
- 4787 manufacturing sources and material shortages (DMSMS).
- 4788 Manufacturing and quality should analyze the contractor Critical Supplier's List (hardware and
 4789 software) for completeness and identification of single points of failure for potential mitigation in
 4790 EMD phase.
- 4791 G.1 Identify Materials Cost Drivers

4792 Manufacturing and Quality Tasks

- Based on manufacturing, quality, and unique or specialized requirements, specifications, and tolerances, and associated risks and issues; analyze and update manufacturing and quality materials cost drivers for the SRR.
- 4796
 4797
 4798
 Include contractor descriptions and plans for materials, materials processes, rates and quantities (including lot buys), supplier quality, special handling and training, environmental compliance and training, materials security (physical and cyber), etc.
- 4798 environmental compliance and training, materials security (physical and cyber), etc.
 4799 o Include as materials identified subsystems, parts, items, and components (supply chain commodities)
- 4801 o Include materials "should-cost" analyses
- 4802 Quantify the materials cost driver uncertainties
- 4803 Include cost drivers from methods used to conserve critical and strategic materials
- 4804 o Include cost drivers for mitigation of supply disruptions
 - Update the estimate for the cost of quality
- 4806 Update the estimate for the cost and impact of materials testing
- Analyze and update the contractor planning (producibility) with respect to materials cost
 drivers and associated risks (see G.2) for the SRR to include:
- 4809 Emerging materials
- 4810oMaterials design requirements
- 4811 Price stability, cost reduction and avoidance
- 4812 o Materials processes
- 4813 o Materials availability
- 4814 o Environmental factors and compliance
- 4815 o Supply chain

4805

- 4816 o Processes and quality
- 4817 o Security, required special handling, cyber protection
- 4818 Facilities, capital equipment, tooling, and test equipment

Manufacturing and Quality Management Body of Knowledge

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4819 4820 4821	•	Update materials cost drivers based on manufacturing, quality, and unique or specialized requirements, specifications, and tolerances, and associated risks and issues for the MRL assessment and the PDR including:
4822 4823 4824 4825 4826 4827 4828 4829 4830 4831	•	 Contractor materials and materials processes used Materials rates and quantities obtained Supplier quality levels, special handling, environmental compliance reported Materials security (physical and cyber) required, etc. Utilized supply chain commodities (subsystems, parts, items, and components) Quantified cost drivers with continuing uncertainties Cost of quality reported cost of completed and projected materials testing Validate the contractor materials cost drivers and associated materials risks, issues, and mitigation plans for the MRL assessment and the PDR including SRR materials planning
4832		areas above.
4833	Metric	CS
4834 4835 4836 4837	•	Manufacturing and quality materials cost drivers have been analyzed and documented as inputs to cost driver identification and analyses (F.1) based on manufacturing, quality, and unique or specialized requirements, specifications, and tolerances, and associated risks and issues for the SRR.
4838 4839 4840 4841 4842 4843 4843		 Contractor descriptions and plans for materials, materials processes, rates and quantities (including lot buys), supplier quality, special handling and training, environmental compliance and training, materials security (physical and cyber), etc. have been included Subsystems, parts, items, and components identified as supply chain commodities have been included Materials "should-cost" analyses have been included Materials cost driver uncertainties have been quantified for the SRR
4845 4846		 O Internals cost driver uncertainties have been quantified for the SKK Cost drivers for methods to be used to conserve critical and strategic materials have been included
4847 4848 4849		 Cost drivers for mitigation plans for supply disruptions included Cost of quality estimates updated Estimated costs and impacts of materials testing included
4850 4851	•	Contractor planning (producibility) with respect to materials cost drivers and associated risks (see G.2) have been analyzed and documented for the SRR to include:
4852 4853 4854 4855		 Emerging materials Materials design requirements Price stability, cost reduction and avoidance Materials processes
4856 4857		 Materials availability Environmental factors and compliance

4858 4859 4860 4861 4862 4863 4864 4865 4866 4867 4868 4869 4869 4870 4871	•	 Supply chain Processes and quality Security, required special handling, cyber protection Facilities, capital equipment, tooling, and test equipment Materials cost drivers based on manufacturing, quality, and unique or specialized requirements, specifications, and tolerances, and associated risks and issues have been updated and documented for the MRL assessment and the PDR including: Contractor materials and materials processes used Materials rates and quantities obtained Supplier quality levels, special handling, environmental compliance reported Materials security (physical and cyber) required, etc. Utilized supply chain commodities (subsystems, parts, items, and components) Quantified cost drivers with continuing uncertainties Cost of quality reported
4872 4873 4874 4875	•	Cost of completed and projected materials testing Contractor identified materials cost drivers and associated contractor materials risks, issues, and mitigation plans have been validated and documented for the MRL assessment and the PDR including SRR materials planning areas above.
4876 4877 4878 4879 4880 4881	Tools • • •	Cost and Lead Time Estimating Worksheet Cost/Schedule Control System Criteria (see EVM) Cost, Schedule Control Systems Criteria (CSCSC) MRL assessment for the Material Management Thread Producibility Assessment
4882 4883 4884 4885 4886 4887	Resou • •	rces Cost/Schedule Control System Criteria Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for Program Managers, Chapter 9 MRL Deskbook Version 2016 Producibility Systems Guidelines, NAVSO P-3687, Dec 1999
4888	G.2	Assess Materials Maturity and Determine Materials Risk
4889 4890 4891 4892	Manu [.]	facturing and Quality Tasks Analyze and update the contractor planning (producibility) with respect to manufacturing and quality maturity of materials (risks, issues, and the associated cost drivers in G.1) for the SRR and the SFR to include:

4893		• Emerging materials
4894		• Materials design requirements
4895		• Cost reduction and avoidance
4896		• Materials processes
4897		• Materials availability and lead times
4898		 Environmental factors and compliance
4899		• Supply chain
4900		• Processes and quality
4901		 Security, required special handling, physical and cyber protection
4902		• Facilities, capital equipment, tooling, and test equipment
4903	٠	Based on contractor data, assess all materials for manufacturing and quality risks and issues:
4904		• Update evaluation of material maturity and availability from the AoA process:
4905		 Assess validity and maturity of emerging (from Research and development and
4906		experiments in MSA) for manufacturability
4907		• Update the manufacturing and quality evaluation of lead times including:
4908		 Impacts to schedule, budget, and critical path, etc.
4909		• Analyses for fluctuations, rarity, availability, capacity, regulatory issues, ITAR, Anti-
4910		Tamper, etc.
4911		• Evaluate maturity of other materials (contractor proposed) for properties, characteristics,
4912		and quality requirements for application in this system
4913		• Evaluate military vulnerability or gaps that could result from the lack of reasonable
4914		materials alternatives
4915		• Identify opportunities for alternative materials (to mitigate known risks and issues)
4916	•	Assess and identify manufacturing and quality risks, issues, and opportunities based on
4917		potential materials obsolescence and lack of availability based on the business climate (e.g.,
4918		business failures, market changes, political, etc.) for the SRR and the SFR, and update for the
4919		PDR.
4920		• Include availability from single or sole sources (domestic or foreign), within the NTIB,
4921		only from sources that are outside the NTIB, vulnerable to foreign acquisition
4922		• Assess business climate for disruptive conditions (e.g., natural disasters, strikes, etc.)
4923		• Develop mitigation for known risks to critical and strategic materials
4924		• Assess availability issues to be addressed for prototype builds
4925		• Initiate government mitigation plans as appropriate as specified in the program SEP
4926		• Monitor contractor mitigation processes and plans as specified in the contractor SEMP in
4927		alignment with the program SEP
4928	•	Analyze and Assess the contractor's make/buy process for adequacy and completeness to
4929		include:

4930 4931		• Contractor's make/buy processes for key and/or critical subsystems, items, parts, and components to include volatility
4932		 Contractor's supply chain (including other divisions) make/buy processes for vendors to
4933		meet quality requirements, schedule and cost targets
4934		• Identification of and mitigation of counterfeit parts and materials (e.g., end items,
4935		components, parts, or assemblies)
4936		• Identify hazardous and special handling/storage/environmental compliance procedures,
4937		risks, and issues to include:
4938		 Potential regulatory requirements
4939		 Hazardous materials and handling procedures
4940		 Security requirements (physical, cyber, etc.)
4941		 Transportation, storage and shelf life
4942		 GFP, GFE (tooling, test equipment, ranges, chambers, etc.)
4943		 Disposal
4944		• Assess the characterization of materials (maturity) and degree of manufacturing and
4945		quality risks applicable to the system under development.
4946		• Determine if materials have been manufactured or produced in a relevant environment
4947		(e.g., a factory, a similar application/program, as part of a prototype, etc.)
4948		• Assess and characterize all GFE, GFF, GFM, GFP
1919		Methods for conserving critical and strategic materials and mitigating supply
4950		disruption risks and program impacts associated with those materials
4951 4952		• Analyze government and contractor maturation efforts to mitigate material (existing and new) production risks
4953	•	Complete manufacturing and quality materials planning for EMD including preliminary
4954		specifications and material properties characterization. This should address:
4955		• Verification of materials maturity through technology demonstration subsystems, items,
4956		and components (articles)
4957		 Availability risks, issues, and opportunities
4958		• Long-lead items
4959		• Future DMSMS risks, issues, and opportunities
4960	Metrio	S
4961	•	Contractor planning with respect to manufacturing and quality maturity of materials (risks,
4962		issues, and the associated cost drivers as in G.1) has been analyzed for adequacy and
4963		sufficiency and documented as an manufacturing and quality input for the SRR and the SFR
4964		including:
4965		• Emerging materials
4966		• Materials design requirements
4967		• Cost reduction and avoidance

4968		• Materials processes
4969		• Materials availability and lead times
4970		• Environmental factors and compliance
4971		• Supply chain
4972		• Processes and quality
4973		• Security, required special handling, physical and cyber protection
4974		• Facilities, capital equipment, tooling, and test equipment
4975	•	All Materials maturity and availability has been assessed and results documented for
4976		manufacturing and quality risks and issues to include:
4977		• Material maturity, manufacturability, and availability for the chosen concept(s) has been
4978		updated and documents the validity and maturity of emerging materials (from R&D and
4979		experiments in MSA)
4980		• Material lead times have been updated and documented in the TMRR IMS and the budget
4981		including results for fluctuations, rarity, availability, capacity, regulatory issues, ITAR,
4982		Anti-Tamper, etc.
4983		• Other contractor-proposed materials for properties, characteristics, and quality
4984		requirements for application in this system
4985		• Military vulnerability or gaps that could result from the lack of materials alternatives
4986		• Opportunities for alternative materials, contractor or GFE for mitigation of known risks
4987		and issues
4988	•	Based on potential materials obsolescence and lack of availability due to the business climate
4989		(e.g., business failures, market changes, political, etc.), manufacturing and quality risks,
4990		issues, and opportunities have been analyzed, assessed, and documented for the SRR and the
4991		SFR, and updated for the PDR, to include:
4992		• Availability from single or sole sources (domestic or foreign), within the NTIB, only
4993		from sources that are outside the NTIB, vulnerable to foreign acquisition
4994		• Disruptive conditions to the business climate (e.g., natural disasters, strikes, etc.)
4995		• Mitigation known risks and issues to critical and strategic materials
4996		• Prototype build availability issues
4997		 Government mitigation plans specified in the program SEP
4998		• Contractor mitigation processes and plans as specified in the contractor SEMP
4999		 Aligned with the program SEP
5000	•	Contractor's Make/Buy process has been assessed, analyzed, and results documented for
5001		adequacy and completeness including:
5002		• Contractor's make/buy processes for key and/or critical subsystems, items, parts, and
5003		components to include volatility
5004		• Contractor's supply chain make/buy processes for meeting quality requirements, schedule
5005		and cost targets for:
5006		 Other contractor divisions

3. Technology Maturation and Risk Reduction (TMRR) Phase

5007		 Vendors
5008 5009 5010 5011		 Identification of and mitigation of counterfeit parts and materials (e.g., end items, components, parts, or assemblies) Identification of hazardous and special handling, storage, and environmental compliance procedures and mitigation of risks and issues in areas, such as
5012 5013 5014 5015 5016 5017		 Regulatory requirements Procedures for hazardous materials and handling Security (physical, cyber, etc.) Transportation, storage and shelf life GFP and GFE (tooling, test equipment, ranges, chambers, etc.) Disposal
5018 5019 5020 5021 5022 5023 5023 5024 5025		 Characterization of materials' maturity and manufacturing and quality risks applicable to the system under development Documentation that materials have been manufactured or produced in a relevant environment (e.g., a factory, a similar application/program, as part of a prototype, etc.) All GFE, GFF, GFM, and GFP (includes methods for conserving critical and strategic materials and mitigating supply) Government and contractor maturation efforts (should be a joint effort) to mitigate material (existing and new) production risks
5026 5027	•	Manufacturing and quality planning and documentation for EMD with preliminary specifications complete and material properties characterized addresses:
5028 5029 5030 5031 5032		 Verification of materials maturity through technology demonstration subsystems, items, and components (articles) Availability risks and issues mitigation, and opportunities Long-lead items Future DMSMS risks, issues, and opportunities
5033	Tools	
5034 5035 5036 5037 5038 5039	• • • •	DMSMS Product Life Cycle Assessment (Consult DLA) Industrial Base Assessment Survey Form DCMA Industrial Analysis Center MRL Assessment Questionnaire for the Materials Thread Supply Chain Management Risk Assessment Checklist Producibility Assessment Worksheet TRL Assessment Questionnaire
5040	Resou	rces
5041 5042 5043	•	AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition; and AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materiel.

• • • • •	DMSMS Guidebook, SD-22, Sep 2009 DOD 4140.1-R, Supply Chain Management Regulation DOD 5000.60, Defense Industrial Capabilities Assessments DOD 5000.60H, Assessing Defense Industrial Capabilities DoDM 4140.1, DoD Supply Chain Management Procedures, Feb 2014 IEEE 15288.2, Standard for Technical Reviews and Audits on Defense Programs, May 2015 MRL Deskbook Version 2016 NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy, Dec 1999
•	Technology Readiness Assessment Guidance, Apr 2011
U.5	facturing and Quality Tasks
•	Conduct assessments of materials producibility (manufacturing processes and techniques), and availability to meet future program requirements (scale-up for prototypes, pilot line, LRIP, and FRP) and determine materials risks, issues, and opportunities.
	 Consider new materials (to the industry, to the program, to the suppliers) Consider source criticality and fragility (e.g., sole or single sources, foreign sources, domestic foreign-owned, etc.) Consider lead times from suppliers where availability is not proven Consider volume rates that are higher or lower than typical Consider obsolescence due to product improvements and market/technology changes Consider regulatory requirements and impacts (e.g., US law, ITAR, environmental, REACH concerns, etc.)
•	Develop manufacturing and quality plans to address scale-up risks, issues, and opportunities. Plans may include:
	 Manufacturing processes and techniques not currently available Probability of meeting delivery dates Addressing potential impacts from critical and long-lead time materials Addressing production equipment availability (acquisition and/or scheduling) Impact analyses to support trade-offs among manufacturing and quality materials alternatives Recommendations for anticipated in-process testing and demonstration Methods for conserving critical and strategic materials and mitigating supply disruption risks and associated impacts Issues associated with materials transportation and security including ITAR considerations
	• • • • • • •

5079	Metric	CS
5080 5081 5082	•	Assessments of materials producibility and availability for future program requirements (e.g., prototypes, pilot line, LRIP, and FRP) have been conducted and document materials risks, issues, and opportunities and include considerations for:
5083 5084 5085 5086 5087 5088 5088 5089 5090		 Mew materials (to the industry, to the program, to the suppliers) Critical and fragile source (e.g., sole or single sources, foreign sources, domestic foreign- owned, etc.) Lead times from suppliers and the supply chain Rates that are potentially higher or lower than typical Obsolescence (product improvements and/or market/technology changes) Meeting regulatory requirements (e.g., US law, ITAR, environmental, REACH concerns, etc.)
5091 5092 5093	•	Manufacturing and quality plans have been developed and documented in the appropriate program plans (e.g., EMD RFP, AS, SEP, etc.) to address scale-up risks, issues, and opportunities. Plans included:
5094 5095 5096 5097 5098 5099 5100 5101 5102 5103 5104 5105	•	 Development of new manufacturing processes and techniques Actions necessary to meet required delivery dates Mitigation of impacts from critical and long-lead time materials Production equipment availability (acquisition and/or scheduling) Trade-off analyses impacts, results, and recommendation for manufacturing and quality materials alternatives In-process testing and demonstration recommendations and schedule Recommended methods for conserving critical and strategic materials and mitigating supply disruption risks and associated impacts Actions necessary for materials transportation and security including ITAR considerations
5106	Tools	
5107 5108 5109 5110	• • •	Cost and Lead Time Worksheet Producibility Assessment Worksheet MRL Assessment Materials Thread ManTech Strategic Plan
5111	Resou	rces
5112 5113 5114 5115	• •	MRL Deskbook Version 2016 MRL Users Guide Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for Program Managers, Chapter 9

5116 5117 5118	•	Producibility Systems Guidelines, NAVSO P-3687, Dec 1999 DoDD 4200.15, ManTech Air Force Technology Development and Transition Strategy Guidebook, Nov 2010
5119	G.4	Review Initial Supply Chain Management (SCM) Program
5120	Manu	facturing and Quality Tasks
5121 5122	•	Assess the contractor's Supply Chain Management (SCM) program for veracity and adherence to industry manufacturing and quality best practices to include:
5123 5124 5125 5126 5127 5128		 Quality management standards (e.g., ISO 9000, AS9100, etc.) Manufacturing management standards (e.g., AS6500, MIL-STD-896A, IEEE 15288, etc.) Configuration management, Sourcing processes Development of strategic partnerships with vendors and suppliers Sub-contract management
5129 5130 5131 5132		 Monitoring sub-tier compliance to contract manufacturing and quality requirements Sub-tier supplier processes (e.g., configuration management, parts management, counterfeit parts management, electro-static discharge program, etc.) Collaboration of information (especially quality and forecasting data)
5133 5134 5135		 Procurement processes (schedule, quantity, packaging, kitting, identification, quality) Variability reduction Logistics and inventory management
5136 5137 5138 5139 5140 5141 5142		 Order Fulfillment (schedule, kitting, identification) Warehouse Management (storage, schedule, kitting, packaging, environmental, security) Transportation Management (methods, special handling, packaging, environment, identification) Vendor Managed Inventory (schedule, quantity, packaging, kitting, identification, quality)
5143 5144		• A robust risk, issue, and opportunity management process for integration of risks, criticality, obsolescence, sourcing
5145 5146	•	Assess the contractor manufacturing and quality processes for compliance with or adherence to Company policy, process, and contracts, utilizing DCMA support (if available).
5147 5148 5149 5150 5151 5152		 Contract Management with evidence of strong contracts and supplier interaction process with plans and schedule to reduce variability and lead times and associated impact on the critical path Assess supply chain interdependencies with regards to other programs Strategic Sourcing to minimize risks, criticality, and obsolescence Supplier qualification, approval, and monitoring processes to include

5153 5154	Suppliers with known risksSupplier parts usage and sources (i.e., GIDEP prohibited)
5155	• Requirements and data flow processes (two-way)
5156 5157 5158 5159	 Program milestones and metrics (consistent with the IMS) Demand Planning consistent with the IMS Quality, safety, technical, and inspection requirements Key and critical characteristics
5160 5161 5162 5163 5164 5165 5166 5167	 Make or buy decision analysis processes DMSMS management processes Material waiver process (should only be utilized in limited circumstances) Requirements for use of industry best practices (e.g., AS6500, ISO 9000, AS9100, etc.) Requirements for first article/qualification unit(s) (i.e., AS 9103) Vendor survey requirements Identification of Sub-tier supplier processes for embedded software and firmware risks, issues, and opportunities management including requirements:
5168 5169 5170	 For conducting Software Acceptance Test (SAT)/ Software Formal Qualification Testing (SFQT) For performing surveillance of this activity
5171 5172	• Initiate SCM planning for EMD, production, developmental and operational test, and life cycle sustainment.
5173 I	etrics
5174 5175 5176	• Contractor's SCM program has been assessed and documented (for engineering and management review, as required) for adherence to industry manufacturing and quality best practices for manufacturing management and quality management including:
5177 5178 5179 5180	 Configuration management Sourcing processes Strategic partnerships with vendors and suppliers Sub-contract management
5181 5182 5183 5184	 Sub-tier compliance to contract manufacturing and quality requirements Sub-tier supplier processes (e.g., configuration management, parts management, counterfeit parts management, electro-static discharge program, etc.) Collaboration of information (quality and forecasting data)
5185 5186 5187	 Procurement processes (schedule, quantity, packaging, kitting, identification, quality) Variability reduction Logistics and inventory management
5188	 Order Fulfillment (schedule, kitting, identification)

5189 5190 5191 5192 5193 5194		 Warehouse Management (storage, schedule, kitting, packaging, environmental, security) Transportation Management (methods, special handling, packaging, environment, identification) Vendor Managed Inventory (schedule, quantity, packaging, kitting, identification, quality)
5195 5196	0	A robust risk, issue, and opportunity management process for integration of risks, criticality, obsolescence, sourcing
5197 5198 5199 5200	Co Co ma de	ontractor manufacturing and quality processes have been assessed for adherence to ompany policy, process, and contractual requirements and documented for engineering and anagement reporting and reviews (e.g., root cause analyses, PMRs, award fee termination, PDR, etc.).
5201 5202 5203	0	Contract Management process metrics demonstrate a strong contracts and supplier interaction process for planning and scheduling that have reduced variability and lead times
5204 5205 5206	0	Supply chain interdependencies with regards to other programs have been analyzed with impacts documented Strategic Sourcing has been utilized and documents reduction of risks, criticality, and
5200 5207	0	obsolescence
5208 5209	0	Supplier management processes have been documented to show adherence to qualification, approval, and monitoring processes that include
5210 5211		Suppliers with known risksSupplier parts usage and sources (i.e., GIDEP prohibited)
5212 5213	0	Requirements and data flow processes have been established and document two-way flow for contract requirements to include:
5214 5215 5216 5217		 Program milestones and metrics (consistent with the IMS) Demand Planning consistent with the IMS Quality, safety, technical, and inspection requirements Key and critical characteristics
5218 5219	0	Make or buy decision analysis processes have been determined and documented as compliant
5220	0	DMSMS management processes have been documented as compliant
5221	0	Material waiver process has been implemented and results and decisions documented
5222		(should only be utilized in limited circumstances)
5223	0	Requirements for selected industry best practices (e.g., AS6500, ISO 9000, AS9100, etc.)
5224		nave been established, applied, and compliance documented
5225	0	Requirements for first article qualification and first article tests (i.e., AS 9103) have been
5220 5227	-	Contractor wonder survive requirements have been met and de survive d
5221	0	Contractor vendor survey requirements have been met and documented

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5228 5229 5230		• Sub-tier supplier processes for embedded software and firmware risks, issues, and opportunities management have been established and compliance documented including requirements for:
5231 5232 5233		 Conducting Software Acceptance Test (SAT)/ Software Formal Qualification Testing (SFQT) Performing surveillance
5234 5235 5236	•	Manufacturing and quality SCM planning (EMD, production, developmental and operational test, and life cycle sustainment) has been initiated and documented in the Acquisition Strategy and the SEP and provided for the PDR process.
5237	Tools	
5238	•	Supply Chain Assessment
5239	•	MRL Assessment using the Material thread
5240	Resou	irces
5241	•	AS 9133, Qualification Procedure for Aerospace Standard Parts
5242	•	AS6500, Manufacturing Management Program, Nov 2014
5243	•	AS9100, Quality Systems - Requirements For Aviation, Space, And Defense Organizations,
5244		Sep 2016
5245	•	ISO 9001:2015, Quality Management System
5246	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
5247	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
5248	•	AS6500, Manufacturing Management Program, Nov 2014
5249	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
5250	G.5	Develop Alternate Source Options
5251	Manu	facturing and Quality Tasks
5252 5253	•	Provide analyses of the program materials (system, subsystem, items, and components) for manufacturing and quality sourcing strategies to address:
5254		• Qualification planning
5255		• Contingencies for capacity, economic/political impacts, disaster impacts, etc.)
5256		• Dual source competition (include GFE)
5257		• Readily available materials that have environmental or health concerns
5258		• Single, sole, foreign, foreign-owned domestic, etc. vulnerability mitigation
5259		• Materials only available outside the NTIB
5260		• Quality, schedule, transportation, fulfillment, etc. requirements
5261		• Hazardous, difficult to obtain, or process materials

5262 5263 5264 5265	•	Based on manufacturing and quality analyses of program materials and assessments of materials maturity, availability, risks, issues, and opportunities, develop recommendations for alternate sources and options. Initiate planning to address DMSMS including:
5266 5267 5268		 Development of recommended options or mitigation plans Analyses of materials, sources, and issues from the GIDEP database relevant to the program
5269	Metric	CS
5270 5271 5272	•	Analyses of the program materials (system, subsystem, items, and components) has been conducted to support manufacturing and quality sourcing strategies and document the following:
5273 5274 5275 5276 5277 5278 5279 5280		 Qualification planning Contingencies for capacity, economic/political impacts, disaster impacts, etc.) Competition (including dual source, GFE, etc.) Problematic materials that have environmental or health concerns Vulnerability mitigation (e.g., single, sole, foreign, foreign-owned domestic, etc.) Materials sources external to the NTIB Meeting the requirements for quality, schedule, transportation, fulfillment, etc. Requirements and plans for hazardous, difficult to obtain, or process materials
5281 5282 5283 5284 5285 5286 5286	•	Recommendations for alternate sources and options have been developed based on manufacturing and quality analyses and assessments of materials maturity, availability, risks, issues, and opportunities; and recommendation have been documented for systems engineering, program management, and support of the program technical review process (e.g., SEP, AS, PDR, etc.) Plans for DMSMS have been developed and documented to include: o Recommended options, metrics, and mitigation plans
5288 5289		 Continuous processes for analyses of materials, sources, and issues in the GIDEP database relevant to the program
5290	Tools	
5291 5292	•	Supply Chain Assessment MRL Assessment using the Material thread
5293	Resou	rces
5294 5295 5296	•	AS 9133, Qualification Procedure for Aerospace Standard Parts FAR Part 46, Quality Assurance MIL-STD-896A, Manufacturing Quality Program
5297	•	MRL Deskbook Version 2016

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5298 G.6 Identify Critical Materials

5299 Manufacturing and Quality Tasks

5300 5301	•	Perform analyses (e.g., FMECA, DFMEA, PFMEA, etc.) to identify KCs, critical characteristics, and key manufacturing and quality processes (See E.5 and E.7)
5302 5303 5304 5305 5306		 Include Critical Technologies list of CTEs with CSIs and CAIs Include sub-tier supplier subsystems, items, and components Include software and firmware configuration items Develop a preliminary list, which includes where produced or accomplished and associated rationale for inclusion, of:
5307 5308 5309 5310 5311 5312		 Key Characteristics Critical characteristics Critical Application Items (CAIs) (e.g., systems, subsystems, software, materials, components, etc.) Key manufacturing and quality processes Critical Safety Items (CSIs)
5313 5314	•	Analyze and validate that the contractor Critical Supplier's List (hardware and software) is up-to-date.
5315 5316		 Include contractor materials planning and management process (See L.3) Include risks and issues management process (See G.2)
5317 5318	•	Analyze and validate material maturity through demonstration of subsystems, items, and components in a relevant environment
5319 5320		 Validate material properties have been characterized Verify material specifications in place
5321	Metrie	CS
5322 5323 5324	•	Analyses of FMECA, DFMEA, PFMEA, etc. have been conducted and have identified KCs, critical characteristics, and key manufacturing and quality processes and have been documented to support program management, reviews, and the PDR processes to include:
5325 5326 5327		 Critical Technologies list of CTEs with CSIs and CAIs Sub-tier supplier subsystems, items, and components Software and firmware configuration items
5328 5329	•	A preliminary list, which includes where produced or accomplished and associated rationale has been developed and documents:
5330 5331 5332 5333		 Key Characteristics Critical characteristics Critical Application Items (CAIs) (e.g., systems, subsystems, software, materials, components, etc.)

5334 5335		Key manufacturing and quality processesCritical Safety Items (CSIs)
5336 5337	•	The contractor Critical Supplier's List of hardware and software items has been analyzed and validated, is up-to-date, and being tracked to include:
5338 5339		 Contractor materials planning and management processes Risks and issues management processes
5340 5341	•	Material maturity has been validated by successful demonstrations of subsystems, items, and components in relevant environments
5342 5343		 Material properties have been characterized Material specifications are in place
5344	Tools	
5345	•	MRL Assessment Checklist for Materials thread
5346	•	Producibility Assessment Worksheet (PAWs)
5347	•	Technology Readiness Assessment
5348	٠	TRL Calculator
5349	٠	FMECA, DFMEA, PFMEA templates
5350	Resou	rces
5351	٠	AS6500, Manufacturing Management Program, Nov 2014
5352 5353	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016
5354	•	Defense Acquisition Guide, Chapter 4
5355	•	Defense Acquisition Program Support Methodology, Ver. 3.0
5356	•	Defense Manufacturing Management Guide for Program Managers, Chapter 7.4.5.5 Failure
5357		Mode and Effects Analysis (FMEA)
5358	•	DoDI4140.69
5359	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
5360	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
5361	٠	Integrated Product Support (IPS) Element Guide, Chapter 2.1.1.3 FMECA, Apr 2017
5362	•	MRL Deskbook Version 2016
5363	•	NAVSO P-3687 Producibility Systems Guidelines, Dec 1999
5364	•	SAE J1739, Potential Failure Mode and Effects Analysis in Design (Design FMEA),
5365		Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes
5366		(Process FMEA), Jan 2009
5367	•	Technology Readiness Assessment Guidance, Apr 2011

5368 H. PROCESS CAPABILITY/CONTROL

5369 Manufacturing and quality process capability and control should be a part of any development

5370 program. Manufacturing and quality engineering efforts should lead to a producible and testable

5371 system with objective of achieving effective and efficient manufacturing processes with the

- 5372 necessary process controls to satisfy requirements with consistent, repeatable products and minimize
- 5373 manufacturing costs. During MSA phase required process capabilities were identified for critical
- 5374 manufacturing and quality processes with the associated risks. In TMRR, process capability data
- 5375 collection begins and continues into EMD.



5377 In preparation for SRR and SFR, prior identified manufacturing and quality process capabilities 5378 should be refined and updated based on data collected and the contractor's plans, processes, and 5379 procedures to identify the process capabilities required for the system. During the development 5380 process, additional studies at the system, subsystem, item, and component levels will be conducted to 5381 define the appropriate level of process capability and control. A thorough knowledge of a 5382 contractor's and supply chain's process capabilities is critical to developing a successful system. 5383 Process capabilities and data must be understood, measured, controlled, and documented, and 5384 process capability information must be up-to-date.

Program manufacturing and quality personnel should have an understanding of the state-of-the-art and industry best practices in manufacturing and production Modeling and Simulation (M&S) tools and or products. In TMRR, the contractor will have proposed use of certain M&S manufacturing and quality tools which must be verified for adequacy, applicability, and consistency with other system models. Additionally, manufacturing and quality must understand the contractor's plans and processes for maturing and validating their M&Ss as high-fidelity representations of the manufacturing and quality systems and systems performance and capability based on actual

5392 program data.

5376

5393 During the TMRR phase the contractor will produce prototypes that will be used during tests to 5394 ensure they will meet the customers' requirements. These prototypes will be built in a relevant 5395 manufacturing environment, meaning that there are some elements of production realism present on 5396 the manufacturing line. To the extent practicable, the processes used for prototype build should be 5397 evaluated to better understand the difficulties and risks that will need to be overcome during the 5398 EMD phase. In preparation for PDR and EMD transition, manufacturing processes, products, and 5399 prototypes demonstrated and assessed in a relevant environment results are incorporated in to the

3. Technology Maturation and Risk Reduction (TMRR) Phase

5400 appropriate M&Ss. These assessments and demonstrations should provide an understanding of the

5401 contractor's M&S tools and provide the basis for program manufacturing planning, resource loading, 5402 and facilities management, etc. for future phases.

5403 H.1 Identify Required Process Capability

5404 Manufacturing and Quality Tasks

- 5405
 Update the analyses of the current state and gaps in process capability within industry for manufacturing and quality processes appropriate to the system, subsystems, items, and components.
- Update or identify manufacturing and quality process capability risks, issues, and
 opportunities for the SRR and the SFR from the manufacturing feasibility and other prior
 assessments including risks to:
- 5411 o Key Characteristics
- 5412 Manufacturing and quality processes (new equipment and technology)
- 5413 Potential cost and schedule impacts
- 5414 o Producibility
- 5415 o Tooling and facilities
- 5416 Testing and qualification
- 5417 o Environmental, transportation, storage, etc.
- 5418 o Data management (collection, storage, cybersecurity, etc.)
- Assess and estimate process maturity and capability for processes with insufficient data
 utilizing information from similar subsystems, items, and components that are currently or
 have been previously manufactured.
- Analyze if planned manufacturing and production processes are capable of producing units
 (subsystems, items, and components) in quantities to the contract specifications and schedule.
- 5424oDetermine if the contract requires the contractor provide estimated and actual yield rates5425by source and/or facility for materials, components, items, and subsystems.
- 5426 Metrics
- Analyses of the current state and gaps in process capability within industry for manufacturing
 and quality processes appropriate to the system, subsystems, items, and components has been
 updated and documented for the SFR and SRR.
- Manufacturing and quality process capability risks, issues, and opportunities have been
 identified and/or updated and documented for the SRR and the SFR. Analyses included data
 from the manufacturing feasibility and other prior assessments including:
- 5433 o Key Characteristics
- 5434 Manufacturing and quality processes (new equipment and technology)
- 5435 Potential cost and schedule impacts
- 5436 o Producibility

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3. Technology Maturation and Risk Reduction (TMRR) Phase

5437 5438 5439		 Tooling and facilities Testing and qualification Environmental, transportation, storage, etc.
5440		• Data management (collection, storage, cybersecurity, etc.)
5441 5442 5443 5444	•	Process maturity and capability for processes with insufficient data has been estimated and documented utilizing information from similar subsystems, items, and components that are currently or have been previously manufactured for the SRR and SFR. Planned manufacturing and production processes have been analyzed and documented to
5445 5446		the contract specifications and schedule.
5447 5448		• If required by the contract, contractor provided estimates and actual yield rates by source and/or facility for materials, components, items, and subsystems, have been included.
5449	Tools	
5450	٠	MRL Assessment Checklist for the Process Capability and Control Thread
5451	Resou	rces
5452	٠	AS6500, Manufacturing Management Program, Nov 2014
5453	٠	Capability-Based Assessment (CBA) Handbook, Mar 2014
5454	٠	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
5455	•	MRL Deskbook Version 2016
5456	H.2	Modeling and Simulation at Functional Level
5457	Manu	facturing and Quality Tasks
5458 5459 5460	•	Update analyses of the state of the art and industry best practices in manufacturing and production modeling and simulation tools and or products (i.e., software) that support the functional analyses of the system.
5461 5462 5463	•	Assess and analyze the contractor-proposed modeling and simulation tools and plan for adequacy and sufficiency for system manufacturing and quality, process capability, control, and maturation.
5464 5465		 Include analyses of capability to provide inputs to manufacturing planning, resource loading, and facilities management
5466 5467		 Include analyses of contractor usage of tools against industry standards for potential improvements and to determine functional constraints
5468	Metrie	CS
5469 5470 5471	•	Analyses of the state of the art and industry best practices in manufacturing and production modeling and simulation tools and or products (i.e., software) have been conducted and documented to support the functional analyses of the system.

Manufacturing and Quality Management Body of Knowledge

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3. Technology Maturation and Risk Reduction (TMRR) Phase

5472 5473	•	Contractor-proposed modeling and simulation tools and plans have been analyzed and documented for adequacy and sufficiency as inputs to the SRR and the SFR to include:
5474 5475 5476		 System manufacturing and quality, process capability, control, and maturation Capability to provide inputs to manufacturing planning, resource loading, and facilities management
5477 5478		 Contractor usage of tools against industry standards for potential improvements and to determine functional constraints
5479	Tools	
5480	٠	MRL Assessment Checklist for the Process Capability and Control Thread
5481	•	System Capabilities Analytic Process (SCAP)
5482 5483	•	Solid modeling and analysis software programs (e.g., NX, CATIA, Pro-Engineer, Nastran add-ins, etc.)
5484	٠	Process Modeling Tools (/Siemens PLM, Delmia, etc.)
5485	•	Plant Modeling and Simulation tools (FlexSim, SimFactory, etc.)
5486	Resou	rces
5487	٠	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
5488	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
5489	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
5490	•	Modeling and Simulation Guidance for the Acquisition Workforce, Oct 2008
5491	•	MRL Deskbook Version 2016
5492	Н.3	Conduct Process Capabilities Studies
5493	Manu	facturing and Quality Tasks
5494 5495	•	Utilizing results of the SRR/SFR, update manufacturing and quality process capability risks, issues, and opportunities for the AS, the SEP, the TEMP, and the CDD including:
5496		• Key Characteristics
5497		• Manufacturing and quality processes (new equipment and technology)
5498		• Potential cost and schedule impacts
5499		o Producibility
5500		• Tooling and facilities
5501		• Testing and qualification
5502		• Environmental, transportation, storage, etc.
5503		• Data management (collection, storage, cybersecurity, etc.)
5504	•	Conduct process capability and variability studies and analyses on:
5505		• Similar subsystems, items, and components that are currently or have been previously
2206		manufactured utilizing previous estimates

3. Technology Maturation and Risk Reduction (TMRR) Phase

5507 5508 5509 5510		 Current subsystems, items, and components manufacturing and production processes and equipment Incorporate data collected from contractor yield rates for subsystem, item, component, and prototype builds
5511 5512 5513 5514	•	Identify required process capability and variability studies and analyses for planned subsystems, items, and components manufacturing and production processes and equipment for the AS, the SEP, and the PDR. Determine process capability requirements for pilot line and production
5515	-	• Identify C_{pk} goals for each key manufacturing process
5516	Metrio	cs
5517 5518 5519	•	Manufacturing and quality process capability risks, issues, and opportunities have been updated and documented as inputs for the AS, the SEP, the TEMP, and the CDD to include inputs on:
5520 5521 5522 5523 5524 5525 5526 5526		 Key Characteristics Manufacturing and quality processes (new equipment and technology) Potential cost and schedule impacts Producibility Tooling and facilities Testing and qualification Environmental, transportation, storage, etc. Data management (collection, storage, cybersecurity, etc.)
5528 5529 5530	•	Process capability and variability studies and analyses have been completed and documented where appropriate for currently available and similar subsystems, items, components, and prototype builds including:
5531 5532		 Manufacturing and production processes and equipment Data collected from contractor yield rates
5533 5534 5535 5536 5537 5538	•	Required process capability and variability studies and analyses for planned subsystems, items, and components manufacturing and production processes and equipment have been identified for the AS, the SEP, and the PDR will be conducted as data from the contractor becomes available. Process capability requirements and indices for pilot line and production have been identified, documented for the SEP and the PDR, and will be monitored.
5539 5540 5541		 Cpk goals for each key manufacturing process have been identified and documented Recommended improvement actions for low yield processes or unacceptable variability have been documented
5542	Tools	

• Cause and Effect Diagram

3. Technology Maturation and Risk Reduction (TMRR) Phase

5544	•	Cost of Quality Estimates
5545	•	Feasibility Study Checklist (TBD)
5546	•	First Pass Yield Estimates Worksheet
5547	•	Histograms
5548	•	MRL Assessment using Process Capability and Control Thread
5549	•	Pareto Analysis
5550	•	Process Capability Studies (C _p and C _{pk} assessment)
5551	•	Producibility Assessment Worksheet (PAWs)
5552	•	Six Sigma Worksheet
5553	•	First Pass Yield Estimates Worksheet
5554	Resou	irces
5555	•	AS6500, Manufacturing Management Program, Nov 2014
5556	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
5557	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
5558	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
5559	•	MRL Deskbook Version 2016
5560	•	DoD-Wide Continuous Process Improvement (CPI/Lean and Six Sigma) Program, May 2008
5561	•	DoD Continuous Process Improvement Transformation Guide, May 2006
5562	٠	NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy, Dec 1999
5563	Н.4	Modeling and Simulation at Subsystem/System Level
5564	Manu	facturing and Quality Tasks
5565	•	Assess contractor Modeling and Simulation (M&S) tools prior to product and/or process
5566		implementation for the capability to model the proposed design concept(s) for the PDR
5567		process. Tools should include:
5568		\circ Capability to evaluate the proposed design and manufacturing concepts to meet
5569		manufacturing and quality objectives
5570		• Capability to estimate outputs of design performance
5571		• Outputs for updating cost models (see F.2)
5572		• Identification of potential manufacturing and quality bottlenecks or constraints
5573		• Confirmation of planned manufacturing and quality cycle times achievability
5574		 Impacts of manufacturing and quality process variability
5575		• Capability to model the factory floor, process flows, assembly lines, yields/ throughput,
5576		cycle times, etc.
5577		• Capability to estimate required quantities of tooling, personnel, and inventory
5578		• Sufficient complexity to represent and support the complexity of the product being

3. Technology Maturation and Risk Reduction (TMRR) Phase

5580 5581 5582	•	Assess the manufacturing and quality aspects of the contractor and/or government prototype environment (i.e., system simulation/integration lab) to validate M&S emulation of subsystems, components, and items, including:
5583 5584 5585 5586 5587		 A mix of mature hardware, prototypes, and models and simulations Integration and interdependencies Identification of constraints Performance Status of contractor M&S of the "to be" system or subsystem
5588 5589 5590	•	Provide manufacturing and quality recommendations to the contractor for innovative M&S capabilities (factory simulations) that go beyond basic capabilities and will allow the manufacturing engineer to address:
5591 5592 5593 5594 5595		 Sustainable manufacturing goals (energy, water and other resource usage) Monitor and optimize maintenance and calibration requirements Supply chain collaboration for product design, quality and scheduling Manufacturing execution and execution systems networked to machines, test and measurement devices, robotics and process planning
5596	Metri	CS
5597 5598 5599	•	Contractor Modeling and Simulation (M&S) tools have been assessed and analyzed prior to product and/or process implementation for the capability to model the proposed design concept(s) and documented to support the PDR process. Tools have documented:
5600 5601 5602 5603 5604 5605 5606 5607 5608 5609 5610 5611		 The evaluation of the proposed design and manufacturing concepts to meet manufacturing and quality objectives Estimated outputs of design performance Cost model updates (see F.2) Potential manufacturing and quality bottlenecks and constraints Confirmation of planned manufacturing and quality cycle times achievability Impacts of manufacturing and quality process variability Modeling and demonstrations of the factory floor, process flows, assembly lines, yields/ throughput, cycle times, etc. Estimates of required quantities of tooling, personnel, and inventory Sufficient complexity to represent and support the complexity of the product being manufactured
5612 5613 5614 5615	•	Manufacturing and quality aspects of the contractor and/or government prototype environment (i.e., system simulation/integration lab) to validate M&S emulation of subsystems, components, and items have been assessed and documents the following attributes:
5616 5617 5618		 Capability to mix mature hardware, prototypes, and models and simulations in the environment Inclusion of integration and interdependencies
		Manufacturing and Quality Management Dady of Vnewladge

5619		• Constraints
5620		• Performance
5621		• Status of contractor M&S of the "to be" system or subsystem
5622 5623 5624	•	Recommendations have been provided for EMD and future phases to the contractor for innovative M&S capabilities (factory simulations) that go beyond basic capabilities and allows the manufacturing engineer to address:
5625 5626 5627 5628 5629		 Sustainable manufacturing goals (energy, water and other resource usage) Monitor and optimize maintenance and calibration requirements Supply chain collaboration for product design, quality and scheduling Manufacturing execution and execution systems networked to machines, test and measurement devices, robotics and process planning
5630	Tools	
5631	٠	MRL Assessment using Process Capability and Control Thread
5632	٠	Solid modeling and analysis software programs (e.g., NX, CATIA, Pro-Engineer, Nastran
5633		add-ins, etc.)
5634	•	Process Modeling Tools (Siemens PLM, Delmia, etc.)
5635	•	Plant Modeling and Simulation tools (FlexSim, SimFactory, etc.)
5636	Resou	rces
5637	٠	AS6500, Manufacturing Management Program, Nov 2014
5638	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
5639	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
5640	•	Modeling and Simulation Guidance for the Acquisition Workforce, Oct 2008
5641	•	MRL Deskbook Version 2016
5642	H.5	Manufacturing Processes Demonstration in Relevant Environment
5643	Manu	facturing and Quality Tasks
5644	•	Based on government/contractor IPT interactions, define and document the appropriate
5645		manufacturing and quality production relevant environment(s) to be used for process
5646		demonstrations and prototypes.
5647	•	Assess demonstrations of manufacturing processes in an environment with some shop floor
5648		production realism present (e.g., actual production facilities, manufacturing personnel, using
5649		production tooling, processes, materials) incorporating factors such as:
5650		 Minimum reliance on laboratory resources
5651		• Environmental conditions (i.e. temperature, humidity, air quality)
5652		• Equipment (i.e., accuracy, calibration, age and condition, suitability, capacity, reliability)
5653		• Workforce (i.e., training, skills, and certifications)
5654		• Human factors (i.e., noise, vibrations, ergonomics)

3. Technology Maturation and Risk Reduction (TMRR) Phase

5655		• Ability to meet the cost, schedule, and performance requirements of the EMD phase
5656 5657	•	Evaluate demonstrations to determine environmental factors impacting the manufacturing of subsystems, items, and components.
5658 5659		 Include ambient temperature, humidity, noise, vibrations, personnel skills levels, materials specifications, etc.
5660 5661 5662 5663	•	Evaluate process demonstrations and production of prototypes for mitigation of manufacturing and quality risks. Evaluate and analyze yields and rates from process demonstrations and production of components and items for prototype builds.
5664		• Utilize results as inputs to improvement plans
5665 5666 5667 5668 5669	•	Collect data from process demonstrations and production of components and items for prototype builds to support verification, validation, and authentication of M&S processes. Develop a comprehensive plan for EMD to demonstrate manufacturing and quality processes in a production representative environment by CDR and on a pilot line to support the Milestone C decision process.
5670		• Include all manufacturing and quality risks
5671 5672	•	Assess manufacturing readiness by conducting an MRL assessment to support PDR and the Milestone B decision process. (See A.3)
5673 5674 5675		 Support a the Technology Readiness Assessment, if conducted Support identification of any critical technologies or manufacturing processes that have not been successfully demonstrated in a relevant environment
5676	Metric	S
5677 5678 5679 5680 5681 5682 5683	•	An initial contractor-delivered and government-approved plan for TMRR with schedule and budget detailing how the contractor(s) intends to achieve and demonstrate manufacturing and quality processes and prototypes in appropriate production relevant environment(s). Successful demonstration of documented manufacturing processes in an environment with some shop floor production realism present (i.e., actual production facilities, manufacturing personnel, using actual tooling, processes, materials) completed with evaluation performed incorporating factors such as:
5684 5685 5686 5687 5688 5689		 Minimum reliance on laboratory resources Environmental conditions (i.e. temperature, humidity, air quality) Equipment (i.e., accuracy, calibration, age and condition, suitability, capacity, reliability) Workforce (i.e., training, skills, and certifications) Human factors (i.e., noise, vibrations, ergonomics) Ability to meet the cost, schedule, and performance requirements of the EMD phase
5690 5691	•	Demonstration results have been analyzed and document the environmental factors that impacted the manufacturing and quality of subsystems, items, and components.

5692 5693		 Factors included and document ambient temperature, humidity, noise, vibrations, personnel skills levels, materials specifications, etc.
5694 5695 5696	•	Results of process demonstrations and production of prototypes effect on mitigation of manufacturing and quality risks have been analyzed, quantified, and documented for the risk, issue, and opportunity process.
5697 5698 5699 5700 5701 5702 5703 5704 5705	•	 Yields and rates from process demonstrations and production of components and items for prototype builds have been analyzed against target and results utilized as inputs to manufacturing and quality improvement plans. Verification and validation data have been specified, collected, and documented for use in verification, validation, and authentication of the M&S processes. A comprehensive plan for EMD to demonstrate manufacturing and quality processes in a production representative environment by CDR and on a pilot line to support the Milestone C decision process including all manufacturing and quality risks has been developed and documented for the AS, the SEP, etc.
5706		• Includes impacts to overall program planning (e.g., IMP/IMS, etc.)
5707 5708	•	A MRL assessment has been conducted and documented in support PDR and the Milestone B decision process. (See A.3)
5709 5710 5711 5712		 Manufacturing and quality inputs to the TRA has been documented Identification of any critical technologies or manufacturing processes that have not been successfully demonstrated in a relevant environment has been documented for the report to Congress
5713	Tools	
5714	•	MRL Assessment using Process Capability and Control Thread
5715	Resou	rces
5716	٠	MRL Deskbook Version 2016
5717	•	Public Law 114-328
5718	•	DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017
5719	H.6	Evaluate Actual Process Capability from Prototype Builds
5720	Manu	facturing and Quality Tasks
5721 5722 5723 5724	•	Based on analyses and evaluations of M&S models, process demonstrations, production of components and items, and prototype builds, summarize, define, and finalize manufacturing and quality processes, process capabilities, and limitations for EMD Acquisition Strategy and SEP planning.
5725		• Refine process capability requirements for the EMD phase.

3. Technology Maturation and Risk Reduction (TMRR) Phase

5726 5727 5728 5729 5730		 Develop plans to transition from production relevant environment with some shop floor realism present to the production representative environment with as much production realism as possible prior to CDR Update models and simulations for use in EMD with actual data to increase fidelity and confidence that the model and prototypes realistically represent the final product
5731	Metrio	CS
5732 5733 5734 5735	•	Analyses and evaluations of M&S models, process demonstrations, production of components and items, and prototype builds have been summarized, defined, and have finalized documentation for manufacturing and quality processes, process capabilities, and limitations for EMD Acquisition Strategy and SEP planning.
5736 5737 5738 5739 5740 5741 5742		 Process capability requirements have been refined and documented for the EMD phase Plans to transition from production relevant environment with some shop floor realism present to the production representative environment with as much production realism as possible prior to CDR have been documented Models and simulations have been updated for use in EMD with actual data to increase fidelity and confidence that the model and prototypes realistically represent the final product
5743	Tools	
5744	•	MRL Assessment using Process Capability and Control Thread
5745	•	Process Capability Studies (C_p and C_{pk} assessments)
5746	•	Producibility Assessment Worksheet (PAWs)
5747	Resou	rces
5748	•	AS6500, Manufacturing Management Program, Nov 2014
5749	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
5750	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
5751	•	MRL Deskbook Version 2016
5752	•	NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy, Dec 1999
5753	•	Process Capability Control and Improvement Requirements – Process Control Plan
5754		Reference Guide, Picatinny Arsenal, Oct 2011
5755	•	Public Law 114-328
5756	I. Q	UALITY MANAGEMENT
5757	An eff	ective quality management strategy and contractor Quality Management System are required if

5758 the program is to deliver operationally safe, suitable and effective weapon systems. The initial

5759 quality strategy should have been developed during the MSA phase. The QMS assures the as-

by delivered configuration is the same as the as-designed and as-tested configuration. The quality

5761 strategy serves as the basis for the management and control function within the program systems

3. Technology Maturation and Risk Reduction (TMRR) Phase

- engineering process and should be continuously updated in each phase. The strategy requires basic
- 5763 controls over requirements reviews, design inputs, verification and validation of design outputs, and
- 5764 control of design changes. It also requires monitoring and measuring of processes and products
- 5765 (including embedded software and firmware) to ensure they conform to requirements. Quality
- 5766 strategy development must begin during the earliest stages of system development and must continue
- 5767 throughout the program life cycle.



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5769 A QMS compliant with industry best practices, ISO 9000 or AS9100, is the foundation for the

5770 contractor to deliver a system that meets requirements. The program must evaluate the contractor's

5771 QMS to ensure implementation of industry best practices. The program and the contractor should

5772 develop a joint government/contractor manufacturing and quality plan that specifies:

- Roles, responsibilities, and quality processes
- Tasks, schedules, and outcomes
- Standards, requirements, and metrics
- 5776 Joint risk, issue, and opportunity processes and procedures
- Quality tools such as Continuous Process Improvement (CPI)

5778 Everything a contractor does will be related to the quality of its products or services, a contractor's 5779 QMS should be the basis for integrating all other management systems within an enterprise. The Program must assess the contractor QMS to ensure that the contractor has an effective QMS and an 5780 5781 effective subcontractor quality management system and plan. Manufacturing and quality personnel must ensure that all manufacturing and quality systems are working toward the same goals and are 5782 5783 not creating conflicting or dysfunctional results. It is important for the program to convey to the 5784 contractor the requirement and importance of quality throughout supply chain and effective supply 5785 chain management, as quality deficiencies often occur in the lower tiers. The contractor, in addition 5786 to having list of qualified vendors, should have visibility into their subcontractors' planned suppliers 5787 with the same requirements.

- 5788 Effective quality management activities are important for identifying and reducing process-related 5789 risks. If not managed and mitigated, these risks may start a chain of events leading to undesirable 5790 outcomes such as defects discovered later in production or testing, not meeting requirements,
- 5790 outcomes such as defects discovered fater in production of testing, not meeting requirements, 5791 degraded mission effectiveness, overruns, shortages, etc. The later these risks are identified, the
- 5791 degraded mission effectiveness, overruns, shortages, etc. The later these risks are identified,
- 5792 greater the cost of corrective action and the greater the delays in schedule.

3. Technology Maturation and Risk Reduction (TMRR) Phase

5793 Quality will permeate all levels of a company only if certain important factors are present in the 5794 contractor's OMS:

- Corporate strategic vision, objectives, policies and procedures with a commitment to quality in-house and in the supply chain
- Communication of organizational direction and values regarding quality
- Structures and resources for full implementation of the QMS
- Commitment to continuous processes improvement
- Goals, objectives, and metrics throughout the organization for customer satisfaction
- Management accountability
- At the conclusion of TMRR phase, post PDR evaluation, the program quality strategy should be
 updated for entry into EMD based on TMRR results, assessment of the contractor and subcontractor
 QMSs, and the revised program quality plans for EMD.
- 5805 I.1 Update Quality Strategy

5806 Manufacturing and Quality Tasks

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- Update and revise the draft Program Quality Management Strategy in the Acquisition
 Strategy and the SEP based on the contractor's Quality Management System and strategies to
 include:
- 5810oThe contractor's quality management strategy should address compliance to established5811standards (e.g., AS9100, ISO 9000, etc.)
- 5812 Alternatively the contractor's quality management requirements should address:
- 5813 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
- Verify that the Program Quality Management Strategy
- 5821oIncorporates new quality technologies and processes (state of the art), unique product5822quality requirements, metrics, and the review frequency.
 - Includes compliance with FAR 52.246-11, Higher-Level Contract Quality Requirements.
- 5824oEncompasses the quality aspects of contractor compliance to industry best manufacturing5825practices (i.e., AS6500).
- 5826 Management, measurement, and control of key and critical characteristics and processes

5828 5829 5830	0	Addresses use of COTS items, GOTS items, and NDIs and their incorporation into the contractor's QMS. Encompasses supply chain quality management requirements that include:
5831 5832 5833 5834 5835 5836		 Need for focused supplier quality management requirements Contractor supplier quality management plan Supply chain best practices and standards (e.g., AS9100, ISO 9000, etc.) Metrics and review frequency Solutions, tools, techniques, and procedures Use of government furnished quality and testing equipment and assets
5837 5838 5839 5840	0	Establishes appropriate agreements, delegations and contracts with other agencies, e.g. the Defense Contract Management Agency (DCMA) throughout the supply chain Addresses software and firmware development quality assurance and configuration management.
5841	Metrics	
5842 5843	• Pro Str	ogram Quality Management Strategy has been revised and updated in the Acquisition rategy and the SEP based on the contractor's Quality Management System which includes:
5844 5845 5846	0 0	The contractor's quality management strategy and compliance to established standards (e.g., AS9100, ISO 9000, etc.) Alternatively the contractor's quality management strategies and processes that address:
5847 5848 5849 5850 5851 5852 5853		 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
5854	• Pro	ogram Quality Management Strategy has been reviewed and documents:
5855 5856 5857 5858 5859	0 0 0	Incorporation of new quality technologies and processes (state of the art), unique product quality requirements, metrics, and the review frequency. Compliance with FAR 52.246-11, Higher-Level Contract Quality Requirements. The quality aspects of Contractor compliance to industry best manufacturing practices (i.e., AS6500).
5860 5861		 Management, measurement, and control of key and critical characteristics and processes
5862 5863 5864	0	The use of COTS items, GOTS items, and NDIs) and their incorporation into the contractor's QMS. Supply chain quality management requirements that include:

3. Technology Maturation and Risk Reduction (TMRR) Phase

5865 5866 5867 5868 5869 5870 5871 5871 5872 5873		 Need for focused supplier quality management requirements Contractor supplier quality management plan Supply chain best practices and standards (e.g., AS9100, ISO 9000, etc.) Metrics and review frequency Solutions, tools, techniques, and procedures Use of government-furnished quality and testing equipment and assets Agreements, delegations and contracts with other agencies, e.g. the DCMA throughout the supply chain Software and firmware development quality assurance and configuration management
5874	Tools	
5875 5876 5877 5878	• • •	Acquisition Strategy Template ISO 9001 QMS Audit Checklist AS9100 Audit Checklist Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread
5879	Resou	rces
5880 5881 5882 5883 5884 5885 5885 5886 5887 5888	• • • • •	AFMC Instruction 63-145 Manufacturing and Quality AS6500, Manufacturing Management Program, Nov 2014 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 DAG Chapter 14.3.1.3.6 Quality Plans DSMC Acquisition Strategy Guide, Dec 1999 FAR 52.246-11 ISO 9001:2015, Quality Management System MRL Deskbook Version 2016
5889	1.2	Prepare Initial Program Quality Plan
5890	Manu	facturing and Quality Tasks
5891 5892	•	Evaluate the contractor's QMS for processes and procedures that are in alignment with industry best practices (e.g., AS9100, ISO 9000, etc.) to include elements such as:
5893 5894 5895 5896 5897 5898 5899		 Effective policies and procedures that encourage adherence to the quality system Organizations with defined authorities and responsibilities Objectives to drive people, processes, and the system Methods to analyze and resolve quality problems Metrics that reflect desired outcomes Interacting processes to transform inputs into outputs Records as evidence of what happened

5900 5901 5902	•	Based on MSA documentation, evaluate Contractor's proposed quality plan for previously determined product quality requirements, metrics, frequency of metrics reviews, and manufacturing and quality risks, issues, and opportunities, and update accordingly.
5903 5904 5905 5906 5907		 Include software development quality requirements Include impacts of safety processes and procedures Include Contactor's planned supply chain Include DCMA inputs on Contractor and supply chain quality performance against quality requirements for similar products or processes
5908 5909 5910 5911	•	Evaluate Contractor-proposed or planned solutions, capabilities, equipment, and processes that address product quality requirements in the form of: Quality technologies (i.e., metrology technologies) that could improve product quality (e.g., new quality technologies, state of the art, etc.)
5912 5913		 Proposed or planned solutions or processes to improve low-yield processes and components product quality
5914 5915	•	Develop a joint government/contractor manufacturing and quality plan based upon the evaluations of contractor's and supplier's QMSs and proposed plans that specifies:
5916 5917		 Roles, responsibilities, and quality processes for government and contractor quality management including:
5918 5919 5920 5921 5922 5923 5924 5925 5926 5927 5928 5929 5930 5931 5932		 Role and participation of DCMA (contractor and supply chain) Key Characteristics management Acceptance test procedures including software In-process and final inspections Statistical process controls and management Quality improvement plans Certification requirements (e.g., flight safety, man-ratings, etc.) Issues and dispositions (i.e., material review boards and processes) Continuous process improvement Software quality assurance Data storage, management, and security (physical and cyber) Use of COTS items, GOTS items, and NDIs GFE/GFP (e.g., controlled products, test ranges, specialized equipment, radiation test facilities, etc.) Audits and verifications
5933 5934		 Tasks, schedules, and outcomes Standards and requirements to be followed (e.g., industry product standards, MIL-STDs,
5935		etc.)
5936		• Joint risk, issue, and opportunity processes including supply chain quality capabilities
5937		and risk, issue, and opportunity identification processes
5938		• Quality processes, roles, and responsibilities identified for:

5939 5940 5941 5942 5943	 Key Characteristics management Acceptance test procedures including software In-process and final inspections Statistical process controls and management Quality improvement plans
5944 5945 5946 5947 5948 5949 5950 5951	 Quality workforce qualifications and training requirements Quality tooling and equipment requirements Quality targets, metrics, incentives, and process capabilities (C_{pk}s) Quality failures identification and analyses processes Software requirements Requirements for tracking quality costs New quality technology identification and introduction processes to include transformative processes
5952 5953 5954	• Update the joint government/contractor risk, issue, and opportunity process to ensure inclusion of updated manufacturing and quality process capability risks, issues, and opportunities from the SRR and the SFR (see H.1) including:
5955 5956 5957 5958 5959 5960 5961 5962 5963 5963 5964	 Key Characteristics Manufacturing and quality processes (new equipment and technology) Potential cost and schedule impacts Producibility Tooling and facilities Testing and qualification Environmental, transportation, storage, etc. Data management (collection, storage, cybersecurity, etc.) Process maturity and capabilities Yields, rates, and quantities
5965 5966 5967	 Metrics Contractor's QMS has been evaluated and documented for use in developing the joint quality plan for processes and procedures that implement industry best practices (e.g., AS9100, ISO
5968 5969	9000, etc.) including elements such as:
5970 5971 5972 5973	 Defined organizational authorities and responsibilities Quality objectives for people, processes, and the system Processes and procedures to analyze and resolve quality risks, issues, and opportunities Quality metrics that reflect desired outcomes
5974 5975	 Integrated transformative processes (inputs into outputs) Documented results (storage and retrieval)

3. Technology Maturation and Risk Reduction (TMRR) Phase

• C re is	ontractor's proposed quality plan has been evaluated for specified product quality equirements, metrics, frequency of metrics reviews, and manufacturing and quality risks, sues, and opportunities, and updated to include:
0 0 0	Software development quality requirements Impacts of safety processes and procedures Contactor's planned supply chain
0	DCMA inputs on contractor and supply chain quality performance against quality requirements for similar products or processes
• C ev re	ontractor-proposed and planned solutions, capabilities, equipment, and processes have been valuated for the capability to measure, monitor, and track product quality to meet program equirements in the form of:
• N	ew quality technologies (i.e., metrology technologies)
• Pi	roposed or planned solutions or processes to improve low-yield processes and components roduct quality
• B ca ar	ased upon the evaluations of contractor's and supplier's QMSs, proposed plans, solutions, apabilities, and equipment, a joint government/contractor quality plan has been developed and documented that specifies:
• R	oles and responsibilities of government and contractor for quality management including:
0	DCMA role and participation both at the contractor facilities and in the supply chain Key Characteristics management
0	Acceptance test procedures including software
0	In-process and final inspections
0	Statistical process controls and management
0	Quality improvement plans
0	Certification requirements (e.g., flight safety, man-ratings, etc.)
0	Processes for issues and dispositions (i.e., material review boards and processes)
0	Continuous process improvement
0	Software quality assurance
0	Data storage, management, and security (physical and cyber)
0	Use of COTS items, GOTS items, and NDIs
0	GFE/GFP (e.g., controlled products, test ranges, specialized equipment, radiation test
	facilities, etc.)
0	Participation in and support to audits and verifications
• T	asks, schedules, and outcomes
• S1	tandards and requirements to be met (e.g., industry product standards, MIL-STDs, etc.)
• Jo	bint risk, issue, and opportunity processes including supply chain quality capabilities and
ri	sk, issue, and opportunity identification processes
• Q	uality requirements for:
0	Workforce qualifications and training requirements
0	Tooling and equipment requirements
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3. Technology Maturation and Risk Reduction (TMRR) Phase

6016 6017 6018 6019		 Targets, metrics, incentives, and process capabilities (C_{pk}s) Failures identification and analyses processes Software Cost of quality tracking
6020 6021 6022 6023 6024	•	Identification and introduction processes for new quality technologies to include transformative processes The joint government/contractor risk, issue, and opportunity process has been updated and documented for inclusion of manufacturing and quality process capability risks, issues, and opportunities (see H.1) from:
6025 6026 6027 6028 6029 6030 6031 6032 6033 6034		 Key Characteristics Manufacturing and quality processes (new equipment and technology) Potential cost and schedule impacts Producibility Tooling and facilities Testing and qualification Environmental, transportation, storage, etc. Data management (collection, storage, cybersecurity, etc.) Process maturity and capabilities Yields, rates, and quantities
6035	Tools	
6036 6037	•	Quality Management Plan Template Systems Engineering Plan (SEP) Outline
6038	Resou	rces
6039 6040 6041 6042 6043 6044 6045	• • • •	AS6500, Manufacturing Management Program, Nov 2014 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System Specified Industry and Military Standards MRL Deskbook Version 2016 Systems Engineering Plan (SEP) Outline, Jun 2015
6046	I.3	Verify Subcontractor Quality Management
6047	Manuf	facturing and Quality Tasks
6048 6049 6050 6051	•	Verify that the contractor supplier management system requires subcontractor QMS processes and procedures that are in alignment with industry best practices (e.g., AS9100, ISO 9000, etc.) to include elements such as: • Management responsibility requirements

3. Technology Maturation and Risk Reduction (TMRR) Phase

6052	0	Quality management system requirements
6053	0	Resource management requirements
6054	0	Product Realization requirements (e.g., risk management, design and development,
6055		purchasing, etc.)
6056	0	Risks, issues, and opportunities
6057	0	Measurement, analysis, and improvement requirements
6058 •	An	alyze the contractor's supplier management system capability to perform the anticipated
6059	des	sign and manufacturing work scope in accordance with industry best practices (i.e.,
6060	AS	S6500) including:
6061	0	Effectiveness of prime and subcontractor communication and interaction processes to
6062		include:
6063		• Flow down of cost, schedule, and performance requirements to suppliers and timely
6064		notification of changes
6065		 Quality data exchange processes
6066		 Integration of risk, issue, and opportunity management
6067		 Responses, status, and reports for cost, schedule, and performance actuals
6068		 Corrective and preventative actions, communication, and end user feedback
6069		 Specification and production of prototypes
6070	0	Key Characteristics management
6071	0	Supplier risk, issue, and opportunity management processes for quality, technical,
6072		schedule, material, facility, scale-up, financial impacts, etc.
6073	0	Make/buy processes for supplier quality performance and impacts
6074	0	Approval/removal and qualification processes for suppliers which includes period re-
6075		assessment
6076	0	Processes and procedures for prevention and/or detection of counterfeit parts and
6077		materials (See AS5553 and AS6174)
6078	0	Identification of major and critical suppliers, and suppliers performing Critical
6079		Manufacturing Processes
6080	0	Supplier development program that focuses on and measures continuous improvement
6081	0	Effective metrics to monitor, evaluate, verify, improve processes, and prevent defects
6082 •	An	alyze the contractor's supplier management system and quality management plan for:
6083	0	Management of COTS items, GOTS items, and NDIs and their incorporation into the
6084		contractor's QMS.
6085		 Request DMCA assistance in analyses and verifications
6086	0	Roles, responsibilities, and quality processes for GFE/GFP (e.g., controlled products, test
6087		ranges, specialized equipment, radiation test facilities, etc.)
6088	0	Software and firmware quality and integration into the program Software Quality
6089		Assurance Plan (SQAP), Software Development Plan (SDP), and Software Configuration
6090		Management Plan (SCMP)

3. Technology Maturation and Risk Reduction (TMRR) Phase

6091 6092	 Acceptance tests (prototypes, hardware, software, and firmware), test procedures including test equipment, and incorporation into the TEMP 	
6093 6094	• Verify the contract and the subcontractor management plan includes right of access for both the contractor and the government to supplier facilities and documentation, where applicable.	
6095	Metrics	
6096 6097 6098 6099	• Contractor supplier management system has been verified and documents for program management and the PDR process the requirements for subcontractor QMS processes and procedures in alignment with industry best practices (e.g., AS9100, ISO 9000, etc.) including elements such as:	
6100 6101 6102 6103 6104 6105	 Management responsibility Quality management system Resource management Product Realization (e.g., risk management, design and development, purchasing, etc.) Risks, issues, and opportunities Measurement, analysis, and improvement 	
6106 6107 6108 6109	• Contractor's supplier management system has been analyzed and documents for program management and the PDR process the capability to perform the anticipated design and manufacturing work scope in accordance with industry best practices (i.e., AS6500) including:	
6110 6111	 Effectiveness of prime and subcontractor communication and interaction processes to include: 	
6112 6113 6114 6115 6116 6117 6118	 Flow down of cost, schedule, and performance requirements to suppliers and timely notification of changes Quality data exchange processes Integration of risk, issue, and opportunity management Responses, status, and reports for cost, schedule, and performance actuals Corrective and preventative actions, communication, and end user feedback Specification and production of prototypes 	
6119 6120 6121 6122	 Key Characteristics management Supplier risk, issue, and opportunity management processes include documenting, monitoring and tracking (includes quality, technical, schedule, material, facility, scale-up financial impacts, etc.) 	
6123 6124 6125 6126 6127 6128	 Risk management processes include mitigation Issue management processes and procedures (e.g., Contractor Performance Assessment Reports (CPARs), Engineering Change Proposals (ECPs), Material Review Boards (MRBs), CM, etc.) Opportunity management includes ECPs and incentives Make/buy processes for supplier quality performance and impacts 	
6129		• Approval/removal and qualification processes for suppliers which includes period re-
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6130		assessment
6131		• Processes and procedures for prevention and/or detection of counterfeit parts and
6132		materials (See AS5553 and AS6174)
6133		• Identification of major and critical suppliers, and suppliers performing Critical
6134		Manufacturing Processes
6135 6136		 Supplier development program that focuses on and measures continuous improvement Effective metrics to monitor, evaluate, verify, improve processes, and prevent defects
6137	•	Contractor's supplier management system and quality management plans have been analyzed
6138		and documented to include:
6139 6140		 Management of COTS items, GOTS items, and NDIs and their incorporation into the contractor's QMS.
6141		 Request DMCA assistance in analyses and verifications
6142		• Roles, responsibilities, and quality processes for GFE/GFP (e.g., controlled products, test
6143		ranges, specialized equipment, radiation test facilities, etc.)
6144		• Software and firmware quality and integration into the program SQAP, SDP, and SCMP
6145		• Acceptance tests (prototypes, hardware, software, and firmware), test procedures
6146		including test equipment, and incorporation into the TEMP
6147	•	Contract and the subcontractor management plans have been verified to include the right of
6148		access for both the contractor and the government to supplier facilities and documentation.
6149	Tools	
6150	•	Supplier QA Questionnaire
6151	٠	ISO 9001 QMS Audit Checklist
6152	•	AS9100 Audit Checklist
6153	•	Manufacturing Readiness Level Assessment Questionnaire for the Quality thread
6154	Resou	rces
6155	٠	AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
6156	•	AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materiel
6157	•	AS6500, Manufacturing Management Program, Nov 2014
6158	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
6159		Sep 2016
6160	٠	ISO 9001:2015, Quality Management System
6161	•	MRL Deskbook Version 2016

6163 I.4 Assess Contractor Quality Management System

6164 Manufacturing and Quality Tasks

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- Assess the contractor's corporate strategic vision, objectives, policies, and procedures for alignment to the contracted program needs and industry best practices (e.g., AS9100, ISO 9000, etc.) for quality both in-house and in suppliers' facilities to include:
- 6168oEstablished quality policy, at the highest level in the company, based on industry best6169practices, which commits to continuously improving processes and exceeding customer6170expectations
- 6171oOrganizational direction and values regarding quality are communicated throughout the6172supply chain
- 6173oManagement provides structures and resources supporting full implementation of the
quality management system
- 6175oManagement solicits quantitative and qualitative feedback on the effectiveness and6176efficiency of quality management system and takes actions based on that feedback
- 6177 o Procedures for internal reviewing of the quality management system periodically with
 6178 goals and objectives throughout the organization, customer satisfaction, and continuous
 6179 improvement
 - Procedures independent reporting channels for quality functions and audits
- o Management accountability with emphasis on quality results and customer satisfaction
- Conduct a functional audit of the contractor's QMS including assessment of:

6183 • Quality processes and supply chain quality including:

- Role and participation of DCMA (contractor and supply chain)
 - Key Characteristics management
 - Acceptance testing including software
 - In-process and final inspection functionality
 - Statistical process controls, rates, and yields (and management of same)
 - Quality improvement plan execution
 - Certification process (e.g., flight safety, man-ratings, etc.)
- Continuous process improvement results
- Software quality assurance results
 - Data storage, management, and security (physical and cyber)
 - Management of safety, environmental, transportation, storage, etc.
- Use of COTS items, GOTS items, and NDIs
- 6196GFE/GFP management (e.g., controlled products, test ranges, specialized equipment,6197radiation test facilities, etc.)
- 6198 Audits and verifications results
- 6199oResults and reports from contractor's developmental testing for CTEs, KPPs, KSAs, and6200Key Characteristics and integration into the QMS.

3. Technology Maturation and Risk Reduction (TMRR) Phase

6201 6202 6203 6204 6205 6206 6207		 Results and reports from the contractor's QMS Failure Reporting, Analysis and Corrective Action System for sufficiency and adequacy including results of dispositions (i.e., material review boards and processes) QMS impacts on tasks, costs, schedules, and outcomes QMS compliance to standards and best practices (e.g., AS9100, ISO 9000, industry product standards, MIL-STDs, etc.) Integration with the Risk, Issue, and Opportunity Management processes
6208 6209	•	Request DCMA support to assess veracity of contractor QMS for inclusion and integration of subsystems, items, and components and inclusion in the initial TEMP including:
6210 6211 6212 6213 6214 6215		 Assessment of the contractor's progress in generating or updating the TEMP Verification of the TEMP addressing requirements to conduct a Physical Configuration Audits (PCAs) and Functional Configuration Audits (FCAs) on designated subsystems, items, components, and software/firmware Verification of Software testing, to include Software Acceptance Test (SAT)/Software Formal Qualification Testing (SFQT) is addressed in the TEMP
6216	Metri	CS
6217 6218 6219 6220 6221 6222 6223 6223 6224	•	 The contractor's corporate strategic vision, objectives, policies, and procedures have been assessed, results documented, and corrective actions implemented for alignment to the contract and industry best practices (e.g., AS9100, ISO 9000, etc.) for quality including: An established quality policy and procedures, at all levels in the company that implements continuously improving processes and exceeding customer expectations Communication throughout the supply chain of organizational direction and values Management structure and resources supporting full implementation of the quality management system
6223 6226 6227 6228 6229 6230 6231		 Management processes based on quantitative and quantative feedback that improve the effectiveness and efficiency of quality management system Periodic internal reviews and updates of the quality management system throughout the organization including customer satisfaction and continuous improvement Independent reporting channels for quality functions and audits in place Management accountability established with emphasis on quality results and customer satisfaction
6232 6233	•	A functional audit of the contractor's QMS has been conducted and the results and corrective actions documented for:
6234		• Quality processes and supply chain quality including:
6235 6236 6237 6238 6239		 Role and participation of DCMA (contractor and supply chain) Key Characteristics management Acceptance testing including software In-process and final inspection functionality Statistical process controls, rates, and yields (and management of same)

6240 6241 6242 6243 6244 6245 6246 6247 6248 6249		 Quality improvement plan execution Certification process (e.g., flight safety, man-ratings, etc.) Continuous process improvement results Software quality assurance results Data storage, management, and security (physical and cyber) Management of safety, environmental, transportation, storage, etc. Use of COTS items, GOTS items, and NDIs GFE/GFP management (e.g., controlled products, test ranges, specialized equipment, radiation test facilities, etc.) Audits and verifications results
6250 6251 6252 6253 6254 6255 6256 6257 6258		 Contractor's developmental testing for CTEs, KPPs, KSAs, and Key Characteristics and integration into the QMS. Contractor's QMS Failure Reporting, Analysis and Corrective Action System (FRACAS) for sufficiency and adequacy including results of dispositions (i.e., material review boards and processes) QMS impacts on tasks, costs, schedules, and outcomes QMS compliance to standards and best practices (e.g., AS9100, ISO 9000, industry product standards, MIL-STDs, etc.) Integration with the Risk, Issue, and Opportunity Management processes
6259 6260 6261 6262 6263	•	 DCMA assistance has been requested and their support used to document the veracity of contractor QMS for inclusion and integration of subsystems, items, and components and inclusion in the initial TEMP including: Assessment of the contractor's progress in generating or updating the TEMP Requirements to conduct a PCAs and FCAs) on designated subsystems, items,
6264 6265	Tools	 components, and software/firmware Software testing, to include SAT/SFQT is addressed in the TEMP
6267	•	ISO 9001 QMS Audit Checklist
6268	•	AS9100 Audit Checklist
6269	•	Manufacturing Readiness Level Assessment Questionnaire for the Quality thread
6270	Resou	rces
6271 6272	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
6272	-	ISO 0001:2015 Quality Management System
6274	•	MPL Daskbook Version 2016
0274 6275	•	NIRL DESKUUUK VEISIOII 2010 Disk Jasua and Opportunity Management Cycide Jan 2017
0213	•	Kisk, issue, and Opportunity Management Guide, Jan 2017

6276	1.5	Update Quality Strategy
6277	Manu	facturing and Quality Tasks
6278 6279	•	Update and revise the initial Program Quality Management Strategy from the Acquisition Strategy and the SEP:
6280 6281		 Incorporate changes based the results of the assessment of the contractor's QMS Update all quality factors from tasks accomplished in I.1 through I.4
6282 6283	•	Initiate quality planning for EMD, production, developmental and operational test, and life cycle sustainment.
6284	Metri	cs
6285 6286	•	Initial Program Quality Management Strategy has been updated, revised, and documented including impacts to cost and schedule in the Acquisition Strategy and the SEP:
6287 6288 6289 6290		 Changes required by the results of the quality assessment of contractor's QMS have been incorporated Changes required by the results from all quality tasks performed in I.1 through I.4 have also been included
6291 6292	•	Initial Quality Plan for EMD, production, developmental and operational test, and life cycle sustainment has been drafted and documented in the AS, SEP, TEMP, and the IMP/IMS.
6293	Tools	
6294	•	Acquisition Strategy Template
6295	Resou	irces
6296 6297	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016
6298	٠	ISO 9001:2015, Quality Management System
6299	•	MRL Deskbook Version 2016
6300	•	KISK, ISSUE, and Opportunity Management Guide, Jan 2017
0301	•	Dowie Acquisition Strategy Guide, Dec 1999
6302	J. N	ANUFACTURING WORKFORCE

A comprehensive assessment of contractor manufacturing plans for prototype and system
development is necessary to understand the requirements workforce skills, capabilities, training, and
certifications. Workforce skills identification and plans provide quantitative inputs to program
planning. Workforce planning should align the skills required to the scope of the technical effort
required to develop, field, and sustain the system.

3. Technology Maturation and Risk Reduction (TMRR) Phase

MIS		AS	Validation RFP RDP
Draf	SRR SFR	TEMP	PDR
J. Mfg. Workforce	J.1 Identify Required Workforce Skills		J.2 Update M & Q Workforce Plan

6308

- To determine the scope of the manufacturing and quality workforce plan to develop, field, and sustain the system, the following should be included:
- Work Breakdown Structure for the technical activities and tasks (including the Bill of Materials)
- Contractor's make/buy plans
- Contractor's manufacturing and quality plans, process, and procedures
- Identified risks, issues, and opportunities
- Integrated Master Plan for all technical activities and tasks
- Time-phased sequence of the technical efforts (Integrated Master Schedule)
- Other resources (support equipment, tools, facilities, training, etc.
- Based on contractor manufacturing and quality planning, execution, and results of the system
 development and prototypes efforts, update the program manufacturing and quality workforce plans
 for required skills, capabilities, training, and certifications for EMD.
- 6322 J.1 Identify Required Workforce Skills

6323 Manufacturing and Quality Tasks

- Assess contractor initial Manufacturing Plans for prototypes and system development to
 identify workforce requirements for skills, capabilities, training, and certifications, including:
- 6326oContractor's make/buy processes for factors that determine the outsourcing of workforce6327skills
- 6328 Scale-up of materials, subsystems, items, and components for TMRR
- o Contractor's labor market (availability, stability, capabilities, training, etc.)
- 6330oPotential ManTech changes, additions, and new manufacturing methods (e.g.,
automation, upgrades, additive manufacturing, etc.)
- 6332oPotential facilities changes (e.g., location, improvements and expansion, lay-out changes,6333etc.)
- 6334oMaterials handling (e.g., safety processes, storage and disposal processes, environmental6335processes, etc.)
- 6336 o Environmental, safety, and health
- 6337 Manufacturing machinery and equipment (e.g., programming and operation,
- 6338 maintenance, calibration, and repair, etc.)

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6339 6340 6341		 Facilities and tooling (e.g., operation and maintenance, safety, security, cleanliness, acoustics, Heating, Ventilation, Air Conditioning (HVAC), and environmental controls, etc.)
6342		• Quality (e.g., inspections, equipment operation, maintenance, calibration, etc.)
6343	•	Review contractor's processes for impacts on the workforce:
6344 6345 6346 6347		 Identify impacts on personnel, training, etc. Identify risk, issues, and opportunities concerning the workforce Include manufacturing and quality requirements on workforce environmental, safety, and health
6348	Metric	S
6349 6350 6351	•	Contractor initial Manufacturing Plans have been assessed and documented for required workforce skills, capabilities, training, and certifications have been identified for system development and prototypes, including:
6352 6353 6354 6355 6356 6357 6358 6359 6360 6361 6362 6363 6364 6365 6366 6367 6368		 Contractor's make/buy processes have been assessed for factors impact outsourcing of workforce skills and the results documented TMRR scale-up of materials, subsystems, items, and components has been included Contractor's labor market assessed for availability, stability, capabilities, and training to meet program workforce requirements and the results documented Potential ManTech changes, additions, and new manufacturing methods (e.g., automation, upgrades, additive manufacturing, etc.) have been included Potential facilities changes (e.g., location, improvements and expansion, lay-out changes, etc.) have been included Materials handling (e.g., safety processes, storage and disposal processes, environmental processes, etc.) Environmental, safety, and health Manufacturing machinery and equipment (e.g., programming and operation, maintenance, calibration, and repair, etc.) Facilities and tooling (e.g., operation and maintenance, safety, security, cleanliness, acoustics, HVAC and environmental controls, etc.) Ouelity (e.g., inspections, equipment operation, maintenance, calibration, equipment operation, maintenance, calibration, environmental controls, etc.)
0308		• Quality (e.g., inspections, equipment operation, maintenance, calibration, etc.)
6369 6370	•	Contractor's processes have been assessed for risks, issues, and opportunities and identify impacts workforce personnel, training, environmental, safety, and health, etc.
6371	Tools	
6372	٠	Assembly Chart Analysis
6373	•	Bottleneck Analysis (Theory of Constraints)
6374	•	Capacity Planning Worksheet
6375	•	Critical Chain Project Management
6376	•	Forecasting and Regression Analysis

3. Technology Maturation and Risk Reduction (TMRR) Phase

6377	٠	Learning Curve Estimator
6378	٠	Line of Balance Template
6379	٠	Manufacturing Resource Planning (MRPII)
6380	•	MRL assessment using Manufacturing Management thread
6381	•	Route Sheet Analysis
6382	•	Shop Floor Manufacturing Plan Analysis
6383	•	SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
6384	•	Work Measurement Analysis
6385	•	Workforce Planning Tools (SAP/Oracle/MRPII)
6386	Resou	rces
6387	•	AS6500, Manufacturing Management System, Sep 2016
6388	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
6389	•	MRL Deskbook Version 2016
6390	٠	Manufacturing Resource Planning (MRP II) software
6391	J.2	Update Manufacturing and Quality Workforce Plan
6392	Manu	facturing and Quality Tasks
6393	•	Based on contractor Manufacturing and Quality planning, execution, and results of the
6394		system development and prototypes efforts, update manufacturing and quality plans for
6395		required workforce skills, capabilities, training, and certifications for EMD planning, update
6396		the Acquisition Strategy and as input for PDR and other decision reviews. Updates include:
6397		• Workforce skills requirements based on contractor's make/buy decisions for internal
6398		and/or outsourcing of workforce skills
6399		• Contractor's labor market impacts on availability, stability, capabilities, and training to
6400		meet manufacturing and quality workforce requirements
6401		• Scale-up of materials, subsystems, items, and components
6402		• Materials handling requirements changes (e.g., safety processes, storage and disposal
6403		processes, environmental processes, etc.)
6404 6405		• Environmental, salety, and nearth requirements changes
6405 6406		o Manufacturing machinery and equipment improvements and changes (e.g., programming and operation, maintenance, calibration, and repair, etc.)
6400 6407		ManTech demonstrations additions and new manufacturing methods (e.g. automation
6408		upgrades additive manufacturing etc.)
6409		• Facilities re-locations, and changes (e.g. location improvements and expansion lay-out
6410		changes, etc.)
6411		• Tooling improvements and changes (e.g., operation and maintenance, safety, security.
6412		cleanliness, acoustics, HVAC and environmental controls, etc.)
6413		• Quality requirements changes and additions (e.g., inspections, equipment operation,
6414		maintenance, calibration, etc.)

3. Technology Maturation and Risk Reduction (TMRR) Phase

6415 6416	•	Assess contractor Manufacturing and Quality workforce management and plans for EMD to include:
6417 6418 6419 6420 6421 6422		 Synchronization with the SEP, the IMP/IMS, and the Subcontractor Management Plan Consistency with the contractor's Manufacturing Plan Staffing rate requirements for pilot line and initial production Workforce skills availability (i.e., number of trained capable workers) Workforce stability (e.g., labor force age, turn-over rate, labor force sustainability, etc.) Special skills certification and training requirements
6423 6424 6425	•	Analyze TMRR planned versus actual staffing rates, training, turn-over, etc. Assess manufacturing and quality workforce and environmental, safety, and health requirements in current guidance, regulations, and laws for impact.
6426	Metri	CS
6427 6428 6429	•	Manufacturing and quality plans for required workforce skills, capabilities, training, and certifications have been updated for EMD planning, documented in the Acquisition Strategy and provided as input for PDR and other decision reviews including updates on:
6430 6431 6432 6433 6434 6435 6436 6437 6438 6439 6440 6441 6442 6443 6443 6444 6445 6446		 Workforce skills required based on contractor's make/buy decisions for internal and/or outsourcing of workforce skills Contractor's labor market impacts based on availability, stability, capabilities, and training to meet manufacturing and quality workforce requirements Scale-up of materials, subsystems, items, and components Materials handling requirements changes (e.g., safety processes, storage and disposal processes, environmental processes, etc.) Environmental, safety, and health requirements changes Manufacturing machinery and equipment improvements and changes (e.g., programming and operation, maintenance, calibration, and repair, etc.) ManTech demonstrations, additions, and new manufacturing methods (e.g., automation, upgrades, additive manufacturing, etc.) Facilities re-locations, and changes (e.g., location, improvements and expansion, lay-out changes, etc.) Tooling improvements and changes (e.g., operation and maintenance, safety, security, cleanliness, acoustics, HVAC and environmental controls, etc.) Quality requirements changes and additions (e.g., inspections, equipment operation,
6447 6448	•	maintenance, calibration, etc.) Contractor Manufacturing and Quality workforce management and plans for EMD have been
6449		assessed sufficiency and robustness including:
6450 6451 6452 6453		 Agreement and consistency with the SEP, the IMP/IMS, and the Subcontractor Management Plan Consistency with the contractor's Manufacturing Plan Staffing rates for pilot line and initial production

3. Technology Maturation and Risk Reduction (TMRR) Phase

6454 6455 6456		 Workforce skills availability and sustainability (i.e., number of trained capable workers) Workforce stability (e.g., labor force age, turn-over rate, labor force sustainability, etc.) Special skills certification and training
6457 6458 6459 6460 6461	•	Analyses of TMRR planned versus actual staffing rates, training, turn-over, etc. have been conducted and validates contractor plan and performance. Manufacturing and quality workforce and environmental, safety, and health requirements in current guidance, regulations, and laws have been assessed and impacts on workforce documented for management planning.
6462	Tools	
6463	•	Assembly Chart Analysis
6464	•	Bottleneck Analysis (Theory of Constraints)
6465	•	Capacity Planning Worksheet
6466	•	Critical Chain Project Management
6467	•	Forecasting and Regression Analysis
6468	•	Learning Curve Estimator
6469	•	Line of Balance Template
6470	•	Manufacturing Resource Planning (MRPII)
6471	•	MRL assessment using Manufacturing Management thread
6472	•	Route Sheet Analysis
6473	٠	Shop Floor Manufacturing Plan Analysis
6474	•	SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
6475	•	Work Measurement Analysis
6476	•	Workforce Planning Tools (SAP/Oracle/MRPII)
6477	Resou	rces
6478	٠	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
6479	٠	AS6500, Manufacturing Management Program, Nov 2014
6480	•	AS9100, Quality Management System, Sep 2016
6481	•	ISO 9001:2015, Quality Management System
6482	•	Manufacturing Resource Planning (MRP II)

6483 K. FACILITIES

- 6484 During the TMRR phase, manufacturing and quality personnel should update the facility and tooling
- 6485 strategies and plans developed for the concept during MSA, and conduct assessments of proposed
- 6486 production facilities, and update and finalize the tooling plan for EMD and future phases.

3. Technology Maturation and Risk Reduction (TMRR) Phase



6487

6488 Based on the concept, new facilities and tools may be required for new materials, new technologies, 6489 and new processes. Programs and the contractor(s) need to address and plan for the capability and 6490 capacity to develop, produce, maintain, and support the program. Included in this are considerations 6491 of the availability of essential tooling, facilities, and production and test equipment for the sustained 6492 production of systems capable of meeting the performance objectives, as well as sustained 6493 operations, maintenance, and repair. Capacity is normally constrained by physical facilities, available 6494 equipment, tooling and/or test equipment. The portion of this capacity actually utilized is determined 6495 by the demand on the plant for current and known future workload. Final validation of manufacturing 6496 and quality plans must be accomplished prior to PDR and prior to entry into EMD.

- 6497 Manufacturing and quality personnel should conduct assessments of contractor-proposed facilities and tooling for TMRR and subsequent phases. These assessments should include subcontractors and 6498 kev suppliers identified in the contractor's manufacturing management plan. Assessments of the 6499 6500 contractor's manufacturing management plans should include tooling and facilities plans with utilization, and any relocation/consolidation considerations, schedules, and requirements for 6501 6502 manufacturing maturity. These assessments should be conducted on-site and can be included as part of the MRL assessment. The results of these assessments should identify and document risks, issues, 6503 6504 and opportunities arising from facility and tooling shortfalls and document the required planning for 6505 mitigation.
- Prior to PDR and entry into EMD, the program tooling plan which includes specialized tooling and
 test equipment is finalized. This requires that all facilities, tooling, and test equipment has been
 appropriately identified from assessments conducted as required by the FAR Section 2.101.
- 6509 The lack of attention to facilities, tooling, and test equipment will increase risk and can be a major
- 6510 factor in cost overruns and schedule delays. Facilities, tooling, and test equipment is a common
- 6511 production risk that can greatly affect cost, schedule and performance if the program is not proactive
- 6512 in managing it.

6513 K.1 Update Tooling and Facility Strategy

6514 Manufacturing and Quality Tasks

 6515
 Update the Manufacturing Strategy (tooling and facilities plans from the MSA Acquisition 6516
 Strategy and SEP) for tooling and facilities to include:

3. Technology Maturation and Risk Reduction (TMRR) Phase

6517	• Design, fabrication, and control of tooling and test equipment	
6518	• Mix of "soft" and "hard" tooling	
6519	o Availability	
6520	 Surge capability to meet rates and/or fluctuating demand 	
6521	 Procurement of commercial or existing tooling, 	
6522	 Identification of any unique tooling required to support production 	
6523	 Planning for Manufacturing and Quality ManTech initiatives for new tools 	
6524	• Specific material specifications that require peculiar production facilities or special	
6525	handling	
6526	 Manufacturing and quality environmental and safety factors 	
6527	• Security requirements for manufacturing and quality facilities (physical and cyber)	
6528 6529	• Initiate planning for construction, fabrication, test, and demonstration of required new or modified facilities or tools.	
6530	• Update the planning for Special Test Equipment (STE) and Special Inspection Equipment	
6531	(SIE) based on prototyping results (e.g., acquisition of specialized fixtures, construction o	f
6532	test chambers, upgrading laboratories and clean rooms, upgrading waste storage and dispo	sal
6533	equipment, etc.).	
6534	• Update planning for new manufacturing tooling and facilities required for new technologi	es.
6535	• Update manufacturing and quality tooling and facilities plans based on the availability,	
6536	storage, and handling requirements of essential raw materials, special alloys, composite	
6537	materials, components, tooling, and production test.	
6538	• Update plans for mitigation of identified tooling and facility shortfalls and risk areas	
6539	associated with the proposed facility.	
6540	• Initiate manufacturing and quality planning for EMD tooling and facilities.	
6541	Metrics	
6542	• Manufacturing Strategy has been updated for the Acquisition Strategy and the SEP for	
6543	tooling and facilities strategies and plans (TMRR and subsequent phases) to include:	
6544	• Design, fabrication, and control of tooling and test equipment	
6545	• Mix of "soft" and "hard" tooling	
6546	o Availability	
6547	 Surge capability to meet rates and/or fluctuating demand 	
6548	 Procurement of commercial or existing tooling, 	
6549	 Identification of any unique tooling required to support production 	
6550	 Planning for manufacturing and quality ManTech initiatives for new tools 	
6551	• Specific material specifications that require peculiar production facilities or special	
6552	handling	
6553	 Manufacturing and quality environmental and safety factors 	
6554	• Security requirements for manufacturing and quality facilities (physical and cyber)	

6555	٠	Plans for construction, fabrication, test, and demonstration of required new or modified
6556		facilities or tools have been documented in the Acquisition Strategy as part of the
6557		Manufacturing Strategy.
6558	•	Plans for required STE and SIE (based on prototyping and future requirements for
6559		specialized fixtures, construction of test chambers, upgrading laboratories and clean rooms,
6560		upgrading waste storage and disposal equipment, etc., have been documented in the
6561		Acquisition Strategy and in the SEP.
6562	•	Plans for new manufacturing tooling and facilities required for new technologies have been
6563		documented as part of the Manufacturing Strategy in the AS.
6564	•	Manufacturing and quality tooling and facilities plans for essential raw materials, special
6565		alloys, composite materials, components, tooling, and production test based on the
6566		availability, storage, and handling requirements have been documented in the Acquisition
6567		Strategy and in the SEP.
6568	•	Mitigation plans for identified tooling and facility shortfalls and risk areas associated with the
6569		proposed facility have been initiated and documented in the Risk, Issues, and Opportunity
6570		management system.
6571	•	Manufacturing and quality planning for EMD and subsequent phases tooling and facilities
6572		has been documented as part of the Manufacturing Strategy in the AS.
6573	Tools	
6574	•	Acquisition Strategy Template
6575	•	Manufacturing Strategy (no template available)
6576	•	Manufacturing Readiness Level Assessment Questionnaire, Facilities thread
6577	Resou	rces
6578	•	AS6500, Manufacturing Management Program, Nov 2014
6579	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
6580	•	MRL Deskbook Version 2016
6581	•	Risk, Issue, and Opportunity Management Guide, Jan 2017
6582	К.2	Conduct Production Facilities Assessments
6583	Мари	facturing and Quality Tasks
0383	Ivianu	actuming and Quanty Tasks
6584	•	Conduct assessments of contractor-proposed facilities and tooling for TMRR and subsequent
6585		phases, including prime/subcontractors and key suppliers identified in the contractor's
6586		manufacturing management plan for the program.
6587	•	Assess the contractor's manufacturing management plans for tooling and facilities including
6588		plans, utilization, and any relocation/consolidation, program schedules, and manufacturing
6589		maturity requirements for adequacy, compliance, and impact to the contract to include:

3. Technology Maturation and Risk Reduction (TMRR) Phase

6590 6591 6592		• Identification new to the contractor materials, technologies, manufacturing methods that require new manufacturing and quality processes requiring additional facilities, equipment, and tools
6593		 Review of the technical data package to identify specific material specifications that
6594		require unique production facilities
6595		• Assessment of current utilization for proposed manufacturing facilities
6596 6597 6598		 Assess adequacy of contractor identified facility, manufacturing equipment, test and quality assurance equipment Review contractor capabilities required for special handling, material storage, ultra-
6599 6600 6601		 Planned relocation and/or consolidation of production facilities, tooling, and production lines impacts to schedule and costs
6602 6603		 Impacts to schedule and costs from planned changes to increase manufacturing maturity (i.e., manufacturing technology)
6604		 Manufacturing and quality environmental and safety factors
6605 6606		 Security requirements for manufacturing and quality facilities (physical and cyber) Request DCMA data and assistance for these efforts
6607 6608	•	Conduct on-site capability assessments of contractor's current and proposed manufacturing facilities (including critical and prototype suppliers) for:
6609 6610		• Adequacy of contractor-identified facility and layout, tooling, manufacturing equipment, test and quality assurance equipment
6611 6612		• Contractor capabilities required for special handling, material storage, ultra-clean work environments, material and part handling, storage and transportation, etc.
6613		• Adequacy for prototype builds
0014 6615		 Program unique production facility and tooling requirements Menufacturing and quality environmental and safety factors
6616		 Manufacturing and quality environmental and safety factors Security requirements for manufacturing and quality facilities (physical and cyber)
6617		 Request DCMA data and assistance for these efforts
6618 6619	•	Identify production facility and tooling shortfalls and risks, issues, and opportunities associated with the proposed facility (include current and subsequent phases).
6620 6621		• Include data from the prototype builds into overall facility risks, issues and opportunities process
6622		• Identify capacity constraints
6623		 Request DCMA data and assistance for these efforts
6624	Metric	CS
6625	•	Contractor's proposed facilities and tooling have been assessed for TMRR and subsequent
6626		phases, including prime/subcontractors and key suppliers identified in the contractor's
6627		manufacturing management plan and updated in the program Manufacturing Plan and the
6628		AS.

3. Technology Maturation and Risk Reduction (TMRR) Phase

662966306631	Contractor's manufacturing management plans for tooling and facilities have been assessed for adequacy and compliance with the contract (includes plans, utilization, and any relocation/consolidation, program schedules, and manufacturing maturity).
6632 6633 6634 6635 6636 6637 6638 6639 6640	 Shortfalls, gaps, and opportunities have been identified with mitigation and opportunity plans implemented (e.g., ECPs, contract changes, etc.) New to the contractor materials, technologies, manufacturing methods that require new manufacturing and quality processes requiring additional facilities, equipment, and tools have been identified, analyzed, and results utilized for programmatic action Technical data packages have been analyzed to identify specific material specifications that require unique production facilities and plans developed Contractor current utilization for proposed manufacturing facilities has been assessed and results documented in the SEP and in the RIO management system for:
6641 6642 6643 6644 6645	 Adequacy of contractor identified facility, manufacturing equipment, test and quality assurance equipment Contractor capabilities to meet special handling, material storage, ultra-clean work environments, material and part handling, storage and transportation, etc. requirements
6646 6647 6648	• Impacts to schedule and costs have been assessed and documented for program budget, schedule impacts, and funding with appropriate updates to the Acquisition Strategy and the SEP including:
6649 6650 6651 6652 6653	 Contractor planned relocation and/or consolidation of production facilities, tooling, and production lines Changes planned to increase manufacturing maturity (i.e., manufacturing technology) Manufacturing and quality environmental and safety factors Security requirements for manufacturing and quality facilities (physical and cyber)
6654	• DCMA data and assistance have been requested and utilized for the above analyses.
6655 • 6656 6657 6658	On-site capability assessments of contractor's current and proposed manufacturing facilities with the assistance of DCMA (including critical and prototype suppliers) have been conducted and results documented (in the AS, SEP, Manufacturing Plan, PDR process, etc.) for the adequacy of:
6659 6660	• Contractor identified facility and layout, tooling, manufacturing equipment, test and quality assurance equipment
6661 6662	 Contractor capabilities for special handling, material storage, ultra-clean work environments, material and part handling, storage and transportation, etc.
6663	• Prototype build tooling and facilities
6664	• Program unique production facilities and tooling
6665	• Manufacturing and quality environmental and safety
6666	 Security for manufacturing and quality facilities (physical and cyber)

6667 6668 6669	•	Production facility and tooling shortfalls and risks, issues, and opportunities associated with the proposed facility have been identified with DCMA assistance and plans are in place for current and subsequent phases in the SEP and the RIO management system including:
6670 6671		 Data from the prototype builds into overall facility risks, issues and opportunities process Capacity constraints
6672	Tools	
6673	•	Manufacturing Readiness Level Assessment Questionnaire, Facilities thread
6674	•	DCMA Production Planning and Control Risk Assessment Checklist
6675	•	DCMA Manufacturing Systems Risk Assessment (MSRA) Checklist
6676	Resou	irces
6677	•	AS6500. Manufacturing Management Program, Nov 2014
6678	•	DCMA-INST-204 Manufacturing and Production
6679	•	DoDI 5000.02DoDI 5000.02. Operation of the Defense Acquisition System. Feb 2017
6680	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
6681	•	MRL Deskbook Version 2016
6682	•	Risk, Issue, and Opportunity Management Guide, Jan 2017
6683	К.З	Identify Special Tooling, Test, and Inspection Equipment
6684	Manu	facturing and Quality Tasks
6685	•	For EMD and subsequent phases, finalize the Tooling Plan (developed in MSA) for
6686		specialized tooling whose use is limited to the development or production of particular
6687		supplies or parts or to the performance of particular functions for the program including jigs,
6688		dies, fixtures, molds, patterns, taps, gauges, and all components of these items including
6689		foundations and similar improvements necessary.
6690	•	For EMD and subsequent phases, finalize the Tooling Plan for single or multipurpose
6691		integrated specialized test equipment (STE/SIE) that is engineered, designed, fabricated, or
6692		modified to accomplish special purpose testing for the program including items or assemblies
6693		of equipment including inter-connected or interdependent, and foundations and similar
6694	_	Improvements necessary.
6695 6696	•	environment for functionality and sufficiency.
6697	Metri	CS
6698	•	The Tooling Plan for FMD and subsequent phases for specialized tooling has been finalized

3. Technology Maturation and Risk Reduction (TMRR) Phase

6700 6701 6702 6703 6704	•	The Tooling Plan for EMD and subsequent phases for single or multipurpose integrated specialized test equipment (STE/SIE) has been finalized and included in the Manufacturing Plan and the SEP with supporting rationale and schedule. Specialized tooling and STE/SIE plans, fabrication requirements, and lead-times established and tracked.
6705		• Long-lead item plan in place
6706 6707	•	Contractor demonstrations of prototype tooling and STE/SIE have been assessed in production relevant environment for functionality and meet program requirements.
6708 6709 6710		 Planning initiated for production environment demonstrations with required metrics (e.g., pilot line, LRIP, etc. Documentation has been provided for the PDR process
6711 6712 6713	•	Production facilities assessment (see K.2) verifies proposed special tooling and STE/SIE meet current and planned production requirements (e.g. capacity, facilities and equipment, etc.).
6714	Tools	
6715	٠	DCMA Production Planning and Control Risk Assessment Checklist
6716	٠	DCMA Manufacturing Systems Risk Assessment Checklist
6717	•	Rough Cut Capacity Planning Spreadsheet
6718	•	Material Requirements Planning
6719	•	Capacity Requirements Planning Assessment Worksheet
6720	•	Bottleneck Analysis (Theory of Constraints)
6721	•	Critical Chain Project Management
6722	•	Manufacturing Resource Planning (MRPII)
6723	•	Manufacturing Readiness Level Assessment Questionnaire, Facilities thread
6724	•	Plant Design and Facility Layout Software Evaluation Tools
6725	Resou	rces
6726	٠	AS6500, Manufacturing Management System, Sep 2016
6727	•	DCMA-INST-204 Manufacturing and Production
6728	•	FAR Part 2, §2.101 Definitions
6729	٠	Manufacturing Resource Planning (MRP II)
6730	٠	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
6731	•	MRL Deskbook Version 2016
6732	L. N	IANUFACTURING MANAGEMENT/CONTROL

The initial program manufacturing and quality strategy should have been developed as part of the program's Acquisition Strategy in MSA phase. The manufacturing and quality strategy is a major

3. Technology Maturation and Risk Reduction (TMRR) Phase

- aspect of the master schedule for development, test, production, fielding, modification,
- 6736 postproduction management, and other activities essential for program success. Now that there is a
- 6737 contractor responsible for technology maturation and risk reduction, the manufacturing and quality
- 6738 strategy will require updating. This requires an assessment of the contractor's manufacturing plans
- 6739 for adequacy and alignment with the AS.



6740 6741

Manufacturing resources consist of facilities, materials, machines, manpower, methods, measurement
systems, and capital that are used to convert or transform raw materials and component parts into end
products. Contractors must have an effective combination of people and systems in order to plan for,
monitor, and control these manufacturing resources. Effective implementation of a manufacturing
management system is required to manage these resources. A well-structured manufacturing

6747 management system generally employs the use of industry best practices. Assessment of the

6748 contractor's manufacturing management and quality systems should be performed against the

6749 recognized industry best practices such as AS6500, ISO 9000, AS9100, etc.

Additionally, the government requires contractors to implement cyber threat protection measures and
manufacturing control systems which include safeguarding manufacturing and quality information,
designed in systems protection, supply chain risks, software assurance, hardware assurance, anticounterfeit practices, anti-tamper (AT), and security-related activities such as physical security and

6754 industrial security. This would be in compliance with:

- 6755 DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
 6756 Reporting
- NIST 800-82 Guide to Industrial Control Systems Security
- NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information
 Systems and Organizations
- NIST, Cybersecurity Framework
- In preparation for PDR, the Request for Proposal Release Decision Point (RFP RDP), and
- 6762 Milestone B, the program's Manufacturing and Quality Management Strategies and Plans should be

6763 updated. The knowledge gained from the results of TMRR assessments, prototypes, demonstrations,

and accomplishments, risk, issue, and opportunity plans and on-going mitigations, etc., should be

tilized for the updates. These comprehensive strategies and plans will provide the basis for program

6766 manufacturing and quality management in the EMD phase.

6767	L.1	Review Contractor Initial Manufacturing Plan	
6768	Manufacturing and Quality Tasks		
6769 6770 6771	•	Compare, contrast, and assess the contractor's Manufacturing Plan for agreement with the program's overall Acquisition Strategy and the program's Manufacturing Strategy for TMRR and future phases to include:	
6772 6773 6774 6775 6776 6777 6778 6778 6779 6780 6781 6782 6783 6783 6784 6785 6784 6785 6786 6787		 Consistency with program IB risk and issue mitigation plans Development and incorporation of enabling/critical technologies (and constraints) Requirements and schedules for incorporating manufacturing development projects (ManTech) Design feasibility, methodology, and producibility Planned rates and schedules (includes processes, tooling, make/buy, etc.) Management of key and critical characteristics Costs, schedule, budgets, and affordability requirements Management of materials, including lead-times, sourcing, risks, and issues (e.g., sole, single, foreign, counterfeit, obsolescence, etc.) Management of the supply chain, including supplier performance, characteristics, and constraints (e.g., sole, single, foreign, etc.) Processes for managing the schedule, including contingencies, variances, and risks Development plans and methodologies (e.g., prototypes, competitive, dual source, coproduction, etc.) Processes and process capability control requirements 	
6788 6789 6790		 Workforce capabilities, training, certifications, availability, etc. Facilities, tooling, and test equipment (including GFE and assets) requirements Environmental, security, and safety requirements 	
6791 6792 6793 6794 6795	•	Assess the contractor's Manufacturing Plan for appropriate cyber threat protection measures including safeguarding manufacturing and quality information, designed in systems protection, supply chain risks, software assurance, hardware assurance, anti-counterfeit practices, anti-tamper , and security-related activities such as physical security and industrial security.	
6796 6797 6798 6799 6800 6801 6802		 Verify that the contractor and subcontractors can comply with DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting Verify periodic assessments are conducted to understand the risk to organizational operations, organizational assets, and individuals, resulting from the operation and the associated processing, storage, or transmission of Controlled Unclassified Information (CUI) by manufacturing information systems Verify contractor's Industrial Control Systems (ICS) are included in plans for cyber 	
6803		threat protection measures to be applied to manufacturing and quality systems	

6804 6805 6806	•	Assess the contractor's Manufacturing Plan for proposed processes, methods, actions and metrics that address manufacturing and quality capability improvement, feasibility, producibility, and risks, issues, and opportunities.
6807 6808		• Review plan for a scheduled review cycle of the above commensurate with the risks and issues
6809 6810	•	Assess the contractor's Risk, Issue, and Opportunity Management System and planning for this contractual TMRR phase (may be part of the SEMP or Reliability plan).
6811 6812		 Verify the contractor has included in their plan a requirement for a joint government/contractor program risk and issue registers
6813 6814 6815 6816	•	Assess the contractor's Configuration Management Plan for control and management of manufacturing and quality data for the program's TMRR phase contract. Assess the contractor's manufacturing and quality safety analyses processes and procedures for compliance to required program standards (i.e., MIL-STD-882) and integration into the
6817 6818 6819 6820 6821 6822	•	Manufacturing Management System. Evaluate the contractor's proposed processes and methods for submission, review, revision, and process for obtaining approval of CDRLs, DIDs, etc. to support manufacturing and quality processes for consistency with program plans and procedures. Evaluate the contractor's proposed processes and methods for providing manufacturing and quality data and support to:
6823 6824 6825 6826 6827 6828 6829 6830 6831 6832		 Milestone and technical reviews Manufacturing and quality reviews (with frequency of reviews) Cost models and data (including Cost of Quality) Key characteristic management process Risk, issue, and opportunity identification, management, and mitigation system Variability reduction processes Materials management processes Supply chain management system Facilities, tooling, and test equipment planning Workforce planning
6833 6834 6835 6836 6837 6838 6839	•	Assess the contractor's Manufacturing Plan for manufacturing and quality TMRR phase goals/exit criteria. Assess the contractor's strategy and plans for acquisition of modern technology, production equipment, and production systems that increase the productivity and reduce life cycle costs including methods to encourage investment in U.S. domestic sources. Assess contractor's capability to comply with DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting.

6840	Metrics
6841 6842 6843	• Contractor's Manufacturing Management Plan has been assessed and consistency with the program's overall Acquisition Strategy and the program's Manufacturing Strategy and plans and gaps and risks and issues documented for program management to include:
6844 6845 6846 6847 6848 6849 6850 6851 6851	 Consistency with program IB risk and issue mitigation plans Development and incorporation of enabling/critical technologies (and constraints) Requirements and schedules for incorporating manufacturing development projects (ManTech) Design feasibility, methodology, and producibility Planned rates and schedules (includes processes, tooling, make/buy, etc.) Management of key and critical characteristics Costs, schedule, budgets, and affordability requirements
6852 6853 6854 6855 6856 6857 6858 6859 6860 6861 6862	 Management of materials, including lead-times, sourcing, fisks, and issues (e.g., sole, single, foreign, counterfeit, obsolescence, etc.) Management of the supply chain, including supplier performance, characteristics, and constraints (e.g., sole, single, foreign, etc.) Processes for managing the schedule, including contingencies, variances, and risks Development plans and methodologies (e.g., prototypes, competitive, dual source, co-production, etc.) Processes and process capability control requirements Workforce capabilities, training, certifications, availability, etc. Facilities, tooling, and test equipment (including GFE and assets) requirements Environmental, security, and safety requirements
6863 6864 6865 6866 6867	• Contractor's Manufacturing Plan for cyber threat protection measures have been assessed with recommendations documented for program management and incorporation into the SEMP and the SEP including safeguarding manufacturing and quality information, designed in systems protection, supply chain risks, software assurance, hardware assurance, anti-counterfeit practices, anti-tamper, and security-related activities.
6868 6869 6870 6871 6872 6873 6874 6875	 Contractor and Subcontractors have been verified in compliance with DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting Periodic assessments have been planned and scheduled for understanding the risks to organizational operations, organizational assets, and individuals, resulting from the operation and the associated processing, storage, or transmission of CUI by manufacturing information systems Contractor's ICSs have been included in plans for cyber threat protection measures to be applied to manufacturing and quality systems
6876 6877 6878 6879	• Contractor's Manufacturing Plan has been assessed for proposed processes, methods, actions and metrics that address manufacturing and quality capability improvement, feasibility, producibility, and risks, issues, and opportunities with recommendations documented for program management.

6880 6881		 Plan documents a scheduled review cycle of the above commensurate with the risks and issues
6882 6883	•	Contractor's Risk, Issue, and Opportunity Management System and planning for this contractual TMRR phase has been assessed and incorporated into the SEMP and the SEP.
6884 6885		 Contractor has included in their plan a requirement for joint government/contractor program risk and issue registers, and appropriate management reviews
6886 6887 6888 6889 6890 6891 6892 6893 6893 6894 6895 6896 6897	•	Contractor's Configuration Management Plan (CMP) for control and management of manufacturing and quality data has been assessed and meets program requirements or recommendations documented for program management. Contractor's manufacturing and quality safety analyses processes and procedures have been assessed and meet required program standards (i.e., MIL-STD-882) and are integrated into the Manufacturing Management System for program management. Contractor's proposed processes and methods for submission, review, revision, and process for obtaining approval of CDRLs, DIDs, etc. in support of manufacturing and quality processes have been evaluated for consistency with program plans and procedures with and recommendations documented for program management.
6898 6899 6900 6901 6902 6903 6904 6905 6906 6907		 Milestone and technical reviews Manufacturing and quality reviews (with frequency of reviews) Cost models and data (including Cost of Quality) Key characteristic management process Risk, issue, and opportunity identification, management, and mitigation system Variability reduction processes Materials management processes Supply chain management system Facilities, tooling, and test equipment planning Workforce planning
6908 6909 6910 6911 6912 6913	•	Contractor's Manufacturing Plan has been assessed for manufacturing and quality TMRR phase goals/exit criteria consistent with industry best practices (i.e., IEEE 15288). Contractor's strategy and plans have been assessed and include acquisition of modern technology, production equipment, and production systems to increase the productivity and reduce life cycle costs (including methods to encourage investment in U.S. domestic sources) consistent with contractual requirements and program goals.
6914	Tools	
6915	•	Assembly Chart Analysis
6916	•	Bottleneck Analysis (Theory of Constraints)
6917	•	Capacity Planning Worksheet
6918	٠	Critical Chain Project Management

6919	•	Learning Curve Estimator
6920	•	Line of Balance Template
6921	•	Material Requirements Planning (MRP)
6922	•	Manufacturing Resource Planning (MRPII)
6923	•	Material Management and Accounting System (MMAS) audit
6924	•	Route Sheet Analysis
6925	•	Shop Floor Manufacturing Plan Analysis
6926	•	SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
6927	•	Work Measurement Analysis
6928	•	Workforce Planning Tools (SAP/Oracle/MRPII)
6929	•	Manufacturing Readiness Level (MRL) assessment questionnaire using Manufacturing
6930		Management/Control thread
6931	•	Risk, Issues and Opportunities assessment
6932	Resou	irces
6933	•	MIL-STD-882E DoD Standard Practice: System Safety, May 2012
6934	•	AS6500, Manufacturing Management Program, Nov 2014
6935	٠	Systems Engineering Preparation Guide, Apr 2008
6936	٠	DAG, Chapter 3-4 3.18, Producibility, Quality and Manufacturing Readiness, 2017
6937	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
6938	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
6939	•	DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017, Enclosure 14
6940	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
6941		Reporting
6942	٠	NIST 800-82 Guide to Industrial Control Systems Security
6943	٠	NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information
6944		Systems and Organizations
6945	•	Systems Engineering Preparation Guide, Apr 2008
6946	•	DAG, Chapter 3-4 3.18, Producibility, Quality and Manufacturing Readiness, 2017
6947	•	DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017
6948	•	DFARS 252.72 Contractor Material Management and Accounting System
6949	•	Risk, Issue, and Opportunity Management Guide, Jan 2017
6950	L.2	Update Manufacturing Strategy
6951	Manu	facturing and Quality Tasks
6952	•	From the assessment of the contractor's Manufacturing Strategy and plans, update the
6953		program Manufacturing Strategy (and the AS) and plans (and the SEP) for TMRR and future
6954		phases to include:

3. Technology Maturation and Risk Reduction (TMRR) Phase

6955	0	Incorporation of industry and government manufacturing and quality best practices (e.g.,
6956		AS6500, AS9100, ISO 9000, MIL-HDBK-896A, etc.)
6957	0	Compliance with policy directives and regulations
6958	0	Requirements for the EMD Acquisition Strategy and RFP
6959	0	Program plans for IB risk and issue mitigation (government plans) complementary to
6960		contractor plans
6961	0	The joint Risk, Issue, and Opportunity Management plans
6962	0	Development and incorporation of enabling manufacturing technologies (e.g., advanced
6963		simulations, additive technologies, etc.)
6964	0	Development and incorporation of system required technologies (and constraints)
6965	0	Requirements and schedules for manufacturing development projects (ManTech)
6966	0	Management of Intellectual Property
6967	0	Design feasibility, methodology, and producibility initiatives
6968	0	Planned rates and schedules (includes processes, surges, tooling, make/buy, etc.)
6969	0	Management of key and critical characteristics
6970	0	Costs, schedule, budgets, and affordability requirements including Integrated Master Plan
6971		and Integrated Master Schedule (IMP/IMS) with critical path
6972	0	Management of materials, including critical and controlled, lead-times, long-lead,
6973		sourcing, risks, and issues (e.g., sole, single, foreign, counterfeit, obsolescence, etc.)
6974	0	Management of the supply chain, including supplier performance, characteristics, and
6975		constraints (e.g., sole, single, foreign, etc.)
6976	0	Processes for managing the schedule, including contingencies, variances, and risks
6977	0	Development plans and methodologies (e.g., prototypes, competitive, dual source, co-
6978		production, etc.)
6979	0	Processes and process capability control requirements
6980	0	Workforce needs, capabilities, training, certifications, availability, etc.
6981	0	Facilities, tooling, and test equipment (including GFE and assets) requirements
6982	0	Acceptance testing (including incorporation in the IMP/IMS)
6983	0	Environmental, security, and safety requirements
6984 •	Ba	sed on assessments of the contractor's Manufacturing System and plans for cyber threat
6985	pro	ptection measures, update the SEP technical approaches for cybersecurity and related
6986	pro	ogram security
6987	0	Include technical risk, processes, industrial control systems, resources, organization,
6988		metrics, and design considerations
6989	0	Provide manufacturing and quality input to the Program Protection Plan (PPP) for
6990		considerations of contractor level of compliance, risks, and issues
6991		• Validate that the updated program Manufacturing Strategy (and AS) includes
6992		appropriate agreements, delegations, and contracts with other agencies (e.g. DCMA).
6993		Defense Logistics Agency (DLA), etc.)
6994		• For the SEP, update the Program Manufacturing Management Plan to address each
6995		key area of the Manufacturing Strategy (in accordance with AS6500) to include:
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3. Technology Maturation and Risk Reduction (TMRR) Phase

6996 6997 6998 6999 7000 7001	• Ide	 Manufacturing Management System Design Analysis for Manufacturing Manufacturing Risk Identification (including mitigation) Manufacturing Planning Manufacturing Operations Management
7002	Ma	anufacturing Strategy accordingly (if required).
7003	Metrics	
7004 7005	• Pro	ogram Manufacturing Strategy and plans have been assessed for adequacy, updated, and cumented in the AS, SEP, and other appropriate documentation to include:
7006	0	Incorporation of industry and government manufacturing and quality best practices (e.g., AS6500 AS9100 ISO 9000 MIL HDBK 896A etc.)
7008	0	Compliance with policy directives and regulations
7008	0	Requirements for the FMD Acquisition Strategy and RFP
7010	0	Program plans for IB risk and issue mitigation (government plans) complementary to
7011	C C	contractor plans
7012	0	Joint Risk, Issue, and Opportunity Management plans
7013	0	Development and incorporation of enabling manufacturing technologies (e.g., advanced
7014		simulations, additive technologies, etc.)
7015	0	Development and incorporation of system required technologies (and constraints)
7016	0	Requirements and schedules for manufacturing development projects (ManTech)
7017	0	Management of Intellectual Property
7018	0	Design feasibility, methodology, and producibility initiatives
7019	0	Planned rates and schedules (includes processes, surges, tooling, make/buy, etc.)
7020	0	Management of key and critical characteristics
7021	0	Costs, schedule, budgets, and affordability requirements including Integrated Master Plan
7022		and Integrated Master Schedule (IMP/IMS) with critical path
7023	0	Management of materials, including critical and controlled, lead-times, long-lead,
7024		sourcing, risks, and issues (e.g., sole, single, foreign, counterfeit, obsolescence, etc.)
7025	0	Management of the supply chain, including supplier performance, characteristics, and
7026		constraints (e.g., sole, single, foreign, etc.)
7027	0	Processes for managing the schedule, including contingencies, variances, and risks
7028	0	Development plans and methodologies (e.g., prototypes, competitive, dual source, co-
7029		production, etc.)
7030	0	Processes and process capability control requirements
7031	0	Workforce needs, capabilities, training, certifications, availability, etc.
7032	0	Facilities, tooling, and test equipment (including GFE and assets) requirements
7033	0	Acceptance testing (including incorporation in the IMP/IMS)
7034	0	Environmental, security, and safety requirements

7035 7036 7037 7038 7039 7040 7041 7042 7043	•	Manufacturing plans for cyber threat protection measures have been updated in Manufacturing Strategy and the SEP for cybersecurity and related program security and include risks, processes, industrial control systems, resources, organization(s), metrics, and design considerations; and provided as manufacturing and quality input to the PPP. Program Manufacturing Strategy and Acquisition Strategy have been updated and document appropriate agreements, delegations, and contracts with other agencies (e.g. DCMA, DLA, etc.) Program Manufacturing Management Plan has been updated in the SEP and addresses each key area of the Manufacturing Strategy (in accordance with AS6500) including:
7044 7045 7046 7047 7048		 Manufacturing Management System Design Analysis for Manufacturing Manufacturing Risk Identification (including mitigation) Manufacturing Planning Manufacturing Operations Management
7049 7050	•	Requirements for IPS for the program have been identified and documented in the Program Manufacturing Strategy accordingly.
7051	Tools	
7052	•	Acquisition Strategy Template
7053	•	Manufacturing Readiness Level assessment questionnaire using Manufacturing
7054		Management/Control thread
7055	Resou	rces
7056	•	Acquisition Plan Preparation Guide, Jan 2009
7057	•	DSMC Acquisition Strategy Guide, Dec 1999
7058	•	MRL Deskbook Version 2016
7059	•	AS6500, Manufacturing Management System, Sep 2016
7060	•	DoDI 5000.02, Operation of the Defense Acquisition System, Feb 2017
7061	•	Service specific policies and regulations (i.e., AFI 63-145)
7062	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
7063		Reporting
7064	•	IEEE 15288.1-2014, Application of Systems Engineering on Defense Programs
7065	•	IEEE 15288.2-2014, Technical Reviews and Audits on Defense Programs
7066	•	MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016
7067	•	NIST 800-82 Guide to Industrial Control Systems Security
7068	•	NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information
7069		Systems and Organizations

7070	L.3	Assess Contractor Manufacturing Management System	
7071	71 Manufacturing and Quality Tasks		
7072	•	Assess the contractor's Manufacturing Management system capability to perform the design	
7073		and manufacturing work scope in accordance with industry best practices (i.e., AS6500)	
7074		including (See I.3) for:	
7075		• Effectiveness of program and contractor communication and interaction processes to	
7076		include:	
7077		 Cost, schedule, and performance requirements and timely notification of changes 	
7078		 Manufacturing data management processes (to include responses, status, and reports 	
7079		for cost, schedule, and performance actuals)	
7080		 Integration of risk, issue, and opportunity management processes 	
7081		 Failures, corrective, and preventative actions, communication processes 	
7082		 Specification and production of prototypes 	
7083		• Design analyses incorporating producibility and manufacturing feasibility	
7084		• Failure mode analyses processes	
7085		 Key Characteristics management processes 	
7086		• Risk, issue, and opportunity management processes (to include quality, technical,	
7087		schedule, material, facility, scale-up, financial impacts, etc.)	
7088		• Make/buy processes (to include performance and impacts)	
7089		• Processes and procedures for prevention and/or detection of counterfeit parts and	
7090		materials	
7091		• Development program that focuses on and measures continuous improvement	
7092		• Effective metrics management processes to identify, monitor, evaluate, and verify to	
7093		improve processes, and prevent defects	
7094		• Supplier management system that tracks and reports supplier performance which includes	
7095		a supplier quality assessment process	
7096		• Manufacturing verification system that verifies the proposed production processes,	
7097		tooling, and test equipment meet program requirements (including Special Tooling and	
7098		Special Test Equipment)	
7099		 Manufacturing assessment and self-assessment processes to measure progress in 	
7100		manufacturing maturation and risk reduction including suppliers	
7101		 Management processes for COTS items, GOTS items, and NDIs 	
7102		• Management processes for GFE/GFP (e.g., controlled products, test ranges, specialized	
7103		equipment, radiation test facilities, etc.) including roles and responsibilities	
7104		• Production Process Verifications (PPVs) that verify manufacturing processes, tooling,	
7105		and equipment are statistically capable of producing required parts and assemblies	
7106		 Process control planning incorporating process capability studies 	
7107		 Variability Reduction (VR) processes and techniques 	
7108		• Manufacturing software and firmware management processes and integration (including	
7109		the SDP, and SCMP	

7110 7111 7112		• Development processes for in-process and acceptance tests (including prototypes, first articles, hardware, software, and firmware), test procedures including test equipment, and incorporation into the TEMP
7113 7114	•	Assess the contractor's materials and inventory control systems for sufficiency and capability to effectively meet program requirements consistent with industry best practices including:
7115 7116 7117 7118 7119 7120		 An appropriate materials, manufacturing, or enterprise resources planning system (MRP/MRP II/Enterprise Resource Plan (ERP)) including cost control, capacity and facility planning, economic order quantities, inventory control, shop floor control, bills of material, scheduling, purchasing, etc. Appropriate organization/expertise to effectively operate, analyze, and maintain the system
7121 7122 7123	•	Assess the contractor's Manufacturing Management System processes for incorporation of manufacturing and quality in the development, management, execution, and maintenance of the IMP/IMS including processes to:
7124 7125 7126 7127 7128		 Identify and assess actual progress versus planned progress Monitor and manage the Critical Path Monitor the status of risk, issue, and opportunity management Manage Key Performance Parameters , Key System Attributes , Technical Performance Measures , and Key Characteristics
7129 7130 7131 7132 7133	•	Assess the contractor's Manufacturing Management System for capability to develop an Integrated Product Support Plan (if required) including planning for EMD, production, developmental and operational test, and life cycle sustainment Assess the contractor's Manufacturing Management System make or buy decision process for compliance with program manufacturing and quality objectives including:
7134 7135 7136 7137 7138 7139 7140 7141 7142		 Rationale for specific make/buy decisions Identification of items that could become obsolete or are from a diminishing or fragile manufacturing source and contingency plans Identification sole source, single source, or foreign sourced items and contingency plans Availability and lead-times (including long lead) ITAR and anti-tamper considerations Security implications COTS items, GOTS items, NDIs, and GFE/GFP (e.g., controlled products, test ranges, specialized equipment, test facilities, etc.)
7143 7144 7145	•	Analyze the contractor's Supplier Management System capability to perform the anticipated design and manufacturing work scope in accordance with industry best practices (i.e., AS6500) including:
7146 7147		• Effectiveness of prime and subcontractor communication and interaction processes to include:

7148 7149 7150 7151 7152 7153 7154	 Flow down of cost, schedule, and performance requirements to suppliers and timely notification of changes Quality data exchange processes Integration of risk, issue, and opportunity management Responses, status, and reports for cost, schedule, and performance actuals Corrective and preventative actions, communication, and end user feedback Specification and production of prototypes
7155 7156 7157 7158 7159 7160 7161 7162 7163 7164	 Key Characteristics management Supplier risk, issue, and opportunity management processes for quality, technical, schedule, material, facility, scale-up, financial impacts, etc. Make/buy processes for supplier quality performance and impacts Approval/removal and qualification processes for suppliers which includes period reassessment Processes and procedures for prevention and/or detection of counterfeit parts and materials (See AS5553 and AS6174) Identification of major and critical suppliers, and suppliers performing Critical Manufacturing Processes
7165 7166	 Supplier development program that focuses on and measures continuous improvement Effective metrics to monitor, evaluate, verify, improve processes, and prevent defects
7168 7169 7170 7171 7172 7173 7174 7175 7176	 Management of COTS items, GOTS items, and NDIs and their incorporation into the contractor's QMS. Roles, responsibilities, and quality processes for GFE/GFP (e.g., controlled products, test ranges, specialized equipment, radiation test facilities, etc.) Software and firmware quality and integration into the program Software Quality Assurance Plan , Software Development Plan , and Software Configuration Management Plan Acceptance tests (prototypes, hardware, software, and firmware), test procedures including test equipment, and incorporation into the TEMP
7177 7178 7179 7180	 Verify the contract and the subcontractor management plan includes right of access for both the contractor and the government to supplier facilities and documentation, where applicable. Request DMCA assistance in data collection, assessment, analyses, and verification of the contractor Manufacturing Management System including the supply chain.
 7181 7182 7183 7184 7185 7186 	 Contractor's Manufacturing Management system has been assessed and results documented in program documentation (Acquisition Strategy and SEP) and utilized for RFP development, to support MRL assessments, and the PDR decision process. The results document the contractor capability to perform based on design and manufacturing work scope in accordance with industry best practices including: (See I.3)

3. Technology Maturation and Risk Reduction (TMRR) Phase

7187	0	Effectiveness of communications and interaction processes to include:
7188 7189 7190		 Cost, schedule, and performance requirements and timely notification of changes Manufacturing data management processes (to include responses, status, and reports for cost, schedule, and performance actuals)
7191		 Integration of risk, issue, and opportunity management processes
7192		 Failures, corrective, and preventative actions, communication processes
7193		 Specification and production of prototypes
7194	0	Design analyses of producibility and manufacturing feasibility
7195	0	Failure mode analyses
7196	0	Key Characteristics management
7197	0	Risk, issue, and opportunity management (to include quality, technical, schedule,
7198		material, facility, scale-up, financial impacts, etc.)
7199	0	Make/buy (to include performance and impacts)
7200	0	Prevention and/or detection of counterfeit parts and materials
7201	0	Continuous process improvement
7202	0	Metrics management including identification, monitoring, evaluation, and verification to
7203		improve processes, and prevent defects
7204	0	Supplier management system that supplier quality assessment
7205	0	Manufacturing verification system that meets program requirements (including Special
7206		Tooling and Special Test Equipment)
7207	0	Manufacturing assessment and self-assessment processes including suppliers
7208	0	Management of COTS items, GOTS items, and NDIs
7209	0	Management of GFE/GFP (e.g., controlled products, test ranges, specialized equipment,
7210		radiation test facilities, etc.)
7211	0	Production Process Verifications (PPVs)
7212	0	Process control and capability studies
7213	0	Variability Reduction
7214	0	Manufacturing software and firmware management and integration (including the
7215		program Software Development Plan, and Software Configuration Management Plan
7216	0	Documentation of in-process and acceptance tests (including prototypes, first articles,
7217		hardware, software, and firmware), and test procedures in the TEMP
7218 •	Co	ntractor's materials and inventory control systems has been assessed and documented in
7219	pro	ogram documentation and utilized for RFP development, to support MRL assessments, and
7220	the	PDR decision process for compliance with program requirements consistent with industry
7221	bes	st practices including:
7222	0	An appropriate materials, manufacturing, or enterprise resources planning system
7223		(MRP/MRP II/ERP) including cost control, capacity and facility planning, economic
7224		order quantities, inventory control, shop floor control, bills of material, scheduling,
7225		purchasing, etc.
7226	0	Appropriate organization/expertise to effectively operate, analyze, and maintain the
7227		system

 7228 7229 7230 7231 	Contractor's Manufacturing Management System has been assessed for development, management, execution, and maintenance of, and documents the incorporation of manufacturing and quality into the Integrated Master Plan and Integrated Master Schedule (IMP/IMS) to include:
7232 7233 7234 7235	 Actual progress versus planned progress Status of the critical path Status of risks, issues, and opportunities Status of KPPs, TPMs, and Key Characteristics
 7236 7237 7238 7239 7240 7241 	Contractor's Manufacturing Management System has been assessed and documents an Integrated Product Support Plan (if required) which includes plans for EMD, production, developmental and operational test, and life cycle sustainment Contractor's Manufacturing Management System make or buy decision process has been assessed and documented in appropriate program for compliance with program manufacturing and quality objectives including:
7242 7243 7244 7245 7246 7247 7248 7249 7250	 Rationale for specific make/buy decisions Identification of items that could become obsolete or are from a diminishing or fragile manufacturing source and contingency plans Identification sole source, single source, or foreign sourced items and contingency plans Availability and lead-times (including long lead) ITAR and anti-tamper considerations Security implications COTS items, GOTS items, NDIs, and GFE/GFP (e.g., controlled products, test ranges, specialized equipment, test facilities, etc.)
7251 • 7252	Contractor's Supplier Management System has been assessed to be in compliance with industry best practices (i.e., AS6500) and documented to include:
7253 7254	• Effectiveness of prime and subcontractor communication and interaction processes to include:
7255 7256 7257 7258 7259 7260 7261	 Flow down of cost, schedule, and performance requirements to suppliers and timely notification of changes Quality data exchange processes Integration of risk, issue, and opportunity management Responses, status, and reports for cost, schedule, and performance actuals Corrective and preventative actions, communication, and end user feedback Specification and production of prototypes
7262 7263 7264	 Management of Key Characteristics Management of supplier risks, issues, and opportunities for quality, technical, schedule, material, facility, scale-up, financial impacts, etc.
7265	• Make/buy decision considering supplier quality performance and impacts

3. Technology Maturation and Risk Reduction (TMRR) Phase

7266		• Approval/removal and qualification processes for suppliers including period re-
7267		assessment
7268		• Prevention and/or detection of counterfeit parts and materials
7269		• Identification of major and critical suppliers, and suppliers performing Critical
7270		Manufacturing Processes
7271 7272		 Supplier development program that focuses on and measures continuous improvement Effective metrics to monitor, evaluate, verify, improve processes, and prevent defects
7273 7274	•	Contractor's Supplier Management System and Quality Management Plan has been assessed and documents Supplier:
7275 7276 7277 7278 7279 7280 7281 7282 7283 7284 7285 7284 7285 7286 7287	•	 Management of COTS items, GOTS items, and NDIs and their incorporation into the contractor's QMS. Roles, responsibilities, and quality processes for GFE/GFP (e.g., controlled products, test ranges, specialized equipment, radiation test facilities, etc.) Software and firmware quality and integration into the program Software Quality Assurance Plan , Software Development Plan , and Software Configuration Management Plan Acceptance tests (prototypes, hardware, software, and firmware), test procedures including test equipment, and incorporation into the TEMP Access for both the contractor and the government to supplier facilities and documentation has been documented in the contract and the subcontractor management plan. DMCA Letters of Delegation are in place to assist in data collection, assessment, analyses, and verification of the contractor Manufacturing Management System including the supply
7288		chain.
7289	Tools	
7290 7291 7292 7293	•	Manufacturing Readiness Level (MRL) Assessment Questionnaire for the Manufacturing Management and Control thread AS6500 Assessment Material Management and Accounting System Audit
7294	Resou	rces
7295 7296 7297 7298 7299 7300 7301 7302 7302	• • • • • • • •	AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materiel AS6500, Manufacturing Management Program, Nov 2014 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 MRL Deskbook Version 2016 MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016 DFAR 242.72 Contractor Material Management and Accounting System IEEE 15288 1 2014. Application of Systems Engineering on Defense Programs
/303	•	TEEE 15266.1-2014, Application of Systems Engineering on Defense Programs

3. Technology Maturation and Risk Reduction (TMRR) Phase

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

7305	L.4	Finalize Manufacturing Strategy and Plan for EMD
7306	Manu	facturing and Quality Tasks
7307	•	Update the Program Manufacturing Strategy for EMD to include:
7308 7309		• Incorporation of direction and results from a completed PDR (e.g., date, open items, issues, etc.)
7310		• Incorporation of requirements for EMD that were included in the EMD RFP
7311		• Incorporation of all Risks, Issues, and Opportunities
7312 7313		• Maturity and plans for manufacturing development and enabling manufacturing technologies
7314		 Manufacturing maturity and plans for system required technologies
7315		• Results of design feasibility, methodology, and producibility initiatives
7316		 Management of Intellectual Property and data rights
7317		• Revised rates and schedules (includes processes, surges, tooling, make/buy, etc.)
7318		• Key and critical characteristics
7319		• Costs, schedule, budgets, and affordability requirements including Integrated Master Plan
7320		and Integrated Master Schedule (IMP/IMS) with critical path
7321		• Management of materials, including critical and controlled, lead-times, long-lead,
7322		sourcing, risks, and issues (e.g., sole, single, foreign, counterfeit, obsolescence, etc.)
7323		• Revisions and updates to development plans and methodologies (e.g., prototypes,
7324		competitive, dual source, co-production, etc.)
7325		• Revisions and updates for use of COTS items, GOTS items, NDIs, and GFE/GFP (e.g.,
7326		controlled products, test ranges, specialized equipment, test facilities, etc.)
7327		 Revised process capability requirements
7328		• Revised requirements for in-process and acceptance tests (including prototypes, first
7329		articles, hardware, software, and firmware), test procedures including test equipment
7330		• Revised workforce needs, capabilities, training, certifications, availability, etc.
7331		• Revised facilities, tooling, and test equipment (including GFE and assets) requirements
7332		• Revised processes and procedures for prevention and/or detection of counterfeit parts and
7333		materials
7334		• Revised acceptance testing (including incorporation in the IMP/IMS)
7335		• Revised environmental, security, and safety requirements
7336		• ITAR and anti-tamper
7337		• Revised plans for manufacturing cyber threat protection measures, including risks,
7338		processes, industrial control systems, resources, metrics, and design considerations
7339	•	Update the Program Manufacturing Management Plan, based on assessments, analyses, and
7340		incremental updates (including issues, open items, etc.) conducted to address each key area of
7341		the Manufacturing Strategy (in accordance with AS6500) to include:
7342		 Manufacturing Management System
		Manufacturing and Quality Management Body of Knowledge

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7343	 Design Analysis for Manufacturing 	
7344	 Design analysis 	
7345	 Producibility analysis 	
7346	 Key Characteristics 	
7347	 Failure Mode Effects Analyses 	
7348	 Manufacturing Risk Identification (including mitigation) 	
7349	 Manufacturing feasibility assessments 	
7350	 MRL assessments 	
7351	 Production readiness reviews 	
7352	 Manufacturing Planning 	
7353	 Supply chain and material management 	
7354	 Manufacturing technology development 	
7355	 Manufacturing cost 	
7356	 Modeling and simulations 	
7357	 Manufacturing system verification 	
7358	 Manufacturing workforce 	
7359	 Tooling, test equipment and facilities 	
7360	 Manufacturing Operations Management 	
7361	 Production Scheduling and Control 	
7362	 Manufacturing Surveillance 	
7363	 Continuous Improvement 	
7364	 Process Control Plans 	
7365	 Process Capabilities 	
7366	 Production Process Verification 	
7367	 First Article Inspection and test 	
7368	 Supplier Management 	
7369	 Supplier Quality 	
7370	• Update the Program Manufacturing Management Plan for manufacturing software and	
7371	firmware management processes and integration (including the program Software	
7372	Development Plan, and Software Configuration Management Plan.	
7373	• Provide revised manufacturing and quality inputs to the Program Protection Plan (PPP) for	
7374	considerations of contractor compliance, risks, and issues for EMD.	
7375	• Update the Program Manufacturing Strategy (and AS) for EMD to include development of	
7376	appropriate agreements, delegations, and contracts with other agencies (e.g. DCMA), DLA,	
7377	National Test Facilities, etc.).	
7378	• Update manufacturing and quality planning for EMD, production, developmental and	
7379	operational test, and life cycle sustainment of proposed products.	
7380	• Initial manufacturing approach developed	

7381	0	All system related manufacturing events included in Integrated Master Plan and Schedule
7382	0	Manufacturing risk mitigation approach for pilot line or technology insertion programs
7383		defined
7384	0	Most material decisions complete (make/buy)
7385	0	Material risks identified and mitigation plans developed
7386	Metrics	
7387	• Pr	ogram Manufacturing Strategy has been updated and documented in the Acquisition
7388	St	rategy for EMD to include:
7389	0	Direction and results from a completed PDR (e.g., date, open items, issues, etc.)
7390	0	Requirements for EMD that were included in the EMD RFP
7391	0	All Risks. Issues, and Opportunities
7392	0	Plans for continued maturation of manufacturing development and enabling
7393	-	manufacturing technologies
7394	0	Plans for continued manufacturing maturation for system required technologies
7395	0	Results of design feasibility, methodology, and producibility initiatives
7396	0	Management of Intellectual Property and data rights
7397	0	Revised rates and schedules (includes processes, surges, tooling, make/buy, etc.)
7398	0	Key and critical characteristics
7399	0	Costs, schedule, budgets, and affordability requirements including Integrated Master Plan
7400		and Integrated Master Schedule (IMP/IMS) with critical path
7401	0	Management of materials, including critical and controlled, lead-times, long-lead,
7402		sourcing, risks, and issues (e.g., sole, single, foreign, counterfeit, obsolescence, etc.)
7403	0	Revisions and updates to development plans and methodologies (e.g., prototypes,
7404		competitive, dual source, co-production, etc.)
7405	0	Revisions and updates for use of COTS items, GOTS items, NDIs, and GFE/GFP (e.g.,
7406		controlled products, test ranges, specialized equipment, test facilities, etc.)
7407	0	Revised process capability requirements
7408	0	Revised requirements for in-process and acceptance tests (including prototypes, first
7409		articles, hardware, software, and firmware), test procedures including test equipment
7410	0	Revised workforce needs, capabilities, training, certifications, availability, etc.
7411	0	Revised facilities, tooling, and test equipment (including GFE and assets) requirements
7412	0	Revised processes and procedures for prevention and/or detection of counterfeit parts and
7413		materials
7414	0	Revised acceptance testing (including incorporation in the IMP/IMS)
7415	0	Revised environmental, security, and safety requirements
7416	0	ITAR and anti-tamper requirements
7417	0	Revised plans for manufacturing cyber threat protection measures, including risks,
7418		processes, industrial control systems, resources, metrics, and design considerations

7419 7420 7421	•	Based on assessments, analyses, and incremental updates to each key area of the Manufacturing Strategy, the Program Manufacturing Management Plan has been updated and documented in the AS, the SEP and other appropriate program documents to include:
7422 7423 7424 7425 7426		 Manufacturing Management System Design Analysis for Manufacturing Manufacturing Risk Identification (including mitigation) Manufacturing Planning Manufacturing Operations Management
7427 7428 7429 7430 7431 7432 7433 7434 7435 7436 7437	•	The Program Manufacturing Management Plan for manufacturing software and firmware management processes and integration has been updated and documented and includes the program SDP, and SCMP. Revised manufacturing and quality inputs to the PPP have been documented and provided for EMD including considerations of contractor compliance, risks, and issues. The Program Manufacturing Strategy (and AS) for EMD has been updated to include plans for appropriate agreements, delegations, and contracts with other agencies (e.g. DCMA, DLA, National Test Facilities, etc.). Manufacturing and quality planning for EMD, production, developmental and operational test, and life cycle sustainment of proposed products has been documented in appropriate program documents (e.g., TEMP, SEP, IMP/IMS, etc.) to include:
7438 7439 7440 7441 7442		 Initial manufacturing approach All system related manufacturing events Manufacturing risk mitigation approach for pilot line and technology insertion Completed material decisions Identification and mitigation of material risks, and issues
7443	Tools	
7444 7445 7446 7447	• •	Acquisition Strategy Template Manufacturing Plan (DID-MGMG-81889) Manufacturing Readiness Level (MRL) Assessment Questionnaire for the Manufacturing Management and Control thread
7448	Resou	rces
 7449 7450 7451 7452 7453 7454 	• • • •	Acquisition Strategy Plan Preparation Guide, Jan 2009 AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materiel AS6500, Manufacturing Management Program, Nov 2014 MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016 MRL Deskbook Version 2016
7455 7456	•	NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations
4. Engineering and Manufacturing Development (EMD) Phase (Milestone B)

3 Introduction

- 4 As stated in Department of Defense Instruction (DoDI) 5000.02, Operation of the Defense
- 5 Acquisition System, "The purpose of the EMD phase is to develop, build, and test a product to verify
- 6 that all operational and derived requirements have been met, and to support production or
- 7 deployment decisions." To accomplish this, the EMD phase involves completing all hardware and
- 8 software detailed designs, mitigation and closure of open risks and issues, and building and testing of
- 9 prototypes and/or first articles and verifying compliance with requirements. EMD also includes the
- 10 Critical Design Review (CDR), which establishes of the initial product baseline and transfers
- 11 configuration control to the program. In preparation for transition to Low-Rate Initial Production
- 12 (LRIP), the final stage of EMD is producing products that look and operate like final production
- 13 units. These units are built on a pilot line.

	AS SEP TEMP M Updates Updates SVR/FCA
CDD	CDR TRR Line PRR CPD
A. DoD Acq. System	A.1 Provide Mfg. and Quality Updates to Program Documentation A.2 Support CDR A.2 Support Program Technical Reviews A.3 Support Program Decision Reviews
B. Defense Contracting System	B.1 Provide Inputs to RFP B.2 Provide Inputs to SSP Award Fee Criteria B.4 Develop Mfg. Incentives Criteria
C. Surveillance System	C.1 DCMA Support for DMD C.2 DCMA Participation in Program Reviews Capabilities for CDR C.3 Utilize DCMA Surveillance Capabilities for CDR C.4 DCMA Contract Administration, Management, and Support Activities C.4 DCMA Contract Administration, Management, and Support
D. Technology & Industrial Base (IB)	D.1 Update Industrial Base Capabilities Assessment and Analyses D.2 Implement Mfg. Technology Projects D.3 Validate CTE Processes D.4 Insert ManTech Projects D.5 Update and Validate B Capabilities
E. Design	E.1 E.2 Assess E.3 Update E.4 Conduct E.5 Develop E.6 Assess E.7 E.8 E.9 E.10 Validate E.11 Pilot Participate Design vs. Producibility Producibility Design Assess Support Update Design E.10 Validate E.11 Pilot in Design IPT Mig. Cap. Plans Assessments Design Maturity KCs CDR SEP Design E.11 Pilot
F. Cost/Funding	F.1 Update Mfg. Costs F.2 Develop Mfg. Cost Mitigation/Maturation Plan F.3 Validate Proposed Learning Curves F.2 Update Mfg. Costs w/Actuals F.5 Update Mfg. Quality Budget
G. Materials Management	G.1 Manage Materials Risks G.2 Manage Materials G.3. Manage Cost Drivers G.4. Manage Scale-Up G.4 Assess Contractor SCM Program G.5 Assess Material Lead Times G.6. Assess Alt. G.9 Assess Critical Source Options G.9 Assess Critical Source State St
H. Process Capability/Control	H.1 Update Process Capability Requirements H.2 Update and Validate M&S H.2 Update and Validate M&S H.5 Validate Yields and Rates H.5 Validate Yields and Rates
I. Quality Management	11 Assess Contractor Quality Management System 12 Assess and Revise Quality Strategy 13 Evaluate Program/System Support 14 Support 15 Program/System Configuration Audits 16 Assess Pilot Line L.7 Finalize Quality Strategy and Plan for LRIP
J. Mfg. Workforce	J.1 Assess Workforce for Pilot Line
K. Facilities	K.1 Assess Facilities K.2 Assess Tooling, Test, & K.3 Assess Facilities, Tooling, and Inspection Equipment
L. Manufacturing Mgmt./Control	L1 Assess Contractor Mfg. MgmL System L2 Update Mfg. Strategy and Plan L3 Evaluate Program/System Supply Chain Management L8 Support CDR L2 Evecute Pilot Line L4 Finalize Mfg. Strategy and Plan for LRIP

Figure 4-1. EMD Phase Manufacturing and Quality Activities

4. Engineering and Manufacturing Development (EMD) Phase

- 16 During EMD, the program will assess the maturity of critical manufacturing processes to ensure they
- are affordable and executable. Early in the EMD phase, the program's initial manufacturing and
- 18 quality requirements are identified and allocated. They are refined during EMD based on the results
- 19 of assessments and analyses to include: the design, the contractor, the supply chain, the Industrial
- 20 Base, materials, processes, procedures, etc., and are finalized at CDR. Later in EMD, programs will
- 21 demonstrate manufacturing and quality process maturity by production of initial systems on a pilot
- 22 line. This enables the program to ensure manufacturing and quality producibility risks are acceptable,
- 23 qualifications are complete throughout the supply chain, and manufacturing processes for Key
- 24 Characteristics (KC) and critical characteristics will be under statistical process control for LRIP,
- 25 prior to the production decision at Milestone C.
- Manufacturing and quality should be a key contributor and participant in all technical reviews and program documentation, providing inputs and recommendations based on results from assessments, analyses, and demonstrations. Key program documentation and reviews during EMD include:
- Acquisition Strategy (AS)
- 30 o Manufacturing Strategy
- 31 o Quality Strategy
- Systems Engineering Plan (SEP)
- 33 o Manufacturing Plan
- 34 o Quality Plan
- Test and Engineering Master Plan (TEMP)
- 36 Capabilities Development Document (CDD)
- 37 o Transitioning to Capabilities Production Document (CPD)
- 38 Requests for Proposals (RFP)
- 39• Source Selection Plans (SSP)
- 40 Critical Design Review(s) (CDR)
- 41 Test Readiness Review (TRR)
- 42 Pilot Line Demonstration(s)
- 43 System Verification Review (SVR)/Functional Configuration Audit (FCA)
- 44 Production Readiness Review(s) (PRR)
- 45 Milestone C Decision (MS C)

46 Manufacturing and Quality Objectives

- 47 Manufacturing and quality risks, issues, and opportunities are important factors in making the
- 48 decision to proceed within all phases of development and production. The producibility of the design
- 49 and risks were reviewed prior to entry into the EMD phase, however, there may be a new
- 50 contractor(s), a changed Industrial Base and/or technology base, etc. requiring new or additional
- 51 assessments.

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4. Engineering and Manufacturing Development (EMD) Phase

52 To meet the EMD phase objective, the program must demonstrate on a pilot line a product capable of

- 53 meeting system performance requirements within cost and schedule constraints. This requires
- 54 complete and thorough planning and documentation of hardware and software designs, mitigation
- and closure of open risks and issues, and compliance with requirements. Manufacturing and quality's
- 56 contributions to the EMD phase objective are documented in updates to the Manufacturing Strategy
- and Plan and the Quality Strategy and Plan which are incorporated into the AS, the SEP, and the
- 58 TEMP.
- 59 To meet the P&D phase objective of producing "products in Low-Rate Initial Production (LRIP) and
- 60 deliver to receiving military organizations," manufacturing and quality should have a key role during
- 61 the EMD phase in development of the Request for Proposal (RFP) and the Source Selection Plan
- 62 (SSP), including providing manufacturing and quality Award Fee and Incentives Criteria for the
- 63 P&D phase. A cohesive effort between the Contracts and manufacturing and quality personnel is
- 64 essential to assuring that manufacturing and quality processes are sufficiently mature for entry into
- 65 the P&D phase and Low-Rate Initial Production (LRIP).
- 66 Day-to-day surveillance of contractor and supply chain activities is key to monitoring progress and
- 67 maturity of the program as it moves through finalizing the design and demonstration on a pilot line.
- 68 Reviews and assessments are important oversight tools that the program can use to review and
- 69 evaluate the state of the system and the program, re-directing activity if necessary. DCMA is key to
- 70 providing monitoring, tracking, and reporting of contractor and supply chain performance, actions,
- and compliance with all contractual requirements. DCMA and program audits and reviews should be
- 72 multi-disciplined to ensure that all of functional aspects of the program are addressed. This
- rd systematic process assesses risk and issues and verifies the application of manufacturing and quality
- best practices (e.g., AS6500, AS9100, IEEE 15288.2, ISO 9000, etc.) at the contractor and in the
- supply chain.
- 76 DoD policy requires an analysis of the capabilities of the National Technology and Industrial Base
- 77 (NTIB) to support the design, development, production, operation, uninterrupted maintenance
- support, and eventual disposal of the system. Without a supporting Industrial Base, the program may
- find that accomplishing objectives within the defined cost and schedule will be difficult because of
- 80 incompatibilities between the requirements and the NTIB available to support it. A key
- 81 manufacturing and quality focus should be on risk mitigation measures needed to sustain a reliable,
- 82 technologically superior, affordable and resilient defense industrial base.
- 83 The necessity to reduce program risk and the desire to improve program performance while reducing
- 84 costs can benefit from development, maturation, and implementation of advanced manufacturing
- 85 technologies. As manufacturing technology project are matured, these ManTech projects should be
- 86 completed, integrated, and demonstrated on a pilot line at the appropriate contractor and/or supply
- 87 chain facilities. Additionally, DoDI 5000.02 requires a systematic process that assesses the maturity
- 88 of Critical Technology Elements (CTE) for all acquisition programs. In completing the development

- 89 of a system or incremental capability, one of the key tasks is to mature Critical Manufacturing
- 90 Processes (CMP) associated with KCs, and therefore with CTEs.
- 91 At CDR, all of the design information necessary to plan the detailed manufacturing operations for the
- 92 system should be available. Manufacturing and quality participation early in the design process
- 93 through active participation in the Design IPT is the key to creating a producible design.
- 94 Manufacturing and quality planning in EMD should address all areas of manufacturing and quality
- 95 impacting cost, schedule, and performance requirements such as KCs, selection of specific materials,
- 96 specific manufacturing and quality processes, changes in requirements, changes in workforce,
- 97 facilities, tooling, equipment, etc.
- 98 Producibility assessments of the design should be conducted throughout the supply chain using
- 99 industry best practice tools, techniques, and procedures. Prior to a system-level CDR, the detailed
- 100 design must be developed from the component level up to the system level with CDRs conducted to
- 101 assure meeting design requirements at all levels of the supply chain. Prior to release of drawings to
- 102 manufacturing, the detailed design drawings, bills-of-material, and product and process specifications
- 103 must be completed.
- 104 Risks associated with manufacturing and quality will have a major impact on the maturity of the
- 105 design. Many system-level risks occur from immature designs and the failure to consider design
- 106 risks. Manufacturing and quality must assess maturity based on manufacturing feasibility, capability,
- 107 producibility, and KCs, in accordance with industry best practices. Manufacturing maturity can be
- 108 verified and validated by demonstrations of manufacturing and quality processes and procedures in a
- 109 representative environment at the system, subsystem, item, and component level.
- 110 Prior to CDR the list of KCs may be reduced through producibility activities as the product design is
- refined to make key characteristics less sensitive to variation. As the KCs are finalized by CDR, the
- 112 corresponding list of critical manufacturing and quality processes should also be completed. An
- assessment of manufacturing readiness to a system-level target of Manufacturing Readiness Level
- 114 (MRL) 7 can be conducted to confirm manufacturing maturity for CDR.
- 115 The role of manufacturing and quality to influence the design culminates at CDR. Design decisions
- 116 made at CDR related to manufacturing and quality have major impacts on future production and life-
- 117 cycle costs. These decisions should be documented in the SEP and the AS via updated
- 118 Manufacturing and Quality Strategies and Plans. Post-CDR activities, including pilot line, will
- 119 provide the basis for validation of the design and adequacy of the contractor's processes and
- 120 capabilities including control of KCs.
- 121 A successful pilot line build provides validation of the system design, demonstrating the system
- design is complete. Outputs of the pilot line will produce articles subject to First Article Inspections
- 123 (FAI) and/or First Article Tests (FAT) and will provide validation that manufacturing and quality
- 124 processes are stable, under control, and ready for LRIP.

- 125 Manufacturing and quality cost estimates should be based on detailed manufacturing and quality
- 126 processes and procedures according to industry best practices. Updates should be performed, as
- 127 necessary, based on current program status and/or learning curves in order to develop a time-phased
- 128 manufacturing cost. These updates will require analyses of contractor Manufacturing and Quality
- 129 Plans regarding costs, cost controls, and cost drivers. As the design progresses to final design at
- 130 CDR, cost estimates, cost models, and associated cost drivers should be updated with actual cost data
- 131 from lower level (item and component) pilot lines and production.
- 132 Within any program there will be certain systems, subsystems, items, and components the cost of
- 133 which will dramatically impact the overall system cost. These manufacturing and quality cost drivers 134 originate with and evolve from:
- 135 Emerging technologies
- Industrial base limitations and constraints 136 •
- Design producibility factors and impacts 137 •
- 138 Maturing of manufacturing and quality processes (i.e., capability and control) •
- 139 Materials (e.g., sourcing, availability, handling, etc.) •
- 140 • Environmental and Environmental, Safety, and Occupational Health (ESOH) impacts
- 141 • Security impacts
- 142 • Manufacturing and Quality management
- 143 Supply chain management •
- 144 Workforce constraints
- 145 • Facilities, equipment, tooling, and test equipment constraints
- Program budget and funding resource limitations and constraints 146 •
- 147 Manufacturing and quality should focus on producibility, planning, and risk and issue mitigation for 148 reduction and mitigation of cost drivers.
- 149 Manufacturing and quality should refine the learning curves for the system established in TMRR and
- 150 collect data to maintain up-to-date cost estimates and budgeting through CDR. Learning curves are
- 151 then validated by data collected on the pilot lines. Manufacturing cost estimates for LRIP should be
- 152 based on the completed design, known manufacturing processes, execution of planned manufacturing
- 153 and quality operations, and actual costs realized at the system level on a pilot line. Based on actual
- 154 data, up-to-date manufacturing and quality cost estimates should be inputs to the program budget and
- 155 spending plan.
- 156 One of the key elements in a successful program is aggressive materials management and planning.
- 157 Materials management ranges from basic considerations of maturity and availability to understanding
- management of the supply chain and to details of government-furnished property (GFP), shelf life, 158
- 159 security, safety, hazardous materials, storage environment, etc. All program manufacturing and
- 160 quality materials risks, issues, and opportunities should be assessed based on contractor data and
- 161 plans to meet program manufacturing and quality requirements

- 162 Manufacturing and quality should obtain key knowledge on scale-up efforts, and potential supply
- 163 chain risks and issues to meet CDR exit criteria. Manufacturing capability should be assessed to
- baseline needed industrial capability. Materials cost drivers must be updated and appropriate
- 165 management plans implemented by CDR. This includes assessments of the contractor's materials
- supply chain for application, implementation, and adherence to industry manufacturing and quality
- 167 best practices, as well as compliance to contractor company policies, processes, procedures, and
- 168 contracts. Materials and components lead times are critical to both meeting program schedules and
- 169 defining program requirements for long lead and advanced buys. Lead times for defense materials
- and components can be long and volatile due to various reasons, such as imbalances between
- capacity and demand, competition from commercial customers, etc. Pilot line and LRIP procurement
- 172 requirements (e.g., schedule and quantities), and associated mitigation plans should be developed and
- 173 implemented for all procurement risks and issues by CDR.
- 174 In the EMD phase, manufacturing and quality should focus on improving process capability and
- 175 maturity, reducing costs, maintaining (or improving) schedule, supporting the Industrial Base, and
- 176 promoting competition by qualification of alternative sources. Based on pilot line results,
- 177 manufacturing and quality should validate the identification of critical sources throughout the supply
- 178 chain, including sources of key and/or critical subsystems, items, parts, and components.
- 179 In support of updates to Industrial Capabilities Assessment required for MS C, manufacturing and
- 180 quality should assess and verify material availability for LRIP. This assessment should address risks,
- 181 issues, and changes in long-lead procurement, supply chain, counterfeit parts,
- 182 physical/cyber/industrial security, handling, transportation, storage, and environmental compliance,
- 183 business climate, diminishing sources, and program plans for P³I.
- 184 Successful completion of the EMD phase with a thorough understanding of materials capabilities,
- 185 capacities, and limitations and the aggressive management of and planning for materials will ensure
- 186 effective transition to LRIP and the Production and Deployment phase.
- 187 Manufacturing and quality process capability and control should be an integral part of any
- 188 development program. Manufacturing and quality efforts should lead to a producible system with the
- 189 objective of achieving effective and efficient manufacturing processes with process controls to
- 190 satisfy program requirements with consistent and repeatable products at minimum manufacturing
- 191 costs. Manufacturing process capabilities and the quality data collected must be measured,
- 192 controlled, documented, and understood with up-to-date process capability information and indices.
- 193 Contractor Modeling and Simulation (M&S) tools and or products should be familiar to
- 194 manufacturing and quality program personnel, if not, an understanding of the contractor tools, as well
- as the industry state-of-the-art and best practices for M&S is necessary. The contractor tools should
- 196 be up-to-date and validated for applicability, adequacy, and consistency with industry best practices.

4. Engineering and Manufacturing Development (EMD) Phase

197 During the EMD phase the contractor will conduct demonstrations that include testing and analysis

- to ensure products meet the program requirements. These products will be built on pilot lines. The
- 199 processes used on the pilot lines should be evaluated to understand the difficulties and quantify the
- risks to be mitigated for LRIP. Results of the pilot lines and the associated assessments should be
- 201 incorporated to provide an up-to-date, accurate M&S of the system. Actual data collected on the pilot
- 202 lines provide up-to-date data for yields and rates, and validation of all manufacturing and quality
- 203 learning curves for the system and subsystems.

204 These assessments and demonstrations should provide an understanding of the contractor's process

- 205 capabilities, M&S tools, and yields and rates, and support program manufacturing and quality
- 206 planning, resource loading, facilities management, etc. for future phases.
- 207 An effective quality management system is required for operationally safe, suitable and effective
- systems. A quality management system compliant with industry standards ISO 9001 or AS9100 is
- 209 the foundation to producing products that meet requirements. The quality system ensures the as-
- 210 delivered configuration is the same as the as-designed and as-tested configuration. In early EMD,
- 211 during design development, programs should assess that the contractor's QMS supports and aligns
- 212 with program manufacturing and quality strategy, objectives, and goals. This requires the use of
- 213 process audits of the contractor's and supply chain activities, resources, and behaviors. Participation
- of DCMA will provide expert assistance in conducting these audits.
- 215 The Manufacturing and Quality Strategies should require quality assessments of the manufacturing
- 216 processes to ensure they have been effectively demonstrated in an appropriate environment, such as a
- 217 pilot line, prior to Milestone C. Revision to the quality strategy, plans, and objectives may be
- required based on the results of process audits and quality assessments. For CDR, an assessment of
- the allocated baseline against the initial product baseline should ensure that quality parameters (e.g.,
- tolerance, process capability indices, etc.) for considerations such as weight, power, cooling, etc.
- have been appropriately specified in the detailed design. This includes completion of all drawings
- and specifications with tolerances and test points under configuration control for all KCs, CSIs, and
- 223 CAIs.
- A system-level Functional Configuration Audit (FCA) should be conducted to assess performance of
- the system against the functional baseline, and may be conducted in conjunction with the system-
- level System Verification Review (SVR). Quality and quality personnel should be an integral
- element in both the FCA and the SVR. The system-level FCA should assess the collected data, test
- results, analysis results, and M&S output and accuracy of the system after completion of
- 229 development testing and pilot line. The SVR should address all changes or additions generated since
- 230 CDR to ensure the as-tested product on the pilot line includes all Engineering Change Proposals,
- 231 specification change notices and revisions, interface control changes, and all manufacturing and
- 232 quality process changes.

- 233 Quality assessments and analyses of pilot lines demonstrate that the manufacturing and quality
- 234 processes and capabilities required for production have matured with high confidence of success.
- 235 These results should be used to finalize the Quality Strategy and Plan to build production
- configuration products in the P&D phase.
- 237 Workforce skills identification and plans provide inputs to program planning. Workforce planning
- should align the skills required to the scope of the effort required to develop, field, and sustain the
- 239 system. In EMD, a comprehensive assessment of contractor manufacturing plans for system
- 240 development is necessary to understand the requirements for workforce skills, capabilities, training,
- and certifications in support of pilot line and LRIP workforce requirements. Based on contractor
- 242 execution of the pilot line and the manufacturing and quality workforce results, the program
- 243 workforce plans contained in the Manufacturing and Quality Strategies should be updated.
- Based upon the results of PDR and program progress during early EMD, manufacturing and quality
- 245 personnel should assess the contractor and supply chain facility, tooling, test and inspection
- equipment plans. This should include pre-CDR assessments and an update to the Manufacturing and
- 247 Quality Strategies and Plans for EMD. The results of these assessments should identify and
- 248 document risks, issues, and opportunities arising from facility and tooling shortfalls and document
- the required planning for mitigation prior to CDR. By CDR, plans should be finalized along with the
- associated risk and issue mitigation actions. Manufacturing and quality plans must be finalized prior
- to execution of a pilot line.
- 252 Based on results of pilot line demonstrations re-assess facilities, tooling, equipment, and test
- 253 equipment requirements, resource requirements, and schedules for LRIP and FRP using the actual
- data collected. Focused attention on facilities, tooling, equipment, and test equipment in EMD will
- decrease risk and can be a major factor in avoiding or preventing cost overruns and schedule delays
- for LRIP and FRP.
- 257 The Manufacturing Strategy and Plan are major aspects of development, test, initial production, and
- other activities essential for program success. With the potential for a new contractor or contractors
- in the EMD phase, responsible for engineering and manufacturing development through completion
- 260 of pilot line production, the contractor Manufacturing Management System should be assessed and
- the Manufacturing and Quality strategies and Plans may require updating. This includes an
- assessment of the contractor, and their supply chain for adequacy and alignment of manufacturing
- 263 with the program Acquisition Strategy (AS). A well-structured manufacturing management system
- requires effective implementation of industry best practices to include management and mitigation of
- risks, issues, and opportunities. Assessment of the contractor's manufacturing management system
- should be performed against the recognized industry best practice (i.e., AS6500).
- Contractor implementation of best practices should include processes and procedures for supply
 chain Management. This includes supply chain communications, risks and issues identification and
 mitigation, KCs control and management, management, control, and monitoring of Technical

4. Engineering and Manufacturing Development (EMD) Phase

- 270 Performance Measures (and consequently Key Performance Parameters (KPP), Key System
- 271 Attributes (KSA)), process control plans, cyber threat protection measures and manufacturing control
- 272 systems, security, etc. Results of all of these assessments are the basis for maintaining the currency of
- 273 the program Manufacturing Strategy and Plans.
- 274 At CDR, the initial product baseline and documentation is transferred to the program for
- 275 configuration control. This should include all drawings and specifications with tolerances and test
- 276 points, all KCs, CSIs, and CAIs specifications, and may include process control plans, work
- 277 instructions, etc. (i.e., the Technical Data Package) to be incorporated in the Manufacturing Strategy
- and Plans. These should be sufficient, complete, and adequate to enable manufacture of all
- 279 components and hardware with embedded software throughout the supply chain on a pilot line.
- 280 The contractor designated pilot lines should be assessed for production realism and affordability in
- 281 production of the system, subsystem, items, and components. Verification and validation of
- 282 contractor and supply chain manufacturing plans, processes, and procedures should be analyzed
- 283 during the demonstrations. Based upon these demonstrations and assessments, the Manufacturing
- 284 Strategy and Plan should be updated, and the Technical Data Package should be finalized for LRIP.
- 285 The EMD phase ends when the design is stable, the system meets validated capability requirements
- 286 demonstrated by developmental and initial operational testing as required in the TEMP,
- 287 manufacturing processes have been effectively demonstrated and are under control, software
- sustainment processes are in place and functioning, industrial production capabilities are reasonably
- available, and the system has met or exceeds all directed EMD phase exit criteria and Milestone C
- 290 entrance criteria.

291 A. DOD ACQUISITION SYSTEM

- 292 The EMD phase objective is to design, develop, and demonstrate on a pilot line a product capable of
- 293 meeting system performance requirements within cost and schedule constraints. To complete all
- hardware and software detailed designs, mitigation and closure of open risks and issues, and building
- and testing of products and first articles, and verifying compliance with requirements, necessitates
- 296 complete and thorough planning and documentation updates to the Acquisition Strategy, containing
- the Manufacturing and Quality Strategies, the Systems Engineering Plan (SEP), the Test Engineering
- 298 Master Plan (TEMP), and plans for program reviews and pilot line demonstrations.



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4. Engineering and Manufacturing Development (EMD) Phase

301 The EMD Acquisition Strategy should document the strategy for completing and verifying the

- 302 system design, and assessing the manufacturing and industrial base readiness. During EMD,
- 303 industrial and manufacturing readiness should be assessed to include the effective demonstration of
- 304 manufacturing processes in an appropriate environment, such as a pilot line environment, prior to
- 305 Milestone C. The pilot line should incorporate key elements (equipment, personnel skill levels,
- materials, components, work instructions, tooling, etc.) required to produce production configuration
 items, subsystems or systems that meet design requirements in low-rate production, utilizing the
- 308 documented rate production processes planned to be used in LRIP. The Acquisition Strategy should
- 309 describe the EMD phase plans to assess and demonstrate that manufacturing processes and/or
- 310 capabilities have matured to a level of high confidence required for production products in the P&D
- 311 phase.
- 312 EMD execution also requires appropriate planning updates in the SEP for all key program events.
- 313 These reviews include the CDR, the Test Readiness Review (TRR), and after pilot line, the System
- 314 Verification Review (SVR)/Functional Configuration Audit (FCA), and the end-of-phase Production

315 Readiness Review (PRR) in preparation for transition to Low-Rate Initial Production (LRIP) and the

- 316 Milestone C Decision.
- 317 Manufacturing and quality considerations should be important criteria at each decision point of the
- 318 system life cycle, and manufacturing criteria used to ensure that a manufacturing and quality
- 319 capabilities exist or will exist when required to produce the system. This capability includes the
- 320 industrial base, factory, workers, processes, material, sub-Contractors, etc. that will be required to
- 321 produce the system at rate and quality standards necessary to deliver the required capability. During
- 322 early EMD phase, the producibility of the design and manufacturing and quality risks and issues are
- 323 assessed and mitigated to support finalizing the design culminating in a CDR, which establishes the
- 324 initial product baseline and transfers configuration control to the program.
- 325 Manufacturing and quality should be a key contributor and participant in all technical reviews,
- 326 providing documented inputs and recommendations based on results from assessments, analyses, and
- demonstrations. Post-CDR, the major technical reviews commonly conducted during EMD include
- 328 the following:
- Test Readiness Review (TRR)
- Human Rating Certification, Flight Readiness Review (FRR), etc.
- System Verification Review (SVR)
- Functional Configuration Audit (FCA)
- Production Readiness Review (PRR)
- 334 During the post-CDR phase leading up to the Milestone C Decision (MS C), the contractor should
- demonstrate manufacturing of the system on a pilot line. While TRR, certification reviews,
- 336 SVR/FCA occur sequentially, pilot line can occur simultaneously with any of these reviews, but all
- should be complete prior to PRR. In addition to these reviews, manufacturing and quality should

4. Engineering and Manufacturing Development (EMD) Phase

- 338 support and participate in both a Manufacturing Readiness Level (MRL) assessment of the system
- using MRL 8 criteria (the target for MS C) and a PRR to support MS C.
- Based on post-CDR, pilot line, and PRR assessment results, manufacturing and quality should also
- provide inputs on the myriad of statutory and regulatory program required updates per DoDI 5000.02
- by MS C. These include the Acquisition Strategy (e.g., Contracting Strategy, Industrial Base
- 343 Considerations, Intellectual Property Considerations, Risk, Issue, and Opportunity Management
- 344 Approach, etc.), the Acquisition Program Baseline, the Cost Analysis Requirements Description
- 345 (CARD), the Program Protection Plan (PPP), the SEP, etc.
- 346 Based on the effective demonstrations of manufacturing processes conducted on the pilot line,
- 347 manufacturing and quality should support and participate in the program's decision processes on
- 348 acceptability of manufacturing and producibility risks, supplier qualifications, and verification of
- 349 manufacturing processes under statistical process control required for a MS C decision.

350 A.1 Provide Updates to Program Documentation

351 Manufacturing and Quality Tasks

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- Based on the results, action items, and resolutions pertaining to manufacturing and quality
 requirements, risks, issues, and opportunities from the PDR, CDR, pilot line, and PRR, (i.e.,
 throughout EMD) maintain and provide manufacturing and quality updates to the Acquisition
 Strategy (AS) to address technical progress and management strategy for:
- 356 Competition and contracting strategies
- Program manufacturing priorities, allocations, and allotments, and justifications (DPAS
 code)
- 359 Management of manufacturing, quality, supply chain, etc.
- 360 Design feasibility, producibility, KCs, critical characteristics, etc.
- 361 o Implementation of new manufacturing technologies
- 362 o Demonstrations of manufacturing processes in the appropriate environment prior to
 363 Milestone C
- 364 o Application of Modular Open Systems Approach (MOSA)
- 365 o Management of Intellectual Property rights (including deliverables and associated license
 366 rights over the entire product life cycle)
- 0 Management of Materials (characteristics, sourcing, risks, etc.)
- 368 Manufacturing cyber threat protection measures (See L.2)
 - Manufacturing and quality inputs Life-Cycle Support Plan
- Manufacturing and quality process, rates, and quantities (capabilities, control, risks, etc.)
 (See H.1)
- Facilities, Tooling, and Workforce (including government-furnished equipment
 (GFE)/government-furnished information (GFI), special test equipment (STE)/special
 inspection equipment (SIE), special requirements, etc.)

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 375 376 377 	Provide in the Manufacturing Strategy and Plan and the Quality Strategy and Plan (for potential inclusion in appropriate program documentation and management reviews) detailed manufacturing and quality requirements and metrics for:
378 379	• Manufacturing maturity and progress against manufacturing and quality goals required for each technical review (PDRs, CDRs, and at other appropriate reviews)
380	• Production quantities per year and the total planned production quantity
381	• Certifications processes and procedures (e.g., Flight Operations/Safety, Human Rating,
382	etc.)
383	• Environmental Safety and Heath (ESOH) (Human safety and health)
384	 Hazardous materials management and pollution prevention
385	• Environmental parameters (e.g., shock, vibration, thermal, humidity, electromagnetic
386	interference/impact, electrostatic discharge, transport, etc.)
387	• Security (physical and cyber) for both hardware and software
388	• Data management and software (including collection, analysis, testing, and methods of
389	analysis, storage, retrieval of manufacturing and quality data)
390	 Manufacturing supportability and sustainment
391	o Management of commercial off-the-shelf (COTS), government off-the-shelf (GOTS), and
392	government-furnished equipment (GFE) (including diminishing manufacturing sources)
393	• Management of parts, materials, and processes (PM&P)
 394 395 396 	Update the Manufacturing Strategy and Plan and the Quality Strategy and Plan to address the sustainment of industrial base capabilities (including manufacturing technologies and capabilities) and the maturation required during the EMD and subsequent phases.
397 398 399 400 401	• Include manufacturing and quality 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.
402 403	 Include manufacturing and quality inputs on products or components (known and/or projected) from sole, single, fragile, or foreign sources including options for:
404	 Domestic alternatives through regeneration of prior capability
405	 Creation of new capability for manufacturing products and processes
406	 Lifetime buy of items at the subsystems, and component levels
407 408 409	 Include manufacturing and quality inputs on Diminishing Manufacturing Sources and Material Shortages (DMSMS) Maintain a watch-list of critical items, parts, and components and their sources through a
410	Critical Capabilities List (CCL)
411 • 412	Provide manufacturing and quality Industrial Base (IB) capability analyses update for the AS (per DoDI 5000.02) and the RFP to include inputs on:

413 414		• IB capabilities, fragility, gaps, and risks (e.g., key technologies and key and critical processes parts components etc.)
415		• Canability of the IB to design develop produce support and restart the acquisition
416		program, if appropriate
417		• Impacts and interdependencies of the program on the National Technology Industrial
418		Base (NTIB) and the analyses used to make this determination including management
419		and future assessments
420		• Government strategy and actions necessary to preserve the IB capabilities (e.g.,
421		incentivizing the contractor to support IB capability preservation, ManTech/Title III
422		initiatives, etc.)
423	•	Maintain manufacturing and quality inputs to Manufacturing Strategy and Plan and the
424		Quality Strategy and Plan up-to date on ManTech and/or contractor manufacturing
425		technology project implementation and status for high-risk manufacturing capabilities and
426		processes (See D.2)
427		• Include manufacturing and quality risks, issues, and opportunities
428		• Include plans for insertion of the new manufacturing capability
429	•	Provide and maintain up-to-date manufacturing and quality inputs and plans to the IMP/IMS
430		including:
431		• Schedule for any planned use of government-furnished special test equipment,
432		government facilities/ranges, unique tooling, or other similar requirements (specific
433		M&S, communications, restricted environment, etc.).
434		• Schedule impacts from the requirements for special materials and allotments with
435		justification
436		• Manufacturing and quality internal and external interdependencies and integration with
437		existing programs, systems, and other programs in development that potentially impact
438		the critical path
439		• Inputs on reviews including the sub-tier level (including CDR, PRR, etc.), documentation
440		inputs (e.g., CDD, TEMP, AS, SEP, CDR, PRR etc.), production events, and deliveries
441	•	Update the government Manufacturing Management Strategy and Plan and Quality
442		Management Strategy and Plan for EMD to include: (See I.1 and L.1 for assessment of
443		contractor and I.2 and L.2 for update considerations)
444		• Updates to manufacturing and quality requirements
445		• Definition and agreement on requirements for manufacturing environments pilot line,
446		LRIP, and FRP
447		 Up-to-date Technical Data Package
448		• Manufacturing and quality resource management (minimizing cost, schedule, and
449		performance risks for the product life cycle)
450		• Potential changes to manufacturing and quality organization and staffing with Key
451		Leadership Positions (KLP) and necessary skilled manpower

452 453	 Changes to manufacturing and quality support organization required to meet program projected needs for P&D and subsequent phases including:
454 455 456	 Earned Value Management requirements Cost control requirements Data collection, reporting, and management
457 • 458 459	Update the manufacturing and quality requirements for the P&D contractor's Manufacturing Management System (MMS) and Quality Management System (QMS) to be included in the AS and the RFP.
460 461 462 463 464 465 466	 Specify the standards to be used to promote industry best practices (e.g., AS6500, ISO 9000, AS9100, IEEE 15288.0,1,2, etc.) If manufacturing and quality standards are not specified, develop alternative requirements for program specific manufacturing management plan and quality management plan. Identify manufacturing and quality opportunities, initiatives, and systems that will contribute to minimizing cost, schedule, and performance risks throughout the product life cycle
467 • 468 469	Ensure a joint manufacturing and quality comprehensive Risk, Issue and Opportunity Management System that is capable of identifying and tracking risks and associated mitigation plans is in place.
470 471 472 473 474 475	 Ensure requirements are up-to-date and maintained for identification, analysis, mitigation, tracking, and control of manufacturing and quality risks, issues, and opportunities that impact performance, technical, cost, schedule, sustainment, and programmatic areas throughout the life of the program Analyze mitigation plans for adequacy and completeness, and potential impacts on EMD and subsequent phases to include:
476 477 478 479 480 481 482 483	 Industry being unable to provide program design and/or manufacturing capabilities at planned cost and schedule Materials, facilities, workforce, interdependencies with other programs, manufacturing technology gaps, quality, software and engineering related risks, issues etc. Required maturation of critical technologies and manufacturing processes to the appropriate level Manufacturing and quality cost and schedule impacts
484 • 485 486 487 • 488 489	Ensure other agencies are providing inputs on strategies (e.g., DCMA, DLA, etc.) for quality, manufacturing, production, engineering, software development, configuration management, testing and quality. Provide and maintain up-to-date manufacturing and quality inputs to the SEP and Test Engineering Master Plan (TEMP) to address technical progress and strategy including the following:

490 491 492 493	0	Manufacturing and quality updates on KCs, critical characteristics, and Technical Performance Measures, and the associated impacts on KPPs including the mandatory KPPs (Force Protection, System Survivability, Sustainment, and Energy) Updates on significant activities to the EMD program schedule including:
494 495 496 497 498 499 500 501 502 503		 Risk and issue mitigations Manufacturing assessments Critical Design Reviews (including supply chain) Long-lead or advanced procurements Prototype builds and demonstrations Projected lots or phases Production Readiness Reviews Independent reviews and audits Changes or impacts to the workforce (i.e., strikes), supply chain (i.e., disruptions) Environmental impacts (e.g., floods, fires, earthquakes, etc.)
504 505 506 507 508	0	Updated outputs and status from the joint Risk, Issue and Opportunity Management System and mitigations. Updated manufacturing and quality inputs from assessment of the contractor's management of and processes for Safeguarding Covered Defense Information and Cyber Incident Reporting including:
509 510 511 512 513		 Compliance with DFARS, PPP, ITAR, etc. Management of Controlled Unclassified Information Technical approaches to cybersecurity and related manufacturing and quality security, including suppliers, risks, processes, industrial control systems, resources, metrics, and design considerations
514 515 516 517 518 519	0	 Application of up-to-date industry best practices for manufacturing to include: Manufacturing Management System Design for Manufacturing Manufacturing Risk Identification (including mitigation) Manufacturing Planning Manufacturing Operations Management
520 521 522 523		 Up-to-date inputs on the manufacturing and quality organization, billets and key assignments including: Roles and Responsibilities of IPTs (Team Details – Name, Chair, Membership, Roles, Responsibility, and Authority, Products and Metrics)
524 525 526 527	0	Up-to-date manufacturing and quality planning for assessments to be conducted; metrics to be tracked; progress against goals, thresholds, and objectives; entry and exit criteria for technical reviews; design considerations; etc. Up-to-date manufacturing and quality inputs to the configuration managed IMP/IMS
528 529	0	Requirements for manufacturing environments (e.g., pilot line, LRIP, FRP)

DRAFT 4. Engineering and Manufacturing Development (EMD) Phase

530 o Requirements the Technical Data Package (including Intellectual Property) 531 • Provide manufacturing and quality requirements for sustainment (e.g., maintainability, serviceability, etc.) and sustainment processes and activities for the LCSP. 532 533 Metrics 534 The AS has been maintained and is up-to-date based on the results, action items, and • 535 resolutions pertaining to manufacturing and quality requirements, risks, issues, and 536 opportunities and provides current status for program technical progress and management 537 strategy for: 538 • Competition and contracting strategies o Program manufacturing priorities, allocations, and allotments, and justifications (DPAS 539 540 code) 541 • Management of manufacturing, quality, supply chain, etc. 542 • Design feasibility, producibility, KCs, critical characteristics, etc. 543 • Implementation of new manufacturing technologies 544 • Demonstrations of manufacturing processes in the appropriate environment prior to Milestone C 545 546 • Application of Modular Open Systems Approach (MOSA) 547 • Management of Intellectual Property rights 548 o Management of Materials 549 • Manufacturing cyber threat protection measures 550 • Manufacturing and quality inputs Life-Cycle Support Plan 551 • Manufacturing and quality process, rates, and quantities 552 o Facilities, Tooling, and Workforce 553 Manufacturing Strategy and Plan and the Quality Strategy and Plan document detailed • 554 manufacturing and quality requirements and metrics for: 555 • Manufacturing maturity and progress against manufacturing and quality goals required 556 for each technical review 557 o Production quantities per year and the total planned production quantity o Certifications (e.g., Flight Operations/Safety, Human Rating, etc.) 558 559 o ESOH 560 • Hazardous materials management and pollution prevention 561 o Environmental parameters 562 • Security (physical and cyber) for both hardware and software • Data management and software 563 • Manufacturing supportability and sustainment 564 o Management of COTS, GOTS, and GFE 565 566 Management of PM&P 0

567 568 569	•	Manufacturing Strategy and Plan and the Quality Strategy and Plan have been updated and document the sustainment of industrial base capabilities and the required maturation to occur during the EMD and subsequent phases, including inputs on:
570 571 572 573 574		 Product or component obsolescence, use and replacement of limited-life items, options for unique manufacturing processes and products, and the capability to convert off-the-shelf items to required specifications at the subsystems, item, and component levels Products or components from sole, single, fragile, or foreign sources including options for:
575 576 577		 Domestic alternatives through regeneration of prior capability Creation of new capability for manufacturing products and processes Lifetime buy of items at the subsystems, and component levels
578 579		 DMSMS Watch-list of critical items, parts, and components and their sources through a CCL
580 581	•	Up-to-date manufacturing and quality Industrial Base (IB) capability analyses have been provided as input for the AS (per DoDI 5000.02) and the RFP to include:
582 583 584 585 586 587		 IB capabilities, fragility, gaps, and risks Capability of the IB to design, develop, produce, support, and restart the acquisition program, if appropriate Impacts and interdependencies of the program on the NTIB and the analyses used to make this determination including management and future assessments Government strategy and actions necessary to preserve the IB capabilities
588 589 590	•	Manufacturing and quality inputs to Manufacturing Strategy and Plan and the Quality Strategy and Plan have been maintained and are up-to date for ManTech and/or contractor manufacturing technology project implementations and status including:
591 592		 Manufacturing and quality risks, issues, and opportunities Plans for insertion of the new manufacturing capability
593 594	•	Up-to-date manufacturing and quality inputs and plans have been provided to the IMP/IMS including:
595 596 597 598		 Schedule for any planned use of government-furnished special test equipment, government facilities/ranges, unique tooling, or other similar requirements (specific M&S, communications, restricted environment, etc.). Schedule impacts from the requirements for special materials and allotments with
599 599		justification
600 601 602		• Manufacturing and quality internal and external interdependencies and integration with existing programs, systems, and other programs in development that potentially impact the critical path
603 604		 Inputs on reviews including the sub-tier level (including CDR, PRR, etc.), documentation inputs (e.g., CDD, TEMP, AS, SEP, CDR, PRR etc.), production events, and deliveries

605 • 606	Government Manufacturing Management Strategy and Plan and Quality Management Strategy and Plan for EMD has been updated and includes:
607 608 609 610 611 612 613 614 615	 Updates to manufacturing and quality requirements Definition and agreement on requirements for manufacturing environments pilot line, LRIP, and FRP Up-to-date Technical Data Package Manufacturing and quality resource management Potential changes to manufacturing and quality organization and staffing with KLP and necessary skilled manpower Changes to manufacturing and quality support organization required to meet program projected needs for P&D and subsequent phases including:
616 617 618	 Earned Value Management requirements Cost control requirements Data collection, reporting, and management
619 • 620	Manufacturing and quality requirements for the P&D contractor's MMS and QMS have been updated in the AS and the RFP, including:
621 622 623 624 625	 Standards to be used for industry best practices Alternative requirements for program specific manufacturing management plan and quality management plan, if manufacturing and quality standards are not specified Manufacturing and quality opportunities, initiatives, and systems that will contribute to minimizing cost, schedule, and performance risks throughout the product life cycle
626 • 627	A joint manufacturing and quality comprehensive Risk, Issue and Opportunity Management System has been implemented, is in place, including:
628 629 630 631	 Up-to-date and maintained identification, analysis, mitigation, tracking, and control of manufacturing and quality risks, issues, and opportunities Mitigation plans that adequately and completely address impacts on EMD and subsequent phases to include:
 632 633 634 635 636 637 638 639 	 Industry being unable to provide program design and/or manufacturing capabilities at planned cost and schedule Materials, facilities, workforce, interdependencies with other programs, manufacturing technology gaps, quality, software and engineering related risks, issues etc. Required maturation of critical technologies and manufacturing processes to the appropriate level Manufacturing and quality cost and schedule impacts
640 • 641 642	Other agencies are providing documented inputs on strategies (e.g., DCMA, DLA, etc.) for quality, manufacturing, production, engineering, software development, configuration management, testing and quality.

643 • 644	Manufacturing and quality inputs to the SEP and TEMP are maintained and provide up-to- date status for technical progress and strategy including:
645 646 647 648 649	 Manufacturing and quality updates on KCs, critical characteristics, and Technical Performance Measures, and the associated impacts on KPPs including the mandatory KPPs (Force Protection, System Survivability, Sustainment, and Energy) Updates on significant manufacturing and quality scheduled activities during EMD including:
650 651 652 653 654 655 656 657 658 659	 Risk and issue mitigations Manufacturing assessments Critical Design Reviews (including supply chain) Long-lead or advanced procurements Prototype builds and demonstrations Projected lots or phases Production Readiness Reviews Independent reviews and audits Changes or impacts to the workforce (i.e., strikes), supply chain (i.e., disruptions) Environmental impacts (e.g., floods, fires, earthquakes, etc.)
660 661 662 663 664	 Updated outputs and status from the joint Risk, Issue and Opportunity Management System and mitigations. Updated manufacturing and quality inputs from assessment of the contractor's management of and processes for Safeguarding Covered Defense Information and Cyber Incident Reporting including:
665 666 667 668 669	 Compliance with DFARS, PPP, ITAR, etc. Management of Controlled Unclassified Information Technical approaches to cybersecurity and related manufacturing and quality security, including suppliers, risks, processes, industrial control systems, resources, metrics, and design considerations
670 671 672 673 674 675	 Application of up-to-date industry best practices for manufacturing to include: Manufacturing Management System Design for Manufacturing Manufacturing Risk Identification (including mitigation) Manufacturing Planning Manufacturing Operations Management
676 677 678 679	 Up-to-date inputs on the manufacturing and quality organization, billets and key assignments including: Roles and Responsibilities of IPTs (Team Details – Name, Chair, Membership, Roles, Responsibility, and Authority, Products and Metrics)

680 681 682		• Up-to-date manufacturing and quality planning for assessments to be conducted; metrics to be tracked; progress against goals, thresholds, and objectives; entry and exit criteria for technical reviews; design considerations; etc.
683		• Up-to-date manufacturing and quality inputs to the configuration managed IMP/IMS
684		including critical path
685 686		 Requirements for manufacturing environments (e.g., pilot line, LRIP, FRP) Requirements the Technical Data Package (including Intellectual Property)
687 688 689	•	Manufacturing and quality requirements for sustainment (e.g., maintainability, serviceability, etc.) and sustainment processes and activities have been documented and provided for the LCSP.
690	Tools	
691	•	Acquisition Strategy Outline
692	•	AS6500 Manufacturing Management System Checklist
693	٠	AS9100 Quality Management System Checklist
694	٠	ISO 9001 Quality Management System Checklist
695	٠	Capability Production Document Template
696	٠	Manufacturing Readiness Level (MRL) Assessment Checklist
697	٠	Technology Readiness Level (TRL) Assessment Checklist
698	٠	ManTech Proposal Rating Worksheet
699	٠	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
700	•	Integrated Master Plan/Integrated Master Schedule use MS Project
701	•	Risk Management Plan Template
702	•	Systems Engineering Plan Outline
703	•	TEMP Outline
704	•	Life Cycle Sustainment Plan Outline
705	Resou	rces
706	٠	Acquisition Strategy Guide, DSMC, Dec 1999
707	٠	AS6500, Manufacturing Management Program, SEP 2016
708	٠	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
709	٠	AS9100 QUALITY SYSTEMS – REQUIREMENTS FOR AVIATION, SPACE, AND
710		DEFENSE ORGANIZATIONS, SEP 2016
711	٠	ISO 9001:2015, Quality Management System
712	•	CDD-CPD Writing Guide, Feb 2015
713	٠	IEEE 15288, System and Software Engineering, 2015
714	٠	Systems Engineering Plan Preparation Guide, Apr 2008
715	٠	Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct
716		2005
717	٠	MRL Deskbook Version 2016

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- Risk, Issue and Opportunity Management Guide, Jun 2015
- Test and Evaluation Management Guide, Dec 2012
- TRA Deskbook, Apr 2012
- DoDI 5000.02, Enclosure 2, 6.d., Jan 2017
- DoDI 4200.15, Manufacturing Technology (ManTech) Program, Dec 2003
- DoD 5000.60-H DoD Handbook: Assessing Defense Industrial Capabilities, Apr 1996
- Life Cycle Sustainment Plan Content Guide

725 A.2 Support CDR

726 Manufacturing and Quality Tasks

727 728	Ensure the program's Manufacturing Management Strategy and Plan and Quality Management Strategy and Plan are updated for CDR.
729 730 731 732	 Include program manufacturing and quality staffing, training, and certifications Include an update to program manufacturing and quality processes and metrics Ensure draft certification plans have been developed and cover all required system certifications (e.g., Flight Operations/Safety, Human Rating, etc.)
733 •	Support an MRL assessment of the system using MRL 7 criteria as the target for CDR.
734 735	 Assess and validate manufacturing and quality materials, facilities, tooling, etc. availability
736 • 737 738	Ensure system baseline documentation for manufacturing and quality is under configuration control, and is sufficient, complete, and adequate to enable component manufacturing, hardware fabrication and software implementation to proceed.
739 740 741 742 743	 Ensure all subsystem, item, and components are included in the system baseline Ensure all KCs, CSIs, and CAIs have complete drawings and specifications under configuration control Ensure all product data essential (e.g., drawings, specifications, interfaces, etc.) for component manufacturing has been released
744 • 745 • 746 • 747 •	Ensure all manufacturing and quality inputs to the AS and the SEP are up-to-date for CDR (See A.1).Ensure all subsystem, item, and component CDRs are complete, under configuration control, and the results available for the system CDR.
748 749 750 751	 Ensure all design maturity assessments are closed and approved for system CDR Include all appropriate subsystem, item, and component reviews (e.g., All CDRs, PPRs, PCAs, FCAs, etc.) Include all system, subsystem, item, and component interfaces (internal and external)
752 • 753	Ensure all manufacturing and quality trade studies and producibility assessments are complete and are incorporated into the system for CDR.

4. Engineering and Manufacturing Development (EMD) Phase

754	• Include ongoing producibility enhancement efforts
755 • 756	Ensure manufacturing and quality input to the schedule (IMP/IMS) and the associated critical path is up-to-date and is executable with acceptable risks.
757 758	 Includes supply chain Includes integration and test
 759 760 761 762 	Ensure all key and critical manufacturing processes, including process control plans and metrics, have been defined, characterized, updated for the detailed design, and the capability to meet design tolerances and are tracked. Ensure manufacturing and quality data management system addresses:
763 764 765	 Communications and availability Data collection, capacity, processing, storage, and control Security (physical and cyber), information security and access
766 • 767	Analyze plans for make/buy and long-lead procurement requirements and incorporate results into procurement plans.
768 • 769	Analyze the assessments of adequacy and completeness of manufacturing and quality requirements validation activities (See E.6):
770 771 772	 Include prototypes and demonstrations in a representative environment at the system level for design maturity Ensure all Critical Safety Items (CSI) and/or Critical Application Items (CAI) are
773 774 775 776	 traceable to key and critical manufacturing and quality processes Include demonstrations of manufacturing processes in appropriate environments for the required level of maturity (e.g., subsystem, item, and component) Ensure all identified KCs, CSIs, and CAIs are incorporated into the Verification Cross-
777	Reference Matrix (VCRM) for required testing and verification
 778 779 780 781 782 783 	Ensure traceability of manufacturing and quality KCs to Critical Manufacturing Processes (CMP) to Technical Performance Measures (TPM) to allocated baseline requirements up to KPPs and KSAs. Based on support to design reviews at all levels of the supply chain, assess adequacy and completeness of manufacturing and quality requirements verification and validation activities for system CDR including
784 785 786 787 788 789 790 791 792	 Producibility (subsystem, item, and component) Product maturity Technology maturity Interoperability, interdependencies, and interfaces (internal and external) Alternate sources to include availability and maturity User interfaces and Human Systems Integration (HSI) Environmental, Safety, and Occupational Health (ESOH) Hazardous materials management and pollution prevention processes MOSA

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793	• COTS, NDIs, and GFE
794 • 795 • 796 • 797 • 798 • 799 •	Provide manufacturing and quality inputs to the Life Cycle Support Plan for CDR. Ensure contractor manufacturing and quality management systems for manufacturing and quality metrics and data collection and tracking to the component level are in place and functional. Ensure manufacturing and quality inputs to DT&E processes and assessments are complete and up-to-date for CDR.
800 801	 Including environments (e.g., thermal, vibrations, shock, and accelerated life testing, etc.) Include required traceability
802 • 803 804 • 805	Ensure manufacturing and quality plans support of OT&E requirements for data and traceability at CDR. Ensure the TEMP incorporates all manufacturing and quality subsystems, items, and components into plans for tests, test facilities, and test equipment.
806 807	• Include all identified KCs, CSIs, and CAIs are incorporated into the required testing and verification plans
808 809	 Include manufacturing and quality impacts on all KPPs including the mandatory KPPs (Force Protection, System Survivability, Sustainment, and Energy)
 810 811 812 813 814 815 816 817 818 	 Include planned significant activities from the up-to-date EMD program schedule (e.g., manufacturing assessments, long-lead or advanced procurements, prototype demonstrations, projected lots or phases, PRRs, etc.) Include up-to-date inputs to the joint Risk, Issue and Opportunity Management System including industrial base, manufacturing, quality, engineering, software (firmware), and risk reduction and/or mitigation efforts Updated planning for manufacturing and quality tests, assessments, and verification and validation activities to be conducted, facilities and test equipment to be used, metrics to be tracked, progress against goals, thresholds and objectives, etc.
819 •	Assess and validate contractor manufacturing and quality plans for pilot line requirements.
820 821 822	 Include materials, facilities, workforce, equipment, test facilities and equipment, tooling, etc. Include EMI control processes and procedures
823 • 824	Ensure the manufacturing and quality considerations and aspects of contractor's plans and inputs are up-to-date and approved for CDR, including:
 825 826 827 828 829 830 	 Parts and Materials (Management) Plan (PMP) Configuration Management Plan (CMP) Software Development Plan (embedded software) Quality Assurance Plan Systems Security Engineering (SSE), COMSEC, cybersecurity, and PPP SEMP

831	o TEMP
832 833 834	• Analyze and update subsystem, item, and component quantity estimates based on program system requirements, component yield and rate data, and results from prototype demonstrations.
835	• Ensure manufacturing and quality design producibility improvements have been
836	implemented in the system design and/or specifications according to the joint
837	government/contractor schedule (See E.4).
838 839 840	• Ensure manufacturing and quality plans, activities, and processes are executable within the existing manufacturing and quality budget to support the approved product baseline and critical path
841	 Provide up-to-date manufacturing and quality inputs to the program budget and the CARD.
842 843	 Update and allocate manufacturing and quality (production) cost models to subsystem, item, and component levels, and track against targets
844 845 846	• Ensure manufacturing and quality cost data including required production costs and production schedule estimates (See F.1) are provide for all cost and budget estimates for CDR.
847	• Analyze results of contractor and key supply chain assessments (e.g., sourcing, materials,
848	subsystems, items, components, lead-times, quality, manufacturing management, ESOH, etc.)
849	for manufacturing and quality risks, issues, and opportunities and appropriate mitigation
850	plans.
851	• Ensure adequacy and completeness of mitigation activities for mitigation of manufacturing
852 853	and quality risks, issues, and opportunities in the joint government/ contractor Risk, Issue, and Opportunity (RIO) Management System, including:
854	• Key and critical manufacturing processes including embedding software
855	• Materials and sourcing
856	• Supply chain including multiple sources
857	• Production rates and yields
858	o Facilities
859	 Special tooling development
860	• Tests and demonstrations
861	o Security
862	 System safety and hazardous materials management
863	• Economic feasibility
864	• Schedule (i.e., IMP/IMS)
865	 Manufacturing capability obsolescence
866	 Manufacturing capability sustainment
867 868	• Analyze manufacturing and quality plans for adequacy and capability of achieving manufacturing readiness level 8 by initial production.

869	Metrics
870 871	• Program's Manufacturing Management Strategy and Plan and Quality Management Strategy and Plan have been updated for CDR, including:
872 873 874	 Program manufacturing and quality staffing, training, and certifications Program manufacturing and quality processes and metrics Draft certification plans (e.g., Flight Operations/Safety, Human Rating, etc.)
875 876 877 878 878	 Manufacturing and quality have supported and provided documented inputs for the system MRL assessment to MRL 7 criteria. Manufacturing and quality inputs to system baseline are under configuration control and document sufficiency, completeness, and adequacy to enable component manufacturing, hardware fabrication and software implementation to proceed.
880 881 882 883 884	 All subsystem, item, and components are included in the system baseline All KCs, CSIs, and CAIs have complete drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, interface control documents, etc.) for component manufacturing has been released
885 886 887 888	 Manufacturing and quality have provided documented, up-to-date inputs to the AS and the SEP (See A.1). All subsystem, item, and component CDRs are complete, under configuration control, and the documented manufacturing and quality results available for the system CDR.
889 890 891 892 893 894	 All manufacturing and quality design maturity assessments are closed and approved for system CDR All manufacturing and quality data from appropriate subsystem, item, and component reviews are included All manufacturing and quality system, subsystem, item, and component interfaces (internal and external) are included
895 896 897 898 899 900 901 902	 All manufacturing and quality trade studies and producibility assessments are complete and results are documented for the system CDR. Manufacturing and quality have provided up-to-date (executable with acceptable risks) inputs to the schedule (IMP/IMS) and the associated critical path. All key and critical manufacturing processes, including process control plans and metrics, have been updated and documented for the detailed design, and are being tracked. Manufacturing and quality data management system has been assessed and the results document adequacy and sufficiency of:
903 904 905	 Communications and availability Data collection, capacity, processing, storage, and control Security (physical and cyber), information security and access

906 • 907	Plans for make/buy and long-lead procurement requirements have been assessed and recommendations documented for procurement plans.
908 • 909	Manufacturing and quality requirements validation activities have been assessed and document the adequacy and completeness of (See E.6):
910 911 912 913 914 915	 Prototypes and demonstrations in a representative environment at the system level Traceability of all CSIs and/or CAIs to key and critical manufacturing and quality processes Demonstrations of manufacturing processes in appropriate environments for the required level of maturity (e.g., subsystem, item, and component) The VCRM for all identified KCs, CSIs, and CAIs
916 917 918 919 920	Traceability of manufacturing and quality KCs to CMPs to TPMs to allocated baseline requirements up to KPPs and KSAs has been established and documented for CDR. Manufacturing and quality requirements verification and validation activities for system CDR have been assessed and document the adequacy and completeness (at all levels of the supply chain), including:
921 922 923 924 925 926 927 928 929 930	 Producibility (subsystem, item, and component) Product maturity Technology maturity Interoperability, interdependencies, and interfaces (internal and external) Alternate sources to include availability and maturity User interfaces and Human Systems Integration (HSI) Environmental, Safety, and Occupational Health (ESOH) Hazardous materials management and pollution prevention processes MOSA COTS, NDIs, and GFE
931 • 932 • 933 • 934 • 935 • 936 • 937 • 938 • 939 • 940 •	 Manufacturing and quality have provided documented inputs to the Life Cycle Support Plan for CDR. Contractor manufacturing and quality management systems have been assessed and documented as in place and functional for manufacturing and quality metrics, data collection, and tracking to the component level. Manufacturing and quality have provided documented, up-to-date inputs to DT&E processes and assessments for CDR, including environments and traceability. Manufacturing and quality have provided documented plans for support of OT&E requirements for data and traceability. Manufacturing and quality have reviewed the TEMP for inclusion of:
941 942	 All manufacturing and quality subsystems, items, and components All identified KCs, CSIs, and CAIs (for required testing and verification)
943 944	 Including manufacturing and quality impacts on all KPPs including the mandatory KPPs (Force Protection, System Survivability, Sustainment, and Energy)

945 946 947 948 949 950 951 952		 Planned significant manufacturing and quality activities from EMD schedule (e.g., manufacturing assessments, long-lead or advanced procurements, prototype demonstrations, projected lots or phases, PRRs, etc.) Up-to-date manufacturing and quality inputs from the joint Risk, Issue and Opportunity Management System including mitigation efforts Updated planning for manufacturing and quality tests, assessments, and verification and validation activities to be conducted, facilities and test equipment to be used, metrics to be tracked, progress against goals, thresholds and objectives, etc.
953 954 955	•	Contractor manufacturing and quality plans for pilot line manufacturing and quality requirements have been assessed and the results with recommendations have been documented for CDR, including:
956 957 958		 Materials, facilities, workforce, tooling and equipment Test facilities, equipment, tooling, etc. EMI control processes and procedures
959 960	•	Contractor's manufacturing and quality plans and inputs for CDR have been assessed, are up- to-date, and approved, and include documentation for:
961 962 963 964 965 966 967		 Parts and Materials (Management) Plan (PMP) Configuration Management Plan (CMP) Software Development Plan (embedded software) Quality Assurance Plan SSE, COMSEC, cybersecurity, and PPP SEMP TEMP
968 969 970 971 972 973 974 975 976 977 978	•	Based on program system requirements, component yield and rate data, and results from prototype demonstrations; manufacturing and quality quantity estimates for subsystems, items, and components have been updated and documented for CDR. Manufacturing and quality design producibility improvements have been documented and implemented in the system design and/or specifications according to the joint government/contractor schedule (See E.4). Manufacturing and quality plans, activities, and processes have been assessed, documented, and are executable within the existing manufacturing and quality budget, the approved product baseline, and the critical path. Up-to-date manufacturing and quality inputs have been documented and provided for the Program budget and the CARD.
979 980		 Manufacturing and quality (production) cost models for subsystem, item, and component levels have been updated and are tracked against targets
981 982 983	•	Up-to-date manufacturing and quality cost data including required production costs and production schedule estimates (See F.1) have been documented and provided for the CDR cost and budget estimates.

984 985 986 987 988 989 989 990 991	•	Contractor and key supply chain have been assessed for manufacturing and quality risks, issues, and opportunities and appropriate mitigation plans (e.g., sourcing, materials, subsystems, items, components, lead-times, quality, manufacturing management, ESOH, etc.) and the results are documented for CDR. Mitigation of manufacturing and quality risks, issues, and opportunities in the joint government/ contractor Risk, Issue, and Opportunity (RIO) Management System, have been assessed and the results document the adequacy and completeness of mitigation activities, including:
992		• Key and critical manufacturing processes including embedding software
993		• Materials and sourcing
994		• Supply chain including multiple sources
995		 Production rates and yields
996		o Facilities
997		• Special tooling development
998		• Tests and demonstrations
999		o Security
1000		• System safety and hazardous materials management
1001		• Economic feasibility
1002		• Schedule (i.e., IMP/IMS)
1003		• Manufacturing capability obsolescence
1004		• Manufacturing capability sustainment
1005 1006	•	Manufacturing and quality plans for achieving manufacturing readiness level 8 by initial production have been documented.
1007	Tools	
1008	•	Critical Design Review (CDR) Checklist
1009	Resou	rces
1010	•	DoDI 5000.02
1011	•	MRL Deskbook Version 2016
1012	•	IEEE 15288.2-2014, IEEE Standard for Technical Reviews and Audits on Defense Programs
1013	•	Defense Manufacturing Management Guide for Program Managers, Chapter 12 – Technical
1014		Reviews and Audits
1015	•	MIL-STD-1521B, Jun 1985 (retired)
1016	A.3	Support Program Technical Reviews

- 1017 Manufacturing and Quality Tasks
- Provide manufacturing and quality support and inputs to the Test Readiness Review to
 include:

1020		0	SEMP review and recommendations made for CDR
1021		0	TEMP review and approval process (to include manufacturing and quality requirements
1022			to the appropriate level)
1023		0	Need for verification and validation of manufacturing and quality requirements for
1024			Critical Manufacturing Processes (CMP) (and therefore KCs)
1025		0	Results of changes in manufacturing and quality processes (flowing from design changes
1026			since CDR, other than CMPs) impacting testing requirements and events
1027		0	Requirements for manufacturing and quality configuration management of system,
1028			subsystem, item, and components (hardware and software) to be tested
1029		0	Status of system, subsystem, item, and components manufacturing process maturity
1030			including:
1031			• Certification processes and procedures (e.g. Flight Operations/Safety Human
1032			Rating etc.)
1032			 Process capability indices (C_{nk}) on demonstrated processes
1024			
1034		0	Requirements for process capabilities (target C_{pk})
1035		0	Status of established bi-directional traceability (manufacturing and quality TPMs to
1036			CMPs to KCs
1037		0	Definition of manufacturing and quality development test environments utilized (e.g.,
1038			thermal, vibrations, shock, and accelerated life testing, etc.)
1039		0	Requirements for manufacturing and quality security (physical, cyber, and industrial)
1040		0	Processes, procedures, and documentation of the Failure Reporting, Analysis, and
1041			Corrective Action System (FRACAS)
1042		0	Verification that system, subsystem, item, and component parts are produced to approved
1043			
1044		0	Direct support of quality personnel to test execution
1045	•	Pa	rticipate in and support the System Verification Review (SVR) including:
1046		0	Provide verification that all manufacturing and quality CDR action items have been
1047			closed and any corrective actions have been successfully completed
1048		0	Provide manufacturing and quality inputs on:
1049			 Verification of requirements from all system, subsystem, item, and component
1050			manufacturing and quality test data and analyses
1051			 Verification of performance to the function baseline based on manufacturing and
1052			quality data
1053			 Verification through analysis of manufacturing and quality data the adequate
1054			management and integrity of all critical program information (CPI) (e.g.,
1055			performance data, yield and rate data, etc.)
1056			• Verification that manufacturing and quality risks are included in the Risk, Issue, and
1057			Opportunity Management process and mitigation plans
1058			• Demonstration of system capability to meet all TPMs, KPPs, and KSAs (thresholds)
1059			based on all available manufacturing and quality test data, analysis, and inspection

1060 1061 1062 1063	 Required "certification" activities (e.g., human rating, flight, space, etc.) Analyses of support and maintenance requirements for incorporation into the LCSP Risks of operational test failures during Initial Operational Test and Evaluation (IOT&E)
1064	• Provide manufacturing and quality inputs to:
1065 1066 1067 1068 1069 1070 1071 1072 1073 1074 1075	 Ensure adequate manufacturing and quality processes and metrics are in place Analysis of contractor's SEMP for appropriate incorporation of manufacturing and quality activities and data collection, analysis, and storage Detailed manufacturing and quality planning and schedules (with required resources for proceeding into LRIP and IOT&E) Updates of the SEP and contractor's SEMP for the production and deployment (P&D) phase The CARD for up-to-date cost of quality inputs The LCSP The TEMP (i.e., up-to-date) The Configuration Management Plan (CMP) (i.e., up-to-date)
1076 • 1077	Provide manufacturing and quality inputs and support of the Functional Configuration Audit (FCA) to include:
1078 1079 1080 1081	 Support to program and the contractor agreements that development is complete and data from development tests (DT), analyses, and simulations are sufficient to achieve performance goals Manufacturing and quality inputs for:
1082 1083 1084 1085	 Verification of manufacturing and quality performance to the baseline Verification traceability documentation for each manufacturing and quality requirement Validity and the completeness of embedded software and integration
1086 1087 1088	 Manufacturing and quality verification of all approved engineering change proposals (ECP), requests for deviation, and requests for waiver impacting manufacturing and quality
1089 1090	• Verification that all KCs, CSIs, and CAIs are identified, managed, and included in the Verification Cross Reference Matrix (VCRM)
1090 1091 1092	 Ensure manufacturing and quality provides support to verification activities and tasks to include:
1093 1094 1095 1096 1097 1098	 Each requirement listed in the VCRM is traceable and is verified with test data, analysis, and/or inspection Demonstration of manufacturing and quality processes to provide the capability to satisfy TPMs, KPPs and KSAs thresholds Review of acceptance test reports and deficiencies with root cause and closed corrective actions

4. Engineering and Manufacturing Development (EMD) Phase

1099	 Certification activities (e.g., human rating, flight/safety, etc.)
1100 • 1101 1102	Provide for PRR results and recommendations of manufacturing and quality assessments of contractor's manufacturing and quality efforts in accordance with industry best practices (i.e., AS6500) on a pilot line to include:
1103 1104 1105 1106 1107 1108 1109	 All manufacturing and quality processes including continuous improvement efforts Manufacturing surveillance and quality data collection and analyses (including supply chain data for items and components) Physical and functional interfaces All work instructions, sequencing, and procedures Process capabilities and process control plans Production scheduling and control
1110 1111 1112 1113	 Model and Simulations Materials Workforce capabilities Manufacturing technology implementations
1114 1115 1116 1117	 Tooling, work holding fixtures, jigs, etc. Test equipment and test facilities (including Special Test Equipment/Special Inspection Equipment (STE/SIE) validation in accordance with plans) Eacilities, transportation, storage, and handling equipment
1117 1118 1119 1120 1121 1122 1122	 Interdependencies (not all will be validated on the pilot line) Safety processes, procedures, and compliance ESOH processes, procedures, and compliance Security processes, procedures, capabilities, and compliance Risk and issue mitigation results and adequacy of resolution Manufacturing and quality costs, schedule, performance
1123 1124 1125	 Manufacturing and quality costs, schedule, performance Materials sources and selections Integration of embedded software Provide for PRR results and recommendations of manufacturing and quality assessments of
1120 1127 1128	Industrial Base Capability and support, conducted for CDR and pilot line demonstrations, for changes in:
1129 1130 1131	 Sources and alternatives Obsolescence (e.g., market trends, environmental factors, policies, etc.) Vulnerabilities (supply chain)
1132 1133 1134 1135 1136	 Sole, single, foreign, etc. Military Counterfeit Potential exploitation Fragility and uncertainty of demand
1137 1138	 Production capability and capacity Security requirements (physical, cyber, and industrial)

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1139 1140 1141 1142 1143 1144		 Availability (e.g., materials, components, equipment, facilities, etc.) Required COTS and NDIs External dependencies Capabilities to support the systems (e.g., tooling, production, equipment, test equipment, etc.) Required government and/or contractor Depot and Maintenance and Repair Operations
1145 1146	•	Provide for PRR results and recommendations of manufacturing and quality assessments of outputs from the pilot line for adequacy and completeness and validate:
1147 1148 1149 1150 1151 1152 1153 1154 1155		 Process control plans, including key and critical processes All Production Process Verifications (PPV) performed Attainability of KCs (will be capable and under process control for LRIP) Variability Reduction including updates based on process improvements All FAIs and FATs against specifications, drawings, models, etc. Design changes and process changes identified during pilot line operations, testing, and qualification Certification processes and procedures (e.g., Flight Operations/Safety, Human Rating, etc.)
1156	Metrics	
1157	•	Manufacturing and quality support and inputs to the Test Readiness Review has been
1158		documented and include the following:
1159		o SEMP review and recommendations
1160		• TEMP review and recommended changes
1161		• Manufacturing and quality requirements verification and validation needs (CMPs and
1162		KCs)
1163		• Results of changes in manufacturing and quality processes impacting testing
1164		requirements and events
1165		• Manufacturing and quality configuration management requirements for system,
1166		subsystem, item, and components (hardware and software) to be tested
1167		• Status of system, subsystem, item, and component certification manufacturing and
1168		quality processes and procedures (e.g., Flight Operations/Safety, Human Rating, etc.)
1169		• Status of system, subsystem, item, and components manufacturing process maturity with
1170		process capability indices (C_{pk})
11/1		• Requirements for process capabilities targets (C_{pk})
11/2		CMPs to KCs
11/3		UNITS 10 KCS
11/4		thermal vibrations shock and accelerated life testing atc.)
11/J		merman, viorations, shock, and accelerated me testing, etc.)
1176		• Requirements for manufacturing and quality security (physical other and industrial)
1176		• Requirements for manufacturing and quality security (physical, cyber, and industrial) • Processes, procedures, and documentation of EPACAS implementation

4. Engineering and Manufacturing Development (EMD) Phase

1178 1179	• Verification that system, subsystem, item, and component parts have been produced to approved specifications
1180 • 1181	Manufacturing and quality personnel have participated in and provided documented inputs to the SVR including:
1182 1183 1184	 Verification that all manufacturing and quality CDR action items have been closed and any corrective actions have been successfully completed Manufacturing and quality inputs on:
1185 1186 1187 1188 1189 1190 1191 1192 1193 1194 1195 1196 1197 1198	 Verification of requirements from all system, subsystem, item, and component manufacturing and quality test data and analyses Verification of performance to the function baseline based on manufacturing and quality data Verification through analysis of manufacturing and quality data the adequate management and integrity of all CPI (e.g., performance data, yield and rate data, etc.) Verification that manufacturing and quality risks are included in the Risk, Issue, and Opportunity Management process and mitigation plans Demonstration of system capability to meet all TPMs, KPPs, and KSAs (thresholds) based on all available manufacturing and quality test data, analysis, and inspection Required "certification" activities (e.g., human rating, flight, space, etc.) Results of support and maintenance requirements analyses for incorporation into the LCSP Risks of operational test failures during IOT&E
1199 1200 1201 1202 1203 1204 1205 1206 1207	 Manufacturing and quality inputs have been developed and document: Adequate manufacturing and quality processes and metrics are in place Adequacy of the contractor' s SEMP with incorporation of manufacturing and quality activities; data collection, analysis, and storage; and any recommended changes Detailed manufacturing and quality planning and schedules (with required resources for proceeding into LRIP and IOT&E) Updates to the SEP for the production and deployment (P&D) phase Changes to the CARD with up-to-dated cost of quality inputs Updates for the LCSP, TEMP, and the Configuration Management Plan
1208 • 1209	Manufacturing and quality have supported and participated in, and provided inputs to the FCA to include:
1210 1211 1212 1213	 Documented support to program and the contractor agreements that development is complete and data from development tests (DT), analyses, and simulations are sufficient to achieve performance goals Documented manufacturing and quality inputs to:
1214 1215 1216	 Verification of manufacturing and quality performance to the baseline Verification traceability documentation for each manufacturing and quality requirement

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4. Engineering and Manufacturing Development (EMD) Phase

1217		 Validity and the completeness of embedded software and integration
1218 1219 1220		• Manufacturing and quality verification of all approved engineering change proposals (ECP), requests for deviation, and requests for waiver impacting manufacturing and quality
1220 1221 1222		 Verification that all KCs, CSIs, and CAIs have been identified, are managed and documented, and are included in the VCRM
1223 1224		• Documented manufacturing and quality input to verification activities and tasks which included:
1225 1226		 Each requirement's traceability and verification with test data, analysis, and/or inspection
1227 1228		 Demonstration of manufacturing and quality processes for meeting TPMs, KPPs and KSAs thresholds Device of the second second
1229 1230 1231		 Review of acceptance test reports and deficiencies with root cause and closed corrective actions Certification activities (e.g. human rating, flight/safety, etc.)
1231		- Certification activities (e.g., numan rating, finght/safety, etc.)
1232 1233 1234	•	In accordance with industry best practices (i.e., AS6500), manufacturing and quality verification and validation of contractor pilot line has been successfully conducted and the results have been documented for PRR including:
1235		• All manufacturing and quality processes with rigorous continuous improvement
1230 1237 1238		 Disciplined, functional, and accessible manufacturing surveillance and quality data acluation system including surply chain
1230		 Documented tested and approved physical and functional interfaces
1239		• Functional work instructions sequencing and procedures
1241		 Process capabilities and process control plans
1242		• Functional production scheduling and control processes
1243		• Refined model and simulations
1244		• Materials
1245		• Confirmed workforce requirements, skills, and capabilities
1246		• Manufacturing technology implementations
1247		o Tooling, work holding fixtures, jigs, etc.
1248		• Test equipment and test facilities (including Special Test Equipment/Special Inspection
1249		Equipment (STE/SIE) validation in accordance with plans)
1250		• Facilities, transportation, storage, and handling equipment
1251		• Pilot line interdependencies
1252		• Safety processes, procedures, and compliance
1253		• ESOH processes, procedures, and compliance
1254		 Security processes, procedures, capabilities, and compliance
1255		• Risk and issue closures and remaining mitigation plans
1256		• Confirmation of and updates to manufacturing and quality costs, schedule, performance
1257		 Materials sources and selections

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1258		 Integration of embedded software
1259 1260 1261	•	Industrial Base Capability assessments have been updated by manufacturing and quality, based on results from CDR and pilot line demonstrations, and have been documented and provided to the PRR for changes in:
1262 1263 1264		 Sources and alternatives Obsolescence (e.g., market trends, environmental factors, policies, etc.) Vulnerabilities (supply chain)
1265 1266 1267 1268 1269		 Sole, single, foreign, etc. Military Counterfeit Potential exploitation Fragility and uncertainty of demand
1270 1271 1272 1273 1274 1275 1276 1277		 Production capability and capacity Security requirements (physical, cyber, and industrial) Availability (e.g., materials, components, equipment, facilities, etc.) Required COTS and NDIs External dependencies Capabilities to support the systems (e.g., tooling, production, equipment, test equipment, etc.) Required government and/or contractor Depot and Maintenance and Repair Operations
1278 1279 1280	•	Results and recommendations from manufacturing and quality assessments of adequacy and completeness of outputs from the pilot line have been documented and validate the following:
1281 1282 1283 1284 1285 1286 1287 1288 1289		 Process control plans, including key and critical processes All Production Process Verifications (PPV) Attainability of KCs Variability Reduction plans including updates based on process improvements All FAIs and FATs against specifications, drawings, models, etc. All design changes and process changes identified during pilot line operations, testing, and qualification Certification processes and procedures (e.g., Flight Operations/Safety, Human Rating, etc.)
1290	Tools	
1291	•	Acquisition Strategy Outline
1292	•	Test Readiness Review (TRR) Checklist
1293	•	Technology Readiness Assessment (TRA) Checklist
1294	٠	MRL Assessment Checklist
1295	•	System Verification Review (SVR) Checklist

4. Engineering and Manufacturing Development (EMD) Phase

- Functional Configuration Audit (FCA) Checklist
- 1297 Production Readiness Review (PRR) Checklist

1298 **Resources**

1299 • Acquisition Strategy Guide, DSMC, Dec 1999 1300 AS6500, Manufacturing Management Program, SEP 2016 1301 • MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016 1302 • AS9100 QUALITY SYSTEMS - REQUIREMENTS FOR AVIATION, SPACE, AND 1303 **DEFENSE ORGANIZATIONS, SEP 2016** 1304 • ISO 9001:2015, Quality Management System 1305 • CDD-CPD Writing Guide, Feb 2015 1306 • Systems Engineering Plan Preparation Guide, Apr 2008 1307 Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct 1308 2005 1309 • MRL Deskbook Version 2016 1310 TRA Deskbook, Apr 2012 • 1311 Risk, Issue and Opportunity Management Guide, Jun 2015 • 1312 Test and Evaluation Management Guide, Dec 2012 • 1313 • IEEE 15288.2, IEEE Standard for Technical Reviews and Audits on Defense Programs Defense Manufacturing Management Guide for Program Managers, Chapter 3.7.4 Technical 1314 • Reviews, and Chapter 12.5 Technical Reviews and Audits 1315 **Support Program Management Decision Reviews** 1316 A.4 1317 **Manufacturing and Quality Tasks** 1318 Support an MRL assessment of the system using MRL 8 criteria as the target for the • 1319 Milestone C decision. o Capture the results of manufacturing and quality processes, demonstrated on a pilot line. 1320 1321 as inputs 1322 • Verify and validate attainability of KCs (i.e., will be capable and under process control 1323 for LRIP) including yields and rates 1324 • Incorporate results of the required Technology Readiness Assessment 1325 o Incorporate industrial base viability 1326 • Verify and validate producibility issues, design stability, and configuration management 1327 • Verify and validate all LRIP manufacturing and quality requirements (e.g., materials, 1328 supply chain, workforce, facilities, tooling, manufacturing planning and management, 1329 etc.) 1330 Assess the contractor designated pilot lines for production realism and affordability of elements required to manufacture systems, subsystems, items, and components to include 1331 1332 evaluation of:

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1333 1334 1335 1336 1337 1338 1339 1340 1341 1342 • 1343	o o o o Pro fol	Manufacturing readiness for manufacture of equipment Materials, components, and tooling availability Adequacy of manufacturing and quality workforce skill levels, facilities, materials, work instructions, processes, tooling, temperature, cleanliness, lighting etc. Capability to meet manufacturing and quality requirements for LRIP Production processes (little or no reliance on laboratory environment or personnel, i.e., non-production resources) Capability and capacity to meet rate production (ramp-up to FRP) Capability and capacity to meet program objectives for cost and schedule ovide manufacturing and quality inputs and updates, for the Milestone C Decision lowing post-CDR pilot line, and PRR assessment results, the following statutory and
1344	reg	gulatory program required updates (per DoDI 5000.02) to:
1345	0	The Acquisition Strategy
1346 1347 1348 1349 1350 1351 1352 1353 1354 1355 1356 1357		 Acquisition Approach Benefit Analysis and Determination (required if no MS B decision) Business Strategy Contracting Strategy (type and termination liability) Cooperative Opportunities (if necessary) General Equipment Valuation Industrial Base Considerations Intellectual Property Considerations Modular Open Systems Approach Multiyear Procurement Risk, Issue, and Opportunity Management Approach Small Business Innovation Research/Small Business Technology Transfer
1358	0	Acquisition Program Baseline
1359	0	Affordability Analysis
1361	0	Analysis of Alternatives (regulatory) Bandwidth Requirements Review
1362	0	Canability Production Document
1363	0	Cost Analysis Requirements Description (CARD), RFP Release Cost Assessment, etc.
1364	0	Exit Criteria
1365	0	Item Unique Identification Implementation Plan
1366	0	Life-Cycle Sustainment Plan (LCSP)
1367	0	Programmatic Environmental Safety and Occupational Health Evaluation (PESHE) and
1368		National Environmental Policy Act (NEPA) compliance Schedule
1369	0	Preservation and Storage of Unique Tooling Plan
1370	0	Program Protection Plan (PPP)
13/1	0	Request for Proposal (RFP) Should Cost Target
1372	0	Snould Cost Laiger Spectrum Supportability Risk Assessment
1373	0	spectrum supportation in Assessment

1374 1375	 Systems Engineering Plan (SEP) Technology Readiness Assessment (TRA)
1376 1377	 Test and Evaluation Master Plan (TEMP) Validated On-line Life-cycle Threat (VOLT) Report
1378 1379 1380	• Provide manufacturing and quality inputs, updates, and proposed changes for the proposed Production and Deployment (i.e., LRIP) contract, based on post-CDR, pilot line, and PRR
1380 1381 1382 1383 1384 1385	 Manufacturing and quality provide support for the Program Manager's decision process for acceptability of manufacturing and producibility risks, supplier qualifications, and verification of manufacturing processes under statistical process control. Manufacturing and quality provide support for the Program Manager's modular approach to product design and Intellectual Property (IP).
1386 1387 1388 1389 1390 1391 1392	 Manufacturing and quality provide verification and validation of adequacy and completeness of Technical Data Packages (to include management of IP) for Production and Deployment Manufacturing and quality provide support to the corrosion prevention and control process to reduce, control, or mitigate corrosion in sustainment. Manufacturing and quality provide input to the Program Managers for assessment of ESOH risks and acceptance decisions. Provide updates to manufacturing and quality exit criteria metrics for EMD.
1393 1394	• Update the manufacturing and quality support plan for an assessment of manufacturing readiness and the mandated independent assessment
1395 1396	• Provide manufacturing and quality updates to the joint Risk, Issue, and Opportunity Management System for the Milestone C decision.
1397	Metrics
1398 1399 1400	• An MRL assessment of the system using MRL 8 criteria as the target for the Milestone C decision has been conducted by trained SMEs and supported by program manufacturing and quality personnel and documents:
1401 1402 1403	 Results of manufacturing and quality processes, demonstrated on a pilot line Attainability of KCs including yields and rates (i.e., will be capable and under process control for LRIP)
1404 1405 1406 1407	 Results of the required Technology Readiness Assessment Industrial base viability and/or recommendations for IB support activities Closure and/or mitigation of producibility issues Design stability
1408 1409 1410	 Detailed design of product features and interfaces is complete All product data essential for system manufacturing has been released and is under configuration management

1411 1412	0	All LRIP manufacturing and quality requirements (e.g., materials, supply chain, workforce, facilities, tooling, manufacturing planning and management, etc.)
1413 • 1414	Pile ele	ot lines have been assessed and documented for production realism and affordability of ments required to manufacture systems, subsystems, items, and components including:
1415 1416 1417 1418 1419 1420 1421 1422 1423 1424 • 1425 1426	o o o o Ma doo	Manufacturing readiness for manufacture of equipment Materials, components, and tooling availability Adequacy of manufacturing and quality workforce skill levels, facilities, materials, work instructions, processes, tooling, temperature, cleanliness, lighting etc. Capability to meet manufacturing and quality requirements for LRIP Production processes (little or no reliance on laboratory environment or personnel, i.e., non-production resources) Capability and capacity to meet rate production (ramp-up to FRP) Capability and capacity to meet program objectives for cost and schedule mufacturing and quality inputs and updates for the Milestone C Decision have been cumented and provided to support the following statutory and regulatory program required lates (per DoDI 5000 02) including:
1427	ар с 0	Acquisition Strategy
1428 1429 1430 1431 1432 1433 1434 1435 1436 1437 1438 1439		 Acquisition Approach Benefit Analysis and Determination (required if no MS B decision) Business Strategy Contracting Strategy (type and termination liability) Cooperative Opportunities (if necessary) General Equipment Valuation Industrial Base Considerations Intellectual Property Considerations Modular Open Systems Approach Multiyear Procurement Risk, Issue, and Opportunity Management Approach Small Business Innovation Research/Small Business Technology Transfer
1440	0	Acquisition Program Baseline
1441 1442	0 0	Affordability Analysis Analysis of Alternatives (regulatory)
1443	0	Bandwidth Requirements Review
1444	0	Capability Production Document
1445	0	CARD, RFP Release Cost Assessment, etc.
1440 1447	0	EXILUTION
1447 1778	0	
1449	0	Programmatic Environmental Safety and Occupational Health Evaluation and National
1450	0	Environmental Policy Act Compliance Schedule

 1452 o PPP 1453 o RFP 1454 o Should Cost Target 1455 o Spectrum Supportability Risk Assessment 1456 o SEP 1457 o TRA 1458 o TEMP 1459 o VOLT Report 1460 • Manufacturing and quality inputs, updates, and proposed changes have been provid to program management for the proposed LRIP contract, based on post-CDR, pilot line, and PRR assessment results. 1463 • Program Manager's decision process, including: 1465 • Acceptability of manufacturing and producibility risks 	
 1453 o RFP 1454 o Should Cost Target 1455 o Spectrum Supportability Risk Assessment 1456 o SEP 1457 o TRA 1458 o TEMP 1459 o VOLT Report 1460 • Manufacturing and quality inputs, updates, and proposed changes have been provid to program management for the proposed LRIP contract, based on post-CDR, pilot line, and PRR assessment results. 1463 • Program Manager's decision process, including: 1465 • Acceptability of manufacturing and producibility risks 	
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 1462 line, and PRR assessment results. 1463 • Manufacturing and quality has provided documented input to: 1464 • Program Manager's decision process, including: 1465 • Acceptability of manufacturing and producibility risks 	
 Manufacturing and quality has provided documented input to: Program Manager's decision process, including: Acceptability of manufacturing and producibility risks 	
 Program Manager's decision process, including: Acceptability of manufacturing and producibility risks 	
Acceptability of manufacturing and producibility risks	
1466 • Supplier qualifications	
• Verification of manufacturing processes under statistical process control	
0 Program Manager's modular approach to product design and Intellectual Property	
1469 • Corrosion prevention and control processes to reduce, control, or mitigate corrosion in	1
1470 sustainment	
1471 o Program Manager's for assessment of ESOH risks and acceptance decisions	
• Technical Data Packages (to include management of IP) have been verified and validated	by
1473 manufacturing and quality for adequacy and completeness and are up-to-date for P&D.	
• Manufacturing and quality has provided documented updates to exit criteria metrics for	
1475 EMD.	
• Provide manufacturing and quality updates to the joint Risk, Issue, and Opportunity	
1477 Management System for the Milestone C decision.	
1478 Tools	
• Market Research using Pugh Template	
CARD use Cost and Lead Time Worksheet	
1481 • Life Cycle Sustainment Plan	
1482 • Technology Readiness Assessment	
1483 • MRL Assessment	
1484 • Test and Evaluation Master Plan	
1485 • Integrated Master Plan/Schedule	
1486 • Transition to Production Assessment	
1487 Resources	
1488 • DoDI 5000 02	

4. Engineering and Manufacturing Development (EMD) Phase

- MRL Deskbook Version 2016
 IEEE 15288.2, Systems and Software Engineering, 2015
- DoDI 4245.7-M Transition from Development to Production, Sep 1985

1492 **B. DEFENSE CONTRACTING SYSTEM**

1493 During the latter part of the EMD phase an essential program activity is to prepare the Request for

1494 Proposal (RFP) for the milestone C decision and entrance to the P&D phase. This RFP will delineate

1495 what is required from the contractor to produce and deliver requirements compliant products to

1496 receiving military organizations. A cohesive effort between all program functional areas and

1497 Contracts is essential to managing and completing the steps in this phase of the contracting process.



1498

1499 An RFP is a formal negotiated solicitation resulting in a contract that includes the contract form, 1500 contract clauses, work statements, specifications, the delivery schedule and payment terms. The contract's primary function is technical with the administrative function secondary. The RFP must 1501 1502 contain clear and sufficient technical guidance so the contractor has a definite picture of how the 1503 system is envisioned to perform once delivered. It is also important that a technical functional 1504 description of hardware requirements is included and that those requirements are clearly defined and 1505 scoped. Inconsistencies, insufficient detail, and inappropriate requirements in the RFP will result in 1506 an inadequate response from industry. From a manufacturing and quality perspective, the RFP should 1507 include, at a minimum:

- Manufacturing Management and Control (best practices)
- 1509 Design Development and Demonstration
- Quality Management and Systems (best practices)
- Manufacturing and Quality Costs
- 1512 Industrial Base
- Process Control and Capability (best practices)
- Materials, Workforce, Facilities, and Tooling
- 1515 Risk, Issues, and Opportunity Management
- 1516 The RFP should specify the requirements for best practices for the contractor's Manufacturing
- 1517 Management System (MMS) and Quality Management System (QMS) and what quality level
- 1518 contract requirement should be met per FAR 52.246-11 (e.g., ISO 9000, AS9100, etc.).
- 1519 Manufacturing and quality should ensure that the RFP includes specific requirements for the

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- 1520 integration of producibility into the design process. During each stage of development, an organized
- and systematic pattern of events must take place if a design is to fully meet all of its objectives.
- 1522 Implicit in these objectives is the requirement that a design achieve the highest possible degree of
- 1523 producibility. The requirements for the contractor to identify and describe in detail in the RFP their
- 1524 proposed specific processes and procedures, methods, and actions to address manufacturing,
- 1525 producibility, quality, and manufacturing and quality risks and issues associated with the proposed
- system should also be included. Manufacturing and quality inputs provided to the RFP development
- 1527 process should be utilized in development of the Source Selection Plan (SSP) and the Statement of 1528 Work (SOW) in order to ensure availability of the necessary disciplines from the contractor. This
- Work (SOW) in order to ensure availability of the necessary disciplines from the contractor. This includes general and specific requirements for developing data packages, designing special purpose
- 1530 production equipment, and performing computer modeling or simulation of the manufacturing
- 1531 process.
- 1532 Based on the SSP, proposal evaluation is an assessment of the proposal and the offeror's ability to
- 1533 perform the prospective contract successfully. The SSP evaluations generally include on or more of
- 1534 the following evaluations:
- 1535 Cost and/or Price
- 1536 Past performance
- Producibility
- Technical and Quality processes
- Manufacturing and Quality capabilities
- Manufacturing and Quality risks, issues, and opportunities
- application of best practices for the MMS and QMS
- SSP should delineate and include metrics and scoring for the above including preferred specific
 processes and procedures, methods, and actions to address manufacturing, producibility, and quality
 associated with the proposed system. Additionally, the SSP should include accommodation and
 support of on-site government Quality Assurance personnel to have access to perform management
 and quality system audits (e.g., program office and/or DCMA).
- 1547 The proposal evaluation criteria must be clearly identified and defined in the RFP and applied in the1548 SSP. Proposal evaluations must be conducted so the government can select the proposal providing
- 1549 the best value to the government.
- 1550 Management tools such as Award Fees and Incentive Fees can provide increased interaction of
- 1551 program and contractor manufacturing and quality management and provide the program with
- 1552 increased visibility into the contractor's best practices for manufacturing, quality, and supply chain
- 1553 processes and procedures. Award fees in the contract should be based on contractor performance to
- 1554 industry manufacturing and quality best practices and program goals and objectives, rewarding
- 1555 specific accomplishments such as:
- Producibility improvements

4. Engineering and Manufacturing Development (EMD) Phase

- Materials characterization in production relevant environment
- 1558 Manufacturing cost reduction efforts
- Manufacturing maturation plan risks burned down
- Variation and variability reduction
- Manufacturing process definition and characterization
- Progress in achieving the targeted Manufacturing Readiness Level (MRL)
- Progress in maturation and demonstration of KCs (i.e., meeting KPPs/KSAs)
- Progress in achieving specific yield and rate goals
- Progress in meeting the EMD exit criteria
- 1566 Incentive Fees in the contract should be consistent with the Acquisition Strategy (AS) and also tied to

1567 goals for exceeding contract requirements and program expectations. Manufacturing and quality

1568 incentives in contracts should be designed to obtain specific manufacturing and quality objectives by

- establishing reasonable and attainable criteria that can meet the goals or targets. These criteria mustbe clearly communicated to the contractor; and include appropriate incentive arrangements that will
- 1571 motivate contractor efforts that might not otherwise be emphasized and discourage contractor
- 1571 inefficiency and waste.
- 1573 Important manufacturing and quality management goals and expectations to be exceeded in contract1574 incentives include:
- Cost (e.g., Cost reductions, Should Costs, Life-Cycle Costs)
- Schedule (e.g., expedited development or delivery, early delivery, on-time delivery, etc.)
- Technical (e.g., quality, reliability, maintainability, product improvement, etc.)
- 1578 Management commitment
- Producibility processes
- 1580 Risk, Issue and Opportunity Management processes
- Commercial best practices

These assist both government and contractor in understanding of program progress and expedites resolution of manufacturing and quality issues. This interaction can serve as a forcing function for the top contractor design personnel to communicate and coordinate decisions with their own

1585 manufacturing personnel.

1586**B.1Provide Input to Request for Proposal (RFP)**

1587 Manufacturing and Quality Tasks

- Ensure that manufacturing and quality personnel are included in the RFPs writing and review teams.
- As a basis for RFP requirements and inputs, analyze all manufacturing and quality outputs
 and results to provide manufacturing and quality requirements on:

1592	0	Risk, Issue, and Opportunity Management System and processes
1593	0	Design producibility, process capability, and manufacturability assessments, analyses,
1594		and reviews (i.e., CDR)
1595	0	Tooling, equipment, facilities assessments, demonstrations, and analyses (including
1596		COTS, GOTS, GFE, etc.)
1597	0	Prototypes, demonstrations, and development tests and analyses
1598	0	Materials characterizations, scale-ups, and analyses
1599	0	Make/buy processes, procedures, and analyses
1600	0	Costs and budget analyses
1601	0	Market research and analyses
1602	0	Modeling and simulations analyses
1603	0	Process capability and production process verification analyses
1604	0	ESOH, environmental, hazardous materials, safety, security analyses and risks
1605	0	Manufacturing and quality processes, procedures, and associated data (especially CMPs)
1606	0	Workforce availability, training, and certification analyses
1607	0	Work measurement/learning curve analyses
1608	0	Industrial Base assessments and analyses
1609	0	ManTech projects
1610	0	supply chain assessments and analyses
1611	0	DCMA surveillance reports
1612	Sne	ecify the requirements for best practices for the contractor's Manufacturing Management
1613	Sv	stem (MMS) (per Section L 2) and Quality Management System (OMS) (per Section L 2)
1614	and	1 per FAR 52 246-11 Higher-Level Contract Quality Requirement) to be used (e.g.
1615	AS	6500. ISO 9000. AS9100. etc.).
1616		
1616	0	Specify the requirements for the contractor to identify and describe in detail their
101/		proposed specific processes and procedures, methods, and actions to address
1618		manufacturing, producibility, quality, and manufacturing and quality risks and issues
1619		associated with the proposed system
1620	0	Specify a requirement for on-site government Quality Assurance personnel to have
1621		access to perform management and quality system audits (e.g., program office and/or
1622		
1623	0	Specify a requirement for on-site government Quality Assurance personnel to have
1624		access to and inputs on:
1625		 Perform source inspections and data monitoring
1626		 Failures and Corrective Actions and resolutions (i.e., FRACAS)
1627		 Material Review actions and dispositions (i.e., Material Review Boards)
1628		 Requests for Variance actions and approvals
1629		 Engineering Change process and approvals

1630 • 1631 1632 1633	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 Manufacturing Management System and Plan. The requirements, at a minimum, should specify that the contractor addresses:
1634	 Manufacturing Management System:
1635 1636	 Documenting how, when, and by whom each requirement of their system is to be accomplished, and define the authority and responsibility for each.
1637	 Design Analysis for Manufacturing:
1638 1639 1640 1641 1642 1643 1644 1645	 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 Failure Modes Effects Analysis (PFMEA) on critical manufacturing processes
1646	• Manufacturing Risk Identification:
1647 1648 1649 1650 1651 1652 1653 1654	 Integrating manufacturing risk management activities into the program risk, issue and opportunity management process to include 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 a competing design alternative Identifying MRL targets and documenting manufacturing risks through the MRL assessments
1655	 Manufacturing Planning:
1656 1657 1658 1659	 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.
1660	 Manufacturing Operations Management including:
1661 1662 1663 1664 1665	 Production Scheduling and Control Manufacturing Surveillance Continuous Improvement Process Control Plans Process Capabilities Production Process Varification
1667	 Froduction Process Verification First Article Inspections and First Article Tests

1668	 Supplier Management and Quality
1669 • 1670 • 1671 • 1672 •	If ISO 9000 or AS9100 is not invoked in the contract(s), the quality management requirements cited in the standards should be the basis for specific contractual requirements for a contractor Quality Management System and Plan. The requirements, at a minimum, should specify that the contractor addresses:
1673	 Quality Management Leadership
1674 1675 1676	 Leadership and Commitment Policy Organizational Roles, Responsibilities, and Authorities
1677	• Quality Planning
1678 1679 1680	 Actions to Address Risks and Opportunities Quality Objectives and Planning Planning of Changes
1681	• Quality Support
1682 1683 1684 1685 1686	 Resources Competence Awareness Communication Documented Information
1687	• Operation
1688 1689 1690 1691 1692 1693 1694	 Operational Planning and Control Requirements for Products and Services Design and Development of Products and Services Control of Externally Provided Processes, Products, and Services Production and Service Provision Release of Products and Services Control of Non-conforming Outputs
1695	• Quality Performance
1696 1697	Monitoring, Measurement, Analyses, and EvaluationInternal Audit
1698	• Quality Improvement
1699 1700	Nonconformity and Corrective Actions (i.e., FRACAS)Continual Improvement
1701 • 1702 1703 1704	Specify appropriate requirements for manufacturing and quality CDRLs, Data Item Description (DID), etc. to support manufacturing and quality processes, include the requisite approval processes (e.g., Manufacturing Plan, Quality Assurance Plan, Producibility Plan, etc.)

1705 1706 1707 1708	 Specify a requirement for on-site government Quality Assurance personnel will ha access to perform source inspection of the plan (include on-site government Qualit Assurance personnel (i.e., DCMA) in contractual distribution of the Program Qualit Plan (ref. I.2)) 	ve y ity
1709 1710	• Provide manufacturing and quality inputs and support for specification of industry best practices for Systems Engineering to be used (e.g., IEEE 15288, -1, -2, etc.) in the RFF	;).
1711 1712 1713	 Include requirements for the contractors to identify and to describe their proposed processes, methods, and actions to address technical processes, technical managem processes, and essential specialty engineering 	ent
1714	• Provide manufacturing and quality inputs and support to contractual requirements for:	
1715 1716 1717	 Content for Statement of Work (SOW), Statement of Objectives (SOO), and contra sections C, L, M, and H, including incentives (See B.4) Conducting manufacturing and quality reviews of engineering and software (with 	ict
1718 1719 1720	 Intellectual Property and government Technical/Manufacturing Data Rights, maintenance, ownership, and access 	
1721 1722 1723	 Identification and description of producibility efforts including cost sharing and including (i.e., Value Engineering) Facilities, tooling, test equipment, and workforce 	entive
1724 1725	 Supply chain management Management of parts and materials (e.g., make/buy, planning, etc.) including: 	
1726 1727 1728 1729 1730 1731 1732 1733 1734 1735	 Long-lead Sources and risks (sole, single, foreign, fragile, and critical) Handling and storage Capacity to support all production needs (e.g., expected, surge, mobilization, e Conservation of critical/strategic materials Counterfeit avoidance Obsolescence Diminishing Manufacturing Sources and Materials Shortages (DMSMS) Reduction/elimination of foreign dependency Standardization of components, items and parts 	
1736 1737 1738 1739 1740 1741 1742	 Configuration management Life-cycle Support Plan (LCSP) Performing analyses of failure mode effects and criticality (e.g., PFMEA, FMECA from the system level down to the component level Traceability of CSIs and/or CAIs to all key and critical manufacturing and quality processes (CMP) Manufacturing system safety (in support of System Safety Assessments in accorda 	, etc.) nce
1743	with MIL-STD-882)	

4. Engineering and Manufacturing Development (EMD) Phase

1744	0	Providing systematic application of statistical process controls and meeting required
1745		process capability (C _{pk}) goals
1746	0	Providing a system for collection, storage, analysis, and management of manufacturing
1747		and quality data including process capabilities, costs, cost models, and cost estimates,
1748		rate, yields, quantities, etc. (including Cost of Quality)
1749	0	Manufacturing technology capability improvements
1750	0	Investments in advanced manufacturing technology production equipment and processes
1751		from U.S. domestic sources that increase the productivity and reduce life-cycle costs
1752	0	A joint Risk, Issue, and Opportunity Management System and mitigation program that
1753		includes manufacturing, quality, and industrial base
1754	0	Manufacturing and quality Variability Reduction program
1755	0	Appropriate cyber threat protection program including:
1756		• Safeguarding manufacturing and quality information, designed in systems protection,
1757		supply chain risks, hardware and software manufacturing network assurance
1758		(including suppliers), anti-counterfeit practices, anti-tamper (AT), and security-
1759		related activities such as physical security and industrial security in accordance with
1760		the PPP
1761		Compliance with DFARS 252.204-7012 Safeguarding Covered Defense Information
1762		and Cyber Incident Reporting
1763		 Periodic assessments to understand the risks to organizational operations,
1764		organizational assets, and individuals, resulting from the operation and the associated
1765		processing, storage, or transmission of Controlled Unclassified Information (CUI) by
1766		manufacturing information systems.
1767		Compliance with NIST 800-82 Guide to Industrial Control Systems (ICS) Security
1768	0	Management of materials and subcontractors including requirements for compliance with
1769		either DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and
1770		Avoidance System, or DFARS 252.246-7008, Sources of Electronic Parts
1771	0	COTS, GOTS, GFE, and NDIs
1772	0	Metrics to be met as exit criteria
1773 •	Pro	ovide manufacturing and quality inputs and support to specialized system requirements
1774	and	d/or certifications, such as Flight Operations, Space Operations, etc.
1775 •	Sp	ecify the requirements that the contractor support and/or conduct, as required,
1776	ma	nufacturing and quality:
1777	0	Technical reviews and audits including Physical Configuration Audit (PCA), PRR, and
1778		other formal program reviews as requested prior to Full-Rate Production Decision
1779		Review (FRPDR)
1780	0	MRL assessments with trained personnel utilizing the MRL criteria
1781	0	Independent risk assessments as directed
1782	0	Performance meetings to discuss quality, manufacturing, production, supply chain,
1783		engineering, software deficiencies and issues, proposed corrective actions, and status of
1784		ongoing actions

4. Engineering and Manufacturing Development (EMD) Phase

1785 1786		 Joint Risk, Issue, and Opportunity Management System meetings to manage mitigation activities
1787	٠	Provide manufacturing and quality inputs on requirements for the contractor to:
1788 1789 1790 1791 1792		 Support of on-site government personnel access to perform surveillance, inspections, and assessments (e.g., DMCA access and support) Address capital investments Provide specific, detailed workforce, facilities, and capacity plans for LRIP and FRP including:
1793 1794 1795 1796		 Relocations Restarts Changes in materials, manufacturing processes, and/or suppliers Processes, procedures, improvements, etc.
1797 1798 1799 1800 1801 1802 1803 1804		 Address meeting program schedule and critical path Manage the supply chain (e.g., products, locations, capacities, capabilities, monitoring, etc.) Manage tooling, Special Test Equipment (STE), and Special Inspection Equipment (SIE) Support and conduct a Continuous Process Improvement (CPI) program Utilize, where applicable, a Material Management and Accounting System (MMAS) in accordance with DFARS 252.242-7004 (e.g., MRP, MRPII, ERP, etc.) Support and maintain the IMP/IMS including the critical path
1805 1806	•	Provide manufacturing and quality inputs on requirements for the contractor to define manufacturing methods and production flow to include:
1807 1808 1809 1810 1811		 Advanced or unique manufacturing technologies required Production flow including the planned fabrication and assembly key points Production test and/or inspections Planned flow of major manufacturing operations Expected process yields and statistical or other methods for process control
1812 1813	•	Provide manufacturing and quality inputs on requirements for contractor support and maintenance of and up-to-date Technical Data Package.
1814	Metric	S
1815 1816 1817	•	As a basis for RFP requirements and inputs, all manufacturing and quality outputs and results have been analyzed and documented manufacturing and quality requirements have been provided for:
1818 1819 1820 1821 1822		 Risk, Issue, and Opportunity Management System and processes Design producibility, process capability, and manufacturability assessments, analyses, and reviews Tooling, equipment, facilities assessments, demonstrations, and analyses (including COTS, GOTS, GFE, etc.)

1823		 Demonstrations and development tests and analyses
1824		• Materials characterizations, scale-ups, and analyses
1825		• Make/buy processes, procedures, and analyses
1826		• Costs and budget analyses
1827		• Market research and analyses
1828		 Modeling and simulations analyses
1829		 Process capability and production process verification analyses
1830		• ESOH, environmental, hazardous materials, safety, security analyses and risks
1831		• Manufacturing and quality processes, procedures, and associated data (especially CMPs)
1832		• Workforce availability, training, and certification analyses
1833		• Work measurement/learning curve analyses
1834		 Industrial Base assessments and analyses
1835		 ManTech projects
1836		• Supply chain assessments and analyses
1837		• DCMA surveillance reports
1838 1839	•	Requirements for best practices for the contractor's MMS (per Section L.2) and QMS (per Section I.2) to be used have been documented and specify:
1840		• Requirements for the contractor to describe in detail proposed specific processes and
1841		procedures, methods, and actions to address manufacturing, producibility, quality, and
1842		manufacturing and quality risks and issues associated with the proposed system
1843		• Requirements for on-site government Quality Assurance personnel to have access to
1844		perform management and quality system audits (e.g., program office and/or DCMA)
1845		• Requirements for on-site government Quality Assurance personnel to have access to and
1846		inputs on:
1847		 Source inspections and data monitoring
1848		 FRACAS and resolutions
1849		 Material Review actions and dispositions (i.e., Material Review Boards)
1850		 Requests for Variance actions and approvals
1851		 Engineering Change process and approvals
1852	•	If AS6500 is not invoked in the contract(s), the AS6500 manufacturing management
1853		requirements have been contractually specified as requirements for a contractor MMS and
1854		Plan. The requirements, at a minimum, specify that the contractor addresses:
1855		Manufacturing Management System
1856		Design Analysis for Manufacturing:
1857		• Manufacturing Risk Identification:
1858		Manufacturing Planning:
1859		 Manufacturing Operations Management including.
1057		Translations operations management meruding.
1860	•	If ISO 9000 or AS9100 is not invoked in the contract(s), the quality management
1861		requirements cited have been contractually specified as requirements for a contractor QMS
1862		and Plan. The requirements, at a minimum, specify that the contractor addresses:

4. Engineering and Manufacturing Development (EMD) Phase

1863 1864 1865 1866 1867 1868		 Quality Management Leadership Quality Planning Quality Support Operation Quality Performance Quality Improvement
1869 1870 1871	•	Appropriate requirements for manufacturing and quality CDRLs, DIDs, etc. have been documented that specify support of manufacturing and quality processes, including the requisite approval and change process, including:
1872 1873		 Requirement for on-site government Quality Assurance personnel access to perform source inspection of the plans
1874 1875	•	Manufacturing and quality inputs and support have been documented and provided for specification of industry best practices to be used for Systems Engineering in the RFP.
1876 1877 1878		• Requirements that the contractor describe their proposed processes, methods, and actions to address technical processes, technical management processes, and essential specialty engineering are included
1879 1880	•	Manufacturing and quality have documented and provided contractual inputs and/or requirements for:
1881 1882		 Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4)
1883 1884		 Conducting manufacturing and quality reviews of engineering and software (with frequency of reviews)
1885 1886		 Intellectual Property and government Technical/Manufacturing Data Rights, maintenance, ownership, and access
1887 1888		• Identification and description of producibility efforts including cost sharing and incentive plans (i.e., Value Engineering)
1889		• Facilities, tooling, test equipment, and workforce
1890		• Supply chain management
1891		• Management of parts and materials (e.g., make/buy, planning, etc.) including:
1892		 Long-lead
1893		 Sources and risks (sole, single, foreign, fragile, and critical)
1894		 Handling and storage
1895		 Capacity to support all production needs (e.g., expected, surge, mobilization, etc.)
1896		 Conservation of critical/strategic materials
1897		Counterfeit avoidance
1898		Obsolescence
1899		 Diminishing Manufacturing Sources and Materials Shortages (DMSMS)
1900		 Reduction/elimination of foreign dependency Standard Line for the standard s
1901		 Standardization of components, items and parts

1902	0	Configuration management
1903	0	Life-cycle Support Plan (LCSP)
1904	0	Analyses of failure modes, effects, and criticality (e.g., PFMEA, FMECA, etc.) from the
1905		system level down to the component level
1906	0	Traceability of CSIs and/or CAIs to all key and critical manufacturing and quality
1907		processes (CMPs)
1908	0	Manufacturing system safety (in support of System Safety Assessments in accordance
1909		with MIL-STD-882)
1910	0	Systematic application of statistical process controls and meeting required process
1911		capability (C_{pk}) goals
1912	0	A system for collection, storage, analysis, and management of manufacturing and quality
1913		data including process capabilities, costs, cost models, and cost estimates, rate, yields,
1914		quantities, etc. (including Cost of Quality)
1915	0	Manufacturing technology capability improvements
1916	0	Investments in advanced manufacturing technology production equipment and processes
1917		from U.S. domestic sources that increase the productivity and reduce life-cycle costs
1918	0	A joint Risk, Issue, and Opportunity Management System and mitigation program that
1919		includes manufacturing, quality, and industrial base
1920	0	Manufacturing and quality Variability Reduction program
1921	0	A cyber threat protection program including:
1922		• Safeguarding manufacturing and quality information, designed in systems protection,
1923		supply chain risks, hardware and software manufacturing network assurance
1924		(including suppliers), anti-counterfeit practices, anti-tamper (AT), and security-
1925		related activities such as physical security and industrial security in accordance with
1926		the PPP
1927		 Compliance with DFARS 252.204-7012 Safeguarding Covered Defense Information
1928		and Cyber Incident Reporting
1929		 Periodic assessments to understand the risks to organizational operations,
1930		organizational assets, and individuals, resulting from the operation and the associated
1931		processing, storage, or transmission of Controlled Unclassified Information (CUI) by
1932		manufacturing information systems.
1933		 Compliance with NIST 800-82 Guide to Industrial Control Systems (ICS) Security
1934	0	Management of materials and subcontractors including requirements for compliance with
1935		either DFARS 252.246-7007. contractor Counterfeit Electronic Part Detection and
1936		Avoidance System, or DFARS 252.246-7008, Sources of Electronic Parts
1937	0	COTS, GOTS, GFE, and NDIs
1938	0	Metrics to be met as exit criteria
1030	М	anufacturing and quality have documented and provided inputs and support to specialized
1940	111	stem requirements and/or certifications, such as Elight Operations, Space Operations, etc.
1940	Sys	such requirements and/or certifications, such as Fright Operations, space Operations, etc.
1941 • 1042	IVI	anuracturing and quality requirements have been documented and specify that the
1942	CO	ntractor support and/or conduct:

1943 1944 1945		• Technical reviews and audits including Physical Configuration Audit (PCA), PRR, and other formal program reviews as requested prior to Full-Rate Production Decision Review (FRPDR)
1946		• MRL assessments with trained personnel utilizing the MRL criteria
1947		• Independent risk assessments as directed
1948		• Performance meetings to discuss quality, manufacturing, production, supply chain,
1949		engineering, software deficiencies and issues, proposed corrective actions, and status of
1950		ongoing actions
1951		o Joint Risk, Issue, and Opportunity Management System meetings to manage mitigation
1952		activities
1953	•	Manufacturing and quality documented inputs have been provided on contractor's
1954		requirements to:
1955		• Support of on-site government personnel access to perform surveillance, inspections, and
1956		assessments (e.g., DMCA access and support)
1957		• Address capital investments
1958		• Provide specific, detailed workforce, facilities, and capacity plans for LRIP and FRP
1959		including:
1960		 Relocations
1961		Restarts
1962		 Changes in materials, manufacturing processes, and/or suppliers
1963		 Processes, procedures, improvements, etc.
1964		• Address meeting program schedule and critical path
1965		• Manage the supply chain (e.g., products, locations, capacities, capabilities, monitoring,
1966		etc.)
1967		• Manage tooling, Special Test Equipment (STE), and Special Inspection Equipment (SIE)
1968		 Support and conduct a Continuous Process Improvement (CPI) program
1969		• Utilize, where applicable, a Material Management and Accounting System (MMAS) in
1970		accordance with DFARS 252.242-7004 (e.g., MRP, MRPII, ERP, etc.)
1971		• Support and maintain the IMP/IMS including the critical path
1972	٠	Manufacturing and quality documented inputs have been provided on requirements for the
1973		contractor to define manufacturing methods and production flow including:
1974		• Advanced or unique manufacturing technologies
1975		 Planned fabrication and assembly key points
1976		 Production test and/or inspections
1977		 Major manufacturing operations
1978		• Expected process yields and statistical or other methods for process control
1979	٠	Manufacturing and quality have documented and provided inputs for contractor requirements
1980		to maintain an up-to-date Technical Data Package.

1981	Tools	
1982	•	AS6500, Manufacturing Management System Checklist
1983	•	AS9100, Quality Management System Checklist, Sep 2016
1984	•	ISO 9001, Quality Management System Checklist, Sep 2016
1985	•	IEEE 15288, System and Software Engineering, 2015
1986	•	IG5315.204-5(b) Section L Guide and Template
1987	•	IG5315.204-5(c) Section M Guide and Template
1988	Resou	rces
1989	•	AS6500, Manufacturing Management Program, SEP 2016
1990	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
1991	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
1992		Sep 2016
1993	•	ISO 9000, Quality Management System, Sep 2016
1994	•	IEEE 15288, System and Software Engineering, 2015
1995	•	IG5315.204-5(b) Section L Guide
1996	•	IG5315.204-5(c) Section M Guide
1997	•	MRL Deskbook Version 2016
1998	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
1999		Reporting
2000	•	DFARS 252.242-7004, Material Management and Accounting System (MMAS)
2001	•	DFARS 252.246-7008, Sources of Electronic Parts
2002	•	DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance
2003		System
2004	•	NIST 800-82 Guide to Industrial Control Systems (ICS) Security
2005	•	MIL-STD-882, DoD System Safety, May 2012
2006	B.2	Provide Input to Source Selection Plan (SSP)
2007	Manu	facturing and Quality Tasks
2008	•	Ensure that manufacturing and quality personnel are included in the Source Selection Plan
2009		(SSP) writing and review teams.
2010	•	Utilizing analyses of EMD manufacturing and quality outputs, specify metrics and scoring
2011		that at a minimum address the contractor(s) plans, processes, and procedures for:
2012		 Risk, Issue, and Opportunity Management System and processes
2013		• Design producibility, process capability, and manufacturability assessments, analyses,
2014		and technical and management reviews
2015		• Tooling, equipment, facilities assessments, demonstrations, and analyses (including
2016		COTS, GOTS, GFE, etc.)
2017		 Demonstrations and development tests

4. Engineering and Manufacturing Development (EMD) Phase

2018	0	Materials
2019	0	Materials management (i.e., make/buy processes, procedures, and analyses)
2020	0	Costs and budget estimates
2021	0	Market research and analyses
2022	0	Modeling and simulations
2023	0	Process capability and production process verifications
2024	0	ESOH, environmental, hazardous materials, safety, and security (physical, cyber, and
2025		industrial)
2026	0	Manufacturing and quality and associated data (especially CMPs)
2027	0	Workforce (e.g., availability, training, and certification)
2028	0	Work measurement (i.e., learning curve analyses)
2029	0	ManTech project implementation
2030	0	Supply chain assessments and analyses
2031	• Sp	ecify in the SSP metrics and scoring for application of best practices for the contractor(s)
2032	M	anufacturing Management System (MMS) and Plan and Quality Management System
2033	(Q	MS) and Plan (e.g., AS6500, ISO 9000, AS9100, etc.).
2034	0	SSP should delineate and include metrics and scoring for preferred specific processes and
2035	Ū	procedures, methods, and actions to address manufacturing, producibility, quality, and
2036		manufacturing and quality risks and issues associated with the proposed system
2037	0	Plan should delineate and include metrics and scoring for accommodation and support of
2038	Ū	on-site government Quality Assurance personnel to have access to perform management
2039		and quality system audits (e.g., program office and/or DCMA) including:
2040		 Source inspections and data monitoring
2041		 Failures and Corrective Actions and resolutions (i.e., FRACAS)
2042		 Material Review actions and dispositions (i.e., Material Review Boards)
2043		 Requests for Variance actions and approvals
2044		 Engineering Change process and approvals
2045	• If :	manufacturing management industry best practice requirements (i.e., AS6500) are not
2046	inv	voked in the contract, the requirements cited in AS6500 should be the basis for specific
2047	SS	P metrics and scoring of the contractor(s) Manufacturing Management System and Plan.
2048	Th	e SSP should delineate and specify metrics and scoring for:
2049	0	Documenting how, when, and by whom each requirement of their system is to be
2050		accomplished, and define the authority and responsibility for each
2051	0	Conducting producibility analyses
2052	0	Identification and management key and critical characteristics in the Technical Data
2053		Package (TDP)
2054	0	Implementation of VR to reduce part to part variation of key and critical characteristics
2055	0	Identification and management of key and critical manufacturing processes
2056	0	Conducting Failure Modes Effects Analysis (PFMEA) on critical manufacturing
2057		processes

2058 2059 2060 2061 2062 2063 2064 2065	0 0 0	Integration of manufacturing risk management activities into the program risk, issue and opportunity management process to include 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 a competing design alternative Identification of MRL targets and documenting manufacturing risks through the MRL assessments Establishing and maintaining a manufacturing plan that includes:
2066 2067 2068 2069 2070 2071 2072		 Supply chain and material management Manufacturing technology development Manufacturing modeling and simulation Manufacturing costs Manufacturing system verification Manufacturing workforce Tooling, test equipment, and facilities
2073	0	Management of operations including:
2074 2075 2076 2077 2078 2079 2080 2081		 Production Scheduling and Control Manufacturing Surveillance Continuous Improvement Process Control Plans Process Capabilities Production Process Verification First Article Inspections and First Article Tests Supplier Management and Quality
2082 • 2083 2084 2085	If I con and del	ISO 9000 or AS9100 quality management industry best practices are not invoked in the ntract, the requirements cited in the standards should be the basis for specific SSP metrics d scoring of the contractor(s) Quality Management System and Plan. The SSP should lineate and specify metrics and scoring for:
2086 2087	0	Quality management leadership, commitment, policy, organizational roles,
2087 2088 2089	0	Quality planning with actions to address risks and opportunities, quality objectives and planning, and change management
2090	0	Quality support with resources, competence, awareness, communication, and documented
2091	~	Information
2092	0	requirements, and design and development
2094	0	Control of externally provided processes, products, and services
2095	0	Production and service provision
2096	0	Release of products and services
2097	0	Control of non-conforming outputs

4. Engineering and Manufacturing Development (EMD) Phase

2098 2099		• Quality performance including monitoring, measurement, analyses, evaluation, and internal audits
2100		• Quality improvement including nonconformities and corrective actions, and continual
2101		improvement
2102 2103 2104 2105 2106 2107 2108	•	Specify metrics and scoring to rank contractor(s) plans (including processes, and procedures) for timeliness, completeness, accuracy, and alignment with program goals (and corrective actions and/or mitigation plans, if required) for managing manufacturing and quality CDRLs, DIDs, etc., including the requisite approval processes (e.g., Manufacturing Plan, Quality Assurance Plan, Producibility Plan, etc.). Specify in the SSP metrics and scoring for contractor(s) application of industry best practices for manufacturing and quality aspects of Systems Engineering management (e.g.
2109		IEEE 15288, -1, -2, etc.).
2110 2111 2112		 Include metrics and scoring for the contractors proposed processes, methods, and actions to address technical processes, technical management processes, and essential specialty engineering
2113 2114 2115	•	Specify manufacturing and quality metrics and scoring for contractor(s) plans for timeliness, completeness, accuracy, and alignment to program goals (with corrective actions and/or mitigation, if required) to include:
2116 2117		 Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4)
2118 2119		• Manufacturing and quality reviews of engineering and software (with frequency of reviews)
2120		 Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance ownership and access
2122		 Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering)
2123		• Utilization of facilities, tooling, test equipment, and workforce
2124		• Supply chain management (e.g., products, locations, capacities, capabilities, monitoring,
2125 2126		etc.) • Parts and materials management (e.g. make/buy planning etc.) including:
2120		 Long-lead
2128		 Sources and risks (sole, single, foreign, fragile, and critical)
2129		 Handling and storage
2130		 Capacity to support all production needs (e.g., expected, surge, mobilization, etc.)
2131		 Conservation of critical/strategic materials
2132		 Counterfeit avoidance
2133		 Obsolescence
2134		 Diminishing Manufacturing Sources and Materials Shortages (DMSMS)
2135		 Reduction/elimination of foreign dependency
2136		 Standardization of components, items and parts
2137		• Configuration management

2138	0	Analyses of failure mode effects and criticality (e.g., PFMEA, FMECA, etc.) from the
2139		system level down to the component level
2140	0	Management (including traceability) of CSI and/or CAIs to all key and critical
2141		manufacturing and quality processes (CMP)
2142	0	Manufacturing system safety (in support of System Safety Assessments in accordance
2143		with MIL-STD-882)
2144	0	Application of statistical process controls and meeting required process capability (C _{pk})
2145		goals
2146	0	Collection, storage, analysis, and management of manufacturing and quality data
2147		including process capabilities, costs, cost models, and cost estimates, rate, yields,
2148		quantities, etc. (including Cost of Quality)
2149	0	Manufacturing technology capability improvements
2150	0	Investments in advanced manufacturing technology production equipment and processes
2151		from U.S. domestic sources that increase the productivity and reduce life-cycle costs
2152	0	Investments in workforce development including processes, work systems, and skill
2153		development
2154	0	Joint Risk, Issue, and Opportunity Management System and mitigation program that
2155		includes manufacturing, quality, and industrial base
2156	0	Manufacturing and quality Variability Reduction program
2157	0	Cyber threat protection including:
2158		• Safeguarding manufacturing and quality information, designed in systems protection,
2159		supply chain risks, hardware and software manufacturing network assurance
2160		(including suppliers), anti-counterfeit practices, anti-tamper (AT), and security-
2161		related activities such as physical security and industrial security in accordance with
2162		the PPP
2163		Compliance with DFARS 252.204-7012 Safeguarding Covered Defense Information
2164		and Cyber Incident Reporting
2165		 Periodic assessments to understand the risks to organizational operations,
2166		organizational assets, and individuals, resulting from the operation and the associated
2167		processing, storage, or transmission of Controlled Unclassified Information (CUI) by
2168		manufacturing information systems.
2169		Compliance with NIST 800-82 Guide to Industrial Control Systems (ICS) Security
2170	0	Management of materials and subcontractors including requirements for compliance with
2171		either DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and
2172		Avoidance System, or DFARS 252.246-7008, Sources of Electronic Parts
2173	0	Utilization of COTS, GOTS, GFE, and NDIs
2174	0	Manufacturing and quality in the Life-cycle Support Plan (LCSP)
2175	0	Metrics to be met as exit criteria for LRIP

2176 2177 2178 2179 2180 2181 2182	•	Specify metrics and scoring to rank the contractor(s) plans (including processes, and procedures) for timeliness, completeness, accuracy, and alignment (corrective actions, if required) for managing specialized system requirements, such as Flight Operations, Space Operations, etc. Specify manufacturing and quality metrics and scoring on timeliness, completeness, accuracy, and alignment with program objectives for contractor planning and processes to support and/or conduct as required manufacturing and quality:
2183 2184 2185 2186 2187 2188 2189 2190 2191 2192		 Technical reviews and audits including Physical Configuration Audit (PCA), PRR, and other formal program reviews as requested prior to Full-Rate Production Decision Review (FRPDR) MRL assessments with trained personnel utilizing the MRL criteria Independent risk assessments as directed Performance meetings to discuss quality, manufacturing, production, supply chain, engineering, software deficiencies and issues, proposed corrective actions, and status of ongoing actions Joint Risk, Issue, and Opportunity Management System meetings to manage mitigation activities
2193 2194 2195 2196 2197 2198	•	 Specify manufacturing and quality metrics and scoring for the contractor(s) plans to: Support on-site government personnel access to perform surveillance, inspections, and assessments (e.g., DMCA access and support) Address capital investments Support LRIP and FRP with specific, detailed workforce, facilities, and capacity plans including:
2199 2200 2201 2202		 Relocations Restarts Changes in materials, manufacturing processes, and/or suppliers Processes, procedures, improvements, etc.
2203 2204 2205 2206 2207 2208 2209		 Address meeting program schedule and critical path Manage Special Test Equipment (STE), and Special Inspection Equipment (SIE) Support and conduct a Continuous Process Improvement (CPI) program Utilize, where applicable, a Material Management and Accounting System (MMAS) in accordance with DFARS 252.242-7004 (e.g., MRP, MRPII, ERP, etc.) Support and maintain the IMP/IMS including the critical path Support and maintenance of an up-to-date Technical Data Package
2210 2211	•	Specify manufacturing and quality metrics and scoring for the contractor(s) plans for manufacturing methods and production flow to include:
2212 2213 2214		 Advanced or unique manufacturing technologies Planned fabrication and assembly key points Production test and/or inspections

4. Engineering and Manufacturing Development (EMD) Phase

2215		• Flow of major manufacturing operations
2216		• Process yields and statistical or other methods for process control
2217	Metrio	CS CS
2218 2219	•	SSP manufacturing and quality metrics and scoring have been developed and documented that rank the contractor(s) plans, processes, and procedures for:
2220 2221 2222		 Risk, Issue, and Opportunity Management System and processes Design producibility, process capability, and manufacturability assessments, analyses, and technical and management raviews
2223 2224		 Tooling, equipment, facilities assessments, demonstrations, and analyses (including COTS, GOTS, GFE, etc.)
2225 2226		 Demonstrations and development tests Materials
2227 2228		 Materials management (i.e., make/buy processes, procedures, and analyses) Costs and budget estimates
2229 2230 2231		 Market research and analyses Modeling and simulations Process capability and production process verifications
2231 2232 2233		 ESOH, environmental, hazardous materials, safety, and security (physical, cyber, and industrial)
2234 2235		 Manufacturing and quality and associated data management (especially CMPs) Workforce management (e.g., availability, training, and certification)
2236 2237 2238		 work measurement (i.e., learning curve analyses) ManTech project implementation Supply chain assessments and analyses
2239 2240 2241	•	Manufacturing and quality metrics and scoring have been developed and documented in the SSP for application of best practices in the contractor(s) MMS and Plan and QMS and Plan including:
2242 2243 2244 2245		 Preferred specific processes and procedures, methods, and actions to address manufacturing, producibility, quality, and manufacturing and quality risks and issues Accommodation and support of on-site government Quality Assurance personnel to have access to perform management and quality audits including:
2246 2247 2248 2249 2250		 Source inspections and data monitoring Failures and Corrective Actions and resolutions (i.e., FRACAS) Material Review actions and dispositions (i.e., Material Review Boards) Variance actions and approvals Engineering changes and approvals
2251 2252 2253	•	If manufacturing management industry best practice requirements (i.e., AS6500) are not invoked in the contract, then specific metrics and scoring have been documented and included in the SSP that rank the contractor(s) plans, processes, and procedures for:

2254	• Documenting how, when, and by whom each requirement of their system is to be
2255	accomplished, and define the authority and responsibility for each
2256	 Conducting producibility analyses
2257	• Identification and management key and critical characteristics in the Technical Data
2258	Package (TDP)
2259	• Implementation of VR to reduce part to part variation of key and critical characteristics
2260	• Identification and management of key and critical manufacturing processes
2261	 Conducting Failure Modes Effects Analysis (PFMEA) on critical manufacturing
2262	processes
2263	• Integration of manufacturing risk management activities into the program risk, issue and
2264	opportunity management process to include the identification of manufacturing risk areas
2265	and the development and implementation of risk mitigation plans tracked to completion
2266	• Conducting and documenting manufacturing feasibility assessments for a competing
2267	design alternative
2268	• Identification of MRL targets and documenting manufacturing risks through the MRL
2269	assessments
2270	• Establishing and maintaining a manufacturing plan that includes:
2271	 Supply chain and material management
2272	 Manufacturing technology development
2273	 Manufacturing modeling and simulation
2274	 Manufacturing costs
2275	 Manufacturing system verification
2276	 Manufacturing workforce
2277	 Tooling, test equipment, and facilities
2278	• Management of operations including:
2279	 Production Scheduling and Control
2280	 Manufacturing Surveillance
2281	 Continuous Improvement
2282	 Process Control Plans
2283	 Process Capabilities
2284	 Production Process Verification
2285	 First Article Inspections and First Article Tests
2286	 Supplier Management and Quality
• 2287	If quality management industry best practice requirements (e.g., ISO 9000, AS9100, etc.) are
2288	not invoked in the contract, then specific metrics and scoring have been documented and
2289	included in the SSP that rank the contractor(s) plans, processes, and procedures for:
2290	• Quality management leadership, commitment, policy, organizational roles,
2291	responsibilities, and authorities
2292	• Quality planning with actions to address risks and opportunities, quality objectives and
2293	planning, and change management

2294		• Quality support with resources, competence, awareness, communication, and documented
2295		information
2296		• Operation including operational planning and control, products and services
2297		requirements, and design and development
2298		 Control of externally provided processes, products, and services
2299		 Production and service provision
2300		• Release of products and services
2301		• Control of non-conforming outputs
2302		• Quality performance including monitoring, measurement, analyses, evaluation, and
2303		internal audits
2304		• Quality improvement including nonconformities and corrective actions, and continual
2305		improvement
2306 2307	•	Specific metrics and scoring have been documented in the SSP that rank the contractor(s) plans (including processes, and procedures) for timeliness, completeness, accuracy, and
2308		alignment (corrective actions, if required) for managing manufacturing and quality CDRLs,
2309		DIDs, etc., including the requisite approval processes.
2310	•	Specific metrics and scoring have been documented in the SSP for contractor(s) application
2311		of industry best practices for manufacturing and quality aspects of Systems Engineering
2312		management (e.g. IEEE 15288 -1 -2 etc.)
2312		• Metrics and scoring include the contractor(s) proposed processes methods and actions to
2313		address technical processes, technical management processes, and essential specialty
2314		address technical processes, technical management processes, and essential specialty
2313		engineering
2316	•	Specific manufacturing and quality metrics and scoring have been documented in the SSP for
2316 2317	•	Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program
2316 2317 2318	•	Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include:
2316 2317 2318 2319	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives
2316 2317 2318 2319 2320	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4)
2316 2317 2318 2319 2320 2321	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of
2316 2317 2318 2319 2320 2321 2322	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews)
2316 2317 2318 2319 2320 2321 2322 2322 2323	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights,
2316 2317 2318 2319 2320 2321 2322 2323 2324	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access
2316 2317 2318 2319 2320 2321 2322 2323 2324 2325	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering)
2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering) Utilization of facilities, tooling, test equipment, and workforce
2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering) Utilization of facilities, tooling, test equipment, and workforce Supply chain management (e.g., products, locations, capacities, capabilities, monitoring,
2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering) Utilization of facilities, tooling, test equipment, and workforce Supply chain management (e.g., products, locations, capacities, capabilities, monitoring, etc.)
2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering) Utilization of facilities, tooling, test equipment, and workforce Supply chain management (e.g., products, locations, capacities, capabilities, monitoring, etc.) Parts and materials management (e.g., make/buy, planning, etc.) including:
2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering) Utilization of facilities, tooling, test equipment, and workforce Supply chain management (e.g., products, locations, capacities, capabilities, monitoring, etc.) Parts and materials management (e.g., make/buy, planning, etc.) including: Long-lead
2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering) Utilization of facilities, tooling, test equipment, and workforce Supply chain management (e.g., products, locations, capacities, capabilities, monitoring, etc.) Parts and materials management (e.g., make/buy, planning, etc.) including: Long-lead Sources and risks (sole, single, foreign, fragile, and critical)
2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering) Utilization of facilities, tooling, test equipment, and workforce Supply chain management (e.g., products, locations, capacities, capabilities, monitoring, etc.) Parts and materials management (e.g., make/buy, planning, etc.) including: Long-lead Sources and risks (sole, single, foreign, fragile, and critical) Handling and storage
2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333	•	 Specific manufacturing and quality metrics and scoring have been documented in the SSP for contractor(s) plans (including timeliness, completeness, accuracy, and alignment to program goals) to include: Meeting each requirement in the Statement of Work (SOW), Statement of Objectives (SOO), and contract sections C, L, M, and H, including incentives (See B.4) Manufacturing and quality reviews of engineering and software (with frequency of reviews) Intellectual Property management and government Technical/Manufacturing Data Rights, maintenance, ownership, and access Producibility efforts including cost sharing and incentive plans (i.e., Value Engineering) Utilization of facilities, tooling, test equipment, and workforce Supply chain management (e.g., products, locations, capacities, capabilities, monitoring, etc.) Parts and materials management (e.g., make/buy, planning, etc.) including: Long-lead Sources and risks (sole, single, foreign, fragile, and critical) Handling and storage Capacity to support all production needs (e.g., expected, surge, mobilization, etc.)

2334		 Conservation of critical/strategic materials
2335		 Counterfeit avoidance
2336		 Obsolescence
2337		 Diminishing Manufacturing Sources and Materials Shortages (DMSMS)
2338		 Reduction/elimination of foreign dependency
2339		 Standardization of components, items and parts
2340	0	Configuration management
2341	0	Analyses of failure mode effects and criticality (e.g., PFMEA, FMECA, etc.) from the
2342		system level down to the component level
2343	0	Management (including traceability) of CSIs and/or CAIs to all key and critical
2344		manufacturing and quality processes (CMP)
2345	0	Manufacturing system safety (in support of System Safety Assessments in accordance
2346		with MIL-STD-882)
2347	0	Application of statistical process controls and meeting required process capability (C _{pk})
2348		goals
2349	0	Collection, storage, analysis, and management of manufacturing and quality data
2350		including process capabilities, costs, cost models, and cost estimates, rate, yields,
2351		quantities, etc. (including Cost of Quality)
2352	0	Manufacturing technology capability improvements
2353	0	Investments in advanced manufacturing technology production equipment and processes
2354		from U.S. domestic sources that increase the productivity and reduce life-cycle costs
2355	0	Investments in workforce development including processes, work systems, and skill
2356		development
2357	0	Joint Risk, Issue, and Opportunity Management System and mitigation program that
2358		includes manufacturing, quality, and industrial base
2359	0	Manufacturing and quality Variability Reduction program
2360	0	Cyber threat protection including:
2361		• Safeguarding manufacturing and quality information, designed in systems protection,
2362		supply chain risks, hardware and software manufacturing network assurance
2363		(including suppliers), anti-counterfeit practices, anti-tamper (AT), and security-
2364		related activities such as physical security and industrial security in accordance with
2365		the PPP
2366		Compliance with DFARS 252.204-7012 Safeguarding Covered Defense Information
2367		and Cyber Incident Reporting
2368		 Periodic assessments to understand the risks to organizational operations,
2369		organizational assets, and individuals, resulting from the operation and the associated
2370		processing, storage, or transmission of Controlled Unclassified Information (CUI) by
2371		manufacturing information systems.
2372		 Compliance with NIST 800-82 Guide to Industrial Control Systems (ICS) Security

4. Engineering and Manufacturing Development (EMD) Phase

2373 2374 2375 2376 2377 2378	 Management of materials and subcontractors including requirements for compliance with either DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance System, or DFARS 252.246-7008, Sources of Electronic Parts Utilization of COTS, GOTS, GFE, and NDIs Manufacturing and quality aspects of the Life Cycle Sustainment Plan (LCSP) Metrics to be met as exit criteria for LRIP
2379 • 2380 2381 2382 2383 • 2384 2385	Specific manufacturing and quality metrics and scoring have been documented in the SSP to rank contractor(s) plans (including processes, and procedures) for timeliness, completeness, accuracy, and alignment for managing specialized system requirements, such as Flight Operations, Space Operations, etc. Specific manufacturing and quality metrics and scoring (alignment with program objectives) have been documented in the SSP for contractor(s) plans and processes to support and/or conduct as required manufacturing and quality:
2386 2387 2388 2389 2390 2391 2392 2393 2394 2395	 Technical reviews and audits including Physical Configuration Audit (PCA), PRR, and other formal program reviews as requested prior to Full-Rate Production Decision Review (FRPDR) MRL assessments with trained personnel utilizing the MRL criteria Independent risk assessments as directed Performance meetings to discuss quality, manufacturing, production, supply chain, engineering, software deficiencies and issues, proposed corrective actions, and status of ongoing actions Joint Risk, Issue, and Opportunity Management System meetings to manage mitigation activities
2396 • 2397	Specific manufacturing and quality metrics and scoring have been documented in the SSP for the contractor(s) plans to:
2398 2399 2400 2401 2402	 Support on-site government personnel access to perform surveillance, inspections, and assessments (e.g., DMCA access and support) Address capital investments Support LRIP and FRP with specific, detailed workforce, facilities, and capacity plans including:
2403 2404 2405 2406	 Relocations Restarts Changes in materials, manufacturing processes, and/or suppliers Processes, procedures, improvements, etc.
2407 2408 2409 2410 2411 2412	 Address meeting program schedule and critical path Manage Special Test Equipment (STE), and Special Inspection Equipment (SIE) Support and conduct a Continuous Process Improvement (CPI) program Utilize, where applicable, a Material Management and Accounting System (MMAS) in accordance with DFARS 252.242-7004 (e.g., MRP, MRPII, ERP, etc.) Support and maintain the IMP/IMS including the critical path

4. Engineering and Manufacturing Development (EMD) Phase

2413		 Support and maintenance of an up-to-date Technical Data Package
2414 2415	•	Specific manufacturing and quality metrics and scoring have been documented in the SSP for the contractor(s) plans for manufacturing methods and production flow to include:
2416 2417		 Advanced or unique manufacturing technologies Planned fabrication and assembly key points
2417		• Production test and/or inspections
2419		• Flow of major manufacturing operations
2420		 Process yields and statistical or other methods for process control
2421	Tools	
2422	•	Source Selection Plan Template, USMC
2423	٠	AS6500, Manufacturing Management System Checklist
2424	•	AS9100, Quality Management System Checklist
2425	•	ISO 9001, Quality Management System Checklist
2426	•	IEEE 15288, System and Software Engineering
2427	Resou	rces
2428	•	DoD Source Selection Procedures Memo, Mar 2011
2429	•	AS6500, Manufacturing Management Program, SEP 2016
2430	•	MIL-HDBK 2450, DoD Handbook for Preparation of Statement of Work, 1996
2431	•	Source Selection Plan Guide, IG5315.303 SSP Guide, Dec 2008
2432	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
2433		Sep 2016
2434	•	ISO 9001:2015, Quality Management System
2435	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
2436	•	ISO 9001:2015, Quality Management System
2437	•	IEEE 15288, System and Software Engineering, 2015
2438	•	MIL-STD-882, DoD System Safety, May 2012
2439	•	MRL Deskbook Version 2016
2440	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
2441		Reporting
2442	•	DFARS 252.242-7004, Material Management and Accounting System (MMAS)
2443	•	DFARS 252.246-7008, Sources of Electronic Parts
2444	•	DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance
2445		System
2116	•	NIST 800 82 Guida to Industrial Control Systems (ICS) Socurity

• NIST 800-82 Guide to Industrial Control Systems (ICS) Security

2447 B.3 Develop Award Fee Criteria

2448 Manufacturing and Quality Tasks

2449 Provide manufacturing and quality input to Award Fee Criteria, appropriate to the contract • 2450 type and consistent with the Acquisition Strategy, that specify program goals and address the 2451 necessary manufacturing and quality (including supply chain) cost, schedule, and performance improvements (to include progress against goals, partial progress, recovery, and 2452 2453 penalty) in the areas of: 2454 • Manufacturing and quality CDRLs, DIDs, etc. (e.g., timely submission and approval) 2455 o Compliance with cyber-threat protection and industrial security requirements (e.g., PPP, DFARS 252.204-7012, NIST 800-82, etc.) 2456 2457 \circ Manufacturing and quality Industrial Base risk mitigations to schedule goals (#,%, 2458 milestones) 2459 • Manufacturing readiness progress (MRL assessments) against targets 2460 • Manufacturing and quality risk and issues mitigations complete (schedule/#) 2461 \circ Manufacturing and producibility projects planned and implemented (#/%) 2462 • Progress of manufacturing and quality learning curves (% to goals) including rates, 2463 yields, variability, process times, re-work and repair, etc. 2464 o Manufacturing and quality systems operations (production line, tooling, equipment, 2465 ManTech insertion, etc.) performance to goals (schedule/%) 2466 • KCs maturation and management to goals (% to goal and schedule progress) 2467 • Technical Performance Measures (TPMs) (% progress to schedule) 2468 o Manufacturing processes and advanced manufacturing capability improvement, and 2469 implementation (#/% to goals) 2470 • Management of CSIs and CAIs to requirements 2471 • Process Capability improvement (Cpk value to goals) 2472 Quality improvement projects planned and completed (#/% to goals) 0 2473 • Variation and Variability reduction efforts (yields/rates/trends) • Manufacturing improvement projects implemented (#/% to goals) 2474 2475 • Parts and materials management against appropriate manufacturing and quality goals 2476 (e.g., availability, capacity, sourcing, standardization, etc.)(#/%) 2477 • Facilities and equipment utilization (% to plan) • Workforce development and management to plan (e.g., hiring, training, and reductions) 2478 2479 (#% to plan) • Testing completion to schedule (% successfully completed) 2480 2481 Manufacturing Management System compliance to best practices and/or contract requirements (# to standard) 2482 2483 • Manufacturing Plan progress against completion (cost and schedule) 2484 • Manufacturing costs and cost reduction (schedule/#/%) 2485 Cost sharing when goals are not met must also be specified.

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4. Engineering and Manufacturing Development (EMD) Phase

2486		0	Quality Management System compliance to best practices and/or contract requirements
2487			(# to standard)
2488		0	Quality Plan progress against completion (cost and schedule)
2489		0	Quality costs and cost reduction (including cost of quality) (schedule/#/%)
2490		0	Manufacturing and quality safety system requirements (% compliance)
2491		0	System Engineering management compliance to best practices for manufacturing and
2492			quality technical processes, technical management processes, and essential specialty
2493			engineering (# to standard)
2494		0	Performance to IMP/IMS (schedule)
2495		0	Progress toward meeting LRIP exit criteria
2496	Metric	s	
2497	•	Ma	nufacturing and quality inputs to Award Fee Criteria consistent with the Acquisition
2498		Str	ategy have been documented and specify periodic phase goals that require manufacturing
2499		and	d quality (including the supply chain) cost, schedule, and performance improvements,
2500		me	asured as progress against goals (or partial progress, recovery, and penalty), for:
2501		0	Timely submission and approval of manufacturing and quality CDRLs, DIDs, etc.
2502		0	Compliance with cyber-threat protection and industrial security requirements (e.g., PPP,
2503			DFARS 252.204-7012, NIST 800-82, etc.)
2504		0	Mitigation of manufacturing and quality Industrial Base risks to schedule goals (#,%,
2505			milestones)
2506		0	Manufacturing readiness progress (MRL assessments) against targets
2507		0	Manufacturing and quality risk and issues mitigations completion (schedule/#)
2508		0	Manufacturing and producibility projects planned and implemented (#/%)
2509		0	Manufacturing and quality achievement of learning curves (% to goals) including rates,
2510			yields, variability, process times, re-work and repair, etc.
2511		0	Manufacturing and quality systems operations (production line, tooling, equipment,
2512			ManTech insertion, etc.) performance to goals (schedule/%)
2513		0	Maturation and management of KCs to goals (% to goal and schedule progress)
2514		0	Management of Technical Performance Measures (TPMs) (% progress to schedule)
2515		0	Implementation of manufacturing processes and advanced manufacturing capability
2516			improvements (#/% to goals)
2517		0	Management of CSIs and CAIs to requirements
2518		0	Process Capability improvement (C _{pk} value to goals)
2519		0	Quality improvement projects completion (#/% to goals)
2520		0	Variation and Variability reduction (yields/rates/trends)
2521		0	Implementation of manufacturing improvement projects (#/% to goals)
2522		0	Management of parts and materials against appropriate manufacturing and quality goals
2523			(e.g., availability, capacity, sourcing, standardization, etc.)(#/%)
2524		0	Facilities and equipment utilization (% to plan)
2525		0	Workforce development and management to plan (e.g., hiring, training, and reductions)
2526			(#/% to plan)

2527		• Testing completion to schedule (% successfully completed)
2528		• Manufacturing Management System compliance to best practices and/or contract
2529		requirements (# to standard)
2530		• Manufacturing Plan progress (cost and schedule)
2531		• Manufacturing costs and cost reduction (schedule/#/%)
2532		• Cost sharing when goals are not met must also be specified.
2533		• Quality Management System compliance to best practices and/or contract requirements
2534		(# to standard)
2535		• Quality Plan progress (cost and schedule)
2536		• Quality costs and cost reduction (including cost of quality) (schedule/#/%)
2537		• Manufacturing and quality safety system compliance (%)
2538		• System Engineering compliance to best practices for manufacturing and quality technical
2539		processes, technical management processes, and essential specialty engineering (# to
2540		standard)
2541		• Meeting schedule (IMP/IMS and critical path)
2542		• Meeting required LRIP exit criteria
2543	Tools	
2544	•	Award Fee Template, USAF
2545	Resou	rces
2546	•	Air Force Award Fee Guide, Oct 2008 (Army and Navy guides available)
2547		
	•	Section L Guide, IG5315.204-5(b)
2548	•	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c)
2548 2549	•	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016
2548 2549 2550	• • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
2548 2549 2550 2551	• • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016
2548 2549 2550 2551 2552	• • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System
2548 2549 2550 2551 2552 2553	• • • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System MRL Deskbook Version 2016
2548 2549 2550 2551 2552 2553 2554	• • • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System MRL Deskbook Version 2016 DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
2548 2549 2550 2551 2552 2553 2554 2555	• • • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System MRL Deskbook Version 2016 DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting
2548 2549 2550 2551 2552 2553 2554 2555 2556	• • • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System MRL Deskbook Version 2016 DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting DFARS 252.242-7004, Material Management and Accounting System (MMAS)
2548 2549 2550 2551 2552 2553 2554 2555 2556 2557	• • • • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System MRL Deskbook Version 2016 DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting DFARS 252.242-7004, Material Management and Accounting System (MMAS) DFARS 252.246-7008, Sources of Electronic Parts
2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558	• • • • • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System MRL Deskbook Version 2016 DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting DFARS 252.242-7004, Material Management and Accounting System (MMAS) DFARS 252.246-7008, Sources of Electronic Parts DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance
2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559	• • • • • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System MRL Deskbook Version 2016 DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting DFARS 252.242-7004, Material Management and Accounting System (MMAS) DFARS 252.246-7008, Sources of Electronic Parts DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance System
2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560	• • • • • •	Section L Guide, IG5315.204-5(b) Section M Guide, IG5315.204-5(c) AS6500, Manufacturing Management Program, SEP 2016 AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016 ISO 9001:2015, Quality Management System MRL Deskbook Version 2016 DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident Reporting DFARS 252.242-7004, Material Management and Accounting System (MMAS) DFARS 252.246-7008, Sources of Electronic Parts DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance System NIST 800-82 Guide to Industrial Control Systems (ICS) Security

4. Engineering and Manufacturing Development (EMD) Phase

2562 B.4 Develop Manufacturing Incentives Criteria

2563 Manufacturing and Quality Tasks

- Develop and provide manufacturing and quality inputs to Incentives Criteria appropriate to the contract type and consistent with the Acquisition Strategy that address reduction of manufacturing and quality cost and improving schedule and performance (including supply chain) in the areas of:
 Management commitment to industry best practices, effective communications, team
- 2569 empowerment, and management visibility in manufacturing and quality planning,
 2570 teamwork, and execution (i.e., world class behavior)
- 2571 o Innovative workforce management and training
 - Manufacturing readiness and maturity of the lower-tier supply chain in advance of the System maturity targets (#/%)
- 2574 Reductions in manufacturing cost (Δ \$), and cost avoidance
 - Early completion of manufacturing and quality risk and issue mitigations (schedule/#/\$)
 - Improvements in schedule (e.g., increased slack time, expedited development, early delivery, or just-in-time implementation, etc.)
 - Exceeding contract requirements for technical enhancements in quality, reliability, maintainability, product improvement, yields, rates, etc.
 - Innovative parts and materials management initiatives
 - Early achievement of manufacturing and quality learning curves (% to goals) including rates, yields, variability, process times, re-work and repair, etc.
- 2583 Early completion of manufacturing and producibility projects (schedule/#)
- 2584 o Improvements in testing and reliability (i.e., positive trends) (%)
 - Exceeding contract test requirements through innovative test reductions and/or combinations
- 2587oImprovements in quality (e.g., positive trends, exceeding goals, acceleration of2588improvements, etc.)(%)
- 2589 o Key and critical manufacturing process capability improvement (i.e., C_{pk} improvements on key and critical processes beyond contract)
- Variation and Variability reduction efforts exceeding contract requirements (yields, rates, and trends)
- 2593oPredictive and pro-active maintenance and modernization of facilities, tooling, and2594equipment (including GFE)
- 2595 o Investments in modern manufacturing methods, software, and equipment (cost share %)
- 2596 Qualification and investments in additional sources within the U.S. IB (\$)

2597 Metrics

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Manufacturing and quality have developed, documented, and provided inputs to Incentives
 Criteria to address reduction of manufacturing and quality cost and improving schedule and
 performance (including supply chain) in the areas of:

2601		0	Management commitment to industry best practices (e.g., AS6500, AS9100, ISO 9000,
2602			etc.), effective communications, team empowerment, and management visibility in
2603			manufacturing and quality planning, teamwork, and execution (i.e., world class behavior)
2604		0	Innovative workforce management and training
2605		0	Manufacturing readiness and maturity of the lower-tier supply chain in advance of the
2606			System maturity targets (#/%)
2607		0	Reductions in manufacturing cost (Δ \$), and cost avoidance (Δ \$)
2608		0	Early completion of manufacturing and quality risk and issue mitigations (schedule/#/\$)
2609		0	Improvements in schedule (e.g., increased slack time, expedited development, early
2610			delivery, or just-in-time implementation, etc.) (schedule/\$)
2611		0	Exceeding contract requirements for technical enhancements in quality, reliability,
2612			maintainability, product improvement, yield, rates, etc. (\$)
2613		0	Innovative parts and materials management initiatives (\$)
2614		0	Early achievement of manufacturing and quality learning curves (% to goals) including
2615			rates, yields, variability, process times, re-work and repair, etc.
2616		0	Early completion of manufacturing and producibility projects (schedule/#)
2617		0	Improvements in testing and reliability (i.e., positive trends) (%)
2618		0	Exceeding contract test requirements through innovative test reductions and/or
2619			combinations (schedule/\$)
2620		0	Improvements in quality (e.g., positive trends, exceeding goals, acceleration of
2621			improvements, etc.)(%)
2622		0	Key and critical manufacturing process capability improvement (i.e., C _{pk} improvements
2623			on key and critical processes beyond contract) (\$)
2624		0	Variation and Variability reduction efforts exceeding contract requirements (yields, rates,
2625			and trends)(\$)
2626		0	Predictive and pro-active maintenance and modernization of facilities, tooling, and
2627			equipment (including GFE)(\$)
2628		0	Investments in modern manufacturing methods, software, and equipment (cost share %/\$)
2629		0	Qualification and investments in additional sources within the U.S. IB (\$)
2630	Tools		
2631	•	Aw	vard/Incentive Fee Plan
2632	Resou	rces	
2633	•	E٨	P Subpart 16 / Incentive Contracts
2033	•		D/NASA Incentive Contracting Guide
2034	•		26500 Manufacturing Managament Program SED 2016
2035	•	AS	10100 Quality Systems – Deguinements For Aviation Space And Defense Organizations
2030	•	AS	> 2016
2037	-	Sel	p 2010 2 0001:2015 Ouslity Management System
2038	•	120	D South and Naming Management System
2639	•	Mł	KL Deskbook Version 2016

2640 C. SURVEILLANCE SYSTEM

2641 DCMA is a unique program asset that can provide access to reliable and accurate QMS data and

2642 process information on costs, schedule, and technical performance and can assist with objective

assessment of Contractor and supply chain plans to include verification of and compliance with

requirements.



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DCMA audits, support for program reviews, and day-to-day surveillance of Contractor and supply chain activities are tools that provides a way to assess progress and maturity of the program as it moves through finalizing the design and demonstration on a pilot line. DCMA and program audits and reviews should be multi-disciplined to ensure that all of functional aspects of the program are addressed. This systematic process that assesses risk and issues should facilitate transition from final design development to initial production and beyond by assessing the maturity of the design effort, verifying and validating design requirements, verifying the system configuration, and providing a

2653 database of surveillance results and technical decisions with rationale.

Reviews and assessments are important oversight tools that the program can use to review and 2654 2655 evaluate the state of the system and the program for CDR, re-directing activity if necessary. DCMA 2656 can provide status of the application of manufacturing and quality best practices (e.g., AS6500, AS9100, IEEE 15288.2, ISO 9000, etc.), which includes Contractor and supply chain use of Failure 2657 Mode, Effects and Criticality Analysis (FMECA), FRACAS, etc., and monitoring and review of 2658 2659 Technical Performance Measures (TPMs) status. Additionally, DCMA monitoring, tracking, and reporting of Contractor and supply chain performance, actions, and compliance with all contractual 2660 requirements is major input to the CDR. 2661

2662 The Defense Contract Management Agency (DCMA) conducts nearly all pre-award surveys required 2663 by government buying activities. The process begins with a buying activity's request for a survey and 2664 concludes with a Procuring Contracting Officer's (PCO) decision based on a recommendation by a 2665 DCMA Contract Management Office (CMO) survey team. A Production and Deployment pre-award 2666 survey can focus on virtually every facet of the Contractors business operations from technical 2667 capability to financial stability, from quality assurance to plant safety. Manufacturing and quality 2668 should provide recommendations and inputs to program management for the pre-award survey 2669 requirements to be addressed by DCMA. In a sense, the survey process is the Contractor's 2670 opportunity to provide evidence (i.e., Plan of Performance) that they can successfully fulfill the terms 2671 of the contract.

C.1 DCMA Support for EMD Activities 2672

2673 **Manufacturing and Quality Tasks**

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- 2674 • Ensure manufacturing and quality provides inputs to the program development of a Letter of 2675 Delegation for DCMA support. 2676 Ensure manufacturing and quality provides inputs on contractual requirements for Contractor and supply chain activities and functions to be monitored, tracked, and reported by DCMA 2677 and/or program personnel in support of EMD, including:
- 2679 DCMA surveillance of Contractor and supply chain use and application of best practices 0 2680 (e.g., AS6500, AS9100, ISO 9000, etc.)
- 2681 o Participate in Post Award Orientation Conference
 - Verify closure of PDR actions supply chain (required in the PDR if the PDR was conducted in the TMRR phase)
- 2684 • Updates on supply chain CDRs, developmental testing, Physical Configuration Audits 2685 (PCAs), Functional Configuration Audits (FCAs), other "critical Path" events, and 2686 notifications to the program office of potential or actual program milestone issues
- 2687 Government surveillance of Contractor and supply chain First Article Inspections 2688 (FAI)/First Article Tests (FATs) and Qualifications (QUAL)
 - Surveillance support of Contractor's Earned Value Management System (EVMS) 0
 - Conduct cost, schedule, and technical performance variance evaluations
- 2691 • Surveillance of Human Rating Certification processes (e.g., Flight Operations, etc.) with 2692 unrestricted government access to inspect and/or test processes (i.e., Safety of Flight (SOF) characteristics) 2693
- 2694 • Government Contract Quality Assurance (GCQA) of engineering development models, 2695 engineering models, production prototypes, production representative models/articles, 2696 production readiness models/articles, as requested by the program office in the contract
- 2697 Authority to accept or reject minor Requests for Variation (RFVs), Material Review 0 2698 Board (MRB) proposals for Use-As-Is (UAI), and post-CDR repair non-conformances 2699 (i.e., after the final product (configuration) baseline (PBL) is established)
- 2700 o Surveillance of the supplier's compliance to DFARS 252.242-7004, Material 2701 Management and Accounting System (MMAS)
- 2702 • Verification of Contractor and supply chain compliance with contractual Special 2703 Packaging Instructions (SPIs) for end item systems and spares
 - Verification of Contractor and supply chain compliance with Surveillance Critical 0 Designator (SCD) (FAR 42.11) requirements applied to the contract
- 2706 • Surveillance of manufacturing and quality processes, procedures, and Contractor program 2707 systems (e.g., Risk, Issue, and Opportunity Management System, Configuration 2708 Management System, FRACAS, FMECA processes, test and evaluation processes, etc.)
- 2709 Ensure manufacturing and quality participates in the development of a Memorandum of 2710 Agreement (MOA) for DCMA support.
4. Engineering and Manufacturing Development (EMD) Phase

2711	Metrics
2712 2713	• Manufacturing and quality has provided inputs to the program development of a Letter of Delegation for DCMA support.
2714 2715 2716	 Manufacturing and quality has provided documented contractual requirements for monitoring, tracking, and reporting of Contractor and supply chain activities and functions by DCMA and/or program personnel in support of EMD, including:
2717 2718 2719 2720 2721	 Surveillance of Contractor and supply chain use and application of best practices (e.g., AS6500, AS9100, ISO 9000, etc.) Participation in Post Award Orientation Conference Verification of PDR actions closure for the entire supply chain Supply chain CDRs, developmental testing PCAs, ECAs, and other "critical Path" events
2722 2723	 Government surveillance of Contractor and supply chain FAIs/FATs and QUAL Surveillance of Contractor's EVMS
2724	 Monitor cost, schedule, and technical performance variances
2725 2726 2727 2728 2729 2730	 Surveillance of Human Rating Certification processes GCQA of engineering development models, engineering models, production prototypes, production representative models and articles, production readiness models and articles, etc. Authority to accept or reject minor RFVs, MRB proposals for UAI, and repair non-conformances (after the final PBL is established post-CDR)
2731 2732 2733	 Surveillance of the supplier's compliance to DFARS 252.242-7004, MMAS Verification of Contractor and supply chain compliance with contractual SPIs for end item systems and spares
2734 2735 2736 2737	 Verification of Contractor and supply chain compliance with SCD (FAR 42.11) requirements applied to the contract Surveillance of manufacturing and quality processes, procedures, and Contractor program systems (e.g., Risk, Issue, and Opportunity Management System, Configuration
2738 2739 2740	 Management System, FRACAS, FMECA processes, test and evaluation processes, etc.) Memorandum of Agreement (MOA) has been executed with manufacturing and quality inputs and implemented between with program and DCMA.
2741	Tools
2742	DCMA Program Assessment Report
2743	Resources
2744 2745 2746 2747	 DCMA-INST-204 Manufacturing and Production DCMA-INST-205, Major Program Support DCMA-INST-207, Engineering Surveillance DCMA-INST-219, SCM Risk Management
2140	Manufacturing and Quality Management Body of Knowledge

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- DCMA-INST-401, Industrial Analysis
- 2750 **C.2 DCMA** Participation in Program Reviews 2751 **Manufacturing and Quality Tasks** 2752 Manufacturing and quality requests DCMA support and participation in program reviews (e.g., IPRs, IPT meetings, etc.), including government only, to provide data on: 2753 2754 • Contractor operations (performance and financial) 2755 • Supply chain operations (performance and financial) 2756 • Program goals and metrics 2757 Request DCMA input on ongoing manufacturing and quality Contractor and supply chain • 2758 activities concerning: 2759 Technical Performance Measures (TPMs) 0 2760 Including CIs, CSIs, KCs, and critical characteristics Design status 2761 2762 • Manufacturing capabilities and capacities 2763 Quality assurance processes and procedures (i.e., compliance to best practices) • EVMS processes, procedures, and data 2764 2765 o Government Property Control (e.g., GFE, GFP, etc.) 2766 Transportation, storage, and packaging processes and controls 0 2767 • Security (physical, cyber, and industrial) o System Safety 2768 • Plant safety, materials handling, hazardous waste disposal, etc. 2769 2770 o Environmental and Energy compliance with applicable policies and statutes • Certifications processes and procedures (e.g., Flight Operations/Safety, Human Rating, 2771 2772 etc.) 2773 • Configuration management processes and procedures 2774 • Software surveillance 2775 0 Test planning, test equipment, and test results 2776 Metrics 2777 Manufacturing and quality has requested DCMA participation in program reviews and 2778 DCMA is supporting and participating, providing data on: 2779 Contractor operations (performance and financial) 0 2780 Supply chain operations (performance and financial) 0 2781 • Program progress to goals 2782 • DCMA is providing data on Contractor and supply chain manufacturing and quality activities 2783 for the following:

2784		o TPMs
2785		 Including CIs, CSIs, KCs, and critical characteristics
2786		• Design status
2787		• Manufacturing capabilities and capacities
2788		• Quality assurance processes and procedures (i.e., compliance to best practices)
2789		• EVMS processes, procedures, and data
2790		• Government Property Control (e.g., GFE, GFP, etc.)
2791		• Transportation, storage, and packaging processes and controls
2792		• Security (physical, cyber, and industrial)
2793		o System Safety
2794		• Plant safety, materials handling, hazardous waste disposal, etc.
2795		• Environmental and Energy compliance with applicable policies and statutes
2796		• Certifications processes and procedures (e.g., Flight Operations/Safety, Human Rating,
2797		etc.)
2798		 Configuration management processes and procedures
2799		• Software surveillance
2800		• Test planning, test equipment, and test results
2801	Tools	
2802	•	DCMA Program Assessment Report
2803	Resou	rces
2804	•	DCMA-INST-204 Manufacturing and Production
2805	•	DCMA-INST-205 Major Program Support
2806	•	DCMA-INST-207 Engineering Surveillance
2807	•	DCMA-INST-219 SCM Risk Management
2808	•	DCMA-INST-309 Government OA Surveillance Planning
2800	•	DCMA-INST-401 Industrial Analysis
2007	·	Demix-11(51-+01, industrial Analysis
2810	C.3	Utilize DCMA Surveillance Capabilities for CDR
2811	Manu	facturing and Quality Tasks
2812	•	Utilize DCMA surveillance capabilities in monitoring, tracking, and reporting for Contractor
2813		and supply chain use and application of manufacturing and quality best practices (e.g.,
2814		AS6500, AS9100, IEEE 15288.2, ISO 9000, etc.).
2815	•	Utilize DCMA surveillance capabilities to monitor manufacturing and quality Failure Mode,
2816		Effects and Criticality Analysis (FMECA) contract requirements for Contractor and supply
2817		chain for:

2818 2819 2820	 Identification of subsystems, items, components, characteristics and/or features, and processes, which if nonconforming, could result in a catastrophic or critical failure of the system:
2821 2822 2823 2824	 Items and components will be designated as either a critical item (CI) or CSI Product characteristics and/or features will be designated as either key characteristics (KCs) or critical characteristics Processes will be designated as critical manufacturing processes (CMPs)
2825 2826 2827 2828	 Review of the FMECA and/or Critical Items List (CIL) for CIs, CSIs, KCs, and critical characteristics to specify the need for government surveillance of these items Verification of updates of FMEA/FMECA based on FRACAS and developmental testing results
2829 • 2830	Utilize DCMA surveillance capabilities to monitor manufacturing and quality aspects of System Safety contract requirements including:
2831 2832	 Review Safety Assessment Reports (SARs) and/or CIL for CIs, CSIs, KCs, and critical characteristics
2833 • 2834	Utilize DCMA surveillance capabilities to monitor manufacturing and quality aspects of Test and Evaluation contract requirements for surveillance of Contractor's and supply chain's:
2835 2836	• Physical Configuration Audits (PCAs) of the required sub-systems/components identified in the contract. Perform government surveillance, as required
2837 2838 2839 2840	 Functional Configuration Audits (FCAs) of the required sub-systems/components identified in the contract. Perform government surveillance, as required Developmental Testing for achievement of Critical Technology Elements (CTEs), KPPs, and KSAs
2841 2842	 Software Testing, to include Software Acceptance Test (SAT)/Software Formal Qualification Test (SFQT), if conducted in the EMD phase
2843 2844 2845	 Environmental testing (e.g., Environmental Stress Screening (ESS), Highly Accelerated Life Testing (HALT), Highly Accelerated Stress Screen (HASS), Thermo-Cycling, Thermo-Shock, Pyrotechnic Shock, Vibration, etc.), if conducted
2846 2847	 Live Fire Test and Evaluation), if applicable Acceptance Testing
2848 • 2849 2850 • 2851	Utilize DCMA surveillance capabilities to enhance manufacturing and quality monitoring of KPPs and KSAs progress and periodic review of TPMs. Utilize DCMA surveillance capabilities to monitor Contractor's and supply chain's manufacturing and quality FRACAS contract requirements including:
2852 2853 2854 2855	 Government personnel attending FRACAS meetings, or review minutes, and adjusting Government surveillance based on FRACAS results, as required Verifying Contractor and supply chain updates of FMEA/FMECA based on FRACAS result, when required

2856 • 2857 2858 2859 • 2860 2861 • 2862	Utilize DCMA surveillance capabilities to monitor manufacturing and quality contract requirements for Contractor and supply chain compliance to manufacturing and quality aspects of Systems Engineering best practices as specified in IEEE 15288.2. Utilize DCMA surveillance capabilities to monitor manufacturing and quality Risk, Issue and Opportunity (RIO) Management contract requirements. Utilize DCMA surveillance capabilities to monitor manufacturing and quality contract Parts Management requirements including:
2863 2864 2865 2866 2867 2868 2869	 Contractor's compliance to Parts Management contract requirements (i.e., MIL-STD- 11991A) Verification that Contractor and supply chain use parts and/or components in the design that are qualified under a government or Industry specifications or standards Validation of Non-Standard Parts Approval Requests (NSPARs) made to the program office for approval in accordance with specified CDRLs, or DDF1423, that specifies what the supplier must provide as part of the NSPAR
2870 • 2871 2872 2873 • 2873 2874 2875	Utilize DCMA surveillance capabilities to monitor manufacturing and quality contract Configuration Management requirements including Contractor's and supply chain compliance to requirements (e.g., SAE/EIA649B, Service specific policies, etc.). Utilize DCMA surveillance capabilities to monitor manufacturing and quality contract Software Development, Quality Assurance, Configuration Management and Testing requirements including:
2876 2877 2878 2879	 Contractor's and supply chain compliance to software development, quality assurance, configuration management and testing requirements Contractor's progress in performance of Software Acceptance Testing (SAT)/Software Formal Qualification Testing (SFQT)
2880 Metric	S
2881 • 2882 2883 2884 • 2885	DCMA is monitoring, tracking, and reporting on Contractor and supply chain use and application of manufacturing and quality best practices (e.g., AS6500, AS9100, IEEE 15288.2, ISO 9000, etc.) for CDR. DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality FMECA contract requirements for CDR including:
2886 2887 2888	• Identification of subsystems, items, components, characteristics and/or features, and processes, which if nonconforming, could result in a catastrophic or critical failure of the system:
2889 2890 2891 2892	 Items and components will be designated as either a CI or CSI Product characteristics and/or features will be designated as either KCs or critical characteristics Processes will be designated as CMPs

4. Engineering and Manufacturing Development (EMD) Phase

2893 2894 2895 2896	 Review of the FMECA and/or CIL for CIs, CSIs, KCs, and critical characteristics to specify the need for government surveillance of these items Verification of updates of FMEA/FMECA based on FRACAS and developmental testing results
2897 2898 2899	DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality aspects of System Safety contract requirements for CDR including:
2900	o Review SARs and/or CIL for CIs, CSIs, KCs, and critical characteristics
2901 2902 2903	DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality aspects of Test and Evaluation contract requirements for CDR including:
2904 2905 2906 2907 2908 2909 2910 2911 2912 2913	 PCAs of the required sub-systems/components identified in the contract. Perform government surveillance, as required FCAs of the required sub-systems/components identified in the contract. Perform government surveillance, as required Developmental Testing for achievement of CTEs, KPPs, and KSAs Software Testing, to include SAT/SFQT, if conducted in the EMD phase Environmental testing (e.g., ESS, HALT, HASS, Thermo-Cycling, Thermo-Shock, Pyrotechnic Shock, Vibration, etc.), if conducted LFT&E, if applicable Acceptance Testing
2914 2915 2916 2917	 DCMA is monitoring, tracking, and reporting on manufacturing and quality aspects of KPPs and KSAs including progress and periodic reviews of TPMs for CDR. DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality FRACAS contract requirements for CDR including:
2918 2919 2920 2921	 Attending FRACAS meetings, or review minutes, and adjusting government surveillance based on FRACAS results, as required Verifying Contractor and supply chain updates of FMEA/FMECA based on FRACAS result, when required
2922 2923 2924 2925 2926 2927 2928 2929	 DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality aspects of Systems Engineering best practices as specified in IEEE 15288.2 for CDR. DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality RIO Management contract requirements for CDR. DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality RIO Management contract requirements for CDR. DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality Parts Management contract requirements (MIL-STD-11991A) for CDR including:
2930 2931	• Verification that Contractor and supply chain use parts and/or components in the design that are qualified under a government or Industry specifications or standards

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2932 2933 2934		• Validation of NSPARs made to the program office for approval in accordance with specified CDRLs, or DDF1423, that specifies what the supplier must provide as part of the NSPAR
2935 2936 2937 2938 2939	•	DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality Configuration Management contract requirements (e.g., SAE/EIA649B, Service specific policies, etc.) for CDR. DCMA is monitoring, tracking, and reporting on Contractor and supply chain compliance to manufacturing and quality Software Development. Quality Assurance, Configuration
2939 2940		Management and Testing contract requirements for CDR including:
2941 2942 2943		 Contractor's and supply chain compliance to software development, quality assurance, configuration management and testing requirements Contractor's progress in performance of SAT/SFQT
2944	Tools	
2945	•	Critical Design Review Checklist
2946	Resou	rces
2947	•	Defense Acquisition Guide (DAG) Chapter 3-3.3.5 Critical Design Review
2948	٠	AS6500, Manufacturing Management Program, Sep 2016
2949	•	AS9100 QUALITY SYSTEMS – REQUIREMENTS FOR AVIATION, SPACE, AND
2950		DEFENSE ORGANIZATIONS, SEP 2016
2951	•	IEEE 15288.2, System and Software Engineering, 2015
2952	•	DD 1423, Contract Data Requirements List
2953	٠	ISO 9001, Quality Management System, Sep 2016
2954 2955	•	MIL-STD-11991A General Standard for Parts, Materials, and Processes, Reinstated Aug 2015
2956	•	Multiple DCMA standards, documents, and procedures
2957	•	NAVAIR 4130.1, Configuration Management
2958	•	SAE EIA 649B Configuration Management Standard
2959	C.4	DCMA Contract Administration, Management, and Support Activities
2960	Manu	facturing and Quality Tasks
2961 2962 2963	•	Request the following manufacturing and quality support from the appropriate (local) Contract Administration Office (CAO)/Contract Management Office (CMO) in attending, monitoring, and reporting on Contractor reviews, performance, and meetings including:
2964 2965 2966 2967		 Inputs from DMCA monitoring, tracking, and reporting on Contractor and supply chain manufacturing and quality activities and functions to meet contractual requirements as delineated in C.3 Interim Program Reviews (IPRs) including supply chain

2968 2969 2970 2971		 Performance of Physical Progress Reviews (PPRs) in support of Program Progress Payments Corrective Action Board (CAB) or similar meetings (e.g., quality, manufacturing, supply chain, engineering, and software issues, corrective actions, and dispositions)
2972 2973 2974	•	Request manufacturing and quality support from the appropriate (local) CAO/CMO in monitoring, tracking, reporting on Contractor performance and actions related to and including the following:
2975 2976 2977 2978 2979 2980 2981	•	 Estimates to Completion (EACs) as requested Delivery delay notices to the customer Performance Base Payment requests (validation and/or verification) Support to customer priority delivery requests (DX rating) Contractor and supply chain pilot lines Ensure manufacturing and quality provides inputs for updates to the Memorandum of Agreement (MOA) between the program and the government contract administration for
2981 2982 2983	Motri	necessary activities.
2983 2984 2985 2986	•	Manufacturing and quality has requested the appropriate DCMA CAO/CMO support in attendance, monitoring, and reporting on Contractor reviews, performance, and meetings including:
2987 2988 2989 2990 2991 2992		 Contractor and supply chain manufacturing and quality performance to meet contractual requirements as delineated in C.3 Contractor and supply chain IPRs and results PPRs in support of Contractor progress payments CABs or similar meetings (e.g., quality, manufacturing, supply chain, engineering, and software issues, corrective actions, and dispositions)
2993 2994 2995	•	Manufacturing and quality has requested the appropriate DCMA CAO/CMO support in monitoring, tracking, reporting on Contractor performance and actions related to and including the following:
2996 2997 2998 2999 3000		 EACs Delivery delay notices Performance Base Payment requests (validation and/or verification) Priority delivery requests (DX rating) Results of Contractor and supply chain pilot lines
3001 3002	•	Manufacturing and quality has provided inputs for updates to the MOA between the program and the government contract administration for changes based on fact-of-life program status.
3003	Tools	
3004	٠	DCMA Pre-Award Survey System (PASS) review

4. Engineering and Manufacturing Development (EMD) Phase

3005	Resou	irces
3006	•	AS6500, Manufacturing Management Program, Sep 2016
3007	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
3008		Sep 2016
3009	•	ISO 9001, Quality Management System, 2015
3010	•	IEEE 15288.2, Systems and Software Engineering, 2015
3011	•	DD 1423, Contract Data Requirements List
3012	•	MIL-STD-11991A General Standard for Parts, Materials, and Processes, Reinstated Aug
3013		2015
3014	•	Multiple DCMA standards, documents, and procedures
3015	•	NAVAIR 4130.1, Configuration Management
3016	٠	SAE EIA 649B Configuration Management Standard
3017	C.5	Conduct Pre-Award Survey
2017	0.0	
3018	Manu	facturing and Quality Tasks
3019	•	Ensure manufacturing and quality provides inputs for the request to DCMA to conduct Pre-
3020		award Surveys of potential LRIP Contractor(s) (including their designated supply chain) for
3021		manufacturing and quality capabilities in the areas of:
3022		• Compliance to appropriate industry best practices (e.g., AS6500, AS9100, etc.)
3023		• Technical Performance including TPMs, CIs, CSIs, KCs, and critical characteristics
3024		0 Design
3025		 Manufacturing capabilities and capacities
3026		• Quality assurance including processes and procedures compliance to best practices
3027		• EVMS processes, procedures, and data
3028		• Government Property management and control (e.g., GFE, GFP, etc.)
3029		• Transportation, storage, and packaging processes and controls
3030		• Security (physical, cyber, and industrial)
3031		• System Safety
3032 2022		• Plant salety, materials nandling, nazardous waste disposal, etc.
3033		• Environmental and Energy compliance with applicable policies and statutes
3034		o Certifications processes and procedures (e.g., Fright Operations/Safety, Human Kating,
3035		Configuration management processes and procedures
3037		• Software surveillance
3038		 Test planning, test equipment, and test results
3039	Metri	CS
30/0	•	Manufacturing and quality has documented and provided inputs for the request Processory
0400	•	manufacturing and quanty has documented and provided inputs for the request file-award

3041 Surveys of potential LRIP Contractor(s) including the supply chain for:

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3042		• Compliance to appropriate industry best practices (e.g., AS6500, AS9100, etc.)
3043		• Technical Performance including TPMs, CIs, CSIs, KCs, and critical characteristics
3044		o Design
3045		 Manufacturing capabilities and capacities
3046		• Quality assurance including processes and procedures compliance to best practices
3047		• EVMS data and performance
3048		o Government Property management and control (e.g., GFE, GFP, etc.)
3049		 Transportation, storage, and packaging processes and controls
3050		• Security (physical, cyber, and industrial)
3051		• System Safety
3052		 Plant safety, materials handling, hazardous waste disposal, etc.
3053		 Environmental and Energy compliance with applicable policies and statutes
3054		• Certifications processes and procedures (e.g., Flight Operations/Safety, Human Rating,
3055		etc.)
3056		 Configuration management processes and procedures
3057		• Software surveillance
3058		• Test planning, test equipment, and test results
3059	Tools	
3060	•	SF 1404 Pre-award Survey – Technical
3061	•	SF 1405 Pre-award Survey – Production
3062	•	SF 1406 Pre-award Survey – Quality Assurance
3063	•	SF 1407 Pre-award Survey – Financial Capability
3064	•	DCMA Pre-Award Survey System (PASS) review
3065	Resou	rces
3066	•	Pre-Award Survey System (PASS) 2.0 (On-line)
3067	•	Pre-Award Survey System Users Guide (On-Line)
3068	•	AS6500, Manufacturing Management Program, Sep 2016
3069	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
3070		Sep 2016
3071	•	ISO 9001, Quality Management System, 2015
3072	•	IEEE 15288.2, Systems and Software Engineering, 2015
3073	•	DD 1423, Contract Data Requirements List
3074	•	MIL-STD-11991A General Standard for Parts, Materials, and Processes, Reinstated Aug
3075		2015
3076	٠	Multiple DCMA standards, documents, and procedures
3077	•	NAVAIR 4130.1, Configuration Management
3078	•	SAE EIA 649B Configuration Management Standard

3079 D. TECHNOLOGY AND INDUSTRIAL BASE

3080 During the Engineering and Manufacturing Development (EMD) phase, Industrial Base (IB)

3081 readiness to support program objectives should be assessed to identify risks, issues, and

3082 opportunities. The Manufacturing and Quality Strategies, and subsequent inputs to the program

3083 Acquisition Strategy (AS), should highlight the strategy for assessing and mitigating any industrial

and manufacturing risks. According to DODI 5000.02 Acquisition Strategies must consider Industrial

3085 Base capabilities at Milestones B and C, and provide an update to the Analysis of Alternatives (AoA)

3086 conducted in the MSA phase which included an assessment of manufacturing feasibility and required

3087 an assessment of the industrial base capabilities.



3088

3089 Policy requires an analysis of the capabilities of the National Technology and Industrial Base (NTIB)

3090 to support the design, development, production, operation, uninterrupted maintenance support of the

3091 system, and eventual disposal. Without this assessment, the program may find that the program

3092 cannot be accomplished within the defined cost and schedule thresholds as a result of

3093 incompatibilities between the system requirements and the NTIB available to support it.

3094 Manufacturing risk resolution involves assessing risks through the formal technical reviews and in 3095 demonstrating the manufacturing capability and maturity. Manufacturing technology development 3096 needs to be accomplished in a phased approach to define and demonstrate capabilities. The TMRR 3097 developer should have demonstrated that the required advanced processes or material capabilities 3098 were achievable in a production relevant environment. The objective of the ManTech program is to 3099 improve performance while reducing acquisition cost by developing, maturing and transitioning 3100 advanced manufacturing technologies. These ManTech projects or other projects must be implemented in time to support production. The focus is on providing a reasonable expectation that 3101 3102 the advanced manufacturing materials and processes, required in EMD and production, can be

3103 achieved.

3104 A systematic process that assesses the maturity of Critical Technology Elements (CTEs) is a DODI

3105 5000.02 requirement for all acquisition programs. In completing the development of a system or

3106 incremental capability, one of the key tasks is to mature Critical Manufacturing Processes (CMPs)

3107 associated with KCs (KCs), and therefore with CTEs. Manufacturing process demonstrations include

- affordable and executable manufacturing processes, system fabrication, production of prototypes and
- 3109 first articles that demonstrate system integration, interoperability, supportability, safety and utility.
- 3110 The focus of demonstrations is on risk reduction in a pilot line environment.

4. Engineering and Manufacturing Development (EMD) Phase

- 3111 Based on funding, schedule, and implementation progress, ManTech projects should be updated and
- 3112 managed to achieve program objectives. Projects should address and reduce risks, improve
- 3113 manufacturing and quality processes, and improve cost and schedule performance. ManTech projects
- 3114 should be completed, integrated, and demonstrated on a pilot line at the appropriate Contractor
- 3115 and/or supply chain facilities.

A key manufacturing and quality focus should be on continually analyzing risks and identifying risk

- 3117 mitigation measures needed to sustain a reliable, technologically superior, affordable and resilient
- defense industrial base. DODI 5000.60 provides policy and identifies responsibilities for assessing
 defense industrial capabilities. These assessments ensure that the industrial capabilities needed to
- 3120 meet current and future national security requirements are available and affordable. The industrial
- 3121 base capability assessment will be used to use to determine if a specific industrial capability is
- 3122 required to meet DOD needs, and if any action should be taken to ensure the continued availability of
- the capability.
- 3124 The effectiveness of actions or investments made in areas of manufacturing capability, obsolescence,

3125 fragility, capacity, and resilience to address manufacturing and quality Industrial Base risks to cost,

3126 schedule, performance should be assessed and validated. These results should be incorporated into

- 3127 the joint Risk, Issues, and Opportunity Management System in support of LRIP and Production and
- 3128 Deployment phase. Additionally, the updated manufacturing and quality inputs should be included in
- 3129 the Industrial Base Capabilities Considerations Summary Report for MS C.

3130 **D.1** Update Industrial Base Capabilities Assessment and Analyses

3131 Manufacturing and Quality Tasks

- Maintain the relevance and applicability of the Industrial Base Capabilities Considerations analyses (from TMRR) of the national technology and industrial base to develop, produce, maintain, and support the program, including foreign dependency. The analyses should include the following components:
- 3136 Relevant sources including identification of:
- **•** Unique manufacturing capabilities
- Capabilities not readily accessible or available (e.g., capability is at maximum
 capacity, materials from a constrained source, etc.)
- Major systems and items available only from sources outside the national technology
 and industrial base
- Alternatives for obtaining such items from within the national technology and
 industrial base if such items become unavailable from sources outside the national
 technology and industrial base
- 3145Government and Contractor Depot and Maintenance and Repair Operations (as part3146of the Industrial Base)

3147		0	Vulnerabilities of and effect on the supply chain including sole, single, fragile, or foreign
3148			sources, cyber exploitation, and foreign acquisition
3149		0	Capability to produce using existing manufacturing capabilities and capacities while
3150			meeting quality, production rate and cost requirements
3151		0	Capability to protect program and system information and data (software and firmware)
3152			including system definition, design and test, contracting, and competitive prototyping
3153		0	Capability to protect industrial resources, materials, equipment, and control systems
3154		0	Capability and capacity to cost-effectively design, develop, produce, maintain, and
3155			support the system with tooling, production and test equipment, and operation,
3156			maintenance, and sustainment of systems
3157		0	Capability and capacity to meet rate and quantity changes that support a response to
3158			contingency and support objectives (surges and contractions)
3159		0	Availability of essential raw materials, special alloys, composite materials, components,
3160			tooling, and production test equipment required to include the availability of alternatives
3161			for obtaining such items from within the NTIB
3162		0	Potential obsolescence of components, parts, and materials
3163		0	Impacts of external dependencies and integration
3164		0	New and unique capabilities and processes
3165		0	Sources for key technologies, components, and processes, including known gaps and
3166			risks
3167		0	Technological developments, market trends, processes, environmental factors, and
3168			policies, etc. that could potentially impact the program
3169		0	DCMA industrial analysis data and reports to include:
3170			 Industrial Capability Assessments
3171			 Appropriate Analytical Products
3172			 Defense Business and Economic Analysis
3173			 Acquisition Planning Support
3174	•	Un	date and maintain the relevance and applicability of manufacturing and quality inputs to
3174	·	the	Industrial Base Canabilities Considerations Summary Report (from TMRR) and the AS
3175		and	1 CED.
3170		and	
3177		0	Include recommended actions or investments that address risks to cost, schedule,
3178			performance, and qualitative considerations that define and recommend how and when
3179			the actions would be incorporated into the budget and schedule and, if possible, identify
3180			budget offsets
3181		0	Ensure the report is finalized for MS C
3182			• Note: If the required investment is greater than \$10 million and is determined to
3183			affect more than one defense program must be coordinated within and across the
3184			Components and approved by the Under Secretary Of Defense For Acquisition.
3185			Technology, And Logistics per DOD 5000.60.

3186 3187 3188	•]]	Manufacturing and quality personnel will analyze, update, and maintain inputs to the joint Risk, Issues, and Opportunity Management System for Industrial Base capabilities and capacities throughout EMD and in support of LRIP and Production and Deployment.
3189		• Include manufacturing, re-manufacturing, and overhaul opportunities
3190	Metrics	
 3191 3192 3193 3194 3195 	•] 4 • (i	Manufacturing and quality resources and personnel are designated to maintain the relevance and applicability of the Industrial Base Capabilities Considerations analyses of the national rechnology and industrial base. Components of the analyses to be maintained and documented for the AS and the SEP include:
3196	(• Relevant sources that identify:
 3197 3198 3199 3200 3201 3202 3203 		 Unique manufacturing capabilities Difficult to access or obtain capabilities (e.g., capability is at maximum capacity, materials from a constrained source, etc.) Major systems and items available only from "foreign" sources Alternative "domestic" sources Government and Contractor Depot and Maintenance and Repair Operations (as part of the Industrial Base)
3204	c	Vulnerabilities and effects from sole, single, fragile, or foreign sources, cyber
3205		exploitation, and foreign acquisition
3206	0	Capability of existing manufacturing capabilities and capacities
3207	(• Capability to protect program and system information and data (software and firmware)
3208		including system definition, design and test, contracting, and competitive prototyping
3209	(Capability and conscitute cost effectively design develop produce maintain and
3210	C	support the system with tooling, production and test equipment, and operation
3212		maintenance and sustainment of systems
3212	(Capability and capacity to meet rate and quantity changes (surges and contractions)
3214	(Availability of essential raw materials, special alloys, composite materials, components,
3215		tooling, and production test equipment
3216	(> Potential obsolescence of components, parts, and materials
3217	(> External dependencies and integration
3218	(> New and unique capabilities and processes
3219	(Sources for key technologies, components, and processes, including known gaps and
3220		risks
3221	(Technological developments, market trends, processes, environmental factors, and
3222		policies, etc. that could potentially impact the program
3223	(D Industrial analysis data and reports from DCMA

4. Engineering and Manufacturing Development (EMD) Phase

3224 3225 3226	•	Manufacturing and quality inputs to the Industrial Base Capabilities Considerations Summary Report have been updated for the AS and SEP and are being maintained for submission to the MS C decision.
3227 3228 3229 3230		• Recommended actions or investments have been included to address risks to cost, schedule, performance, along with qualitative considerations that define and recommend how and when the actions should be incorporated into the budget and schedule with budget offsets
3231 3232 3233 3234		 Note: If the required investment is greater than \$10 million and is determined to affect more than one defense program must be coordinated within and across the Components and approved by the Under Secretary Of Defense For Acquisition, Technology, And Logistics per DOD 5000.60.
3235 3236 3237	•	Manufacturing and quality have documented and are maintaining up-to-date inputs to the joint Risk, Issues, and Opportunity Management System for Industrial Base capabilities and capacities including support of LRIP and Production and Deployment.
3238		• These inputs include manufacturing, re-manufacturing, and overhaul opportunities
3239	Tools	
3240	•	Industrial Base Assessment Survey Form, DCMA Industrial Analysis Center
3241	•	MRL Assessment Checklist for Technology and Industrial Base thread
3242	Resou	rces
3243	٠	10 USC 2440, Technology and Industrial Base
3243 3244	•	10 USC 2440, Technology and Industrial Base10 USC 2501, National Security Objectives Concerning National Technology and Industrial
3243 3244 3245	•	10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base
3243 3244 3245 3246 3247	•	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000 02
3243 3244 3245 3246 3247 3248	•	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments
3243 3244 3245 3246 3247 3248 3249	• • • •	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments MRL Deskbook Version 2016
 3243 3244 3245 3246 3247 3248 3249 3250 	• • • • • •	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments MRL Deskbook Version 2016 Implement Manufacturing Technology Projects
3243 3244 3245 3246 3247 3248 3249 3250 3251	• • • • • • • • • • • • • • • • • • •	10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments MRL Deskbook Version 2016 Implement Manufacturing Technology Projects facturing and Quality Tasks
 3243 3244 3245 3246 3247 3248 3249 3250 3251 3252 	• • • • • • • • • • • • •	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments MRL Deskbook Version 2016 Implement Manufacturing Technology Projects facturing and Quality Tasks Update program manufacturing technology plans, including approved and funded ManTech
 3243 3244 3245 3246 3247 3248 3249 3250 3251 3252 3253 	• • • D.2 Manu	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments MRL Deskbook Version 2016 Implement Manufacturing Technology Projects facturing and Quality Tasks Update program manufacturing technology plans, including approved and funded ManTech proposals, which should address:
 3243 3244 3245 3246 3247 3248 3249 3250 3251 3252 3253 3254 	• • • D.2 Manu	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments MRL Deskbook Version 2016 Implement Manufacturing Technology Projects facturing and Quality Tasks Update program manufacturing technology plans, including approved and funded ManTech proposals, which should address: o Identified high-risk manufacturing process areas
 3243 3244 3245 3246 3247 3248 3249 3250 3251 3252 3253 3254 3255 	• • • D.2 Manu	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments MRL Deskbook Version 2016 Implement Manufacturing Technology Projects facturing and Quality Tasks Update program manufacturing technology plans, including approved and funded ManTech proposals, which should address: Identified high-risk manufacturing process areas Identified risks and issues with associated event-based mitigation plans
 3243 3244 3245 3246 3247 3248 3249 3250 3251 3252 3253 3254 3255 3256 3256 	• • • D.2 Manu	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments MRL Deskbook Version 2016 Implement Manufacturing Technology Projects facturing and Quality Tasks Update program manufacturing technology plans, including approved and funded ManTech proposals, which should address: Identified high-risk manufacturing process areas Identified risks and issues with associated event-based mitigation plans Identified manufacturing technology efforts to be funded other sources
 3243 3244 3245 3246 3247 3248 3249 3250 3251 3252 3253 3254 3255 3256 3257 3258 	• • • • • • •	 10 USC 2440, Technology and Industrial Base 10 USC 2501, National Security Objectives Concerning National Technology and Industrial Base 10 USC 2503, Analysis of the Technology and Industrial Base DoDI 5000.02 DODI 5000.60H Defense Industrial Capabilities Assessments MRL Deskbook Version 2016 Implement Manufacturing Technology Projects facturing and Quality Tasks Update program manufacturing technology plans, including approved and funded ManTech proposals, which should address: Identified high-risk manufacturing process areas Identified risks and issues with associated event-based mitigation plans Identified manufacturing technology efforts to be funded other sources Any new or emerging manufacturing technology gaps

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3259 3260 3261 3262	 Contractor/subcontractor participation in the project Relevant data to support the plan (e.g., DCMA, Title III, etc.) Review other program portfolios for potential alternatives/solutions (e.g., ManTech, Title III, IBAS, Technical Assistance Centers, NIST, etc.)
3263 3264 3265 3266 3267	 Execute approved and funded manufacturing technology projects. Monitor and track progress of projects against the goals (e.g., process improvement, quality improvement, etc.) Monitor ongoing DoD/Service ManTech projects for potential applicability to program needs.
3268 Met 3269 • 3270	Approved manufacturing technology plans have been documented in the Manufacturing Plan and in the Risk, Issue, and Opportunity process, and funded ManTech proposals have been
3271 3272 3273 3274 3275 3276 3277 3278 3279 3280	 High-risk manufacturing process areas Event-based risk and issue mitigation planning and reduction Manufacturing technology efforts funded by other sources Any new or emerging manufacturing technology gaps Completion of manufacturing technology efforts to support program schedule Contractor/subcontractor participation in the project Updated data to support the plan (e.g., DCMA, Title III, etc.) Other program portfolios for potential alternatives/solutions (e.g., ManTech, Title III, IBAS, Technical Assistance Centers, NIST, etc.)
3281 3282 3283 3283 3284 3285	Approved and funded manufacturing technology projects are executed and monitored to schedule and the risk burn-down plan. Progress of projects against the goals is reported at program reviews. Ongoing DoD/Service ManTech projects are being monitored on a recurring basis for potential applicability to program needs.
3286 Tool 3287 • 3288 • 3289 • 3290 •	 Army ManTech Proposal Rating spreadsheet ManTech Phase I project questionnaire MRL Assessment Checklist for Technology and Industrial Base thread TRL Assessment Checklist
3291 Reso 3292 • 3293 • 3294 • 3295 •	Defense Production Act, Title III DoDD 4200.15, ManTech DoDI 5000.02 MRL Deskbook Version 2016

3296 3297 3298 3299 3300	•	Defense Manufacturing Management Guide for PMs, Chapter 8, Technology Development and Investments Technology Readiness Assessment Guidance, Apr 2011 Service ManTech guidance, e.g. Air Force Technology and Transition Strategy Guidebook, Nov 2010
3301 D .	.3	Validate Critical Technology Element (CTE) Processes
3302 M	lanuf	acturing and Quality Tasks
3303 3304	•	Update manufacturing and quality assessments to ensure all CTEs have been identified and all CTE risks and issues have been mitigated to acceptable levels.
3305 3306 3307		 Including integration, interdependencies, and associated risks and issues Exceptions have mature alternative components or subsystems identified, approved, and budgeted
3308	•	Ensure all CTEs have been decomposed to specific manufacturing and quality processes.
3309 3310 3311		 Assess each manufacturing and quality processes for maturity (e.g., process capability, work instruction status, appropriate yield, etc.) Validate CTEs for feasibility, affordability, and supportability
3312 M	letric	S
3313 3314 3315 3316 3317	•	Manufacturing and quality assessments have been conducted to ensure all CTEs have been identified and the results documented for program management and systems engineering. All CTE manufacturing and quality risks and issues have been mitigated to acceptable levels, including integration and interdependencies and documented for the joint Risk, Issue, and Opportunity Management System.
3318 3319		• Mature, approved, budgeted alternative components or subsystems have been included as required
3320 3321	•	All CTEs have been decomposed and documented to specific manufacturing and quality processes.
3322 3323 3324 3325		 Each manufacturing and quality process has been assessed and documented for its level of maturity (e.g., process capability, work instruction status, appropriate yield, etc.) CTEs have been validated and documented for manufacturing and quality feasibility, affordability, and supportability in the Program Manufacturing Plan, and the Quality Plan
3326 T C	ools	
3327 3328 3329 3330	• • •	MRL Assessment Checklist for Technology and Industrial Base thread Producibility Assessment Worksheet (PAWs) Technology Readiness Assessment TRL Calculator

3331	Resou	rces
3332 3333 3334 3335 3336	• • •	DoDI 5000.02, 5d(4)(b)3. And 5d(4)(c) Defense Acquisition Program Support Methodology, Ver. 3.0 MRL Deskbook Version 2016 NAVSO P-3687 Producibility Systems Guidelines, Dec 1999 Technology Readiness Assessment Deskbook, Jul 2009
3337	D.4	Insert Manufacturing Technology Projects
3338	Manu	facturing and Quality Tasks
3339 3340	•	Update program manufacturing technology plans based on status (funding and schedule) and results of project, which should address:
3341 3342 3343 3344 3345 3346 3347 3348 3349 3350 3351 3352 3353 3354 3355	•	 Risk reduction manufacturing process areas Improvements in manufacturing processes (cost and schedule) Resulting quality improvements (e.g., C_{pks}, yields, rates, etc.) Other source manufacturing technology efforts (e.g., Title III, IBAS, Technical Assistance Centers, NIST, etc.) Demonstrations of completed manufacturing technology projects to industry in the appropriate facility Contractor/subcontractor level of participation in the project Scheduled manufacturing technology project insertion at the Contractor/subcontractor facility Relevant data collected to support insertion (e.g., DCMA, Title III, etc.) Manage manufacturing technology projects to plan. Conduct demonstrations of completed ManTech projects to industry in the appropriate facility. Implement, monitor, and track manufacturing technology projects at Contractor/
3356 3357 3358 3359		 subcontractor facility for effectiveness and performance. Demonstrate manufacturing technology development solutions in a production representative environment Continue manufacturing technology efforts for validation on the Pilot Lines
3360	Metrie	cs
3361 3362	•	Program manufacturing technology plans are implemented and being updated based on status and interim results from the project, which address:
3363 3364 3365 3366		 Manufacturing process area risk reductions and issue resolutions Manufacturing process improvements (with documented cost and schedule improvements) Quality improvements (with documented improvements in C_{pk}s, yields, rates, etc.)

3367		• Results, impacts, and initiatives documented and adapted from other source
3368		manufacturing technology efforts (e.g., Title III, IBAS, Technical Assistance Centers,
3369		NIST, etc.)
3370		• Demonstrations to industry in the appropriate facility
3371		• Changes in Contractor/subcontractor level of participation in the project
3372		• Changes in manufacturing technology project insertion scheduling by the
3373		Contractor/subcontractor
3374		• Data collected to support insertion (e.g., DCMA, Title III, etc.)
3375 3376	•	Report progress of manufacturing technology projects to plan at management reviews as required.
3377	•	Documentation of completed ManTech project industry demonstrations has been included in
3378		the Manufacturing Plan for implementation.
3379	•	Manufacturing technology projects have been implemented, are being monitored, and tracked
3380		at Contractor/ subcontractor facility with data being collected (e.g., cost, schedule, yield, rate,
3381		etc.) to document effectiveness and performance in a production representative environment.
3382	•	Data collection and documentation to support continuing manufacturing technology
3383		validation on the Pilot Lines is ongoing (e.g., cost, schedule, yield, rate, etc.).
3384	Tools	
3385	•	Army ManTech Proposal Rating spreadsheet
3386	•	ManTech Phase I project questionnaire
3387	•	MRL Assessment Checklist for Technology and Industrial Base thread
3388	•	TRL Assessment Checklist
3389	Resou	rces
3390	•	Defense Production Act, Title III
3391	•	DoDD 4200.15, ManTech
3392	•	DoDI 5000.02,
3393	•	MRL Deskbook Version 2016
3394	•	Defense Manufacturing Management Guide for PMs, Chapter 8, Technology Development
3395		and Investments
3396	•	Technology Readiness Assessment Guidance, Apr 2011
3397	•	Service ManTech guidance, e.g. Air Force Technology and Transition Strategy Guidebook,
2208		Nov 2010

3399	D.5	Update and Validate Industrial Base Capabilities
3400	Manu	facturing and Quality Tasks
3401 3402 3403	•	Update and validate prior Industrial Base Capability assessments based on CDR and Pilot Line demonstrations for program management and technical reviews (e.g., PRR, SVR, FCA, etc.) prior to LRIP for (See D.1) changes in:
3404 3405 3406		 Sources and alternatives Obsolescence (e.g., market trends, environmental factors, policies, etc.) Vulnerabilities
3407 3408 3409 3410 3411		 Sole, single, foreign, etc. Military Counterfeit Potential exploitation Fragility and uncertainty of demand
3412 3413 3414 3415 3416 3417 3418 3419		 Production capability and capacity Security (threat physical and cyber) Availability (e.g., materials, components, equipment, facilities, etc.) LRIP required COTS and NDIs External dependencies Capabilities to support the systems (e.g., tooling, production, equipment, test equipment, etc.) Government and Contractor Depot and Maintenance and Repair Operations
3420 3421	•	Incorporate into the update changes in manufacturing and quality maturity of new and unique capabilities and processes that are included in the system.
3422 3423		• Include technological developments, market trends, processes, environmental factors, and policies, etc.
3424 3425 3426 3427 3428	•	As part of the update, include reporting and analyses from DCMA and DLA on relevant Industrial Base capabilities, status, and trends. Assess effectiveness of actions or investments made to address manufacturing and quality Industrial Base risks to cost, schedule, performance; areas that should have been included are:
3429 3430 3431 3432 3433 3434		 Capabilities required throughout the life of the system Product or technology obsolescence Business fragility for unique services, products, or manufacturing and quality capabilities Industrial Base resilience to rates, vulnerabilities, capacity, Availability of system required materiel (e.g., materials, special alloys and composites, components, tooling, equipment, alternatives, etc.)
3435		 Maturation of new and unique capabilities

3436 3437 3438 3439 3440	 Update the manufacturing and quality inputs to the joint Risk, Issues, and Opportunity Management System (to include mitigation status) for Industrial Base capabilities and capacities in support of LRIP and Production and Deployment phase. Update the manufacturing and quality inputs to the Industrial Base Capabilities Considerations Summary Report for Milestone (MS) C.
3441	Metrics
3442 3443 3444 3445	• Industrial Base Capability assessments have been updated and validated by manufacturing and quality based on results from CDR and Pilot Line demonstrations and have been documented and provided to program management for technical reviews (e.g., PRR, SVR, FCA, etc.) for changes in:
3446 3447 3448	 Sources and alternatives Obsolescence (e.g., market trends, environmental factors, policies, etc.) Vulnerabilities
3449 3450 3451 3452 3453	 Sole, single, foreign, etc. Military Counterfeit Potential exploitation Fragility and uncertainty of demand
3454 3455 3456 3457 3458 3459 3460 3461	 Production capability and capacity Security (threat physical and cyber) Availability (e.g., materials, components, equipment, facilities, etc.) LRIP required COTS and NDIs External dependencies Capabilities to support the systems (e.g., tooling, production, equipment, test equipment, etc.) Government and Contractor Depot and Maintenance and Repair Operations
3462 3463	• Changes in manufacturing and quality maturity of new and unique capabilities and processes that are included in the system have been incorporated and documented.
3464 3465	 Including technological developments, market trends, processes, environmental factors, and policies, etc.
3466 3467 3468 3469 3470 3471 3472	 Reporting and analyses from DCMA and DLA on relevant Industrial Base capabilities, status, and trends have been included in the manufacturing and quality updates to program planning. Actions and/or investments made to address manufacturing and quality Industrial Base risks to cost, schedule, performance have been assessed the results documented and include the following: Capabilities required throughout the life of the system
3473	 Product or technology obsolescence

4. Engineering and Manufacturing Development (EMD) Phase

3474		• Business fragility for unique services, products, or manufacturing and quality capabilities
3475		 Industrial Base resilience to rates, vulnerabilities, capacity,
3476		• Availability of system required materiel (e.g., materials, special alloys and composites,
3477		components, tooling, equipment, alternatives, etc.)
3478		• Maturation of new and unique capabilities
3479	٠	The joint Risk, Issues, and Opportunity Management System has been updated with
3480		manufacturing and quality inputs on Industrial Base capabilities and capacities in support of
3481		LRIP and Production and Deployment phase.
3482	•	Manufacturing and quality inputs to the Industrial Base Capabilities Considerations Summary
3483		Report for MS C have been documented and provided.
3484	Tools	
3485	٠	Industrial Base Assessment Survey Form, DCMA Industrial Analysis Center
3486	٠	MRL Assessment Checklist for Technology and Industrial Base thread
3487	Resou	rces
3488	•	10 USC 2440, Technology and Industrial Base
3489	•	10 USC 2501, National Security Objectives Concerning National Technology and Industrial
3490		Base
3491	•	10 USC 2503, Analysis of the Technology and Industrial Base
3492	•	DoDI 5000.02
3493	٠	DODI 5000.60H Defense Industrial Capabilities Assessments
3494	•	MRL Deskbook Version 2016

3495 **E. DESIGN**

- 3496 During the EMD phase, by CDR, all of the design information necessary to plan the detailed
- 3497 manufacturing operations for the system should be available. Manufacturing and quality participation
- early in the design process through active participation in the Design IPT is the key to creating a
- 3499 producible design. Participants should support and provide inputs on design trade studies
- 3500 (producibility, materials, IB capabilities, etc.), analyses, testing, configuration control, design
- reviews, etc. This information should be the basis for the Manufacturing Strategy and Plan and the
- 3502 Quality Strategy and Plan, which cover the issues of manufacturing and quality organization, make
- or buy planning, subcontract management, resources and capabilities, and the required detailed
- 3504 fabrication and assembly planning to include pilot line and ramp-up for LRIP. The Contractors' and
- supply chain manufacturing and quality capabilities should be assessed throughout the EMD phase as
- these capabilities will be required in this phase and must be in place for LRIP.

4. Engineering and Manufacturing Development (EMD) Phase



3507

3508 Producibility planning started during the concept exploration phase and has influenced the entire design effort from that point on. The objectives of producibility include both engineering design 3509 criteria and the producibility planning requirements. The program is required to "reduce 3510 3511 manufacturing risk and demonstrate producibility" prior to full-rate production (per DoDD 5000.01). 3512 This requires producibility plans to be assessed and updated on a periodic basis and producibility activities to be monitored and assessed on a continuing basis. Additionally, producibility planning in 3513 3514 EMD should address all areas of manufacturing and quality impacting cost, schedule, and 3515 performance requirements such as KCs (KCs), selection of specific materials, specific manufacturing 3516 and quality processes, changes in requirements, changes in workforce, facilities, tooling, equipment,

3517 etc.

3518 Producibility assessments of the design should be conducted at the Contractor and in the supply chain

using of a wide range of producibility tools, techniques, and procedures including Modeling and

3520 Simulation, Failure Mode and Effects Analyses (and Criticality), Design for Manufacture and

3521 Assembly, product and process capabilities with measurements utilizing Statistical Process Control,

3522 etc. Results of manufacturing and quality design producibility assessments should generate

3523 recommendations for design improvements to be integrated into the detailed system design and/or

3524 system specifications according to a joint government/ Contractor producibility schedule.

3525 For EMD, in order to identify and obtain the required manufacturing and quality processes and

resources, the design should be specified in detail. The final design (i.e., approved at CDR) results

3527 from performance requirements, outcomes of the testing accomplished, producibility studies, and

other design influences related to cost, schedule, and performance. Prior to a system-level CDR,

detailed design must be developed from the component level up to the system level with design

reviews conducted to assure meeting design requirements and goals at all levels of the supply chain.

3531 Prior to release of drawings to manufacturing, the detailed design drawings, bills-of-material, and

product and process specifications must be completed. Further, it is essential that assessments be conducted to ensure that the Contractor is complying with requirements and meeting cost/design

3534 goals.

3535 Many system-level risks evolve from immature designs and failure to consider design risks. Risks

associated with manufacturing and quality processes will have a major impact on the maturity of

design. Manufacturing and quality must assess design maturity based on manufacturing feasibility,

3538 capability, producibility, and KCs, in accordance with industry best practices. Through support of all

design reviews at all levels of the supply chain, the adequacy and completeness of manufacturing and

4. Engineering and Manufacturing Development (EMD) Phase

- 3540 quality requirements verification and validation activities can be determined. Additional design
- 3541 maturity can be achieved through demonstrations of manufacturing and quality processes and
- 3542 procedures in a representative environment at the system, subsystem, item, and component level.

3543 Manufacturing and quality program personnel should monitor and assess the maturity of KCs and

- 3544 critical characteristics, as well as the associated manufacturing and quality processes, and risk and
- issues mitigation activities. The correctness, adequacy, and completeness of key and critical
- 3546 processes for KCs and critical characteristics should be verified as part of this monitoring and
- assessment of maturity to include the closure of post-PDR manufacturing and quality mitigation
- 3548 measures.
- 3549 As the design progresses from preliminary design to detailed design, the Design IPT must ensure that
- all design considerations are maturing on schedule for CDR and address all design risk contributors
- including trade studies, design policies, processes, and analyses, parts and materials selections,
- software design, testing, configuration control, and design reviews. The PDR and CDR are the
- 3553 systems engineering technical reviews that are used to measure design maturity. By CDR, the design
- should be mature, stable and with few engineering changes. Producibility is a best practice for
- associate the sign is producible and affordable.
- 3556 Identification of KCs was initiated in the early phases of development, and the list of KCs should be 3557 continually updated and refined. In EMD phase, the list should matured to a final list of all KCs, 3558 corresponding to the finalized design at CDR. Prior to completing design, the list of KCs could be 3559 reduced through producibility activities as the product design is refined to make key characteristics 3560 less sensitive to variation. As the KCs are finalized, the corresponding list of critical manufacturing 3561 and quality processes should also be completed. Post-CDR activities, including pilot line, will 3562 provide the basis for validation and adequacy of the Contractor's processes, capabilities, and control 3563 of KCs.
- The role of manufacturing to influence the design culminates at CDR. Manufacturing and quality design decisions have major impact on future production and life-cycle costs. By the time the CDR is held the production and life-cycle costs commitment is approximately 90 percent. Therefore, manufacturing, quality, and other considerations must be finalized by CDR to enhance affordability. All key and critical manufacturing processes, including process control plans, should be defined, characterized, and up-to-date for the final detailed design. Government and contractor producibility analyses should identify manufacturing and quality risk and issues. The associated mitigation
- activities should be ongoing, up-to-date, and monitored in the joint government/contractor Risk,
- 3572 Issue, and Opportunity Management System for resolution prior to the Milestone C decision.
- Programs prepare a SEP for each milestone review, beginning with Milestone A. It is intended to be
 a living document, tailored to the program, and a roadmap that defines comprehensive SE activities,
 addressing both government and Contractor technical activities and responsibilities. Additionally, the
 SEP describes the timing, conduct, entrance criteria, and success/exit criteria of technical reviews. A

4. Engineering and Manufacturing Development (EMD) Phase

- well-managed, periodically maintained SEP should be updated post-CDR by manufacturing andquality to facilitate program success.
- 3579 The Manufacturing and Quality Strategies should include assessments of the manufacturing and
- 3580 quality processes effective demonstrations in an appropriate environment, such as a pilot line
- anvironment, prior to Milestone C. These demonstrations on a pilot line should incorporate all key
- 3582 elements (equipment, personnel skill levels, materials, components, work instructions, tooling, etc.)
- required to produce components, items, subsystems, or systems and validate meeting design
- 3584 requirements for low-rate production (LRIP). Manufacturing and quality processes and procedures
- required for production must be matured to a level of high confidence for LRIP in the P&D phase.
- A successful pilot line build provides the means to validate that system design is complete and
- 3587 sufficiently stable to enter low-rate production. All materials, manpower, tooling, test equipment and
- 3588 facilities, STE/SIE, processes and procedures are proven on the pilot line, meeting the planned low-
- 3589 rate production schedule, and known manufacturing and quality risks are under control, posing no
- 3590 significant challenges. Outputs of the pilot line will produce articles subject to First Article
- 3591 Inspections (FAIs) and/or First Article Tests (FATs) and will provide validation of the design and
- that manufacturing and quality processes are under control and ready for LRIP.
- 3593 E.1 Participate in Design IPT
- 3594 Manufacturing and Quality Tasks

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- Manufacturing and quality Design IPT participants assess and monitor continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.).
 Update manufacturing and quality requirements based on analyses of system requirements and design concepts from TMRR developments and the PDR including:
- 3599 o System capabilities and constraints
 - The required manufacturing and quality capabilities baseline
- 3601 Manufacturing and quality cost drivers and impact on schedule and performance
- Provide manufacturing and quality input to design trade studies (i.e., functional and performance requirements) that include criteria concerning:
 - KCs and the associated KPPs, KSAs, and APAs
 - Manufacturing and quality process capabilities, limitations, and concerns
- 3606 Materials, components, and items sourcing (e.g., domestic vs. foreign risks)
 - Embedded software and firmware development and re-use
 - Use of intellectual property and proprietary data
- 3609 Safety, handling, storage, and disposal considerations and restrictions
- 3610 O Quality constraints and costs (measurements, destructive/non-destructive tests, process
 3611 capabilities, limitations, etc.)
- 3612 Manufacturing costs, materials, special tooling, and test equipment

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3613 3614		• Manufacturing facility and equipment capacity, workforce availability and capability, and schedule impacts
3615	•	Manufacturing and quality participation in the design producibility process provides:
3616 3617 3618 3619 3620 3621 3622 3623 3623 3624 3625 3626		 Analyses of products and processes that would benefit from producibility analyses (i.e., DFM/DFA) Monitoring and reporting on producibility processes and testing with respect to risks, issues, and opportunities Integration of producibility with other design activities including software and firmware development and re-use Analyses and results of producibility design trade studies to include process capabilities, manufacturing costs, tooling, test equipment, materials, manufacturing capacity, workforce training, schedule impacts, etc. Assessment of additional innovative manufacturing technology opportunities (beyond current ManTech projects)
3627 3628 3629 3630 3631 3632 3633 3634 3635 3636	• • • •	 Provide a focal point for producibility assessments and integration with other design activities. Provide assessments of key and critical manufacturing and quality assembly and test processes to be evaluated and matured. Provide ongoing manufacturing and quality assessments of risks, issues, and opportunities (e.g., technologies, manufacturing, software development, and sustainment). Provide monitoring, reviews, analyses, and reports on multiple FMEAs (e.g., DFMEA, PFMEA, etc.) as part of the manufacturing and quality inputs to the FMECA process. For the Engineering and Manufacturing Development and demonstration process, manufacturing and quality participants should provide:
3637 3638 3639 3640 3641 3642 3643 3644 3645 3646		 Inputs that establish, implement, and maintain appropriate processes to manage key and critical subsystems, components, and items including process controls for KCs Criteria and metrics for design and production process verification, test, inspection, product verification and acceptance (including statistical techniques) Monitoring and managing the data from the development process with acceptable frequency, quantity, and metrics Criteria for and monitoring of manufacturing and quality development testing for validating design outputs (products) Manufacturing and quality inputs for design configuration management (including verification, validation, and change control)
3647 3648 3649	•	Update the analyses of manufacturing and quality design activity impacts and interdependencies to other functional areas or activities (e.g., engineering, producibility, costs, safety, manpower, schedule, etc.).

4. Engineering and Manufacturing Development (EMD) Phase

3650 3651 3652	•	Perform re-assessments of manufacturing and quality risks, issues, and opportunities and the associated mitigation activities, based on the changes to and progress of the design, in meeting critical design entrance criteria (e.g., technology, manufacturing, cybersecurity,
3653		software development, and sustainment).
3654	•	Provide manufacturing and quality support to Design IPT participation in program reviews
3655		(e.g., PMRs, CDR, etc.).
3656	•	Assess and monitor the development of the system design for use of COTS, GOTS,
3657		GFP/GFE, and NDIs for impacts to manufacturing and quality, potential obsolescence
3658		requiring re-design and design changes, and sustainment (e.g., availability, storage, etc.)
3659	•	Provide updated manufacturing and quality inputs to program documentation (e.g., SEP,
3660		TEMP, AS, CDD, etc.) based on design changes and progress:
3661		• Include inputs and support for CPD efforts
3662		• Include inputs for Manufacturing Plan undates (including changes investments etc.)
5002		• Include inputs for infuturationing Fian appares (including changes, investments, etc.)
3663	٠	Manufacturing and quality participants should provide support to other IPTs as required (e.g.,
3664		Systems Engineering, Costs, Proposal Team, etc.).
3665	•	Provide manufacturing and quality inputs to Program Management in support of assessments
3666		and reports mandated by Congress.
3667		• Inputs on manufacturing and quality risks associated with the program
3668		• Inputs on manufacturing and quality processes that need to be matured
3669	Metri	CS
3669 3670	Metrie •	cs Manufacturing and quality Design IPT participants have assessed and are monitoring
3669 3670 3671	Metrie •	cs Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500,
3669 3670 3671 3672	Metrie •	cs Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program
3669 3670 3671 3672 3673	Metrie •	cs Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate.
3669 3670 3671 3672 3673 3674	Metrie •	Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and
3669 3670 3671 3672 3673 3674 3675	Metrie •	cs Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and
3669 3670 3671 3672 3673 3674 3675 3676	Metrie •	Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on:
3669 3670 3671 3672 3673 3674 3675 3676 3677	Metrie •	CS Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on:
3669 3670 3671 3672 3673 3674 3675 3676 3677 3678	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline
 3669 3670 3671 3672 3673 3674 3675 3676 3677 3678 3679 	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline Cost drivers and impacts to schedule and performance
3669 3670 3671 3672 3673 3674 3675 3676 3677 3678 3679	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline Cost drivers and impacts to schedule and performance
 3669 3670 3671 3672 3673 3674 3675 3676 3677 3678 3679 3680 	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline Cost drivers and impacts to schedule and performance
3669 3670 3671 3672 3673 3674 3675 3676 3677 3678 3679 3680 3681	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline Cost drivers and impacts to schedule and performance Manufacturing and quality has participated in and provided documented inputs to design trade studies including criteria concerning:
 3669 3670 3671 3672 3673 3674 3675 3676 3677 3678 3679 3680 3681 3682 	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline Cost drivers and impacts to schedule and performance Manufacturing and quality has participated in and provided documented inputs to design trade studies including criteria concerning: KCs and the associated KPPs, KSAs, and APAs
3669 3670 3671 3672 3673 3674 3675 3676 3677 3678 3679 3680 3681 3682 3683	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline Cost drivers and impacts to schedule and performance Manufacturing and quality has participated in and provided documented inputs to design trade studies including criteria concerning: KCs and the associated KPPs, KSAs, and APAs Manufacturing and quality process capabilities, limitations, and concerns
3669 3670 3671 3672 3673 3674 3675 3676 3677 3678 3679 3680 3681 3682 3683 3683	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline Cost drivers and impacts to schedule and performance Manufacturing and quality has participated in and provided documented inputs to design trade studies including criteria concerning: KCs and the associated KPPs, KSAs, and APAs Manufacturing and quality process capabilities, limitations, and concerns Materials, components, and items sourcing (e.g., domestic vs. foreign risks)
3669 3670 3671 3672 3673 3674 3675 3676 3677 3678 3679 3680 3681 3682 3683 3684 3685	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline Cost drivers and impacts to schedule and performance Manufacturing and quality has participated in and provided documented inputs to design trade studies including criteria concerning: KCs and the associated KPPs, KSAs, and APAs Manufacturing and quality process capabilities, limitations, and concerns Materials, components, and items sourcing (e.g., domestic vs. foreign risks) Embedded software and firmware development and re-use
 3669 3670 3671 3672 3673 3674 3675 3676 3677 3678 3679 3680 3681 3682 3683 3684 3685 3686 	Metrie •	 Manufacturing and quality Design IPT participants have assessed and are monitoring continuing adherence to manufacturing and quality design best practices (e.g., AS6500, AS9100, ISO 9001, etc.) and providing documented recommendations to Program Management and the Contractor as appropriate. Manufacturing and quality requirements, based on analyses of system requirements and design concepts from TMRR developments and the PDR, have been updated for the SEP and included inputs on: System capabilities and constraints The required manufacturing and quality capabilities baseline Cost drivers and impacts to schedule and performance Manufacturing and quality has participated in and provided documented inputs to design trade studies including criteria concerning: KCs and the associated KPPs, KSAs, and APAs Manufacturing and quality process capabilities, limitations, and concerns Materials, components, and items sourcing (e.g., domestic vs. foreign risks) Embedded software and firmware development and re-use Use of intellectual property and proprietary data

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3688 3689 3690 3691 3692	 Quality constraints and costs (measurements, destructive/non-destructive tests, process capabilities, limitations, etc.) Manufacturing costs, materials, special tooling, and test equipment Manufacturing facility and equipment capacity, workforce availability and capability, and schedule impacts
3693 •	Manufacturing and quality participants in the design producibility process have provided:
3694 3695 3696 3697 3698 3699 3700 3701 3702 3703 3704	 Reports to Program Management and the Contractor with recommendations of products and processes that require producibility analyses performed Monitoring, reporting, and status of mitigation of risks and issues, and progress on opportunities from producibility processes and testing Analyses and documentation of the integration of producibility with other design activities (including software and firmware development and re-use) Documentation of producibility design trade studies results and impacts, including process capabilities, manufacturing costs, tooling, test equipment, materials, manufacturing capacity, workforce training, schedule impacts, etc. Analyses and recommendations for addition of new innovative manufacturing technology opportunities (beyond current ManTech projects)
3705 • 3706 • 3707 • 3708 • 3709 • 3710 • 3711 • 3712 • 3713 • 3714 • 3715 • 3716 •	Documentation has been provided for producibility assessments and integration with other design activities to Program Management and Systems Engineering. Key and critical manufacturing and quality assembly and test processes have been assessed for maturity with documented recommendations to finalize and implement in the Manufacturing Plan and potentially the SEP. Manufacturing and quality participants have provided monitoring and reports on manufacturing and quality risks and issues mitigation status (burn-down), and opportunity activities progress. As part of the manufacturing and quality inputs to the FMECA process, reports on reviews, analyses, and status of multiple FMEAs (e.g., DFMEA, PFMEA, etc.) have been provided to Program Management and System Engineering. Manufacturing and quality participants have provided and documented in the Manufacturing Plan for EMD and the demonstration process:
3718 3719 3720 3721 3722 3723 3724 3725	 Inputs that establish, implement, and maintain appropriate processes to manage key and critical subsystems, components, and items including process controls for KCs Criteria and metrics for design and production process verification, test, inspection, product verification and acceptance (including statistical techniques) Future processes to monitor and manage data with acceptable frequency, quantity, and metrics based on ongoing monitoring and management activities Criteria for manufacturing and quality development testing to validate the design Manufacturing and quality inputs for design configuration management

3726	•	Analyses of manufacturing and quality design activity impacts and interdependencies to other
3727		functional areas or activities (e.g., engineering, producibility, costs, safety, manpower,
3728		schedule, etc.) have been updated and documented in the SEP and in the IMP/IMS.
3729	•	Based on design changes and progress in meeting critical design entrance criteria, re-
3730		assessments of manufacturing and quality risks, issues, and opportunities and the associated
3731		mitigation activities have been performed and documented for the joint RIO Management
3732		System.
3733	•	Manufacturing and quality Design IPT participants have provided support and documentation
3734		to program reviews (e.g., PMRs, CDR, etc.).
3735	•	The use of COTS, GOTS, GFP/GFE, and NDIs in the system design has been assessed and
3736		documented for impacts to manufacturing and quality as well as potential obsolescence
3737		requiring re-design and design changes and impacts on sustainment (e.g., availability,
3738		storage, etc.).
3739	•	Updated manufacturing and quality inputs have been provided to program documentation
3740		(e.g., SEP, TEMP, AS, CDD, etc.) based on design changes and progress including:
3741		• Inputs and support for CPD efforts
3742		• Inputs for Manufacturing Plan updates (including changes, investments, etc.)
2712		Manufacturing and quality participants have provided support and decomponiestion (inputs) to
3743	•	other IDTs as required (a.g. Systems Engineering Costs Proposal Team, etc.)
5744 2745		Manufacturing and quality has manifold inputs to Program Management in support of
3745	•	Manufacturing and quality has provided inputs to Program Management in support of
3/40		Congressionally mandated assessments and reports including inputs on:
3747		 Manufacturing and quality risks associated with the program
3748		• Manufacturing and quality processes that need to be matured
3749	Tools	
3750	•	Design for Manufacturing and Assembly (DFMA)
3751	•	CDR checklist
3752	•	TRR Checklist
3753	•	TRA checklist
3754	•	MRL assessment checklist, Design thread
3755	•	PRR Checklist
3756	•	SVR Checklist
3757	•	FCA Checklist
3758	•	SEP template
3759	•	TEMP template
3760	•	Life Cycle Sustainment Plan template
3761	•	IMP/IMS template
3762	•	CPD template

4. Engineering and Manufacturing Development (EMD) Phase

3763	Resou	rces
3764	٠	10 USC 144B, Sec 2366 and 2448
3765	٠	Acquisition Strategy Guide, DSMC, Dec 1999
3766	•	Systems Engineering Plan Preparation Guide, Apr 2011
3767	•	Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct
3768		2005
3769	•	TEMP Guide, Dec 2012 and DAG Chapter 8-4.1
3770	•	LCSP memo, Sep, 2011 and DAG Chapter 4-3.1
3771	•	CDD-CPD writing Guide, Feb 2015
3772	•	Critical Design Review, DAG Chapter 3-3.3.5
3773	•	Test and Evaluation Management Guide
3774	•	System Verification Review, DAG Chapter 3-3.3.6
3775	٠	Functional Configuration Audit, DAG Chapter 3-3.3.6
3776	•	Production Readiness Review, DAG Chapter 3-3.3.7
3777	•	TRA Guidance 2011
3778	•	MRL Deskbook version 2016
3779	E.2	Assess Design vs. Manufacturing Capability
3780	Manu	facturing and Quality Tasks
3781 3782	•	Perform manufacturing and quality design trade studies and analyses on system, subsystems, items, and components for:
3783		• Interdependencies and interfaces
3784		• Design for Assembly
3785		• Manufacturing and quality "ilities": maintainability, serviceability, testability, etc.
3786	•	Perform manufacturing and quality assessments of the Contractor(s) and supply chain
3787		capability to mature and manufacture the design(s) within the program overall cost, schedule,
3788		and performance goals, including:
3789		• Design status and progress for CDR including exit criteria
3790		 Quantification of risks, issues, opportunities and status of mitigation plans
3791		 Including shortfalls to the required baseline manufacturing and quality capability
3792		 Including materials, producibility, equipment, and schedule (e.g., availability,
3793		hazardous, long-lead, etc.)
3794		• All competing technologies, prototypes, systems, etc.
3795		 Including manufacturing and quality inputs to production unit cost and schedule
3796		estimates realism
3797		• Manufacturing and quality processes and techniques, not yet part of the Contractor's
3798		baseline, development requirements driven by the design, including:

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3799 3800 3801 3802		 Facilities, equipment, manpower, quality technologies, Planned and/or anticipated manufacturing and quality developmental testing and demonstration efforts Capabilities with respect to safety, security, environmental, hazardous materials, etc.
3803 3804 3805 3806 3807 3808	•	Update the preliminary list from TMRR of KCs, critical characteristics, CAIs, Key manufacturing and quality processes, and CSIs, based on design trade studies and assessments, and PDR results. Assess required manufacturing and quality budget and investments for necessary capabilities (e.g., facilities, capital equipment, tooling, test equipment, ManTech, GFE processes, M&S, etc.)
3809	Metri	cs
3810 3811	•	Manufacturing and quality design trade studies and analyses have been conducted and documented for system, subsystems, items, and components including:
3812 3813 3814		 Interdependencies and interfaces Design for Assembly Manufacturing and quality "ilities", maintainability, serviceability, testability, etc.
3815 3816 3817 3818	•	Assessments of the Contractor(s) and supply chain capability to mature the manufacturing and quality aspects and manufacture the design(s) within the program overall cost, schedule, and performance goals have been conducted and recommendations for changes have been documented and provided to the Design IPT, including:
3819 3820 3821		 Recommendations for achieving CDR exit criteria (See E.7) Updated and quantified risks and issues mitigation plans, and potential opportunities which address:
3822 3823 3824		 Shortfalls to the required baseline manufacturing and quality capability Materials, producibility, equipment, and schedule (e.g., availability, hazardous, long-lead, etc.)
3825 3826 3827 3828		 Recommendations for each competing technology, prototype, system, etc. which include inputs to production unit cost and schedule estimates realism Recommendations on manufacturing and quality processes and techniques that are not yet part of the Contractor's baseline but are driven by the design, including:
3829 3830 3831 3832		 Facilities, equipment, manpower, quality technologies, Planned and/or anticipated manufacturing and quality developmental testing and demonstration efforts Capabilities with respect to safety, security, environmental, hazardous materials, etc.
3833 3834 3835 3836	•	Based on the design trade studies and assessments, and the PDR results, the preliminary list from TMRR of KCs, critical characteristics, CAIs, Key manufacturing and quality processes, and CSIs has been updated and provided to the Design IPT and System Engineering IPT, and recommendations provided for the Contractor(s) SEMP.

4. Engineering and Manufacturing Development (EMD) Phase

Manufacturing and quality budget and investments have been documented and provided to
 Program Management for necessary capabilities (e.g., facilities, capital equipment, tooling,
 test equipment, ManTech, GFE processes, M&S, etc.).

3840 **Tools**

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CDR checklist 3842 • 3843 • **TRR** Checklist 3844 • TRA checklist 3845 • MRL assessment checklist, Design thread 3846 • PRR Checklist 3847 • SVR Checklist • FCA Checklist 3848 3849 SEP template • 3850 **TEMP** template • 3851 • Life Cycle Sustainment Plan template 3852 IMP/IMS template • 3853 • **CPD** template 3854 **Resources** 3855 AS6500, Manufacturing Management Program, Nov 2014 •

Design for Manufacturing and Assembly (DFMA)

- 3856 DoDI 5000.02
- 10 USC 144B, Sec 2366 and 2448
- Acquisition Strategy Guide, DSMC, Dec 1999
- Systems Engineering Plan Preparation Guide, Apr 2011
- Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct
 2005
- TEMP Guide, Dec 2012 and DAG Chapter 8-4.1
- LCSP memo, Sep, 2011 and DAG Chapter 4-3.1
- CDD-CPD writing Guide, Feb 2015
- Critical Design Review, DAG Chapter 3-3.3.5
- Test and Evaluation Management Guide
- System Verification Review, DAG Chapter 3-3.3.6
- Functional Configuration Audit, DAG Chapter 3-3.3.6
- Production Readiness Review, DAG Chapter 3-3.3.7
- **•** TRA Guidance 2011
- MRL Deskbook version 2016

4. Engineering and Manufacturing Development (EMD) Phase

3872 E.3 Update Producibility Plans

3873 Manufacturing and Quality Tasks

3874 Review and analyze the Contractor(s) design plans for scope, realism, completeness, and • 3875 clarity of specific processes, methods, and actions to address manufacturing feasibility, 3876 producibility, and quality to include: 3877 A schedule for regular reviews to monitor and support design progress 0 3878 Delineation of responsibilities and management controls 0 3879 • Application of producibility design criteria 3880 o Interdependencies and integration factors 3881 • Manufacturing and quality technology project insertion Technology insertion opportunities, schedule, and budget 3882 0 3883 Ensure updates to Contractor producibility plans for identified and potential manufacturing • 3884 and quality risks, issues, and opportunities to include: 3885 KCs and critical design characteristics 0 3886 Modeling and Simulation results from design, manufacturing, and production modeling 0 3887 • Manufacturing and quality processes, capacity, capability, yield, rates, and variability 3888 • Materials and components (including embedded software) 3889 o Cost, schedule, and performance 3890 o Facilities, tooling, testing, and qualification Workforce 3891 3892 Ensure updated Contractor producibility plans for design, manufacturing, and quality include: • 3893 Security (physical and cyber) 0 3894 o System safety and hazardous materials management criteria 3895 • Interdependencies and integration o Modular Open Systems Approach (MOSA) (includes interfaces and subsystems) 3896 3897 o Benchmarking 3898 o Costing 3899 • Management of manufacturing and quality data 3900 Results of Failure Mode and Effects Analysis (FMEA) 0 3901 Design Failure Mode and Effects Criticality Analysis (DFMECA) 3902 System Failure Mode and Effects Criticality Analysis (SFMECA) Process Failure Mode and Effects Analysis (PFMEA) 3903 3904 Results from prototype builds and demos 0 3905 Evaluate updated Contractor producibility plans for the specific applications of producibility • 3906 design tools such as: 3907 o Failure Mode and Effects Analyses (including Design, Process, and Criticality) 3908 • Design of Experiments (DOE)

4. Engineering and Manufacturing Development (EMD) Phase

 Manufacturing and quality personnel should evaluate Contractor's design producibility process for factors such as: Robust tolerances (dimensions, mechanical, electrical) Materials that provide optimum machinability, formability and weldability Economic use of shapes and forms designs for castings, stampings, extrusions, etc. Optimum inspection and test requirements Use of available and standard inspection equipment Economical methods and procedures Optimized requirements for manufacturing tooling and/or special skills Metrics Assessment and review of Contractor's ongoing producibility enhancement efforts documents cost and/or schedule improvements. Contractor(s) design plans have been evaluated for scope, realism, completeness, and clari with respect to specific processes, methods, and actions that address manufacturing feasibility, producibility, and quality. Recommendations for and required actions or addition to the plans have been provided to Program Management and the Contractor. Documented Contractor plans should have included: A schedule of regular reviews to monitoring and supporting design progress Roles, responsibilities, and management controls Insertion points for manufacturing and analyty technology projects 	
 3920 Robust tolerances (dimensions, mechanical, electrical) Materials that provide optimum machinability, formability and weldability 3922 Economic use of shapes and forms designs for castings, stampings, extrusions, etc. 3923 Optimum inspection and test requirements 3924 Use of available and standard inspection equipment 3925 Economical methods and procedures Optimized requirements for manufacturing tooling and/or special skills 3927 Metrics 3928 Assessment and review of Contractor's ongoing producibility enhancement efforts documents cost and/or schedule improvements. Contractor(s) design plans have been evaluated for scope, realism, completeness, and clari with respect to specific processes, methods, and actions that address manufacturing geasibility, producibility, and quality. Recommendations for and required actions or additid to the plans have been provided to Program Management and the Contractor. Documented Contractor plans should have included: A schedule of regular reviews to monitoring and supporting design progress Roles, responsibilities, and management controls Producibility design criteria Management of interdependencies and integration factors Insertion point for manufacturing and anality technology projects 	
 Metrics Assessment and review of Contractor's ongoing producibility enhancement efforts documents cost and/or schedule improvements. Contractor(s) design plans have been evaluated for scope, realism, completeness, and clari with respect to specific processes, methods, and actions that address manufacturing feasibility, producibility, and quality. Recommendations for and required actions or addition to the plans have been provided to Program Management and the Contractor. Documented Contractor plans should have included: A schedule of regular reviews to monitoring and supporting design progress Roles, responsibilities, and management controls Producibility design criteria Management of interdependencies and integration factors Insertion points for manufacturing and quality technology projects 	
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 3935 A schedule of regular reviews to monitoring and supporting design progress 3936 Roles, responsibilities, and management controls 3937 Producibility design criteria 3938 Management of interdependencies and integration factors 3939 Insertion points for manufacturing and quality technology projects 	ity ons 1
 3940 o Schedule and budget for technology insertions 	
 Updates to the Contractor producibility plans have been identified and documented recommendations provided to Program Management and the Contractor for the following: 	:
 3943 3943 Updates to KCs and critical design characteristics Results from design, manufacturing, and production modeling (i.e., M&S) Changes in manufacturing and quality processes, capacity, capability, yield, rates, and variability Changes in materials and components (including embedded software) 	Į

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4. Engineering and Manufacturing Development (EMD) Phase

3948 3949		 Updates to cost, schedule, and performance Facilities, tooling, testing, and qualification updates
3950		• Workforce changes (e.g., skill sets, availability, training, turnover, etc.)
3951 3952	•	Documented Contractor producibility plans have been reviewed and approved, and should include the following design, manufacturing, and quality considerations:
 3953 3954 3955 3956 3957 3958 3959 3960 3961 3962 		 Security (physical and cyber) System safety and hazardous materials management criteria Interdependencies and integration Modular Open Systems Approach (MOSA) (includes interfaces and subsystems) Benchmarking Costing Management of manufacturing and quality data Results of Failure Mode and Effects Analysis (FMEA) Design Failure Mode and Effects Criticality Analysis (DFMECA) System Failure Mode and Effects Criticality Analysis (SEMECA)
3962 3963		 System Failure Mode and Effects Chucality Analysis (SFMECA) Process Failure Mode and Effects Analysis (PFMEA)
3964		• Results from prototype builds and demos
3965 3966 3967 3968	•	Updated Contractor producibility plans for use of specific design tools have been evaluated and analyses performed and documented to indicate expected results. Contractor's design producibility process has been evaluated and reported to Program Management, and should include producibility best practices of:
 3969 3970 3971 3972 3973 3974 3975 		 Robust tolerances (dimensions, mechanical, electrical) Materials that provide optimum machinability, formability and weldability Economic use of shapes and forms designs for castings, stampings, extrusions, etc. Optimum inspection and test requirements Use of available and standard inspection equipment Economical methods and procedures Optimized requirements for manufacturing tooling and/or special skills
3976	Tools	
3977	•	Producibility Engineering and Planning (PEP) Data Item Description
3978	Resou	rces
3979 3980 3981 3982 3983	•	AS6500, Manufacturing Management Program, Nov 2014 IEEE 15288.2, System and Software Engineering, 2015 NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy, Dec 1999 MIL-HDBK-727, Design Guidance for Producibility, Apr 1984 Producibility Engineering Standard Practice Manual US Army Belvoir R&D Center, Sep
3984	•	1993

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4. Engineering and Manufacturing Development (EMD) Phase

- Defense Manufacturing Management Guide for Program Managers, Chapter 7.6
 Producibility Engineering and Planning (PEP)
- 3987 E.4 Conduct Producibility Assessments
- 3988 Manufacturing and Quality Tasks
- Manufacturing and quality Design IPT participants support and/or perform producibility
 assessments utilizing updated and approved Contractor producibility plans and other
 Contractor and/or programmatic information and data including the following factors in the
 assessments:
- 3993oPlanned producibility goals and metrics
- 3994 Management roles, responsibilities, and controls
- 3995 o Updates to KCs and critical design characteristics
- 3996 O Contractor core capabilities and processes (e.g., manufacturing and quality technologies, design and process disciplines, etc.)
- 3998 Design analyses and testing (i.e., prototypes)
- 3999 Results from design, manufacturing, and production modeling (i.e., M&S)
- 4000oChanges in manufacturing and quality processes, capacity, capability, yield, rates, and
variability4001variability
- 4002 Changes in materials and components (including embedded software)
- 4003 o Build and test data (from subsystem, items, components, and/or the supply chain)
- 4004 o Updates to cost, schedule, and performance
 - Updates to interdependencies and integration
 - Modular Open Systems Approach (MOSA) (includes interfaces and subsystems)
- 4007 o Risks, issues, and opportunities
- 4008 o Insertion points for manufacturing and quality technology projects
- 4009 o Technology insertion schedule and budget
- 4010 o Review of goals, realism, completeness, and clarity
- 4011 o Implementation of industry best practices, tools, and techniques
- 4012 o System safety design and hazardous materials management criteria
- 4013oSecurity (physical and cyber) including all digital communications and connectivity for4014design, facilities, equipment, etc.
- 4015 o Facilities, tooling, testing, and qualification updates
- 4016 Workforce changes (e.g., skill sets, availability, training, turnover, etc.)
- 4017 o GFE, etc.

4005

4006

- Incorporate and investigate producibility possibilities that exist in the industrial base outside
 the Contractor's supply chain from the assessments of the IB. (See D.1)
- Manufacturing and quality Design IPT participants monitor, recommend, and support use of
 a wide range of producibility tools, techniques, procedures that include:
| 4022
4023 | 0 | State of the art Modeling and Simulation software including element analyses software nackages |
|--------------|---------|--|
| 4024 | 0 | Failure Mode and Effects Analyses (FMEA) |
| 4025 | | Design Failure Mode and Effects Criticality Analysis (DFMECA) |
| 4026 | | System Failure Mode and Effects Criticality Analysis (SFMECA) |
| 4027 | | Process Failure Mode and Effects Analysis (PFMEA) |
| 4028 | 0 | Design for Manufacture and Assembly (DFMA) |
| 4029 | 0 | Design of Experiments (DOE) |
| 4030 | 0 | Design for Six Sigma (DSS) |
| 4031 | 0 | Quality Function Deployment (QFD) |
| 4032 | 0 | Value Stream Mapping (VSM) |
| 4033 | 0 | Benchmarking |
| 4034 | 0 | Materials and process design guides (e.g., standards organizations, materials supplier, |
| 4035 | | industry association, etc.) |
| 4036 | 0 | Interdependencies and integration analyses |
| 4037 | 0 | Tolerance analyses (e.g., stacking, robustness, geometric, etc.) |
| 4038 | 0 | Requirements validation analyses |
| 4039 | 0 | Trade studies on alternative product and process designs |
| 4040 | 0 | Product complexity analyses |
| 4041 | 0 | Manufacturing process analyses (i.e., Lean Manufacturing) |
| 4042 | 0 | Quality and quality process analyses |
| 4043 | 0 | Costs, cost drivers, and controls analyses |
| 4044 | 0 | Materials characterization and availability |
| 4045 | 0 | Prototyping of component, item, subsystem, competitive, etc. |
| 4046 | 0 | Learning curve goals and projections |
| 4047 | 0 | Product, process capabilities, and measurements utilizing Statistical Process Control |
| 4048 | | (SPC) |
| 4049 | 0 | Data and database management |
| 4050 | 0 | Developmental testing |
| 4051 | • Pr | ovide program manufacturing and quality support to design producibility analyses, in order |
| 4052 | to | validate and recommend appropriate producibility improvements (by rank and/or priority) |
| 4053 | to | be implemented in the system design and/or specifications. |
| 4054 | • Pr | epare a joint government/Contractor schedule for implementation of the producibility |
| 4055 | im | provements based determined rank and priority. |
| 4056 | Metrics | |
| 4057 | • Ma | anufacturing and quality Design Integrated Product Team (IPT) participants have provided |
| 4058 | su | pport and/or performed producibility assessments utilizing updated and approved |
| 4059 | Co | ontractor producibility plans and other Contractor and/or programmatic information and |
| 4060 | da | ta. Documented assessment results have been analyzed for potential design improvements |
| 4061 | (aı | nd possible ECPs) and include the following: |

4062	С	Status and progress toward producibility goals and metrics
4063	С	Changes in management roles, responsibilities, and controls
4064	С	Improved control of KCs and critical design characteristics
4065	С	Incorporation of Contractor core capabilities and processes (e.g., manufacturing and
4066		quality technologies, design and process disciplines, etc.)
4067	С	Design analyses and testing results (i.e., prototypes)
4068	С	Improvements from design, manufacturing, and production modeling (i.e., M&S)
4069	С	Improvements in manufacturing and quality processes, capacity, capability, yield, rates,
4070		and variability
4071	С	Improvements in materials and components (including embedded software)
4072	С	Analyses of build and test data (from subsystem, items, components, and/or the supply
4073		chain)
4074	С	Improvements to cost, schedule, and performance
4075	С	Reduction of interdependencies and integration considerations
4076	С	Inclusion of MOSA interfaces and subsystems
4077	С	Risks and issues mitigation, and opportunity planning
4078	С	Scheduled insertion points for manufacturing and quality technology projects
4079	С	Scheduled technology insertion
4080	С	Review of goals, realism, completeness, and clarity or the design improvements
4081	С	Industry best practices, tools, and techniques
4082	С	Criteria for System safety design and hazardous materials management
4083	С	Improvements in security (physical and cyber) including all digital communications and
4084		connectivity for design, facilities, equipment, etc.
4085	С	Updates to facilities, tooling, testing, and qualifications
4086	С	Workforce improvements (e.g., skill sets, availability, training, turnover, etc.)
4087	С	Updates for use of GFE, etc.
4088	Р	roducibility possibilities in the industrial base outside the Contractor's supply chain have
4089	h	een analyzed and recommended for implementation. (See D.1)
4090	N	Anufacturing and quality Design IPT participants track and document results and
4091	e	ffectiveness of the wide range of producibility tools techniques procedures applied during
4092	S	vstem design. Documented reports should include:
4002	~	
4093	С	Lessons learned for further application within the program and future programs
4094	С	Updates to learning curves (goals and projections)
4095	С	Analyses of effectiveness and realism Modeling and Simulations utilized for both the
4096		system models and the manufacturing models
4097	С	EMEA -
4098		FMEAS
4099	С	Design changes and improvements to product complexity, manufacturing and quality
4100		processes, and process capabilities recommended by results from application of DOE,
4101		DFMA, DSS, VSM, and Lean Manufacturing

4102		• QFD analyses ranking and validating the requirements and the subsequent impacts on the
4103		design
4104		• Comparisons of system, subsystems, items and components designs to existing or under-
4105		development products (benchmarking) with appropriate data collection and
4106		recommendations for program actions
4107		• Analyses of system, subsystem, items, and components against design guides (e.g.,
4108		standards organizations, materials supplier, industry association, etc.) and
4109		recommendations for design improvements
4110		• Analyses and impacts of interdependencies and integration down to the component level
4111		• Results and recommendations from tolerance analyses (e.g., stacking, robustness,
4112		geometric, etc.)
4113		• Results from trade studies on alternative product and process designs with
4114		recommendations
4115		• Results from analyses of materials characterization and availability with recommended
4116		actions or improvements
4117		• Results from developmental testing and prototyping of component, item, subsystem,
4118		competitive, etc.
4119		• Summary of impacts and improvements to costs, cost drivers, schedule and performance
4120	•	Manufacturing and quality support to design producibility assessments and analyses has
4121		produced a report that validates and recommends appropriate producibility improvements by
4122		rank and/or priority to be implemented in the system design and/or specifications.
4123	•	A joint government/contractor implementation schedule for producibility improvements has
4124		been developed based determined rank and priority.
4125	Tools	
4125	10013	
4126	•	Producibility Assessment Worksheet
4127	Resou	rces
4128	•	AS6500, Manufacturing Management Program, Sep 2016
4129	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
4130		Sep 2016
4131	•	ISO 9001:2015, Ouality Management System
4132	•	IEEE 15288.2. System and Software Engineering, 2015
4133	•	NAVSO P-3687. Producibility System Guidelines. Dept. of the Navy. Dec 1999
4134	•	MIL-HDBK-727. Design Guidance for Producibility Apr 1984
4135	•	Producibility Engineering Standard Practice Manual US Army Belvoir R&D Center Sen
4136		1993

4. Engineering and Manufacturing Development (EMD) Phase

4137 E.5 Develop Detailed Design

4138 Manufacturing and Quality Tasks

- 4139 Support and participate in design reviews at all possible levels of the supply chain to assure • 4140 that the Contractor is complying with the manufacturing and quality design requirements 4141 within the cost/design goals to include: 4142 • Adherence to manufacturing and quality best practices (e.g., AS6500, AS9100, 4143 ISO 9001. etc.) 4144 • Ensure all PDR action items are closed and corrective actions completed. 4145 • Results of appropriate producibility studies including manufacturing technology improvements, recommended design changes, and recommended facilities and equipment 4146 changes 4147 • Results of ManTech projects 4148 4149 • Detailed design drawings, bills-of-material, and product and process specifications are on 4150 track for completion by CDR 4151 • Performance requirements, the outcomes of the testing accomplished, producibility 4152 studies, and other design influences are part of the final design 4153 • Design is specified to the lowest level of detail to meet capability and capacity 4154 requirements 4155 • As part of detailed design activities, manufacturing and quality should identify and quantify risks with associated mitigation (e.g., re-direct, re-design, etc.) to minimize manufacturing 4156 and quality risks in the completed design for CDR. 4157
- As part of detailed design, ensure KCs whose variation has a significant influence on product fit, performance, service life, or manufacturability are specified and monitored for CDR.
- 4160 Manufacturing and quality should identify requirements for in-process and acceptance testing
 4161 to be included in manufacturing and quality processes.
- Ensure manufacturing and quality requirements for physical, digital, and industrial security
 are in compliance with DoD policies and NIST standards incorporated into the design and
 manufacturing system.
- Ensure that required manufacturing and quality products and processes comply with specified
 security (e.g., SSE, COMSEC, and PPP) requirements of the program including trusted
 production of products down to the component level.
- Assess requirements for required system certifications (e.g., statutory, safety, environmental, airworthiness, others as required) and the impacts on manufacturing and quality requirements and associated costs, budget, schedule, etc.
- 4171 Assess design requirements for the following (include associated costs, budget, schedule, etc.):
- 4173 o Incorporation of all ESOH, environmental, hazardous material, etc. requirements into the
 4174 detailed design

 planned facilities and equipment (including EMI susceptibility) Radiation hardening, thermal, vibration, and shock environments, all environmental parameters, and Highly Accelerated Life Testing (HALT) requirements for impacts to and requirements of manufacturing and quality (e.g., facilities, tooling, equipment, test equipment and facilities, processes, procedures, storage, waste disposal, etc.) Impacts to and requirements of manufacturing and quality personnel (e.g., operators, assemblers, welders, platers, coatings specialists, etc.) Impacts to and requirements of manufacturing and quality personnel (e.g., operators, assemblers, welders, platers, coatings specialists, etc.) Corrosion, contamination, hazards, hazardous combinations of materials, and impacts on manufacturing processes, availability, etc.) Impacts to manufacturing and quality data requirements (e.g., collection, processing, storage, security, access, availability, etc.) Impacts to manufacturing and quality equipment, fixtures, tooling, work-holding, parts interim storage and handling equipment, ancillary equipment, etc. Asseess the adequacy of manufacturing and quality sustainment requirements (e.g., maintainability, serviceability, etc.), processes, and activities being considered and addressed in the design specifications. Asseess Contractor's and supplier's configuration management systems for traceability, accuracy, sufficiency, and accessibility in preparation for CDR. Analyze results of demonstrations in a relevant environment have been incorporated into design specifications, and requirements. Analyze results of demonstrations prior to CDR. Assess manufacturing and quality physical architectures, development specifications, and detailed designs for key manufacturing processes (i.e., KCS), CSIs and CAIs to be under Contractor's configuration control and on track for completion by CDR. Ensure all long lead production require	4175		• EMI requirements and constraints for the design, control processes, procedures, and
 Radiation hardening, thermal, vibration, and shock environments, all environmental parameters, and Highly Accelerated Life Testing (HALT) requirements for impacts to and requirements of manufacturing and quality (e.g., facilities, tooling, equipment, test equipment and facilities, processes, procedures, storage, wate disposal, etc.) Impacts to and requirements of manufacturing and quality personnel (e.g., operators, assemblers, welders, platers, coatings specialists, etc.) Corrosion, contamination, hazards, hazardous combinations of materials, and impacts on manufacturing processes, quality control processes, and procedures for both Impacts on manufacturing and quality duta requirements (e.g., collection, processing, storage, sceurity, access, availability, etc.) Impacts to manufacturing and quality from materials, components, and items maturity and availability, lead-times; source availability, capability and capacity to include the supply chain Necessary manufacturing and quality equipment, fixtures, tooling, work-holding, parts interim storage and handling equipment, ancillary equipment, etc. Assess the adequacy of manufacturing and quality sustainment requirements (e.g., manitaniability, serviceability, etc.), processes, and activities being considered and addressed in the design specifications. Assess Contractor's and supplier's configuration management systems for traceability, accuracy, sufficiency, and accessibility in preparation for CDR. Analyze results of demonstrations in a relevant environment from the previous phases of all new technologies to be incorporated into the design to ensure they can be incorporated and integrated into a system with acceptable manufacturing and quality risks. If not conducted, recommend demonstrations prior to CDR. Assess the system design for parts, for completion by CDR. Assess the system design for parts, materials	4176		planned facilities and equipment (including EMI susceptibility)
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 4180 equipment and facilities, processes, procedures, storage, waste disposal, etc.) 4181 Impacts to and requirements of manufacturing and quality personnel (e.g., operators, assemblers, welders, platers, coatings specialists, etc.) 4182 Correston, contamination, hazards, hazardous combinations of materials, and impacts on manufacturing and quality data requirements (e.g., collection, processing, storage, security, access, availability, etc.) 4187 Impacts to manufacturing and quality data requirements (e.g., collection, processing, storage, security, access, availability, etc.) 4187 Impacts to manufacturing and quality data requirements (e.g., collection, processing, storage, security, access, availability, capability and capacity to include the supply chain 4190 Neccessary manufacturing and quality equipment, fixtures, tooling, work-holding, parts interim storage and handling equipment, ancillary equipment, etc. 4192 Assess the adequacy of manufacturing and quality sustainment requirements (e.g., maintainability, serviceability, etc.), processes, and activities being considered and addressed in the design specifications. 4193 Assess Contractor's and supplier's configuration management systems for traceability, accuracy, sufficiency, and accessibility in preparation for CDR. 4197 As the system, subsystem, items, and components are being specified, analyze these to ensure manufacturing and quality constraints and requirements have been incorporated into design specifications and requirements. 4200 Analyze results of demonstrations in a relevant environment from the previous phases of all new technologies to be incorporated into the design to ensure they can be incorporated and integrated into a system with acceptable manufacturing and quality risks. o If not conducted, recommend demonstrations prior to CDR. 4204 Assess smaufacturing and quality physical architectures, development specifications, and detail	4179		and requirements of manufacturing and quality (e.g., facilities, tooling, equipment, test
 Impacts to and requirements of manufacturing and quality personnel (e.g., operators, assemblers, welders, platers, coatings specialists, etc.) Corrosion, contamination, hazards, hazardous combinations of materials, and impacts on manufacturing processes, quality control processes, and procedures for both Impacts on manufacturing and quality data requirements (e.g., collection, processing, storage, security, access, availability, etc.) Impacts to manufacturing and quality from materials, components, and items maturity and availability; lead-times; source availability, capability and capacity to include the supply chain Necessary manufacturing and quality equipment, fixtures, tooling, work-holding, parts interim storage and handling equipment, ancillary equipment, etc. Assess the adequacy of manufacturing and quality sustainment requirements (e.g., maintainability, serviceability, etc.), processes, and activities being considered and addressed in the design specifications. Assess Contractor's and supplier's configuration management systems for traceability, accuracy, sufficiency, and accessibility in preparation for CDR. As the system, subsystem, items, and components are being specified, analyze these to ensure manufacturing and quality constraints and requirements have been incorporated into design specifications and requirements. Analyze results of demonstrations in a relevant environment from the previous phases of all new technologies to be incorporated into the design to ensure they can be incorporated and integrated into a system with acceptable manufacturing and quality risks. If not conducted, recommend demonstrations prior to CDR. Assess manufacturing and quality physical architectures, development specifications, and detailed designs for key manufacturing processes (i.e., KCs), CSIs and CAIs to be under Contractor's configuration control and on track for completion by CDR. Assess the system desig	4180		equipment and facilities, processes, procedures, storage, waste disposal, etc.)
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4214 KCs and therefore associated KPPs to verify that all requirements are being met	4214		KCs and therefore associated KPPs to verify that all requirements are being met

4215	• Bi-directional traceability among all manufacturing and quality considerations:
4216	 Allocated and physical requirements
4217	 Engineering trade study results
4218	 Technical, schedule and cost risks, issues, and opportunities
4219	Metrics
1000	
4220	• Manufacturing and quality are active participants and support all design reviews at all
4221	possible levels of the supply chain and have documented Contractor compliance to the
4222	manufacturing and quality design requirements and are within the manufacturing and quality
4223	cost and/or design goals to include:
4224	 Adherence to manufacturing and quality best practices (e.g., AS6500, AS9100,
4225	ISO 9001, etc.)
4226	 Closure of all PDR action items and corrective actions
4227	 Results of manufacturing technology improvements, design changes, and facilities and
4228	equipment changes
4229	 ManTech projects implementations
4230	 Updated design drawings, bills-of-material, and product and process specifications on
4231	track for completion by CDR
4232	• Performance requirements, the outcomes testing, producibility studies, and other design
4233	influences are part of the final design
4234	 Design specifications to the lowest level of detail to meet capability and capacity
4235	requirements
4236	• Manufacturing and quality has identified, quantified, and documented risks with associated
4237	mitigation to be at an acceptable level (i.e., minimized manufacturing and quality risks) in the
4238	completed design for CDR.
4239	• KCs have been specified and documented in the manufacturing and quality plan, and are
4240	being tracked and monitored for CDR with risks and issues mitigation plans in place.
4241	• Manufacturing and quality have identified and documented requirements for in-process and
4242	acceptance testing and have included these in the manufacturing and quality plans.
4243	• Manufacturing and quality requirements for physical, digital, and industrial security have
4244	been documented to be in compliance with DoD policies and NIST standards.
4245	• Manufacturing and quality products and processes including trusted production of products
4246	down to the component level have been documented to be in compliance with specified
4247	security requirements of the program (e.g., SSE, COMSEC, and PPP).
4248	• Requirements for system certifications (e.g., statutory, safety, environmental, airworthiness,
4249	others as required) and the impacts on manufacturing and quality have been documented in
4250	the SEP with associated costs, budget, schedule, etc. in appropriated program documentation
4251	(e.g., IMP/IMS, etc.).
4252	• Design with associated costs, budget, schedule, etc. has been analyzed and documents the
4253	following manufacturing and quality requirements:

4. Engineering and Manufacturing Development (EMD) Phase

4254		• ESOH, environmental, hazardous material, etc.
4255		• EMI consideration and constraints including control processes, procedures, and planned
4256		facilities and equipment
4257		• Radiation hardening, thermal, vibration, and shock environments, all environmental
4258		parameters, and HALT
4259		o Corrosion, contamination, hazards, hazardous combinations of materials
4260		• Data collection, processing, storage, security, access, availability, etc.
4261		• Materials, components, and items maturity and availability; lead-times; source
4262		availability, capability and capacity to include the supply chain
4263		• Manufacturing and quality facilities, tooling, test equipment and facilities, processes,
4264		procedures, storage, waste disposal, etc.
4265		• Item and component equipment, fixtures, work-holding, parts interim storage and
4266		handling equipment, ancillary equipment, etc.
4267		• Manufacturing and quality workforce (e.g., operators, assemblers, welders, platers,
4268		coatings specialists, etc.)
4269		• Manufacturing processes, quality control processes, and procedures for both
4270	•	Manufacturing and quality requirements for sustainment (e.g., maintainability, serviceability,
4271		etc.) and sustainment processes and activities have been documented and provided for the
4272		LCSP.
4273	•	Contractor's and supplier's configuration management systems have been assessed and
4274		documented to be in compliance with manufacturing and quality contractual requirements for
4275		traceability, accuracy, sufficiency, and accessibility in preparation for CDR.
4276	•	Manufacturing and quality constraints and requirements have been incorporated and
4277		documented in the design specifications and requirements for the system, subsystem, items,
4278		and components.
4279	•	Recommended demonstrations in a relevant environment have been conducted for all new
4280		technologies to be incorporated and integrated into the system and document an acceptable
4281		level of manufacturing and quality risks.
4282	•	Physical architectures, development specifications, and detailed designs have been assessed
4283		for key manufacturing processes (i.e., KCs), CSIs and CAIs and are under Contractor's
4284		configuration control and are on track for completion by CDR.
4285	•	All long lead production requirements have been identified and documented in preparation
4286		for CDR.
4287	•	System design for parts, materials, and processes with the appropriate manufacturing and
4288		quality requirements allocation for the detailed design are being documented in in the
4289		configuration management system and the requirements tracking system (i.e., DOORS) and
4290		are on schedule for completion by CDR.
4291	•	Results of all design trade studies for manufacturing and quality impacts and changes to KCs
4292		have been verified and documented that all requirements are being met for CDR. (See E.8)
4293	•	Manufacturing and quality has documented and provided updated inputs based on the results
4294		of the detailed design development activities to the program WBS.

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4. Engineering and Manufacturing Development (EMD) Phase

- Completed detailed design demonstrates and documents manufacturing and quality bidirectional traceability among all allocated and physical requirements, engineering trade
- 4296 directional traceability among all allocated and physical requirements, engineering trade 4297 study results, and technical, schedule and cost risks, issues, and opportunities. (See E.8)

4298 **Tools**

- 4299 • Design for Manufacturing and Assembly (DFMA) CDR checklist 4300 • 4301 • **TRR** Checklist 4302 • TRA checklist 4303 MRL assessment checklist, Design thread • 4304 • PRR Checklist 4305 SVR Checklist 4306 • FCA Checklist 4307 SEP template • 4308 **TEMP** template • 4309 Life Cycle Sustainment Plan template • 4310 IMP/IMS template • 4311 **CPD** template • 4312 **Resources** 10 USC 144B, Sec 2366 and 2448 4313 • 4314 Acquisition Strategy Guide, DSMC, Dec 1999 • Systems Engineering Plan Preparation Guide, Apr 2011 4315 • 4316 Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct 4317 2005 4318 TEMP Guide, Dec 2012 and DAG Chapter 8-4.1 • 4319 LCSP memo, Sep, 2011 and DAG Chapter 4-3.1 • 4320 • CDD-CPD writing Guide, Feb 2015 4321 Critical Design Review, DAG Chapter 3-3.3.5 • 4322 • Test and Evaluation Management Guide System Verification Review, DAG Chapter 3-3.3.6 4323 • 4324 Functional Configuration Audit, DAG Chapter 3-3.3.6 • 4325 Production Readiness Review, DAG Chapter 3-3.3.7 • TRA Guidance 2011 4326 • MRL Deskbook version 2016 4327 •
- 4328 IEEE 15288.2
- MRL Deskbook Version 2016

4. Engineering and Manufacturing Development (EMD) Phase

4330	E.6	Assess Design Maturity
4331	Manu	facturing and Quality Tasks
4332 4333 4334 4335 4336 4337 4338	•	Manufacturing and quality will assess design maturity based on assessments of manufacturing feasibility, capability analyses, producibility, and KC analyses, in accordance with industry best practices (e.g., AS6500, AS9100, etc.) and assess readiness for the CDR (per IEEE 15288). Update manufacturing and quality assessments of the Contractor(s) and supply chain capability to mature and manufacture the detailed design within the overall cost, schedule, and performance goals (e.g., producibility, feasibility, and capability)
4339 4340 4341 4342 4343		 Assess manufacturing processes and quality results for each individual configuration item to verify each meets the stated performance requirements Assess completeness of product data required for component manufacturing Assess adequacy and robustness of the parts management and configuration control processes (e.g., design, engineering, and software)
4344 4345 4346 4347	•	Through support of all design reviews at all levels of the supply chain, assess adequacy and completeness of manufacturing and quality requirements verification and validation activities including demonstrations in a representative environment at the system, subsystem, item, and component levels.
4348 4349		• Assess and verify product and technology requirements and features as ready for system CDR including
4350 4351 4352 4353 4354 4355		 Products producibility (subsystem, item, and component) Products and technology maturity Alternate sources and products producibility, maturity, and availability (i.e., second sources) MOSA COTS, NDIs, and GFE
4356		• Assess manufacturing and quality results of Technical Performance Measure (TPMs)
4357 4358 4359		 Maturation activities to support design maturity Assess and validate if product data essential for item and component manufacturing is under configuration control and has been released
4360		• Verify completion of physical and functional interface designs for the system
4361		• Verify long-lead production requirements have been established and are understood
4362		• Verify manufacturing and quality safety requirements are in the detailed design to include
4363		all safety hazards
4364		• Assess and validate prototype demonstrations in a relevant environment for all
4365		enabling/critical items, parts and components including relevant software
4366		• Verify completion of subsystem design (with closure schedule for open items) and
4367		percentage of subsystems in current production

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4368 4369	•	Monitor and assess the maturity of KCs and critical characteristics, the associated manufacturing and quality processes, and associated mitigation activities.
4370 4371		• Verify correctness, adequacy, and completeness of key and critical processes for KCs and critical characteristics (e.g., C _{pk} , tolerances, etc.)
4372		• Verify correctness, adequacy, and completeness of KCs and critical characteristics to the
4373		associated KITS
4375		adequacy and completeness (e.g. demonstrations documentation drawings testing data
4376		collection and management, etc.)
4377		 Analyze data from demonstrations of key and critical manufacturing and quality
4378		processes in a production-representative environment to satisfy design tolerances and
4379		meet objectives
4380 4381	•	Monitor post-PDR manufacturing and quality mitigation measures and maintain the status of all mitigation measures up-to-date for all gaps, risks, and issues including those from:
4382		• Key and critical manufacturing processes including embedding software
4383		• Materials
4384		• Supply chain including multiple sources
4385		• Production rates and yields
4386		• Facilities
4387		• Special tooling development
4388		• Tests and demonstrations
4389		• Security
4390		• System safety and hazardous materials management
4391		• Schedule (i.e. IMP/IMS)
4392		• Manufacturing canability obsolescence
4394		• Manufacturing capability sustainment
4395	•	Assess adequacy and completeness of mitigation activities for mitigation of manufacturing
4396		and quality risks, issues, and opportunities in the joint Government/ Contractor (\RIO
4397		Management System.
4398	Metric	CS
4399	•	Based on assessments of manufacturing feasibility, capability analyses, producibility, and KC
4400		analyses, in accordance with industry best practices, manufacturing and quality has assessed
4401		design maturity and provided input on manufacturing and quality readiness for the CDR.
4402	•	Manufacturing and quality assessments of the Contractor(s) and supply chain have been
4403		conducted and document for CDR:
4404 4405		• Capability to mature and manufacture the detailed design within the overall cost, schedule, and performance goals

4406 4407 4408 4409	 Manufacturing processes and quality results for each individual configuration item have been verified to meet the stated performance requirements Product data required for component manufacturing is complete Parts management and configuration control processes are adequate and robust
4410 • 4411 4412 4413	Adequacy and completeness of manufacturing and quality requirements verification and validation activities, throughout the supply chain, including demonstrations in a representative environment at the system, subsystem, item, and component levels, have been assessed, are reported in the appropriate documentation for CDR, and include the following:
4414	• Product and technology requirements and features as ready for system CDR including:
4415 4416 4417 4418 4419 4420	 Products producibility (subsystem, item, and component) Products and technology maturity Alternate sources and products producibility, maturity, and availability (i.e., second sources) MOSA COTS, NDIs, and GFE
4421	• Maturation activities to support design maturity of manufacturing and quality Technical
4422 4423	 Product data essential for item and component manufacturing is under configuration
4424	control and has been released
4425	• Physical and functional interface designs for the system are complete
4420	 All manufacturing and quality safety requirements are in the detailed design and include
4428 4429 4430	 all manufacturing safety hazards Results of prototype demonstrations in a relevant environment for all enabling/critical items, parts and components including relevant software.
4431 4432	 Completed subsystem design (with closure schedule for open items) and percentage of subsystems in current production
4433 4434 4435	Maturation progress of KCs and critical characteristics, the associated manufacturing and quality processes, and associated mitigation activities have been assessed and documented for CDR to include:
4436 4437	• Correctness, adequacy, and completeness of key and critical processes for KCs and critical characteristics (e.g., C _{pk} , tolerances, etc.)
4438 4439	• Correctness, adequacy, and completeness of KCs and critical characteristics to the associated KPPs
4440 4441 4442	 Adequacy and completeness of Contractor manufacturing and quality engineering and management activities (e.g., demonstrations, documentation, drawings, testing, data collection and management, etc.)
4443 4444	 Results from demonstrations of key and critical manufacturing and quality processes in a production-representative environment that meet design tolerances and objectives

4445 4446 4447	•	Post-PDR manufacturing and quality mitigation measures have been monitored and the status of all mitigation measures is up-to-date, and is documented in the appropriate system documentation for CDR to include:
4448 4449 4450 4451 4452 4453		 Key and critical manufacturing processes including embedding software Materials Supply chain including multiple sources Production rates and yields Facilities Special tooling development
4454 4455 4456 4457 4458 4459		 Tests and demonstrations Security System safety and hazardous materials management Economic feasibility Schedule (i.e., IMP/IMS) Manufacturing capability obsolescence
4460 4461 4462 4463	• Tools	 Manufacturing capability sustainment Adequacy and completeness of mitigation activities for the above mitigation efforts are included in the joint Government/ Contractor RIO Management System. (See A.1)
4464 4465	•	Design for Six Sigma MRL assessment checklist, Design thread
4466	Resou	rces
4467 4468 4469 4470 4471 4472 4473	• • • •	AS6500, Manufacturing Management Program, Nov 2014 AS9100 QUALITY SYSTEMS – REQUIREMENTS FOR AVIATION, SPACE, AND DEFENSE ORGANIZATIONS, SEP 2016 IEEE 15288.2 ISO 9000 MIL-STD 882E, System Safety MRL Deskbook Version 2016
4474	E.7	Assess Key Characteristics (KC)
4475	Manu	facturing and Quality Tasks
4476 4477 4478 4479	•	Analyze and verify of the flowdown of requirements to manufacturing and quality from the functional baseline to the lowest-level system detailed design element for all end items in the specification tree to ensure all are traced to specific manufacturing processes and quality metrics in the detailed design.

4480 4481 4482 4483 4484 4485 4486	•	Analyze all internal and external interface KCs (e.g., physical, electrical, digital, etc.) for manufacturing and quality specifications and requirements (e.g., flatness, attachment, connectivity, bi-directionality, compatibility, etc.) and changes since PDR to ensure acceptable risks for proceeding into fabrication, integration and testing. Analyze each specific manufacturing process and quality metric in the detailed design to verify that each is a KC (these should have been previously identified, but additional KCs may be identified).
4487 4488		• Ensure each component level KCs is traceable to system design and is under control by the Contractor specified in the documentation appropriately
4489 4490 4491 4492 4493	•	Analyze identified KCs for validity and adequacy utilizing Contractor tolerances and/or process capability indexes and supporting data. Ensure survivability and vulnerability threat (KPPs) allocations incorporated into the design down to the component level that are tied to specific manufacturing processes and quality metrics in the detailed design have been specifically identified by the Contractor as such.
4494 4495		• Ensure manufacturing and quality processes have been identified, analyzed, and are under configuration control
4496 4497	•	Ensure that the Contractor has established and is maintaining lists of Key and/or critical items, CSIs, and CAIs with the lists including:
4498 4499 4500		 Rationale for designation Control and risk mitigation plan(s) Where produced or accomplished (including potential changes)
4501 4502	•	Ensure all identified KCs are incorporated into the Verification Cross-Reference Matrix (VCRM) for required testing and verification.
4503	Metri	cs
4504 4505 4506 4507 4508 4509 4510 4511 4512 4513 4514	•	 Flowdown of requirements to manufacturing and quality from the functional baseline to the lowest-level system detailed design element for all end items in the specification tree has been verified and is documented in the Requirements System (i.e., DOORS) with each end item tied to specific manufacturing processes and quality metrics. All internal and external interface KCs (e.g., physical, electrical, digital, etc.) have been analyzed for manufacturing and quality specifications and requirements (e.g., flatness, attachment, connectivity, bi-directionality, compatibility, etc.) and all changes to ensure acceptable risks for proceeding into fabrication, integration and testing, and have been documented in all appropriate CDR documents for finalization at CDR. Each specific manufacturing process and associated quality metrics in the detailed design have been analyzed to verify that each is a KC.
4515 4516		• Each component level KCs has been traced to system design and is under control by the Contractor and documented appropriately

4517 4518 4519	•	Utilizing Contractor tolerances and/or process capability indexes and supporting data, KCs have been analyzed for validity and adequacy and the results and recommended changes have been documented.
4520 4521 4522 4523	•	Survivability and vulnerability threat (KPPs) allocations incorporated into the design have been analyzed and tied to specific manufacturing processes and quality metrics and have been specifically identified by the Contractor as such which have been placed under configuration control.
4524 4525	•	Contractor has established and documented lists of Key and/or critical items, CSIs, and CAIs with the lists including:
4526 4527 4528		 Rationale for designation Control and risk mitigation plan(s) Where produced or accomplished (including potential changes)
4529 4530	•	All identified KCs have been incorporated into the VCRM for required testing and verification.
4531	Tools	
4532	•	MRL Assessment Checklist for Process Capability and Control thread
4533	•	Critical to Quality Tree
4534	•	Failure Mode and Effects Analysis
4535	٠	Process Capability Analysis Worksheet
4536	٠	Producibility Assessment Checklist
4537	•	Technology Readiness Level Assessment Checklist
4538	Resou	rces
4539	٠	IEEE 15288.2
4540	٠	AS6500, Manufacturing Management Program, Sep 2016
4541	•	AS9100 QUALITY SYSTEMS – REQUIREMENTS FOR AVIATION, SPACE, AND
4542		DEFENSE ORGANIZATIONS, SEP 2016
4543	•	JCIDS Manual
4544	•	MRL Deskbook Version 2016
4545	•	NAVSO P-3687 Producibility System Guidelines, Dec 1999
4546	•	Technology Level Assessment Guidance, Apr 2011
4547	E.8	Support Critical Design Review (CDR)
4548	Manu	facturing and Quality Tasks
4549	•	Ensure initial product baseline documentation for manufacturing and quality is sufficient,
4550		complete, and adequate to enable component manufacturing, hardware fabrication and
4551		software implementation to proceed.

4. Engineering and Manufacturing Development (EMD) Phase

4552 4553 4554 4555		 Ensure all KCs, CSIs, and CAIs have completed drawings and specifications under configuration control Ensure all product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released
4556 4557	•	Ensure all manufacturing and quality design trade studies and producibility assessments are completed and incorporated into the design for CDR.
4558 4559		 Ensure producibility enhancement efforts ongoing for optimized integrated system (e.g. Design for Manufacturability, Design for Assembly, etc.)
4560 4561	•	Ensure all subsystem, item, and component CDRs are complete and the results available for the system CDR.
4562 4563 4564		• Analyze the results of design maturity assessments (See E.6) including all appropriate reviews (e.g., All CDRs, PPRs, PCAs, FCAs, etc.) for closure or approved rationale to enter CDR without completion is documented and accepted by the program office.
4565 4566	•	Ensure manufacturing and quality input to the schedule (IMP/IMS) is up-to-date and is executable with acceptable risks.
4567 4568 4569	•	Ensure manufacturing and quality plans, activities, and processes are executable within the existing manufacturing and quality budget to support the approved initial product baseline and critical path.
4570 4571 4572	•	Ensure all key and critical manufacturing processes, including process control plans, have been defined, characterized, updated for the detailed design, and the capability to meet design tolerances has been determined.
4573 4574	•	Analyze Contractor manufacturing and quality plans for materials, facilities, equipment, test facilities and equipment, and tooling to support the pilot line requirements.
4575 4576	•	Analyze manufacturing and quality plans for adequacy and capability of achieving manufacturing readiness level 8 by initial production.
4577 4578	•	Analyze plans for long-lead procurement requirements and incorporate results into procurement plans.
4579 4580 4581 4582	•	Analyze results of Contractor and key supply chain assessments (e.g., sourcing, materials, subsystems, items, components, lead-times, quality, manufacturing management, ESOH, etc.) for manufacturing and quality risks, issues, and opportunities and appropriate mitigation plans.
4583 4584 4585 4586	•	Analyze the assessments of adequacy and completeness of manufacturing and quality requirements validation activities (See E.6) which included prototypes and demonstrations in a representative environment at the system, subsystem, item, and component levels for design maturity.
4587 4588		 Include demonstrations of manufacturing processes in a representative environment Include demonstrations of manufacturing and quality processes for KCs, CSIs, and CAIs
4589	•	Provide manufacturing and quality inputs to the Life Cycle Support Plan for CDR.

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4590 4591 4592	•	Ensure Contractor manufacturing and quality management systems for manufacturing and quality metrics and data collection and tracking to the component level are in place and functional.
4593 4594	•	Ensure the TEMP incorporates all manufacturing and quality subsystems, items, and components into plans for tests, test facilities, and test equipment
4595 4596	•	Ensure the manufacturing and quality considerations and aspects of Contractor's plans and inputs are up-to-date and approved for CDR, including:
4597 4598 4599 4600 4601 4602 4603		 Parts and Materials (Management) Plan (PMP) Configuration Management Plan (CMP) Software Development Plan (embedded software) Quality Assurance Plan PPP SEMP TEMP
4604 4605 4606	•	Analyze and update subsystem, item, and component quantity estimates based on program system requirements, component yield and rate data, and results from prototype demonstrations.
4607 4608 4609	•	Ensure manufacturing and quality design producibility improvements have been implemented in the system design and/or specifications according to the joint government/contractor schedule (See E.4).
4610	٠	Provide up-to-date manufacturing and quality inputs to the program budget and the CARD.
4611 4612		 Update and allocate manufacturing and quality (production) cost models to subsystem, item, and component levels, and track against targets
4613 4614 4615	•	Ensure adequacy and completeness of mitigation activities for mitigation of manufacturing and quality risks, issues, and opportunities in the joint Government/ Contractor RIO Management System, including:
4616 4617		 Key and critical manufacturing processes including embedding software Materials and sourcing
4618		• Supply chain including multiple sources
4619		• Production rates and yields
4621		 Special tooling development
4622		• Tests and demonstrations
4623		o Security
4624		• System safety and hazardous materials management
4625		• Economic feasibility
4626		• Schedule (i.e., IMP/IMS)
4627		 Manufacturing capability obsolescence
4628		 Manufacturing capability sustainment

4629	Metrics			
4630 4631 4632	• Initial product baseline documentation for manufacturing and quality analyzed, validated, and approved for component manufacturing, hardware fabrication and software implementation to proceed.			
4633 4634 4635 4636	 All KCs, CSIs, and CAIs have completed drawings and documented specifications in the configuration management system All essential product data for all components throughout the supply chain is in the configuration management system and released for manufacturing 			
4637 4638	• All manufacturing and quality design trade studies and producibility assessments have been completed and results incorporated into the system design for CDR.			
4639 4640 4641	 Producibility enhancement efforts for optimizing the integrated system (e.g. Design for Manufacturability, Design for Assembly, etc.) are ongoing, documented, and progress monitored 			
4642 4643	• All subsystem, item, and component CDRs have been completed including closure of actions with the documented results, risks, and/or issues available for the system CDR.			
4644 4645 4646	 Results of design maturity assessments (See E.6) and all appropriate reviews have been analyzed and documented Inputs on the risks and issues have been provided to and accepted by the program office 			
4647 4648 4649 4650 4651 4652 4653 4654	 Manufacturing and quality inputs to the schedule have been provided and included in the IMP/IMS. Manufacturing and quality plans, activities, and processes have been analyzed as executable within the existing manufacturing and quality budget and documented to support the approved product baseline and critical path. All key and critical manufacturing processes have been analyzed and documented in the manufacturing and quality plans with associated risks and issues mitigation plans for the detailed design including: 			
4655 4656 4657	 Process control plans Process definition characterization Process capability to meet design tolerances 			
4658 4659 4660 4661 4662 4663 4664	 Contractor manufacturing and quality plans have been analyzed and document adequacy, shortfalls, and recommendations to meet pilot line requirements for materials, facilities, equipment, test facilities and equipment, and tooling. Manufacturing and quality have analyzed the system design and the Contractor's manufacturing and quality plans for achieving MRL 8 criteria by initial production and have documented shortfalls and recommendations for CDR. Long-lead procurement requirements and plans have been analyzed and shortfalls and 			
4665	recommendations documented for CDR.			

4666 4667	•	Results of Contractor and key supply chain assessments for manufacturing and quality risks, issues, and opportunities with appropriate mitigation plans have been analyzed and
4668		documented for consistency with Government assessments and include:
4669		• Costs, schedule, performance
4670		• Materials (e.g., lead-times, availability, etc.)
4671		• Subsystems, items, and components
4672		• Manufacturing and quality management
4673		• Facilities, tooling, and test equipment
4674		• Developmental tests
4675		• Workforce
4676		• Transportation, storage, and handling
4677		o Security
4678		• Embedded software
4679		• ESOH
4680		• Industrial Base risks and issues
4681	•	Assessments of the adequacy and completeness of manufacturing and quality requirements
4682		validation activities (See E.6) have been analyzed for design maturity and document the
4683		conduct of demonstrations, prototypes, and processes in a representative environment at all
4684		product levels for CDR, including KCs, CSIs, and CAIs.
4685	•	Manufacturing and quality have provided documented inputs to the Life Cycle Support Plan
4686		for CDR.
4687	•	Contractor's manufacturing and quality management systems for manufacturing and quality
4688		metrics and data collection and tracking to the component level have been documented as in
4689		place, functional, and consistent with industry best practices for CDR.
4690	•	TEMP has been analyzed and results document inclusion of all manufacturing and quality
4691		subsystems, items, and components into plans for tests, test facilities, and the necessary test
4692		equipment.
4693	•	Contractor's plans and inputs have been assessed to include appropriate program
4694		manufacturing and quality requirements, are up-to-date, and approved for CDR, including:
4695		• Parts and Materials (Management) Plan (PMP)
4696		• Configuration Management Plan (CMP)
4697		 Software Development Plan (embedded software)
4698		• Quality Assurance Plan
4699		o PPP
4700		• SEMP
4701		o TEMP
4702	•	Subsystem, item, and component quantity estimates have been updated based on program
4703		system requirements, component yield and rate data, and results from prototype
4704		demonstrations and documented in the AS for CDR.

4. Engineering and Manufacturing Development (EMD) Phase

4705 4706 4707	•	Manufacturing and quality design producibility improvements have been integrated into the system design and specifications, are being tracked, and are meeting the joint Government/ Contractor producibility implementation schedule (See E.4).				
4708 4709	•	• Updated and documented manufacturing and quality inputs have been provided to the program budget and the CARD.				
4710 4711		 Manufacturing and quality (production) cost models have been updated, allocated to lowest level, and tracked against targets 				
4712 4713	•	Adequacy and completeness of mitigation activities has been included in the joint Government/ Contractor RIO Management System, including:				
4714 4715 4716 4717 4718 4719 4720 4721		 Key and critical manufacturing processes including embedding software Materials and sourcing Supply chain including multiple sources Production rates and yields Facilities Special tooling development Tests and demonstrations Security 				
4722 4723 4724 4725 4726		 System safety and hazardous materials management Economic feasibility Schedule (i.e., IMP/IMS) Manufacturing capability obsolescence Manufacturing capability sustainment 				
4727 4728	Tools •	CDR checklist				
4729	Resou	rces				
4730	•	AS65000				
4731	•	Defense Acquisition Guide (DAG) Chapter 3-3.3.5 Critical Design Review				
4732	•	IEEE 15288.2				
4733	•	MRL Deskbook Version 2016				
4734	E.9	Provide Updates to SEP				
4735	Manu	facturing and Quality Tasks				
4736 4737	•	At a minimum manufacturing and quality should ensure updates are provided for the following:				
4738 4739 4740		 System architectures and interfaces Required DoD certifications (e.g., Space-worthiness, Airworthiness, Insensitive Munitions, etc.) 				

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4741		• Manufacturing and quality risk, issue, and opportunity assessments, including schedule,
4742		costs, performance, PRRs, pilot lines, prototypes, demonstrations, milestones, etc.
4743		• Program manufacturing and quality structure and organization including WBS, positions,
4744		staffing, etc.
4745		• Manufacturing and quality Technical Performance Measures and metrics including
4746		yields, rates, process capability indices, etc.
4747		• Planned manufacturing and quality activities for the next phase including Value
4748		Engineering, ManTech and other improvements, learning curves, initiating production,
4749		etc.
4750		• Manufacturing and quality requirements tracking and change processes including
4751		changes from prototypes, demonstrations, development testing, etc.
4752		• Manufacturing and quality configuration and Engineering Change Proposal (ECP)
4753		management
4754		• KCs considerations and impacts critical to the achievement of the program's technical
4755		requirements
4756	Metri	CS
4757	•	Manufacturing and quality has documented and provided updates to the SEP for the
4758		following:
1750		
4759		• System architectures and interfaces changes
4760		• DoD certifications (e.g., Space-worthiness, Airworthiness, Insensitive Munitions, etc.)
4701		o Manufacturing and quanty fisk, issue, and opportunity assessments, including schedule,
4762		Costs, performance, PKRS, pilot lines, prototypes, demonstrations, milestones, etc.
4705		WDS monitions staffing sta
4765		W DS, positions, starting, etc.
4705		o Changes to manufacturing and quanty reclinical reformance measures and metrics with
4760		Planned manufacturing and quality activities and schedule for the payt phase including
4707		Value Engineering MenTech and other improvements learning outweet initiating
4700		production ate
4709		Changes to manufacturing and quality requirements tracking and change processes
4770		o Changes to manufacturing and quanty requirements tracking and change processes
4//1		Changes to manufacturing and quality configurations and proposed ECPs
4//2		• Changes to manufacturing and quality configurations and proposed ECPs
4//5		• Changes to KCs and resulting impacts critical to the achievement of the program's
4//4		tecnnical requirements
4775	Tools	
4776	•	SEP Outline
4777	٠	Manufacturing Plan (included I n the SEP)
4778	•	Quality Assurance Plan (included in the SEP)
4779	•	Critical to Customer/Critical to Quality Tree

4. Engineering and Manufacturing Development (EMD) Phase

- Producibility Assessment Worksheet
- 4781 **Resources**
- TAB B SEP Outline Version 3.0 Final V4 (provided by OSD)
- Systems Engineering Plan Preparation Guide, Apr 2008
- MRL Deskbook Version 2016
- NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy, Dec 1999
- AS6500, Manufacturing Management Program, Sep 2016
- AS9100 Quality Systems Requirements For Aviation, Space, And Defense Organizations,
 Sep 2016
- ISO 9001:2015, Quality Management System
- 4790 E.10 Validate Design
- 4791 Manufacturing and Quality Tasks 4792 Ensure all product level manufacturing and quality design requirements are defined and • 4793 validated to be consistent with the specifications. 4794 Ensure all manufacturing and quality inputs to the product design support meeting the • 4795 program requirements. 4796 o Verify manufacturing and quality requirements meet program cost, schedule, and 4797 performance requirements 4798 Verify manufacturing and quality requirements are met at the subsystem, item, and 0 4799 component levels 4800 Assess prototypes and demonstrations, including system, subsystem, item, and component • 4801 prototypes, for adequacy and completeness to include: 4802 Verification that prototypes and demonstrations occur in the appropriate environment for 0 4803 the system, subsystem, or component (e.g., production representative, pilot line, or 4804 production line) 4805 o Verification and validation of manufacturing and quality specifications, processes, 4806 procedures, metrics, etc. 4807 • Verification and validation of KCs and critical characteristics and the associated key and 4808 critical manufacturing processes 4809 • Manufacturing and quality validation activities to support proof of building the right 4810 product o Subsystem, item, and component development specifications 4811 4812 Verification of product and technology requirements and features necessary for system 0 4813 pilot line and/or LRIP including: 4814 Producibility (subsystem, item, and component) 4815 . Products and technology maturity 4816 Sources maturity and availability (including second sources)

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4817 4818	MOSACOTS, NDIs, and GFE
4819 4820 4821	 Verification of manufacturing and quality status and results of TPMs Verify long-lead production requirements have been established and are understood Verify completion of subsystem design (with closure schedule for open items)
4822 • 4823	Analyze prototype demonstrations and manufacturing and quality demonstrations at the system, subsystem, item, and component levels for validation of:
4824 4825 4826 4827 4828 4829 4830 4831 4832 4833 4834 4835 4836	 Product data essential for item and component manufacturing Physical and functional interface designs for the system Interdependencies Manufacturing and quality safety processes and procedures ESOH processes and procedures Security processes, procedures, and compliance Risks and issues mitigation Manufacturing and quality costs, schedule, performance Materials sources and selections Facilities, tooling, and test equipment requirements Workforce requirements Transportation, storage, and handling Embedded software
4837 • 4838 • 4839 • 4840 •	Ensure known producibility issues have been resolved and pose no significant risks or issues for pilot line and/or LRIP. Develop manufacturing and quality metrics and data requirement to support successful transition to pilot line, LRIP, and FRP
4841 4842	 Metrics should provide the capability to assess, monitor, manage, and control the transition process
4843 • 4844 • 4845 • 4846 • 4847 • 4848 • 4849 •	Based on demonstrations, prototypes, results of CDR, assess and update the manufacturing and quality inputs to the WBS for planning, execution and control of the pilot line and LRIP. Manufacturing and quality ensures all product data essential for system manufacturing will be released for pilot line. Manufacturing and quality should ensure the adequacy and completeness of all mitigation activities in the joint Government/ Contractor Risk, Issue, and Opportunity (RIO) Management Process, including:
4850 4851 4852 4853 4854 4855	 Key and critical manufacturing processes including embedding software Materials and sourcing Supply chain including multiple sources Production rates and yields Facilities Special tooling development

4. Engineering and Manufacturing Development (EMD) Phase

4856		• Tests and demonstrations
4857		o Security
4858		 System safety and hazardous materials management
4859		 Economic feasibility
4860		• Schedule (i.e., IMP/IMS)
4861		• Manufacturing capability obsolescence
4862		 Manufacturing capability sustainment
4863	Metric	cs
4864	•	All product level manufacturing and quality design requirements defined, validated, and
4865		documented, and are consistent with the specifications detailed in the SEP.
4866	•	All manufacturing and quality inputs to the product design support meeting the program
4867		requirements.
4868		• Manufacturing and quality requirements have been verified and documented to meet
4869		program cost, schedule, and performance requirements
4870		• Manufacturing and quality requirements have been verified and documented at the
4871		system, subsystem, item, and component levels
4872	•	Assessments of prototypes and demonstrations at the system, subsystem, item, and
4873		component levels have been conducted and documented to verify and validate:
4874		• That prototype and other demonstrations occurred in the appropriate environment
4875		• Manufacturing and quality specifications, processes, procedures, metrics, etc.
4876		• KCs and critical characteristics and the associated key and critical manufacturing
4877		processes
4878		• Manufacturing and quality activities to support proof of building the right product
4879		• Subsystem, item, and component manufacturing and quality development specifications
4880		• Product and technology manufacturing and quality requirements and features necessary
4881		for system pilot line and/or LRIP including:
4882		 Producibility (subsystem, item, and component)
4883		 Products and technology maturity
4884		 Sources maturity and availability (including second sources)
4885		 MOSA
4886		 COTS, NDIs, and GFE
4887		• Status and results of manufacturing and quality TPMs
4888		• That manufacturing and quality long-lead production requirements have been established
4889		and are understood
4890		 Completion of subsystem design and closure schedule for open items
4891	•	Prototype and manufacturing and quality demonstrations have been analyzed and the results
4892		documented at the system, subsystem, item, and component levels for the validation of:
4893		• Product data essential for item and component manufacturing

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4894		• Physical and functional interface designs for the system
4895		o Interdependencies
4896		 Manufacturing and quality safety processes and procedures
4897		• ESOH processes and procedures
4898		 Security processes, procedures, and compliance
4899		• Risk and issue mitigations
4900		• Manufacturing and quality costs, schedule, performance
4901		• Materials sources and selections
4902		• Facilities, tooling, and test equipment requirements
4903		• Workforce requirements
4904		• Transportation, storage, and handling
4905		• Embedded software
4906	•	Known producibility issues have been resolved and documented and pose no significant risks
4907		or issues for pilot line and/or LRIP.
4908	•	Manufacturing and quality metrics and data requirement have been developed and
4909		documented to support successful transition to pilot line, LRIP, and FRP
4910		• Metrics provide the capability to assess, monitor, manage, and control the transition
4911		process
4912	•	Manufacturing and quality inputs to the WBS for planning, execution and control of the pilot
4913		line and LRIP have been updated and documented.
4914	•	All manufacturing and quality product data essential for system manufacturing has been
4915		documented and released for the pilot line.
4916	•	Manufacturing and quality have verified, validated, and documented the adequacy and
4917		completeness of all mitigation activities in the joint Government/ Contractor Risk, Issue, and
4918		Opportunity Management System for pilot line build, including:
4919		• Key and critical manufacturing processes including embedding software
4920		• Materials and sourcing
4921		• Supply chain including multiple sources
4922		• Production rates and yields
4923		o Facilities
4924		• Special tooling development
4925		• Tests and demonstrations
4926		o Security
4927		 System safety and hazardous materials management
4928		• Economic feasibility
4929		• Schedule (i.e., IMP/IMS)
4930		• Manufacturing capability obsolescence
4931		 Manufacturing capability sustainment

4932	Tools	
1033	System Varification Paviaw Chacklist	
4933	 System Vermeation Review Checklist Eunctional Configuration Audit Checklist 	
4935	Manufacturing Readiness Assessment Design thread	
4936	 Test and Evaluation Template 	
4937	IMP/IMS Template	
4757		
4938	Resources	
4939	• DoD 5000.02	
4940	• IEEE 15288.2, System and Software Engineering, 2015	
4941	MRL Deskbook Version 2016	
4942	• System Verification Review, DAG Chapter 3-3.3.6	
4943	• Functional Configuration Audit, DAG Chapter 3-3.3.6	
4944	Test and Evaluation Management Guide	
4945	• Integrated Master Plan and Integrated Master Schedule Preparation and Users	Guide, Oct
4946	2005	
10.15		
4947	E.11 Pilot Line Build	
4948	Manufacturing and Quality Tasks	
4949	• Assess the Contractor designated pilot lines for production realism of elements	s required to
4950	manufacture systems, subsystems, items, and components.	
4951	• Evaluate the manufacturing and quality readiness to manufacture of equipt	nent,
4952	workforce skill levels, facilities, materials, components, initial work instru-	ctions,
4953	processes, tooling, temperature, cleanliness, lighting etc.	
4954	 Evaluate capability to meet design requirements for LRIP 	
4955	• Evaluate the use of full-rate production processes (little or no reliance on la	aboratory
4956	environment or personnel, i.e., non-production resources)	
4957	• Evaluate production processes for capability to meet rate production (ramp	-up to FRP)
4958	• Evaluate the production capability and capacity to meet program objective	s for cost and
4959	schedule	
4960	• Validate the Contractor's manufacturing processes for affordability and execut	ion including
4961	work instructions.	
4962	Evaluate Contractor Production Process Verifications (PPVs) to verify process	outputs for
4963	compliance to process capabilities and requirements.	
4964	Capture necessary manufacturing and quality design and process changes iden	tified during
4965	pilot line operations.	
4966	• Capture the results of manufacturing and quality processes, demonstrated on a	pilot line, as
4967	inputs to the system MRL assessment, PRR, and to the Industrial Base Capabil	lities
10 -0		

4969 4970	•	Assess Contractor's LRIP verification and validation manufacturing and quality efforts in accordance with industry best practices (i.e., AS6500) on a pilot line including:
4971		• All manufacturing and quality processes including continuous improvement efforts
4972		• Manufacturing surveillance and quality data collection and analyses (including supply
4973		chain data for items and components)
4974		• Physical and functional interfaces
4975		• All work instructions sequencing and procedures
4976		• Process capabilities and process control plans
4977		• Production scheduling and control
4978		• Model and Simulations
4979		o Materials
4980		• Workforce capabilities
4981		• Manufacturing technology implementations
4982		• Tooling, work holding fixtures, jigs, etc.
4983		• Test equipment and test facilities (including Special Test Equipment/Special Inspection
4984		Equipment (STE/SIE) validation in accordance with plans)
4985		• Facilities, transportation, storage, and handling equipment
4986		• Interdependencies (not all will be validated on the pilot line)
4987		• Safety processes, procedures, and compliance
4988		• ESOH processes, procedures, and compliance
4989		• Security processes, procedures, capabilities, and compliance
4990		• Risk and issue mitigation results and adequacy of resolution
4991		• Manufacturing and quality costs, schedule, performance
4992		• Materials sources and selections
4993		• Integration of embedded software
4994	•	Assess Contractor's conduct of First Article Inspections (FAI) and/or First Article Tests
4995		(FAT) and the outputs for manufacturing and quality impacts.
4996	•	Based on pilot line operations and demonstrations, assess all manufacturing and quality risks
4997		and issues for impacts to LRIP (e.g., producibility, quality, manufacturability, etc.)
4998		• Include newly identified risks, issues, and opportunities
4999	•	Based on the results of the Pilot Line build, finalize the Technical Data Package including
5000		applicable technical data such as models, drawings, associated lists, specifications, standards,
5001		performance requirements, quality assurance provisions, software documentation and
5002		packaging details.
5003	Metri	CS
5004	•	Pilot line has been assessed in manufacture of systems, subsystems, items, and components to
5005		confirm adequacy of production realism and documents the following:

5006		0	Manufacturing and quality readiness to manufacture of equipment, workforce skill levels,
5007			facilities, materials, components, initial work instructions, processes, tooling,
5008			temperature, cleanliness, lighting etc.
5009		0	Capability to meet design requirements for LRIP
5010		0	Employment of full-rate production processes with little or no reliance on laboratory
5011			environment or personnel
5012		0	Capability to meet rate production (ramp-up to FRP)
5013		0	Capability and capacity to meet program objectives for cost and schedule
5014		0	Pilot line risks, issues, and potential opportunities to be included in Risk, Issue, and
5015			Opportunity Management System
5016	•	Co	ntractor's manufacturing processes for affordability and execution, including work
5017		ins	tructions, have been assessed as adequate and validated, documented in Manufacturing
5018		and	d Quality Plans for PRR.
5019	•	Co	ntractor PPVs have been verified for compliance with process capability requirements and
5020		doo	cumented for the PRR.
5021	•	Ne	cessary manufacturing and quality design and process changes have been captured during
5022		pil	ot line operations and documented for potential ECPs and for the PRR.
5023	•	Re	sults of demonstrations of manufacturing and quality processes on a pilot line have been
5024		doo	cumented as inputs to the system MRL assessment, the PRR, and to the Industrial Base
5025		Ca	pabilities Considerations (required for Milestone C).
5026	•	In	accordance with industry best practices, manufacturing and quality verification and
5027		val	lidation of Contractor pilot line has been successfully conducted and the results have been
5028		doo	cumented for PRR, SVR/FCA, and Milestone C the including:
5029		0	All manufacturing and quality processes with rigorous continuous improvement
5030			processes
5031		0	Disciplined, functional, and accessible manufacturing surveillance and quality data
5032			collection system including supply chain
5033		0	Documented, tested, and approved physical and functional interfaces
5034		0	Functional work instructions, sequencing, and procedures
5035		0	Process capabilities and process control plans
5036		0	Functional production scheduling and control processes
5037		0	Refined model and simulations
5038		0	Materials
5039		0	Confirmed workforce requirements, skills, and capabilities
5040		0	Manufacturing technology implementations
5041		0	Tooling, work holding fixtures, jigs, etc.
5042		0	Test equipment and test facilities (including Special Test Equipment/Special Inspection
5043			Equipment (STE/SIE) validation in accordance with plans)
5044		0	Facilities, transportation, storage, and handling equipment
5045		0	Pilot line interdependencies
5046		0	Safety processes, procedures, and compliance

4. Engineering and Manufacturing Development (EMD) Phase

5047		• ESOH processes, procedures, and compliance
5048		• Security processes, procedures, capabilities, and compliance
5049		• Risk and issue closures and remaining mitigation plans
5050		• Confirmation of and updates to manufacturing and quality costs, schedule, performance
5051		• Materials sources and selections
5052		• Integration of embedded software
5053 5054	•	Contractor's FAIs and/or FATs and the outputs for manufacturing and quality have been assessed and analyzed for impacts and the results documented for PRR.
5055	•	At the conclusion of pilot line operations and demonstrations, all manufacturing and quality
5056		risks and issues have been assessed and analyzed for impacts to LRIP and known
5057		producibility issues and risks understood (i.e., pose no significant challenges or have been
5058		accepted)
5059	•	Technical Data Package has been finalized based on the results of the Pilot Line build and
5060		includes the applicable technical data such as models, drawings, associated lists,
5061		specifications, standards, performance requirements, quality assurance provisions, software
5062		documentation and packaging details.
5063	Tools	
5064	٠	First Article Test Checklist
5065	•	First Article Inspection Checklist
5066	•	Production Verification Test
5067	•	Production Part Approval Process (PPAP) Checklist
5068	٠	Manufacturing Readiness Level Assessment, Design thread
5069	Resou	irces
5070	٠	DCMA Instruction 302, First Article and Production Lot Testing, Jan 2015
5071	•	AS/EN/SJAC9102, Aerospace First Article Inspection Requirement
5072	•	AS6500, Manufacturing Management System
5073	•	DoD 5000.02
5074	•	IEEE 15288.2, System and Software Engineering, 2015
5075	•	MRL Deskbook Version 2016
	F 0	

5076 **F. COST/FUNDING**

5077 Manufacturing and quality cost estimates require updating regularly, based on the increasing degree 5078 of detail available from the completed PDR, the Manufacturing and Quality Strategies and Plans, and 5079 progress toward final design. These estimates should be based on detailed manufacturing and quality

5080 processes and procedures to industry best practices with updates to be performed and adjusted, as

5081 necessary, for current program status and/or learning curves in order to develop a time-phased

5082 manufacturing cost. This will require analyses of Contractor Manufacturing and Quality Plans

4. Engineering and Manufacturing Development (EMD) Phase

- 5083 regarding costs, cost controls, and cost drivers. As the design progresses, cost estimates, cost models,
- and associated cost drivers should be updated with actual cost data from lower level (item and
- 5085 component) pilot lines and production.



5086

5087 Utilizing the DOD funding and management approach, both the should-cost and will-cost analyses, 5088 and the cost reduction and/or control plans should be updated based on the results of CDR and 5089 maintained current. Tracking and monitoring of the Contractor's planning and ongoing efforts is 5090 intended to not only evaluate proposed Contractor costs, but to track and monitor costs and to 5091 identify further savings opportunities that will lead to further cost reductions. Utilizing this process 5092 manufacturing and quality cost mitigation and/or maturation plans are maintained current to include 5093 the schedule (i.e., IMP/IMS).

- 5094 Based on data collected post-PDR through CDR, established learning curves (cost improvement 5095 curve, or experience curve) should be up-to-date and validated by data collected on the pilot line. 5096 Manufacturing and quality should continue to refine the learning curves for the system and the plans 5097 for data collection to support up-to-date cost estimates and budgeting. Manufacturing cost estimates 5098 for LRIP are based on the completed design, known manufacturing processes, and execution of 5099 planned manufacturing and quality operations. Actual costs at the system level are realized for the 5100 first time on a pilot line. Once the system is being produced or constructed, the actual cost method 5101 can be accumulated for budgeting.
- A Program's approved cost estimate is often used to create the budget and spending plan. Since resources are not infinite, budgeting requires the rate of spending matches the resources and funding available. This requires manufacturing and quality costs to be as accurate as possible, based on actual data. This process facilitates the development of realistic cost estimates for the Program.

5106 F.1 Update Manufacturing Costs

5107 Manufacturing and Quality Tasks

- Based on the results of the PDR, analyze and update manufacturing and quality design changes for technical content and should-cost inputs for consistency with the current Cost Analysis Requirements Document (CARD); and provide updates, if necessary, in order to maintain consistency with the approved system specification and budget for CDR.
- 5112 o Include updates to the will-cost model based on industry best practices
- 5113 o Include updates to manufacturing and quality cost sensitivity analyses

5114 • 5115 5116 5117	Based on the results of PDR design, design changes, and program progress, analyze and update manufacturing and quality cost drivers derived from manufacturing, quality, materials, and/or unique requirements, and associated risks, issues, and opportunities for the CDR to include:
5118 5119 5120 5121 5122 5123 5124 5125	 Identified subsystems, parts, items, and components Sourcing risks from sole, single, fragile, foreign sources, cyber exploitation, and foreign acquisition of domestic sources Should-cost and will-cost analyses Required trade studies and engineering change requests Updates to predicted life-cycle estimates and their associated models Interdependencies Uncertainties from quantification of cost drivers
5 126 •	Analyze the Contractor Manufacturing and Quality Plans for costs and cost drivers based on:
5127 5128 5129 5130 5131 5132 5133 5134 5135 5136 5137 5138 5139	 Processes and procedures (i.e., best practices) Producibility program and plans Supplier Chain management Materials (e.g., processing, handling, storage, etc.) Workforce (e.g., availability, training, etc.) Facilities (e.g., location, condition, maintenance, etc.) Capital equipment, tooling, and test equipment, etc. Special handling and environmental compliance (including disposal) Security (physical and cyber), etc. Updates for the cost of quality Updates for costs and impacts of testing Impacts from other work performed throughout the supply chain
5140 5141	data from lower level (item and component) pilot lines and production, and from subsystem and system-level prototypes and demonstrations including:
5142 5143 5144 5145	 Systems and sub-systems produced in a production representative environment Production plant layout and design Obsolescence solutions Rolled up manufacturing system and sub-system actual costs vs. targets
5146 • 5147 5148 • 5149 5150 5151 •	Update Learning Curves based on results of PDR and actual manufacturing and quality data collected from pilot lines, prototypes, and demonstrations. Ensure the updated cost estimates and associated drivers include the costs associated with the manufacturing and quality risks, issues, and associated mitigation plans and activities, and opportunities. Update the contract to include cost monitoring by DCMA throughout the Contractor's
5152	facilities and supply chain.

5153 5154 5155 5156 5157 5158	•	Update the letter of delegation to DCMA to include cost monitoring and tracking. Ensure updated manufacturing and quality costs including costs for outstanding manufacturing and quality risks, issues, and mitigations for CDR and estimates for meeting manufacturing readiness requirements for Milestone C are included in all budget estimates. If an Independent Cost Estimate (ICE) or verified Program Office Economic Analysis is requested, provide manufacturing and quality inputs and support.
5159 5160 5161 5162		 Provide validated manufacturing and quality capability requirements Provide manufacturing and quality inputs on required funding for the FYDP Verify manufacturing and quality compliance with affordability goals for production and sustainment
5163	•	
5164 5165 5166 5167	Metrics •	Manufacturing and quality design changes have been analyzed for technical content and should-cost inputs and required updates have been provided as inputs to the CARD including:
5168 5169 5170 5171		 Updates, if necessary, in order to maintain consistency with the approved system specification and budget for CDR Updates to the will-cost model based on industry best practices Updates to manufacturing and quality cost sensitivity analyses
5172 5173 5174 5175	•	Manufacturing and quality cost drivers derived from manufacturing, quality, materials, and/or unique requirements (e.g., processes, procedures, techniques, etc.), and associated risks, issues, and opportunities have been updated and documented for the CDR including drivers from:
5176 5177 5178 5179 5180 5181 5182 5183		 Subsystems, parts, items, and components Sourcing (e.g., sole, single, fragile, foreign sources, cyber exploitation, and foreign acquisition of domestic sources) Should-cost and will-cost analyses Trade studies and engineering change requests Life-cycle estimates and their associated models Interdependencies Uncertainties
5184 5185	•	Contractor Manufacturing and Quality Plans have been analyzed for costs and cost drivers and results and recommendations documented for CDR based on:
5186 5187 5188 5189 5190		 Processes and procedures (i.e., best practices) Producibility program and plans Supplier Chain management Materials (e.g., processing, handling, storage, etc.) Workforce (e.g., availability, training, etc.)

5191 5192 5193 5194 5195 5196 5197 5198		 Facilities (e.g., location, condition, maintenance, etc.) Capital equipment, tooling, and test equipment, etc. Special handling and environmental compliance (including disposal) Security (physical and cyber), etc. Updates for the cost of quality Updates for costs and impacts of testing Impacts to schedule and resources from other work performed throughout the supply chain (i.e., other programs in the same facility)
5199 5200 5201	•	Comparison of rolled up manufacturing system and sub-system actual costs vs. targets has been conducted and documented for CDR, and actual cost data has been utilized to update cost estimates, cost models, and associated cost drivers for CDR including data from:
5202 5203 5204 5205		 Systems and sub-systems produced in a production representative environment Items and components produced on pilot and production lines Production plant layout and design Obsolescence solutions
5206 5207 5208	•	Learning Curves have been updated based on results of PDR and actual manufacturing and quality data collected from pilot lines, prototypes, and demonstrations, and have been documented for CDR.
5209 5210 5211	•	plans and activities, and opportunities have been utilized to update and document cost estimates and associated drivers for CDR.
5212 5213	•	Contract includes cost monitoring by DCMA throughout the Contractor's facilities and supply chain.
5214	•	Letter of delegation to DCMA includes cost monitoring and tracking.
5215 5216 5217 5218	•	Updated manufacturing and quality costs including those outstanding for manufacturing and quality risks, issues, and mitigations have been updated and documented for CDR and estimates for meeting manufacturing readiness requirements for Milestone C have been included in all budget estimates.
5219 5220 5221	•	If an Independent Cost Estimate (ICE) or verified Program Office Economic Analysis has been requested, manufacturing and quality has provided documented inputs and support including:
5222 5223 5224 5225		 Validated manufacturing and quality capability requirements Inputs on required manufacturing and quality funding for the FYDP Manufacturing and quality compliance with affordability goals for production and sustainment
5226	Tools	
5227	•	Cost Analysis Requirements Description (CARD) template
5228	٠	Cost and Lead Time Estimating Worksheet

4. Engineering and Manufacturing Development (EMD) Phase

5230	•	Design to Cost Estimates
5231	•	Manufacturing Cost Estimating Spreadsheet
5232	•	MRL assessment for the Cost Thread
5233	•	See CAPE website for tools
5234	Resou	irces
5235	٠	DoD 5000.02
5236	•	IEEE 15288.2
5237	•	MRL Deskbook Version 2016
5238	•	Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
5239		Program Managers, Chapter 9
5240	•	MIL-HDBK-766 Design to Cost
5241	•	Should-cost and Affordability Memo, Aug 2011
5242	•	DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
5243	•	CARD Website and process
5244	F.2	Develop Manufacturing Cost Mitigation Plan
5245	Manu	facturing and Quality Tasks
5246	•	Based on manufacturing and quality planning for CDR, ensure appropriate inputs are
5247		provided for required investments and planning for Contractor and supply chain
5248		manufacturing and quality capabilities (e.g., facilities, equipment, tooling, hardware,
5249		firmware, software, etc.)
5250	•	Utilizing the outputs from CDR update the should-cost and will-cost analyses, and cost
5251		reduction and/or control plans to include:
5252		• Coordinated, in-depth review of the Contractor's planning and ongoing efforts against
5253		best practices
5254		• Up-to-date cost drivers
5255		• Up-to-date tracked and monitored costs to support further savings opportunities
5256		• Risks and issues mitigation plans and activities
5257	•	Ensure DCMA cost monitoring and tracking data are utilized to develop and/or update
5258		manufacturing and quality cost mitigation plans.
5259	•	Update manufacturing and quality cost targets, post CDR, to include assessments of:
5260		o Producibility
5261		• Manufacturing and quality process capabilities, implementations, obsolescence, and
5262		sustainment including key and critical processes
5263		• Schedule (i.e., IMP/IMS)
5264		• Supply chain, materials and sourcing availability
5265		• Environmental management and disposal impacts
5266		• Process capability and throughput (setup, yield, scrap, rework, Work In Progress)

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5267		• Data management (collection, storage, cyber security, etc.)
5268		• Manufacturing and quality risks and issues including Supplier Chain
5269		• Workforce risks and issues
5270		• Tooling, equipment availability, capacity, and constraints
5271		• Facilities and facility conditions (e.g., temperature control, cleanliness, lighting, factory
5272		floor, process flows, assembly lines, cycle times, etc.)
5273		• Yields and rates (e.g., projected and actual throughputs)
5274		• Inventory (e.g., WIP, backlog, customer demand, etc.)
5275		• System security, cyber protection, safety, and hazardous materials management
5276		• Testing and test equipment (including in-process tests)
5277		• Transportation, storage, and handling
5278		 New equipment and new manufacturing technologies
5279		• Life-cycle sustainment
5280	•	Based on results of CDR, update manufacturing and quality cost models to include:
5281		• Updated cost targets
5282		• Actuals, where available, in place of estimates
5283		• Cost impacts of specific design changes, production process changes, or changes in
5284		materials
5285	•	Monitor and track Contractor performance of manufacturing and quality activities in meeting
5286		the Earned Value Management System (EVMS) requirements including the critical path as an
5287		input to cost mitigation planning.
5288	•	Develop Manufacturing Maturation Plans (MMPs) for any areas assessed that do not comply
5289		with the appropriate Manufacturing Readiness Level criteria.
5290	Metrio	S
5291	•	Manufacturing and quality has provided appropriate budget planning inputs to program
5292		investment plans for Contractor and supply chain manufacturing and quality capabilities
5293		(e.g., facilities, equipment, tooling, hardware, firmware, software, etc.).
5294	•	Manufacturing and quality has updated and documented in the SEP, the AS, and the CARD,
5295		the should-cost analyses, will-cost analyses, and cost reduction and/or control plans
5296		including:
5297		• Contractor's planning and ongoing efforts against best practices
5298		• Up-to-date cost drivers
5299		• Up-to-date tracked and monitored costs
5300		 Mitigation plans and activities
5301	•	DCMA cost monitoring and tracking data has been documented in appropriate program
5302	•	documentation and utilized to develop and/or update cost mitigation plans in the
5302		Manufacturing and Quality Plans
5505		

5304 5305 5306	•	Manufacturing and quality cost targets have been assessed, updated, and documented in the Manufacturing and Quality Strategies and Plans and appropriate program budget documents including targets derived from or impacted by:
5307 5308 5309		 Producibility Manufacturing and quality process capabilities, implementations, obsolescence, and sustainment including key and critical processes
5310		• Schedule (i.e., IMP/IMS)
5311		 Supply chain, materials and sourcing availability
5312		 Environmental management and disposal impacts
5313		• Process capability and throughput (setup, yield, scrap, rework, Work In Progress)
5314		• Data management (collection, storage, cyber security, etc.)
5315		 Manufacturing and quality risks and issues including Supplier Chain
5316		• Workforce risks and issues
5317		 Tooling, equipment availability, capacity, and constraints
5318		• Facilities and facility conditions (e.g., temperature control, cleanliness, lighting, factory
5319		floor, process flows, assembly lines, cycle times, etc.)
5320		• Yields and rates (e.g., projected and actual throughputs)
5321		• Inventory (e.g., WIP, backlog, customer demand, etc.)
5322		• System security, cyber protection, safety, and hazardous materials management
5323		• Testing and test equipment (including in-process tests)
5324		• Transportation, storage, and handling
5325		• New equipment and new manufacturing technologies
5326		• Life-cycle sustainment
5327 5328	•	Manufacturing and quality cost models have been updated, documented, and maintained current in the program cost model to include:
5329		• Up-to-date cost targets
5330		• Actuals as they become available replacing of estimates
5331		• Updated cost impacts from changes to design, manufacturing and quality processes
5332		and/or materials, etc.
5333	•	Contractor performance of manufacturing and quality activities is being tracked and
5334		monitored to meet the EVMS requirements including the critical path.
5335	•	MMPs have been developed for all areas assessed that do not meet the appropriate MRL cost
5336		thread criteria.
5337	Tools	
5338	•	Parametric Engineering and Actual estimating
5330	•	CARD - Cost Analysis Requirements Description (see CAPE website for tools)
5370	•	Manufacturing Readiness Level Assessment Checklist, Cost and Funding Thread
524U	•	Cost and L and Time Estimating Workshoet
5242	•	Cost and Leau Thile Estimating worksheet
5342	•	Cost/Schedule Control Systems Criteria (C/SCSC)

5343	٠	Manufacturing Cost Estimating Worksheet
5344	٠	Manufacturing Maturation Plan (no template available)
5345	Resou	irces
5346	٠	10 USC Sec. 2334 Independent Cost Estimation and Cost Analysis
5347	•	DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
5348	•	Public Law 114-328, §807, Cost, Schedule and performance of major defense acquisition
5349		programs
5350	•	CARD - Cost Analysis Requirements Description Template (See CAPE website for
5351		guidance)
5352	•	Cost/Schedule Control Systems Criteria Reference Guide, Sep 1992
5353	•	DODI 5000.73 Cost Analysis Guidance and Procedures
5354	•	DoDI 5000.02, Change 1, Jan 2017
5355	•	MRL Deskbook Version 2016
5356	F.3	Validate Proposed Learning Curves
5357	Manu	facturing and Quality Tasks
5358	•	Update all manufacturing and quality learning curves for the system and subsystems based on
5359		CDR results, Contractor and supply chain improvements, program progress to date to
5360		include:
5361		• Contractor and supply chain data as required by contract
5362		• DCMA data to validate Contractor data for the learning curve updates
5363		• Costs for quality, processes, personnel, out-sourcing, re-work, scrap, etc.
5364		• Design changes
5365		• Producibility program results
5366		• Timing for processes, kitting, idle, takt, cycle, re-work, etc.
5367		• Planning and scheduling
5368		• Throughput (yield and rates)
5369		• Labor efficiency and ergonomics
5370		• Improvements in materials, methods, processing, equipment, tools, automation (i.e.,
5371		manufacturing technology)
5372		• Handling, transportation, and storage (including WIP)
5373		• Supply chain changes
5374		• Standardization and common processes
5375	٠	Utilize data from pilot line production for validation of learning curves.
5376	•	Plan for collection of data in LRIP to support learning curve refinement that includes the
5377		following factors, improvements, and investments (at a minimum):
5378		• Update of cost models
5379		• Workforce learning, worker and supervisor
5380		• Process, line, and workstation
------	--------	---
5381		• Machinery, equipment, and tooling
5382		• Design producibility changes
5383		• Reduced Engineering Change activities
5384		• Mitigations of risks and issues
5385		• Work methods and processes
5386		• Planning and scheduling processes
5387		 Lot and batch sizing (increases) and optimization (just-in-time)
5388		• Engineering and test activities and changes
5389		 Quality inspections/tests sampling requirements
5390		• Reduction in Scrap and Rework
5391		• Inventory levels and storage
5392		 Operation sequencing and synchronization
5393		• Pre-Planned Product Improvement (P ³ I)program and processes
5394	Metric	CS
5395	•	All manufacturing and quality learning curves for the system and subsystems have been
5396		assessed and updated based on CDR results, Contractor and supply chain improvements,
5397		program progress to date which includes:
5398		• Contractor and supply chain data
5399		o DCMA data to validate Contractor data
5400		• Costs for quality, processes, personnel, out-sourcing, re-work, scrap, etc.
5401		• Design changes
5402		• Producibility program results
5403		• Timing for processes, kitting, idle, takt, cycle, re-work, etc.
5404		• Planning and scheduling
5405		• Throughput (yield and rates)
5406		 Labor efficiency and ergonomics
5407		• Improvements in materials, methods, processing, equipment, tools, automation (i.e.,
5408		manufacturing technology)
5409		 Handling, transportation, and storage (including WIP)
5410		• Supply chain changes
5411		• Standardization and common processes
5412	٠	Learning curves have been validated utilizing data from pilot line production.
5413	•	Plans for collection of data in LRIP have been developed, documented, and are in place to
5414		support learning curve refinement that includes the following:
5415		• Up-to-date cost models
5416		• Workforce learning, worker and supervisor
5417		• Process, line, and workstation improvements and investments
5418		• Machinery, equipment, and tooling improvements and investments
5419		• Design producibility changes

5420		 Reduced Engineering Change activities
5421		• Results of mitigations of risks and issues
5422		• Work methods and processes
5423		 Planning and scheduling processes
5424		• Lots and batch sizes (optimization)
5425		• Engineering and test activities and changes
5426		 Quality inspections/tests sampling requirements
5427		 Reduction in Scrap and Rework
5428		• Inventory levels and storage
5429		 Operation sequencing and synchronization
5430		• P ³ I program and processes
5431	Tools	
5432	٠	Learning Curve Estimator
5433	•	Manufacturing Cost Estimating Spreadsheet
5434	Resou	irces
5435	•	IEEE 15288.2, System and Software Engineering, 2015
5436	•	Defense Manufacturing Management Guide for Program Managers, Chapter 9.8 Learning
5437		Curve
5438	F.4	Update Manufacturing Costs with Pilot Line Actuals
5439	Manu	facturing and Quality Tasks
5440	•	Based on all data collected for updated cost drivers and learning curves (See F.3) including
5441		results from pilot line, ensure cost models are updated and maintained current with up-to-date
5442		information and:
5443		• Drivers and estimates
5444		• Roll up of all tracked manufacturing and quality costs from the component level
5445		• Engineering change requests
5446		• Cost reduction and avoidance strategies
5447		• Mitigation of risks and issues
5448		• Analyses (of pilot line actual costs)
5449		• Analyses of proposed changes to manufacturing and quality processes and procedures
5450		Based on the results of CDP and the pilot line, analyze and undate manufacturing and quality
5430	•	based on the results of CDK and the phot fine, analyze and update manufacturing and quanty
5450 5451	•	cost inputs for consistency with the current Cost Analysis Requirements Document (CARD);
5450 5451 5452	•	cost inputs for consistency with the current Cost Analysis Requirements Document (CARD); and provide updates, if necessary.
5451 5452 5453	•	cost inputs for consistency with the current Cost Analysis Requirements Document (CARD); and provide updates, if necessary. Based on validated stable detailed design and supply chain (from pilot line), provide inputs to

4. Engineering and Manufacturing Development (EMD) Phase

Provide manufacturing and quality cost estimate and realistic production unit cost goals for
 the P&D budget process.

5457 Metrics

- Cost drivers (See F.2) and learning curves (See F.3) have been updated with results from pilot line, and cost models are maintained up-to-date to include:
- 5460 o Drivers and estimates
- o All manufacturing and quality cost data
- 5462 o Engineering change requests
- 5463 Cost reduction and avoidance results
- 5464 Risks and issues mitigation results
- 5465 o Pilot line actual costs
- 5466 Changes to manufacturing and quality processes and procedures
- Manufacturing and quality cost inputs have been analyzed and updated for the CARD.
- Manufacturing and quality inputs to the program life-cycle cost estimate and schedule
 (IMP/IMS) have been provided and documented for PRR.
- Manufacturing and quality cost estimates and realistic production unit cost goals have been documented and provided to the P&D budget process.
- 5472 **Tools**
- Cost Analysis Requirements Description (CARD) template
- Cost and Lead Time Estimating Worksheet
- Cost/Schedule Control System Criteria (see EVM)
- Design to Cost Estimates
- Manufacturing Cost Estimating Spreadsheet
- MRL assessment for the Cost Thread
- See CAPE website for tools

5480 **Resources**

- 5481 IEEE 15288.2
- MRL Deskbook Version 2016
- Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
 Program Managers, Chapter 9
- MIL-HDBK-766 Design to Cost
- Should-cost and Affordability Memo, Aug 2011
- DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
- CARD Website and process

5489	F.5	Update Manufacturing and Quality Budget
5490	Manu	facturing and Quality Tasks
5491 5492	•	Ensure all manufacturing and quality Milestone C risks and issues (i.e., MRL 8) are understood with approved and budgeted mitigation plans in place including:
5493 5494 5495		 A reasonable budget estimate for achieving required manufacturing and quality capability by the FRP decision point (i.e., MRL 9) Investment required for LRIP and FRP
5496 5497	•	Provide manufacturing and quality cost estimates for the P&D budget process (LRIP and FRP) including the following considerations:
5498 5499 5500 5501 5502 5503 5504 5505 5506 5507 5508 5507 5508 5509 5510 5511 5512 5513 5514 5515		 Ongoing cost reduction initiatives. Manufacturing and quality costs and cost drivers Updated manufacturing and quality learning curves Validation of manufacturing and quality processes (from pilot line) for affordability and executability Results of analyses of manufacturing and quality risks, issues, and the status of mitigations Required facilities, equipment, tooling, test equipment, GFE, etc. for scale-up to LRIP quantity production Results of analyses of the Contractor's proposed manufacturing labor hours and material costs for adequacy, reasonableness, and necessity Recommended manufacturing and quality cost reduction and avoidance initiatives Results of cost performance analyses and trends Manufacturing investment opportunities for future manufacturing improvement and development efforts (See F.3) Funding and budgeting requests for applicable and/or emerging manufacturing and quality initiatives Industrial base investment programs that create, expand, or preserve assured, affordable,
5516 5517		robust, and commercially viable manufacturing and quality capabilities and capacities for LRIP and FRP
5518	Metrie	CS CS
5519 5520	•	All manufacturing and quality Milestone C risks and issues (i.e., MRL 8) are understood with approved and budgeted mitigation plans in place including:
5521 5522 5523		 A reasonable budget estimate for achieving required manufacturing and quality capability by the FRP decision point (i.e., MRL 9) Investment required for LRIP and FRP
5524 5525	•	Manufacturing and quality cost estimates have been developed for the P&D budget process (LRIP and FRP) and include:

4. Engineering and Manufacturing Development (EMD) Phase

5526	0	Ongoing cost reduction initiatives
5527	0	Manufacturing and quality costs and cost drivers
5528	0	Updated manufacturing and quality learning curves
5529	0	Validated of manufacturing and quality processes (affordability and executability)
5530	0	Results and status of mitigations of manufacturing and quality risks and issues
5531	0	LRIP scale-up requirements for facilities, equipment, tooling, test equipment, GFE, etc.
5532	0	Realistic Contractor proposed manufacturing labor hours and material costs (adequacy,
5533		reasonableness, and necessity)
5534	0	Detailed manufacturing and quality cost reduction and avoidance initiatives/plans
5535	0	Cost performance trends and recommendations as required
5536	0	Investment opportunities for future manufacturing improvements and development
5537		efforts
5538	0	Budgeting requests for emerging manufacturing and quality initiatives
5539	0	Industrial base investment programs for commercially viable manufacturing and quality
5540		capabilities and capacities for LRIP and FRP
55/11	Tools	
3341	10015	
5542	• Ma	anufacturing Cost Estimating Spreadsheet
5543	• Ma	anufacturing Readiness Level Assessment Checklist, Cost and Funding Thread
5544	• Te	chnology Readiness Level Assessment Checklist
5545	Resources	6
5546	• IE	EE 15288.2
5547	• Te	chnology Readiness Assessment Guidance, Apr 2011
5548	• Pu	blic Law 114-328. §807
5549	• M	RL Deskbook Version 2016
5550	G. MAT	ERIALS MANAGEMENT

5551 One of the key elements in a successful program is aggressive materials management and planning.

5552 Materials management ranges from basic considerations of maturity and availability to understanding

5553 management of the supply chain and to details of GFP, shelf life, security, safety, hazardous

materials, storage environment, etc. All program manufacturing and quality materials risks, issues,

and opportunities should be assessed based on Contractor data and plans to meet program

5556 manufacturing and quality requirements.

4. Engineering and Manufacturing Development (EMD) Phase

CDD	MS	AS Updates	SEP Updates	TEMP Updates	CDR	TRR	Pilot Line	VR/FCA
20					\sim	\sim	× ·	
G. Materials Management	G.1 Manage Materials Risks	G.2 Manage Materials Cost Drivers	G.3. Manage Scale-Up Risk	G.4 Assess Contractor SCM Program	G.5 Analyze Material Lead Times	G.b Assess Alternate Source Options	G.9 Assess Critical Sources	G. Assess Material Availability for LRIP

5557

The assessment should include analyses for materials fluctuations, rarity, availability, capacity, regulatory issues, ITAR, anti-tamper, and military vulnerability, as well as alternate materials that may mitigate known risks and issues. Additionally, manufacturing and quality risks, issues, and opportunities based on potential materials obsolescence and lack of availability from business climate impacts (e.g., business failures, market changes, political, etc.) should be included in assessments. Results of these assessments should be incorporated into recommended changes and updates for appropriate government/contractor mitigation plans.

5565 For CDR, materials cost drivers must be updated and appropriate management plans implemented for 5566 control of all aspects of materials costs (actual and planned) for both the Government and the

5567 Contractor. The industrial and manufacturing capability should be assessed to baseline needed

industrial capability and to obtain key knowledge on scale-up efforts, and potential supply chain

issues. Managing scale-up for EMD should include planning that addresses new manufacturing and

quality processes and techniques, meeting delivery dates, critical and long-lead materials, facility,
 equipment, tooling availabilities and capabilities, tests and demonstrations, conservation of critical

5572 and strategic materials, and transportation and security including ITAR considerations. Management

also includes planning for mitigation of risks and issues, as well as exploiting opportunities.

5574 Manufacturing and quality should assess the Contractor's materials supply chain for application,

5575 implementation, and adherence to industry manufacturing and quality best practices, as well as

5576 Contractor's compliance with Company policies, processes, procedures, and contracts.

5577 The materials and components lead times are extremely critical to both meeting program schedules

and defining requirements for long lead and advanced buys. Lead times for defense materials and

5579 components can be long and volatile due to various reasons, such as imbalances between capacity

5580 and demand, competition from commercial customers, testing cycles, materials availability,

budgeting, funding and contracting processes, transportability, workforce issues, etc. All of these can

bave an impact on capacity, quality, and schedule, thus driving lead times and the program must

5583 maintain visibility of the current status and the forecast changes in lead times.

5584 The program's objectives should be to improve capabilities and quality, and reduce costs by

5585 maintaining (or improving) schedule, supporting the Industrial Base, and promoting competition by

5586 qualification of alternative sources. There many factors that can interfere with these objectives,

requiring alternative sources. Natural disasters, such as earthquakes and tsunamis can severely

disrupt production operations for many industries as can counterfeit parts and the loss of sources of

items or material. Additionally, programs must account for Diminishing Manufacturing Sources and

4. Engineering and Manufacturing Development (EMD) Phase

5590 Material Shortages (DMSMS) to mitigate risks to life-cycle support and viability of the weapon

- system or equipment. As a resource for this process, the Government Information Data Exchange
- 5592 Program (GIDEP) was established as the central repository within the DOD for all parts
- discontinuance and counterfeit notices. GIDEP receives notices from manufacturers and participants
- and distributes alerts to DOD and to private industry.

5595 Future requirements (i.e., Operations and Support phase) for items which represent recurring spare

- 5596 parts requirements and substantial cost for annual buys, require aggressive action to develop
- alternative sources of supply. These sources ensure continuing part availability and competitive
 sources for these parts. The process of establishing competitive sources for these parts starts early ir
- sources for these parts. The process of establishing competitive sources for these parts starts early inthe production phase and continues as long as they are in the supply system. Based on pilot line
- results, manufacturing and quality should validate the identification of critical sources throughout the
- 5601 supply chain. Include sources of key and/or critical subsystems, items, parts, and components,
- 5602 including KCs (KCs), Configuration Items (CIs), and CSIs, required to meet program requirements.
- 5603 Based on updates to Industrial Capabilities Assessments in support of MS C, manufacturing and
- 5604 quality should assess and verify material availability for LRIP, include availability risks, issues, and
- 5605 mitigations, costs and schedule updates, long-lead procurement risks, mitigation, and status,
- obsolescence, Supply chain management including first, second, and lower tier suppliers, counterfeit
- 5607 detection and avoidance, physical, cyber, and industrial security, special handling, transportation,
- storage, and environmental compliance risks and issues, etc. This assessment should consider
- 5609 emerging technology advancements in materials and processes, changes in Government statute,
- 5610 policy, and regulations, changes in business climate conditions (e.g., mergers and acquisitions,
- failures, etc.), changes in environmental impacts (e.g., natural disasters, etc.), DMSMS, and program
- 5612 plans for P^3I in LRIP.
- 5613 Successful completion of EMD with a thorough understanding of materials capabilities, capacities,
- and limitations and the aggressive management of and planning for materials will ensure effective
- transition to LRIP and Production and Deployment phase.

5616 G.1 Manage Materials Risk

5617 Manufacturing and Quality Tasks

- Analyze the Contractor's plans to meet manufacturing and quality requirements for maturity
 of materials by CDR, including:
- 5620 o Risks and issues
- o Associated cost drivers (See G.2)
- 5622oDesign requirements
- 5623oConfiguration Management
- 5624oMaterials processes maturity
- 5625 o Materials specifications

4. Engineering and Manufacturing Development (EMD) Phase

5626		• Emerging materials
5627		• Cost reduction and avoidance
5628		• Materials availability and lead times
5629		• Environmental factors
5630		• Management of the supply chain
5631		• Counterfeit parts and obsolescence
5632		• Security, required special handling, physical and cyber protection
5633		• Facilities, capital equipment, tooling, and test equipment
5634		• Storage, handling, transportation, etc.
5635 5636	•	Based Contractor data, assess all materials for manufacturing and quality risks, issues, and opportunities:
5637 5638		• Update evaluation of material maturity and availability from TMRR for adequacy to support pilot line
5639 5640		Assess validity and maturity of emerging materials for manufacturabilityAssess maturity in a production environment
5641		• Update the manufacturing and quality evaluation of lead times including:
5642 5643 5644 5645		 Long lead materials Impacts to schedule, budget, and critical path, etc. Impacts from fluctuations, availability, capacity, regulatory issues, ITAR, Anti-Tamper, etc.
5646 5647		 Identify opportunities for alternative materials (to avoid or mitigate known risks and issues)
5648 5649 5650	•	Assess and identify manufacturing and quality risks, issues, and opportunities for materials obsolescence and lack of availability based on analyses of the business climate (e.g., business failures, market changes, political, etc.) for the CDR including:
5651 5652 5653 5654		 Availability from single or sole sources (domestic or foreign), within the NTIB, only from sources that are outside the NTIB, vulnerable to foreign acquisition Disruptive business climate conditions (e.g., natural disasters, strikes, etc.) Diminishing Manufacturing Sources and Materials Shortages (DMSMS)
5655	•	Develop Government mitigation plans as appropriate (specified in the program SEP) for:
5656 5657		 Known risks to critical and strategic materials Availability issues to be addressed for pilot line and LRIP builds
5658 5659 5660 5661	•	Monitor Contractor mitigation processes and plans as specified in the Contractor SEMP for alignment with the program SEP. Analyze and assess the Contractor's Make/Buy process for adequacy and completeness including capabilities, capacities, and processes for:
5662		• Key and/or critical subsystems, items, parts, and components to include volatility

4. Engineering and Manufacturing Development (EMD) Phase

Management of the supply chain (including other divisions)

Vendors to meet quality requirements, schedule and cost targets

5663

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0

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5665 5666 5667	 Identification and mitigation of counterfeit parts and materials (e.g., end items, components, parts, or assemblies) Management of GFE, GFM, etc.
5668 5669	• Analyze and assess the Contractor's hazardous and special handling, storage, and environmental compliance procedures for risks and issues to include:
5670 5671 5672 5673 5674 5675	 Regulatory requirements Hazardous materials and handling procedures Security requirements (physical, cyber, industrial, etc.) Transportation, storage, and shelf life GFP, GFE (tooling, test equipment, ranges, chambers, etc.) Disposal
5676 5677 5678 5679 5680	 Metrics Contractor's plans to meet manufacturing and quality requirements for material maturity by CDR have been assessed and recommended approvals, changes, updates, and appropriate government/contractor mitigation plans have been documented for program management for the following:
5681 5682 5683 5684 5685 5686 5687 5688 5689 5690 5691 5691 5692 5693 5693 5694 5695	 Risks and issues Associated cost drivers (See G.2) Design requirements Configuration Management Materials processes maturity Materials specifications Emerging materials Cost reduction and avoidance Materials availability and lead times Environmental factors Management of the supply chain Counterfeit parts and obsolescence Security, required special handling, physical and cyber protection Facilities, capital equipment, tooling, and test equipment Storage, handling, transportation, etc.
5696 5697 5698 5699 5700 5701	 Based Contractor data, all materials have been assessed for manufacturing and quality risks, issues, and opportunities and recommended changes, updates, and appropriate government/contractor mitigation plans have been documented for program management for: Adequacy of material maturity and availability to support pilot line including: Validity and maturity of emerging materials Use in a production environment

4. Engineering and Manufacturing Development (EMD) Phase

5702		• Capability and capacity to meet required availability (lead times) including:
5703 5704 5705		 Long lead materials Schedule, budget, and critical path, etc. impacts Fluctuations, regulatory issues, ITAR, Anti-Tamper, etc.
5706		• Opportunities for alternative materials (to avoid or mitigate known risks and issues)
5707 5708 5709 5710	•	Based on analyses of the business climate (e.g., business failures, market changes, political, etc.), manufacturing and quality risks, issues, and opportunities for materials obsolescence and availability have been assessed for CDR and the results documented for CDR with recommended mitigations for:
5711 5712 5713		 Single or sole sources (domestic or foreign), and sources vulnerable to foreign acquisition Disruptive business climate conditions (e.g., natural disasters, strikes, etc.) DMSMS
5714 5715	•	Manufacturing and quality inputs to Government materials risks and issues mitigation plans have been provided for:
5716 5717		 Known risks to critical and strategic materials Availability issues to be addressed for pilot line and LRIP builds
5718 5719 5720 5721 5722 5723 5724	•	Contractor manufacturing and quality mitigation processes and plans, as specified in the Contractor SEMP, have been assessed for compliance with the program SEP and recommendations for changes to the SEMP and/or SEP have been documented and provided to program management. Contractor's Make/Buy process has been assessed for adequacy and completeness of capabilities, capacities, and processes and recommended changes, updates, and appropriate government/contractor mitigation plans have been documented for program management for:
5725 5726 5727 5728 5729 5730		 Key and/or critical subsystems, items, parts, and components Management of the supply chain (including other divisions) Vendors capability to meet quality requirements, schedule and cost targets Process for counterfeit parts and materials detection and avoidance (e.g., end items, components, parts, or assemblies) Management of GFE, GFM, etc.
5731 5732 5733 5734	•	Contractor's hazardous and special handling, storage, and environmental compliance procedures for risks and issues have been assessed for adequacy and completeness and recommended manufacturing and quality changes, updates, and appropriate government/contractor mitigation plans have been documented for CDR to include:
5735 5736 5737 5738 5739		 Regulatory requirements Hazardous materials and handling procedures Security requirements (physical, cyber, industrial, etc.) Transportation, storage, and shelf life GFP, GFE (tooling, test equipment, ranges, chambers, etc.)

4. Engineering and Manufacturing Development (EMD) Phase

5740 o Disposal

57/1	Tools
5741	10015

- DCMA Material Management and Accounting System Audit
- PESHE Assessment/Template
- ISO 14001 Gap Analysis Toolkit
- DMSMS Product Life Cycle Assessment (Consult DLA)
- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
- MRL Assessment Questionnaire for the Materials Thread
- Supply chain Management Risk Assessment Checklist
- Producibility Assessment Worksheet
- TRL Assessment Questionnaire

5751 Resources

- Strategic and Critical Materials Stock Piling Act, as amended by PL 114-328, Dec 16
- DFARS Subpart 242.7200 Contractor Material Management and Accounting System
- ESOH in Acquisition Guide, Apr 2009
- ISO 14001 Environmental Management Systems
- DMSMS Guidebook, SD-22, Sep 2009
- DOD 5000.60 Defense Industrial Capabilities Assessments
- DOD 5000.60H Assessing Defense Industrial Capabilities
- DOD 4140.1-R supply chain Management Regulation
- DoDM 4140.1 DoD supply chain Management Procedures, Feb 2014
- MRL Deskbook Version 2016
- Technology Readiness Assessment Guidance, Apr 2011
- Producibility Systems Guidelines, NAVSO P-3687, Dec 1999
- 5764 G.2 Manage Materials Cost Drivers

5765	Manufacturing	and	Quality	Tasks
5705	manactaring	una	Quanty	105105

- Based on manufacturing, quality, and unique and/or specialized requirements, specifications,
 and tolerances, and associated risks and issues; analyze and update manufacturing and quality
 materials cost drivers for the CDR to include:
- 5769oContractor plans for materials, materials processes, rates and quantities (including lot5770buys),
- 5771 Risk mitigation processes (ongoing, identification, reduction, etc.)
- 5772 Supplier Chain (e.g., capability, capacity, quality, etc.)
- 5773 Special handling and training
- 5774 o Environmental compliance and training,
- 5775 Materials security (physical, cyber, industrial, etc.)

Manufacturing and Quality Management Body of Knowledge

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5776		o Planned subsystems, parts, items, and components (supply chain commodities) to include
5777		alternative sources
5778		• Planned rates and quantities for pilot line and LRIP
5779		• Updated "should-cost" analyses and actuals
5780		• Updated materials cost driver uncertainties (based on actuals)
5781		• Cost drivers updates impacted by conservation critical and strategic materials
5782		• Cost drivers for mitigation of supply disruptions
5783		• Updated estimates for the cost of quality
5784		• Updated estimates for the cost of materials testing
5785 5786	•	Analyze and update the contractor planning (producibility) with respect to materials cost drivers and associated risks (see G.1) for the CDR to include:
5787		• Design requirements
5788		• Configuration management
5789		• Emerging materials
5790		• Price stability, cost reduction and avoidance
5791		• Rates and quantities
5792		• Materials process maturity including quality processes
5793		• Materials specifications
5794		• Materials availability (lead times)
5795		• Cost reduction and avoidance
5796		• Environmental factors and compliance
5797		• Management of supply chain
5798		• Processes and quality
5799		• Counterfeit parts avoidance
5800		o Obsolescence
5801		• Security, required special handling, physical, cyber, and industrial
5802		• Facilities, capital equipment, tooling, and test equipment
5803		• Storage, handling, and transportation, etc.
5804	•	Assess and identify manufacturing and quality materials cost drivers based on industrial base
5805		analyses of the business climate (e.g., business failures, acquisitions, market changes,
5806		political changes, etc.) for the CDR including:
5807		• Materials availability only from single or sole sources, foreign sources (only from
5808		sources that are outside the NTIB), and sources vulnerable to foreign acquisition
5809		• Disruptive business climate conditions (e.g., natural disasters, strikes, etc.)
5810		• Materials subject to Diminishing Manufacturing Sources and Materials Shortages
5811		(DMSMS)
5812		 Materials market stability (commodities)

5813	Metrie	CS	
5814 5815	•	Ba ano	sed on manufacturing, quality, and unique and/or specialized requirements, specifications, d tolerances, and associated risks and issues, manufacturing and quality has assessed
5816 5817		ma ano	terials cost drivers and documented recommended updates and changes to cost drivers risk d issue mitigation plans for the CDR on the following:
5818		0	Contractor plans for materials, materials processes, rates, and quantities
5819		0	Risk mitigation processes (ongoing, identification, reduction, etc.)
5820		0	Supplier Chain (e.g., capability, capacity, quality, etc.)
5821		0	Special handling and training
5822		0	Environmental compliance and training,
5823		0	Materials security (physical, cyber, industrial, etc.)
5824		0	Planned subsystems, parts, items, and components (supply chain commodities) to include
5825			alternative sources
5826		0	Planned rates and quantities for pilot line and LRIP
5827		0	Updated "should-cost" analyses and actuals
5828		0	Updated materials cost driver uncertainties (based on actuals)
5829		0	Cost drivers updates impacted by conservation critical and strategic materials
5830		0	Cost drivers for mitigation of supply disruptions
5831		0	Updated estimates for the cost of quality
5832		0	Updated estimates for the cost of materials testing
5833	٠	Co	ntractor planning with respect to materials cost drivers and associated risks (see G.1) has
5834		bee	en assessed and based on the results manufacturing and quality recommendations, changes,
5835		and	d updates have been documented for the CDR to include:
5836		0	Design requirements
5837		0	Configuration management
5838		0	Emerging materials
5839		0	Price stability, cost reduction and avoidance
5840		0	Rates and quantities
5841		0	Materials process maturity including quality processes
5842		0	Materials specifications
5843		0	Materials availability (lead times)
5844		0	Cost reduction and avoidance
5845		0	Environmental factors and compliance
5846		0	Management of supply chain
5847		0	Processes and quality
5848		0	Counterfeit parts avoidance
5849		0	Obsolescence
383U		0	Security, required special nandling, physical, cyber, and industrial
5851		0	Facilities, capital equipment, tooling, and test equipment
5852		0	Storage, nandling, and transportation, etc.

5853 5854 5855 5856 5857 5858 5859 5860 5861 5862 5863 5864	•	 Manufacturing and quality has participated in and provided support for assessments and analyses of the industrial base business climate materials cost drivers (e.g., business failures, acquisitions, market changes, political changes, etc.) and has provided documented recommendations and changes on the following: Materials availability (e.g., single or sole sources, foreign sources, and sources vulnerable to foreign acquisition) Business climate conditions (e.g., natural disasters, strikes, etc.) Market changes from technological evolution Business changes (e.g., political, etc.) Materials subject to Diminishing Manufacturing Sources and Materials Shortages (DMSMS) Materials market stability (commodities)
5865	Tools	
5066		Cost and Load Time Estimating Workshoot
5967	•	Cost and Lead Time Estimating Worksheet
5867	•	$C_{\rm ost}$ Schedule Control System Criteria (see EVM)
5868	•	Cost, Schedule Control Systems Criteria (CSCSC)
5869	•	MRL assessment for the Material Management Thread
5870	•	Producibility Assessment
5871	Resou	rces
5872	•	Cost/Schedule Control System Criteria
5873	•	Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
5874		Program Managers, Chapter 9
5875	•	Producibility Systems Guidelines, NAVSO P-3687, Dec 1999
5876	•	Strategic and Critical Materials Stock Piling Act, as amended by PL 114-328, Dec 16
5877	•	MRL Deskbook Version 2016
5878	G.3	Manage Scale-Up Risk
5879	Manu	facturing and Quality Tasks
5880	•	Analyze and update materials producibility assessments, manufacturing processes,
5881		techniques, procedures, capacity, and availability to meet program requirements (scale-up for
5882		pilot line, LRIP, and FRP) and assess materials risks, issues, and opportunities including:
5883		• New materials (to the industry to the program to the suppliers)
5884		• Supply chain and/or source capability and capacity
5885		\circ Source criticality and fragility (e.g. sole or single sources foreign sources domestic
5886		foreign-owned etc.)
5887		• Workforce (e.g. knowledge availability etc.)
5888		• Lead times for required quantities (un-proven suppliers)
5000		C Louis antes for requires quantities (un proven suppliers)

4. Engineering and Manufacturing Development (EMD) Phase

5889 5890 5891 5892 5893 5894 5895 5896	 Rates that are higher and/or lower than typical Introduction of counterfeit materials Obsolescence due to product improvements and market/technology changes Regulatory requirements and impacts (e.g., US law, ITAR, environmental, REA concerns, etc.) Testing aspects throughout the production processes and supply chain Security (e.g., special handling, physical, cyber, industrial, etc.) Facilities, equipment, and tooling 	СН
5897 5898	 Transportation, storage, and handling Update and ensure manufacturing and quality plans for CDR address scale-up risks, 	issues,
5900 5901 5902 5903 5904 5905 5906 5907 5908 5909 5910 5911 5912 5913	 Manufacturing processes, techniques, and procedures (including special handlin Meeting schedule Addressing impacts from critical and long-lead time materials Addressing facility, equipment, and tooling availability (acquisition and/or sche Cost models, drivers, and schedules Manufacturing and quality materials alternatives Required testing Conservation of critical and strategic materials Workforce DMSMS Counterfeit avoidance Supply disruption Regulatory requirements and impacts (e.g., environmental, HAZMAT, etc.) Security (e.g., special handling, physical, cyber, industrial, etc.) 	g) duling)
5915 N	• I ransportation, storage, and nandling	
5916 5917 5918 5919 5920	 Manufacturing and quality have assessed, updated, and/or validated materials produ manufacturing processes, techniques, procedures, capacity, and availability assessm the capability to meet program scale-up requirements and materials risks, issues, and opportunities results have been documented in the Manufacturing Strategy and Plan Quality Strategy and Plan (for CDR) for pilot line, LRIP, and FRP including: 	cibility, ents for d and
5921 5922 5923 5924 5925 5926 5927 5928	 New materials (to the industry, to the program, to the suppliers) Supply chain and/or source capability and capacity Source criticality and fragility (e.g., sole or single sources, foreign sources, dom foreign-owned, etc.) Workforce (e.g., knowledge, availability, etc.) Lead times for required quantities (un-proven suppliers) Rates that are higher and/or lower than typical Introduction of counterfeit materials 	estic

4. Engineering and Manufacturing Development (EMD) Phase

5929		• Obsolescence due to product improvements and market/technology changes
5930		• Regulatory requirements and impacts (e.g., US law, ITAR, environmental, REACH
5931		concerns, etc.)
5932		• Testing aspects throughout the production processes and supply chain
5933		• Security (e.g., special handling, physical, cyber, industrial, etc.)
5934		• Facilities, equipment, and tooling
5935		• Transportation, storage, and handling
5936	•	Program Manufacturing Strategy and Plan and Quality Strategy and Plan (See L.2 and I.2)
5937		have been updated to mitigate and/or eliminate risks and issues and address opportunities for
5938		pilot line, LRIP, and FRP material scale-up requirements to include:
5939		• Manufacturing processes, techniques, and procedures (including special handling)
5940		o Schedule
5941		• Impacts from critical and long-lead time materials
5942		• Facility, equipment, and tooling availability (acquisition and/or scheduling)
5943		• Cost models, drivers, and schedules
5944		• Manufacturing and quality materials alternatives
5945		o Testing
5946		• Conservation of critical and strategic materials
5947		o Workforce
5948		o DMSMS
5949		• Counterfeit avoidance
5950		• Supply disruption
5951		• Regulatory requirements and impacts (e.g., environmental, HAZMAT, etc.)
5952		• Security (e.g., special handling, physical, cyber, industrial, etc.)
5953		• Transportation, storage, and handling
5954	Tools	
5955	•	Cost and Lead Time Worksheet
5956	•	Producibility Assessment Worksheet
5957	•	Manufacturing Readiness Assessment Materials Thread
5958	•	ManTech Strategic Plan
5959	Resou	irces
5960	•	EC 1907/2006 Registration Evaluation Authorisation and Restriction of Chemicals
5961	-	(REACH)
5962	•	Producibility Systems Guidelines NAVSO P-3687 Dec 1999
5963	•	MRL Deskhook Version 2016
5961	-	MRL Users Guide
5965	•	DoD Directive 4200 15 ManTech
5905	•	Air Force Technology Development and Transition Strategy Cylidebeck, New 2010
2200	•	An Porce rechnology Development and Transition Strategy Guidebook, Nov 2010

Assess Contractor supply chain Management (SCM) Program 5967 G.4

Manufacturing and Quality Tasks 5968

5969 5970 5971	•	Assess the contractor's materials supply chain Management (SCM) program for implementation and adherence to industry manufacturing and quality best practices to include:
5972 5973 5974 5975		 Manufacturing management standards (e.g., AS6500, MIL-STD-896A, etc.) Quality management standards (e.g., ISO 9000, AS9100, etc.) Configuration management Systems Engineering standards (e.g., IEEE 15288, etc.)
5976	•	Assess the contractor's materials supply chain Management (SCM) program for:
5977 5978 5979 5980 5981		 Management of suppliers and sub-tier materials manufacturing processes and procedures, especially suppliers performing key and/or critical materials manufacturing processes impacting KCs Implementation and compliance to security processes, plans, and procedures for materials including:
5982 5983 5984		 Industrial security and anti-tamper for risks, issues, processes, industrial control systems, resources, organization, and metrics Physical, digital, and cyber security (associated with SSE, COMSEC, and PPP)
5985 5986		• Materials special handling, storage, safety, and environmental compliance procedures to include:
5987 5988 5989 5990 5991		 Regulatory requirements Hazardous materials and handling procedures Transportation, storage, and shelf life GFP, GFE (tooling, test equipment, ranges, chambers, etc.) Disposal
5992		• Materials supplier sourcing processes for:
5993 5994 5995		 Supplier evaluation, qualification, approval, re-qualification, and removal Management of sole or single sources, foreign sources, domestic foreign-owned, etc. Management of capabilities and capacities
5996 5997		 Development of strategic partnerships with vendors and suppliers Materials sub-contract management for:
5998 5999 6000 6001 6002 6003		 Monitoring sub-tier compliance to manufacturing and quality contractual requirements Monitoring sub-tier processes (e.g., configuration management, parts management, obsolescence, counterfeit parts management, electro-static discharge program, etc.) Communications (e.g., two-way flow of quality data, requirements, forecasting data, etc.)

6004 6005 6006	 Materials data (e.g. testing, analyses, storage, and traceability, etc.) Quality program implementation (e.g., SPC, process capabilities, predictive indicators, variability reduction, etc.)
6007	• Materials procurement processes for:
6008 6009 6010 6011 6012 6013 6014	 Specification of requirements (e.g., drawings, revisions, packaging, kitting, identification, etc.) Specification of quality standards and metrics Scheduling, quantities, etc. Supplier assistance programs Monitoring and evaluations Deficiencies and corrective actions (i.e. FRACAS)
6015	• Internal logistics and inventory management processes for materials including:
6016 6017 6018 6019 6020 6021 6022	 Production scheduling, kitting, identification, etc. Pre- and post-production storage, scheduling, kitting, packaging, environmental, security, etc. Transportation methods, special handling, packaging, environmental controls, identification and tracking, etc. Vendor Managed Inventory (e.g., quality, schedule, quantity, packaging, kitting, identification and tracking, etc.)
6023 6024 6025	 Integration of supply chain risks and issues for KCs, security, compliance, sourcing (counterfeit, obsolescence, etc.), and procurement into the joint contractor's Risk, Issue, and Opportunity System
6026 • 6027 6028	Assess the contractor manufacturing and quality materials processes for compliance with or adherence to Company policy, process, and contracts, utilizing DCMA support (requires a Letter of Delegation) to include:
6029 6030 6031 6032 6033	 Implementation of industry best practices (e.g., AS6500, ISO 9000, AS9100, etc.) Performing first article/qualification(s) (i.e., AS9103) SCM of interdependencies Sourcing to minimize risks, criticality, and obsolescence Supplier qualification, approval, and monitoring processes to include
6034 6035	Suppliers with known risksSupplier parts usage and sources (i.e., GIDEP prohibited)
6036	• Processes for data flow (two-way)
6037 6038 6039 6040 6041	 Program reviews, milestones, and metrics Demand Planning Quality, safety, technical, and inspection requirements and changes Key and critical characteristics Make or buy decision analysis processes
0071	o make of our decision analysis processes

6042		 Counterfeit and DMSMS management processes
6043		• Inventory management
6044		• FRACAS process
6045		• Security processes
6046		• ESOH management
6047		• Material waiver process (should only be utilized in limited circumstances)
6048		 Implementation of supply chain Management oversight processes
6049		 Vendor survey requirements
6050		 Identification and management of risks, issues, and opportunities
6051		 Surveillance
6052	٠	Ensure assessments of critical first, second, and lower tier supply chain for compliance to
6053		purchase order/subcontract quality, manufacturing/ production, engineering and software
6054		requirements are completed.
6055	•	Initiate SCM planning for EMD, production, developmental and operational test, and life-
6056		cycle sustainment.
6057	Metric	S
6058	•	Contractor's materials SCM program has been assessed for implementation and adherence to
6059		industry manufacturing and quality best practices with documented changes and
6060		recommendations provided to program management on the following:
6061		• Manufacturing management standards (e.g., AS6500, MIL-STD-896A, etc.)
6062		• Quality management standards (e.g., ISO 9000, AS9100, etc.)
6063		• Configuration management
6064		 Systems Engineering standards (e.g., IEEE 15288, etc.)
6065	•	Contractor's materials SCM program has been assessed for specific manufacturing and
6066		quality requirements, processes, and procedures with documented recommendations and
6067		changes provided to program management on the following:
6068		• KCs (KCs) management, including suppliers and sub-tier materials manufacturing
6069		processes and procedures
6070		• Compliance with security processes, plans, and procedures for materials including:
6071		 Industrial security and anti-tamper for risks, issues, processes, industrial control
6072		systems, resources, organization, and metrics
6073		 Physical, digital, and cyber security (associated with SSE, COMSEC, and PPP)
6074		• Special handling, storage, safety, and environmental compliance for materials to include:
6075		 Regulatory requirements
6076		 Hazardous materials and handling
6077		 Transportation, storage, and shelf life
6078		 GFP, GFE (tooling, test equipment, ranges, chambers, etc.)
6079		 Disposal

6080	• Supplier sourcing processes for:
6081 6082 6083	 Supplier evaluation, qualification, approval, re-qualification, and removal Management of sole or single sources, foreign sources, domestic foreign-owned, etc. Management of capabilities and capacities
6084 6085	 Vendor and supplier strategic partnerships Contract management for sub-tier including:
6086 6087 6088 6089 6090 6091 6092 6093	 Compliance monitoring for manufacturing and quality contractual requirements Process monitoring (e.g., configuration management, parts management, obsolescence, counterfeit parts management, electro-static discharge program, etc.) Communications (e.g., two-way flow of quality data, requirements, forecasting data, etc.) Materials data management (e.g. testing, analyses, storage, and traceability, etc.) Quality (e.g., SPC, process capabilities, predictive indicators, variability reduction, etc.)
6094	• Materials procurement including:
6095 6096 6097 6098 6099 6100	 Requirements (e.g., drawings, revisions, packaging, kitting, identification, etc.) Quality standards and metrics Scheduling, quantities, etc. Supplier assistance programs Monitoring and evaluations Deficiencies and corrective actions (i.e. FRACAS)
6101	• Internal logistics and inventory management including:
6102 6103 6104 6105 6106 6107 6108	 Production scheduling, kitting, identification, etc. Pre- and post-production storage, scheduling, kitting, packaging, environmental, security, etc. Transportation methods, special handling, packaging, environmental controls, identification and tracking, etc. Vendor Managed Inventory (e.g., quality, schedule, quantity, packaging, kitting, identification and tracking, etc.)
6109 6110 6111	 Integration of supply chain risks and issues for KCs, security, compliance, sourcing (counterfeit, obsolescence, etc.), and procurement into the joint contractor's Risk, Issue, and Opportunity System
6112 • 6113 6114 6115	Utilizing DCMA support, contractor's manufacturing and quality materials processes have been assessed for compliance with or adherence to Company policies, processes, procedures, and contracts with documented recommendations and changes provided to program management on the following for CDR:
6116 6117	 Company adherence to industry best practices (e.g., AS6500, ISO 9000, AS9100, etc.) First article inspections and qualification(s) (i.e., AS9103)

4. Engineering and Manufacturing Development (EMD) Phase

6118 6119 6120		 SCM of interdependencies Sourcing to minimize risks, criticality, and obsolescence Supplier qualification (approval and monitoring) including
6121 6122		Suppliers with known risksSupplier parts usage and sources (i.e., GIDEP prohibited)
6123		• Management of data flow (two-way)
6124 6125 6126 6127		 Program reviews, milestones, and metrics Demand Planning Quality, safety, technical, and inspection requirements and changes Key and critical characteristics
 6128 6129 6130 6131 6132 6133 6134 6135 		 Make or buy decision analysis Counterfeit and DMSMS management Inventory management FRACAS Security ESOH management Material waivers Implementation of SCM oversight including:
6136 6137 6138		 Vendor survey requirements Identification and management of risks, issues, and opportunities Surveillance
6139 6140 6141 6142 6143 6144	•	Assessments of critical first, second, and lower tier supply chain for compliance to purchase order/subcontract quality, manufacturing/ production, engineering and software requirements have been completed and are documented for CDR. Program SCM planning for the Manufacturing and Quality Strategies and Plans has been documented to include EMD, production, developmental and operational test, and life-cycle sustainment for CDR.
6145	Tools	
6146	•	AS5553 supply chain Assessment
6147	•	DCMA Material Management and Accounting System Audit
6148	•	Manufacturing Readiness Assessment using the Material thread
6149	Resou	rces
6150	٠	AS6500, Manufacturing Management Systems
6151	•	DFARS Subpart 242.7200 Contractor Material Management and Accounting System
6152	٠	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
6153 6154	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations, Sep 2016s

4. Engineering and Manufacturing Development (EMD) Phase

•	AS9103 Variation Management of Key Characteristics
•	AS9133, Qualification Procedure for Aerospace Standard Parts
•	ISO 9001:2015, Quality Management System
•	MIL-STD-896A, Manufacturing Quality Program
•	AS5553, Counterfeit Electronics Parts
•	IEEE 15288.2, System and Software Engineering, 2015
•	DFARS 246.870, Contractors' Counterfeit Electronic Part Detection and Avoidance
•	DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance
	System
•	DFARS 252.246-7008, Sources of Electronic Parts
•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
	Reporting
•	DoDI 5000.02, Enclosure 14
•	NIST 800-82 Guide to Industrial Control Systems Security
•	NIST 800-171. Protecting Controlled Unclassified Information in Nonfederal Information
	Systems and Organizations
G.5	Analyze Material Lead Times
Manu	facturing and Quality Tasks
•	Perform an analysis of contractor's manufacturing and quality schedule and quantities for
	sub-systems, items, and components to meet program IMP/IMS and critical path
	requirements.
•	Analyze results of assessments of contractor and key supply chain to ensure identification of
•	Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling
•	Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include:
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes,
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes, policies and political changes, etc.)
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes, policies and political changes, etc.) Market changes (e.g., technological changes and obsolescence, workforce, etc.)
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes, policies and political changes, etc.) Market changes (e.g., technological changes and obsolescence, workforce, etc.) Impacts from scale-up
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes, policies and political changes, etc.) Market changes (e.g., technological changes and obsolescence, workforce, etc.) Impacts from scale-up Impacts from regulatory issues, ITAR, Anti-Tamper, etc.
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes, policies and political changes, etc.) Market changes (e.g., technological changes and obsolescence, workforce, etc.) Impacts from regulatory issues, ITAR, Anti-Tamper, etc. Assess pilot line and LRIP procurement requirements (e.g., schedule and quantities).
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes, policies and political changes, etc.) Market changes (e.g., technological changes and obsolescence, workforce, etc.) Impacts from regulatory issues, ITAR, Anti-Tamper, etc. Assess pilot line and LRIP procurement requirements (e.g., schedule and quantities). Ensure government manufacturing and quality funding supports contractor schedule and
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes, policies and political changes, etc.) Market changes (e.g., technological changes and obsolescence, workforce, etc.) Impacts from regulatory issues, ITAR, Anti-Tamper, etc. Assess pilot line and LRIP procurement requirements (e.g., schedule and quantities). Ensure government manufacturing and quality funding supports contractor schedule and procurement requirements.
•	 Analyze results of assessments of contractor and key supply chain to ensure identification of manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) to include: Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes, policies and political changes, etc.) Market changes (e.g., technological changes and obsolescence, workforce, etc.) Impacts from scale-up Impacts from regulatory issues, ITAR, Anti-Tamper, etc. Assess pilot line and LRIP procurement requirements (e.g., schedule and quantities). Ensure government manufacturing and quality funding supports contractor schedule and procurement requirements.
	• • • • • • • • • • • • • • • • • • •

4. Engineering and Manufacturing Development (EMD) Phase

6193	Metric	CS
6194 6195 6196 6197 6198 6199 6200	•	Contractor's manufacturing and quality schedule and quantities for sub-systems, items, and components have been assessed for meeting program schedule and critical path requirements and recommendations and changes have been documented for the contractor plans and/or the IMP/IMS and provided for CDR. Contractor and key supply chain assessment results have been analyzed and document for CDR manufacturing and quality risks, issues, and opportunities associated with scheduling procurement of materials (e.g., sub-systems, items, and components) including:
6201 6202 6203 6204 6205 6206 6207 6208 6209		 Long-lead Items Lead time fluctuations Impacts from single or sole sources, sources that are outside the NTIB, and sources vulnerable to foreign acquisition Business climate conditions (e.g., acquisitions and mergers, natural disasters, strikes, policies and political changes, etc.) Market changes (e.g., technological changes and obsolescence, workforce, etc.) Impacts from scale-up Impacts from regulatory issues, ITAR, Anti-Tamper, etc.
6210 6211 6212 6213 6214 6215	• •	Pilot line and LRIP procurement requirements for schedule and quantities have been assessed and documented for CDR.Government manufacturing and quality funding support for the contractor schedule and procurement requirements has been verified and confirmed for CDR.Mitigation plans have been developed and are in place for mitigation of all procurement risks and issues for CDR.
6216	Tools	
6217	•	Cost and Lead Time Estimating Worksheet
6218	Resou	rces
6219 6220 6221	•	Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct 2005 MRL Deskbook Version 2016
6222	G.6	Assess Alternate Source Options
6223 6224	Manu ⁺	facturing and Quality Tasks Analyze the contractor's manufacturing and quality sourcing plans, policies, and procedures
6225		(e.g., make/buy, alternate sources, etc.) for subsystems, items, and components for:
6226 6227		• Meeting qualification requirements
6228		 Competitive sources (e.g., dual source, GFE, etc.)

6229		• Costs (e.g., per unit, investment, storage and handling, etc.)
6230		• Materials with environmental or ESOH concerns
6231		• Vulnerability mitigation for single, sole, foreign, foreign-owned domestic, fragile,
6232		critical, etc.
6233		• Materials only available outside the NTIB
6234		• Quality, schedule, transportation, fulfillment, etc.
6235		• Hazardous materials
6236		• Difficulty to obtain and/or process materials
6237		• Meeting Government requirements for support of the NTIB
6238		• Counterfeit detection and prevention (including GIDEP data)
6239	٠	Based on manufacturing and quality analyses of program materials and assessments of
6240		materials maturity, availability, risks, issues, and opportunities, develop recommendations for
6241		alternate sources and options for pilot line, LRIP, and O&S including:
6242		 Emerging technology advancements in materials and processes
6243		 Changes in Government statute, policy, and regulations
6244		• Changes in business climate conditions (e.g., mergers and acquisitions, failures, etc.)
6245		• Changes in environmental impacts (e.g., natural disasters, etc.)
6246		 Diminishing Manufacturing Sources and Material Shortages (DMSMS)
6247	٠	Ensure alternate materials sources and/or materials mitigate current risks and issues and/or do
6248		not introduce new risks and issues to the program.
6249	•	Ensure contractor's alternate manufacturing and quality sourcing plans, policies, and
6250		procedures are consistent with program plans for program plans for Product Improvement
6251		$(\mathbf{P}^{3}\mathbf{I}).$
6252	•	Ensure continuing parts and materials availability for future requirements (i.e., Operations
6253		and Support phase) by assessing the supply chain for its long term viability and competitive
6254		sourcing.
6255	Metrio	CS
6256	٠	Contractor's manufacturing and quality sourcing plans, policies, and procedures (e.g.,
6257		make/buy, alternate sources, etc.) have been assessed and document recommended updates
6258		and changes to subsystems, items, and components for:
6259		• Meeting qualification requirements
6260		• Contingency planning (e.g., capacity, economic/political impacts, disaster impacts, etc.)
6261		• Competitive sourcing (e.g., dual source, GFE, etc.)
		• Costs (e.g., per unit, investment, storage and handling, etc.)
6262		• Materials with environmental or ESOH concerns
6262 6263		
6262 6263 6264		• Mitigation for sources that are single, sole, foreign, foreign-owned domestic, fragile,
6262 6263 6264 6265		• Mitigation for sources that are single, sole, foreign, foreign-owned domestic, fragile, critical, etc.
6262 6263 6264 6265 6266		 Mitigation for sources that are single, sole, foreign, foreign-owned domestic, fragile, critical, etc. Materials only available outside the NTIB

6268		• Hazardous materials
6269		• Materials that are difficult to obtain and/or process materials
6270		 Materials to meet Government requirements for supporting the NTIB
6271		• Detection and prevention of counterfeit parts (using GIDEP data, etc.)
6272	•	Manufacturing and quality recommendations to minimize risks and issues, and exploit
6273		opportunities, through alternate sources and options for pilot line and LRIP have been
6274		documented for program management to include:
6275		• Emerging technology advancements in materials and processes
6276		 Changes in Government statute, policy, and regulations
6277		• Changes in business climate conditions (e.g., mergers and acquisitions, failures, etc.)
6278		• Changes in environmental impacts (e.g., natural disasters, etc.)
6279		o DMSMS
6280	٠	Contractor's proposed alternate materials sources and/or materials have been assessed for
6281		mitigation of current risks and issues and/or do not introduce new risks and issues to the
6282		program with results documented for program management.
6283	•	Contractor's alternate manufacturing and quality sourcing plans, policies, and procedures
6284		have been assessed to be are consistent with program plans for P ³ I.
6285	•	Continuing parts and materials availability have been assessed for capability and capacity of
6286		the supply chain and proposed alternate competitive sources to meet future requirements (i.e.,
6287		O&S phase).
6288	Tools	
6289	•	Contractor Purchasing System Review
6290	•	DCMA Material Management and Accounting System Audit
6291	Resou	rces
6292	•	DFAR 15.407-2 Make or Buy Programs
6293	•	DFARS Subpart 242.7200 Contractor Material Management and Accounting System
6294	•	Contractor Purchasing System Review (CPSR) Guidebook, May 2017
6295	•	MRL Deskbook Version 2016
6296	•	AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
6297	•	AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Material
6298	G.7	Assess Critical Sources
6299	Manu	facturing and Quality Tasks
6300	•	Based on pilot line results, review and undate assessment of the contractor's Make/Buy
6301	-	process for adequacy and completeness including canabilities canacities and processes for
6302		(See G.1)
5502		

6303 6304 6305 6306 6307 6308		 Key and/or critical subsystems, items, parts, and components to include volatility Management of the supply chain (including other divisions) Vendors to meet quality requirements, schedule and cost targets Identification and mitigation of counterfeit parts and materials (e.g., end items, components, parts, or assemblies) Management of GFE, GFM, etc.
6309	•	Conduct an assessment of the Bill of Materials for LRIP to include:
6310 6311 6312		 Make/buy process and decisions Identification of key and/or critical items, parts and components Identification of risks, issues, and opportunities
6313 6314	•	Ensure identification and management of critical sources throughout the supply chain including:
6315 6316 6317		 All configuration items (CIs) All CSIs All KCs
6318 6319 6320 6321	•	Based on pilot line results, update manufacturing and quality assessments and validation of materials to meet program requirements and mitigation progress on materials risks, issues, and opportunities delineated in the Manufacturing Strategy and Plan and Quality Strategy and Plan (pre-CDR, See G.3) for LRIP, and FRP including:
6322 6323 6324 6325 6326 6327 6328 6329		 Materials producibility, manufacturing processes, techniques, procedures Source availability, capacity, and capability Source criticality and fragility (e.g., sole or single sources, foreign sources, domestic foreign-owned, etc.) Counterfeit detection and avoidance Security (physical, cyber, industrial, anti-tamper, etc.) ITAR Surveillance (program and/or DCMA)
6330 6331	•	Based on pilot line results, review and update the Manufacturing Strategy and Plan and Quality Strategy and Plan (from CDR) for changes to the contractor's:
6332 6333 6334 6335 6336		 Materials planning and control systems Bill of Materials and make/buy decisions Materials processes and procedures Facilities, equipment, tooling Tests, test facilities and equipment
6337 6338	•	Based on pilot line assessments and results, ensure required material maturity has been proven and validated for LRIP, including:
6339 6340		 Properties and characteristics Material producibility, predictability, manufacturability, etc.

6341	Metrics		
6342 6343 6344	•	Based on pilot line results, contractor's Make/Buy process has been reviewed for adequacy and completeness and updates and recommended changes have been documented for PRR, including capabilities, capacities, and processes for: (See G.1)	
6345 6346 6347 6348 6349 6350		 Key and/or critical subsystems, items, parts, and components to include volatility Management of the supply chain (including other divisions) Vendors to meet quality requirements, schedule and cost targets Identification and mitigation of counterfeit parts and materials (e.g., end items, components, parts, or assemblies) Management of GFE, GFM, etc. 	
6351 6352	•	Assessment of the LRIP Bill of Materials has been conducted and recommendations and changes documented for PRR to include:	
6353 6354 6355 6356 6357		 Make/buy decisions Changes to delineation of key and/or critical items, parts and components Delineation and mitigation of risks and issues Exploitation plans for opportunities and investments (Government, contractor, and supply chain) 	
6358 6359	•	Critical sources throughout the supply chain have been delineated and documented for PRR to include:	
6360 6361 6362		 All configuration items (Cis) All CSIs All KCs 	
6363 6364 6365 6366	•	Manufacturing and quality assessments and validation of materials to meet program requirements and mitigation progress on materials risks, issues, and opportunities have been conducted and changes and recommendations have been documented in Manufacturing Strategy and Plan and Quality Strategy and Plan for LRIP, and FRP including the following:	
6367 6368 6369 6370 6371 6372 6373 6374		 Materials producibility, manufacturing processes, techniques, procedures Source availability, capacity, and capability Source criticality and fragility (e.g., sole or single sources, foreign sources, domestic foreign-owned, etc.) Counterfeit detection and avoidance Security (physical, cyber, industrial, anti-tamper, etc.) ITAR Surveillance (program and/or DCMA) 	
6375 6376	•	Changes have been documented in the program's Manufacturing Strategy and Plan and Quality Strategy and Plan based on pilot line and changes in the contractor's:	
6377 6378		 Materials planning and control systems Bill of Materials and make/buy decisions 	

6379 6380 6381		 Materials processes and procedures Facilities, equipment, tooling Tests, test facilities and equipment
6382 6383 6384	•	Based on pilot line assessments and results, capability, capacity, and adequacy of materials to support the LRIP has been proven and validated and the results documented for PRR, including:
6385 6386		 Properties and characteristics Material producibility, predictability, manufacturability, etc.
6387	Tools	
6388	•	Contractor Purchasing System Review
6389	•	DCMA Material Management and Accounting System Audit
6390	Resou	rces
6391	٠	DFAR 15.407-2 Make or Buy Programs
6392	•	DFARS Subpart 242.7200 Contractor Material Management and Accounting System
6393	•	Contractor Purchasing System Review (CPSR) Guidebook, May 2017
6394	•	MRL Deskbook Version 2016, Materials Management thread
6395	•	AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
6396	•	AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Material
6397	•	Strategic and Critical Materials Stock Piling Act, as amended by PL 114-328, Dec 16
6398	•	MRL Deskbook Version 2016
6399	G.8	Assess Material Availability for LRIP
6400	Manu	facturing and Quality Tasks
6401 6402	•	Based on updates to Industrial Capabilities Assessments (See D.5 in support of MS C), assess and verify material availability for LRIP, including the following considerations:
6403		• Availability risks, issues, and mitigations (including for FRP)
6404		• Costs and schedule
6405		 Long-lead procurement risks and mitigation
6406		o Obsolescence
6407		• Long lead procurements
6408		• Supply chain
6409		• Effective supply chain management processes (including first, second, and lower tier
6410		suppliers as necessary)
0411 6412		• Counterfeit detection and avoidance • Security (physical cyber industrial anti temper ata)
0412 6/12		• Security (physical, cyber, industrial, anti-tamper, etc.)
641 <i>1</i>		• Special handling transportation storage and environmental compliance risks and issues
J-1-		5 Special handning, transportation, storage, and environmental compliance fisks and issues

4. Engineering and Manufacturing Development (EMD) Phase

6415	o GFE, GFF, etc.
6416 6417 6418	• Based on manufacturing and quality analyses of program materials and assessments of materials maturity, availability, risks, issues, and opportunities, assess and verify material availability for LRIP, including the following considerations:
6419 6420 6421 6422 6423	 Emerging technology advancements in materials and processes Changes in Government statute, policy, and regulations Changes in business climate conditions (e.g., mergers and acquisitions, failures, etc.) Changes in environmental impacts (e.g., natural disasters, etc.) Diminishing Manufacturing Sources and Material Shortages (DMSMS)
6424 6425	• Assess materials availability to for contractor's manufacturing and quality materials plans to meet program plans for P ³ I in LRIP.
6426	Metrics
6427 6428 6429	• Based on updates from the Industrial Base Assessments, material availability has been assessed and the capability to meet LRIP requirements has been documented for PRR including:
6430 6431 6432 6433 6434 6435 6436 6437 6438 6439 6440 6441 6442 6443	 Availability from Industrial Base sources including risk and issue mitigations Ability to meet costs and schedule Obsolescence plans are in place. Procurements of long lead materials Effective supply chain management processes in place with assessment of critical first tier supply chain completed Adequacy of supply chain to support LRIP with assessment of critical second and lower tier supply chain completed Counterfeit detection and avoidance Security (physical, cyber, industrial, anti-tamper, etc.) Completed Make/Buy decisions. Special handling, transportation, storage, and environmental compliance mitigations in place All GFE, GFF, etc.
6444 6445 6446	• Based on manufacturing and quality analyses of program materials and assessments of materials maturity, availability, risks, issues, and opportunities, recommendations for materials sourcing and options for LRIP have been documented for PRR including:
6447 6448 6449 6450 6451	 Emerging technology advancements in materials and processes Changes in Government statute, policy, and regulations Changes in business climate conditions (e.g., mergers and acquisitions, failures, etc.) Changes in environmental impacts (e.g., natural disasters, etc.) Diminishing Manufacturing Sources and Material Shortages (DMSMS)

4. Engineering and Manufacturing Development (EMD) Phase

6452	•	Materials sources and/or materials have been assessed to mitigate current risks and issues, do
6453		not introduce new risks and issues to the program for LRIP, and have been documented for
6454		PRR.
6455	٠	Contractor's manufacturing and quality materials sourcing plans, policies, and procedures
6456		have been assessed and changes and/or recommendations for consistent with program plans
6457		for P ³ I for LRIP have been documented for PRR.
6458	Tools	
6459	•	MRL Assessment Questionnaire for the Materials Thread
6460	•	Supply chain Management Risk Assessment Checklist
6461	•	DCMA Material Management and Accounting System Audit
6462	Resou	rces
6463	•	DFARS Subpart 242.7200 Contractor Material Management and Accounting System
6464	•	AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
6465	•	AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Material
6466	٠	MRL Deskbook Version 2016

6467 H. PROCESS CAPABILITY/CONTROL

- 6468 Manufacturing and quality process capability and control should be an integral part of any
- 6469 development program. Manufacturing and quality efforts should lead to a producible system with the
- 6470 objective of achieving effective and efficient manufacturing processes with process controls in order
- to satisfy program requirements with consistent and repeatable products at minimum manufacturing
- 6472 costs.



6473

- In preparation for CDR, previously identified manufacturing and quality process capabilities should
 be refined and updated based on data collected and the contractor's plans, processes, and procedures
 to identify the process capabilities required for the system. During the development process,
- 6477 additional studies at the system, subsystem, item, and component levels will be conducted to define
- 6478 the appropriate level of process capability and control. A thorough knowledge of a contractor's and
- 6479 supply chain's process capabilities is critical to developing a successful system. Process capabilities
- and data must be understood, measured, controlled, and documented, and process capability
- 6481 information must be up-to-date.

4. Engineering and Manufacturing Development (EMD) Phase

6482 Program manufacturing and quality personnel should have an understanding of the contractor's

- Modeling and Simulation (M&S) tools and or products, as well as the industry state-of-the-art and
- best practices manufacturing and production M&S. The contractor should have and be utilizing
- 6485 manufacturing and quality M&S tools which must be validated for applicability, adequacy, and
- 6486 consistency. Additionally, program manufacturing and quality must assess and understand the
- 6487 correlation of demonstration results with M&S results and ensure M&Ss are updated to reflect
- 6488 maturity of manufacturing and quality systems, systems performance, and capability.
- 6489During the EMD phase the contractor will conduct pilot line demonstrations that will include testing
- and analysis to ensure products meet the program requirements. These products will be built on pilotlines. This means all of the key production realism elements (e.g., equipment, personnel skill levels,
- 6492 facilities, materials, components, work instructions, processes, tooling, temperature, cleanliness,
- 6493 lighting, etc.) required to manufacture products (e.g., items, subsystems, or systems) meet
- requirements for low-rate production and have been incorporated into the demonstrations. The
- 6495 processes used on the pilot lines should be evaluated to understand the difficulties and quantify the
- risks to be mitigated for LRIP. Results of the pilot lines and the associated assessments should be
- 6497 incorporated in to the appropriate M&Ss to provide an up-to-date, accurate M&S of the system.
- 6498 Pilot line demonstrations of system and subsystem manufacturing and quality processes, and 6499 production line manufacturing and quality data for components and items provide opportunity to 6500 collect up-to-date data for yield and rate analyses. These analyses should be used to validate all 6501 manufacturing and quality learning curves for the system and subsystems to include evaluation of 6502 yields and rates against pilot line and LRIP targets, goals, and projections for rate production.
- These assessments and demonstrations should provide an understanding of the contractor's process
 capabilities, M&S tools, and yields and rates, and support program manufacturing and quality
 planning, resource loading, facilities management, etc. for future phases.

6506 H.1 Update Process Capability Requirements

6507 Manufacturing and Quality Tasks

- Analyze process capability index (C_{pk}) goals for each key manufacturing process throughout the supply chain for support to manufacturing and quality program goals.
- 6510oReview contractor and supply chain processes, process control plans, process yields, and6511Process Failure Modes and Effects Analyses (PFMEAs) for identification of appropriate6512key and/or critical manufacturing processes and verify the need for and validity of6513process capability index (C_{pk}) goals and targets
- Utilizing results of the PDR and current program status, update manufacturing and quality
 process capability risks, issues, and opportunities for the Manufacturing Strategy and Plan
 and the Quality Strategy and Plan, and the SEP, including:

6517		o KCs
6518		• New equipment and new manufacturing technologies (including ManTech)
6519		• Potential manufacturing and quality cost and schedule impacts
6520		o Producibility
6521		• Tooling and facilities
6522		• ESOH and Safety
6523		• Testing and qualification
6524		o Security
6525		• Environmental, transportation, storage, etc.
6526		• Data management (collection, storage, cyber security, etc.)
6527	•	Update and maintain required manufacturing and quality process capability requirements for
6528		consistency with product design as design progresses to CDR including producibility,
6529		manufacturability, supportability, affordability, etc.
6530	•	Ensure system-level manufacturing processes will be demonstrated in a production
6531		representative environment by CDR with subsystem, item, and component processes, at a
6532		minimum, demonstrated on a pilot line.
6533		• Ensure subsystems, items, and components manufacturing processes and equipment
6534		process capabilities from variability studies and analyses meet pilot line targets
6535	٠	Continue to collect, monitor, manage, and analyze (or estimate where necessary) process
6536		capability data from subsystem, item, and component processes to include:
6537		• Subsystems, items, and components that are currently or have been previously
6538		manufactured for other systems by the supply chain
6539		• Data collected from supply chain yields, rates, and process capabilities from other similar
6540		subsystems, items, components, and prototype builds
6541	•	Utilize collected data from manufacture of subsystems, items, and components (e.g.,
6542		production representative, pilot lines, etc.) to refine process capability requirements.
6543	•	Ensure DCMA support and/or external agency support for Government surveillance of and
6544		updates to manufacturing and quality process capability requirements is requested and
6545		utilized (for the entire supply chain).
6546	Metric	CS
6547	•	Process capability index (C_{pk}) goals for each key manufacturing process throughout the
6548		supply chain have been analyzed for support of manufacturing and quality program goals.
6549		• Contractor and supply chain processes, process control plans, process yields, and
6550		PFMEAs have been reviewed for updates and/or identification (inclusion) of key and/or
6551		critical manufacturing processes and verification of process capability index (C_{pk}) goals
6552		and targets

6553 • 6554 6555 6556	Program, contractor, and supply chain manufacturing and quality process capability risks, issues, and opportunities have been assessed and updated in the Manufacturing Strategy and Plan and the Quality Strategy and Plan (and therefore the AS), and the SEP, based on results of the PDR and current program status to include:
6557 6558 6559 6560 6561 6562 6563 6564 6565 6566	 KCs New equipment and new manufacturing technologies (including ManTech) Potential manufacturing and quality cost and schedule impacts Producibility Tooling and facilities ESOH and Safety Testing and qualification Security Environmental, transportation, storage, etc. Data management (collection, storage, cyber security, etc.)
6567 6568 6569 6570 6571 6572 6573 6574 6575 6576	 Required manufacturing and quality process capabilities are up-to-date and reflect product design and maintained in the Manufacturing and Quality Plans as design progresses to CDR including producibility, manufacturability, supportability, affordability, etc. Plans for system-level manufacturing process demonstrations in a production representative environment have been documented and implemented to be conducted and completed by CDR with subsystem, item, and component processes, at a minimum, demonstrated on a pilot line. Variability studies have been conducted and completed on subsystems, items, and components manufacturing processes and equipment process capabilities for CDR and meet pilot line targets
6577 6578 6579 6580 6581 6582 6583	 Process capability data from subsystem, item, and component processes is being collected, monitored, managed, analyzed (or estimated where necessary), and maintained under configuration control to include: Subsystems, items, and components that are currently or have been previously manufactured for other systems by the supply chain Data collected from supply chain yields, rates, and process capabilities from other similar subsystems, items, components, and prototype builds
6584 • 6585 6586 • 6587 6588 6589	Collected data has been utilized to update and refine process capability index requirements (C _{pk} s) and documented in the Manufacturing and Quality Strategies and Plans. DCMA support and/or external agency support for Government surveillance of process capability data and support to updates of manufacturing and quality process capability requirements and indices has been requested and is being utilized (for the entire supply chain).

6590	Tools	
6591	•	Process Capability Study (Cp and Cpk assessment)
6592	•	MRL Assessment Checklist for the Process Capability and Control Thread
6593	•	AS9100 Quality Management System Assessment
6594	•	AS9103 Variation Management Assessment
6595	•	AS6500 Manufacturing Management Assessment
6596	Resou	rces
6597	•	AS9100 QUALITY SYSTEMS – REQUIREMENTS FOR AVIATION, SPACE, AND
6598		DEFENSE ORGANIZATIONS, SEP 2016
6599	•	AS9103 Variation Management of Key Characteristics
6600	•	AS9145 Requirements for Advanced Product Quality Planning and Production Part Approval
6601		Process
6602	•	AS6500, Manufacturing Management Program, Nov 2014
6603	•	MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016
6604	•	MRL Deskbook Version 2016
6605	H.2	Update and Validate Models and Simulations
6606	Manu	facturing and Quality Tasks
6607	٠	Assess contractor Modeling and Simulation (M&S) System prior to product and/or process
6608		implementation for the capability to model (product and processes) and assess the system for
6609		CDR and pilot line to include:
6610		• Integration with supply chain M&S Systems
6611		• Integration with CAD, MRP, scheduling, time standards, work instructions, planning, etc.
6612		• Yield and rate modeling to predict first pass yields including key design and process
6613		attributes
6614		• Manufacturing ergonomics M&S to ensure human factors considerations are applied in
6615		manufacturing
6616		• Production process M&S addressing material flow, surges, processing times, scrap,
6617		rework and repair levels, etc.
6618		• Supply chain M&S including impacts of disruptions, supplier capabilities and yields,
6619		learning curve effects, obsolescence issues, etc.
6620		• Other tools such as:
6621		 Value stream mapping completes with all types of information, material, parts,
6622		physical processing times, physical movements, wait times, etc.
6623		 Factory simulations for system production including facility, production lines,
6624		transportation, storage, handling, security, etc.
6675		Loon Monufacturing Civ Sigma ato

6626 6627 6628	С	Capability to evaluate the design and manufacturing processes to meet program manufacturing and quality objectives including quantification of risk and issue mitigation including:
6629 6630 6631		 Factory floor, process flows, assembly lines, yields/ throughput/variability, cycle times, etc. with estimated quantities of tooling, personnel, and inventory Throughput concurrent with other ongoing production
6632 6633	C	Capability to provide estimated yields, rates, cycle times, schedule and cost performance to meet program manufacturing and quality goals
6634 6635 6636 6637 6638		 Utilize data from production of subsystems, items, and components to validate M&S System Utilize data from production of subsystems, items, and components to identify of manufacturing and quality bottlenecks or constraints Validate manufacturing and quality cycle times achievability
6639 6640 6641	• A o e	Assess the results and data from manufacturing and quality demonstrations, tests, production f items and components, etc. by the contractor and supply chain in production representative nvironment to validate M&S of subsystems, components, and items for CDR, including:
6642 6643 6644 6645 6646 6647		 A mix of mature hardware, prototypes, and models and simulations Interfaces, integration, and interdependencies Ergonomics Identification of constraints Performance Throughput
6648	C Motrics	Sufficient complexity to match the complexity of the system
6649 6650 6651 6652	• C a ii	Contractor M&S System has been assessed prior to product and/or process implementation nd documents the capability to model and assess the system for CDR and pilot line to nclude:
6653 6654 6655 6656	c c	 Integration and/or utilization of supply chain M&S Systems Integration with other systems (e.g., CAD, MRP, scheduling, time standards, work instructions, planning, etc.) Yield and rate model predictions of first pass yields
6657 6658 6659	c	Manufacturing ergonomics models to include human factors in manufacturing Production process models (e.g., material flow, surges, processing times, scrap, rework and repair levels, etc.)
6660 6661 6662	c	 Supply chain models (e.g., impacts of disruptions, supplier capabilities and yields, learning curve effects, obsolescence issues, etc.) Other tools such as:
6663		 Value stream mapping

4. Engineering and Manufacturing Development (EMD) Phase

6664 6665 6666		 Factory simulations (e.g., processes, facilities, production lines, transportation, storage, handling, security, etc.) Lean Manufacturing, Six-Sigma, etc.
6667 6668 6669		 Capability to meet program manufacturing and quality objectives with quantification of risk and issue mitigation Capability to evaluate both the design and supporting manufacturing processes including:
6670 6671 6672 6673		 Factory floor, process flows, work cells, assembly lines, etc. Yields, throughputs, variability, cycle times, etc. Tooling, personnel, and inventory requirements, etc. Throughput concurrent with other ongoing production
6674 6675		• Capability to estimate yields, rates, cycle times, schedule and cost performance, etc. to meet program manufacturing and quality goals and utilizing data to:
6676 6677 6678		 Validate the M&S System Identify of bottlenecks or constraints Validate cycle times
6679 6680 6681 6682	•	Results and data from manufacturing and quality demonstrations, tests, production of items and components, etc. by the contractor and supply chain in production representative environment have been assessed and validation M&S of subsystems, components, and items has been documented for CDR, to include the following factors:
6683 6684 6685 6686 6687 6688 6689		 Mature hardware, prototypes, and models and simulations Interfaces, integration, and interdependencies Ergonomics Constraints Performance Throughput Complexity (reflecting system complexity)
6690	Tools	
6691 6692 6693 6694 6695 6696	• • • •	MRL Assessment Checklist for the Process Capability and Control Thread System Capabilities Analytic Process (SCAP) Solid modeling and analysis software programs (e.g., NX, CATIA, Pro-Engineer, Nastran add-ins, etc.) Process Modeling Tools (Siemens PLM, Delmia, etc.) Plant Modeling and Simulation tools (FlexSim, SimFactory, etc.)
6697	Resou	rces
6698 6699 6700	• •	AS6500, Manufacturing Management Program, NOV 2014 MIL-HDBK-896A Modeling and Simulation Guidance for the Acquisition Workforce, Oct 2008
4. Engineering and Manufacturing Development (EMD) Phase

- MRL Deskbook Version 2016
- 6702 H.3 Mature Key Manufacturing Processes

6703 Manufacturing and Quality Tasks

- Based on contractor, supply chain, Government IPT, and Government contracting personnel interactions, define and document the appropriate manufacturing and quality production representative and pilot line environments to be placed on contract, and utilized for process demonstrations and maturations, verifications and validations, qualifications, first articles, etc.
- 6709 o Ensure provisions for Government surveillance of contractor and supply chain "proof-of-6710 builds" and/or "product/process walkthroughs" are included
- For CDR, assess demonstrations of manufacturing and quality processes in an environment
 with as much production realism as possible, considering the maturity of the design
 throughout the supply chain including:
- 6714 Equipment (e.g., accuracy, calibration, age and condition, suitability, capacity, reliability)
 - Workforce (i.e., training, skills, and certifications)
- 6716 o Human factors (i.e., noise, vibrations, ergonomics)
 - Environmental conditions (i.e. temperature, humidity, air quality)
- o Testing and test equipment

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- 6719 Capability to meet the cost, schedule, and performance requirements
- o Estimates of costs, yields, rates, etc.
- Assess risks, issues, and impacts of the manufacturing environment (i.e., production
 representative) on manufacturing and quality processes and develop recommended mitigation
 plans for both the contractor and the supply chain for CDR.
- Collect data from process demonstrations and production of components and items in a
 production representative environment throughout the supply chain to support verification,
 validation, and authentication of M&S for CDR.
- 6727 Ensure data is under configuration control
- 6728
 Update status of the comprehensive Manufacturing and Quality Plans based on
 6729
 demonstrations of manufacturing and quality processes in a production representative
 6730
 environment for CDR
- o Include all manufacturing and quality risks and issues
 - Utilize Process Failure Modes and Effects Analyses (PFMEAs) on all manufacturing and quality processes
 - Update plans for achieving pilot line process capability targets
- Ensure key manufacturing and quality processes are sufficiently mature by conducting a system-level MRL assessment in support of CDR.

Manufacturing and Quality Management Body of Knowledge

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4. Engineering and Manufacturing Development (EMD) Phase

6737 6738 6739	 System-level target should utilize MRL 7 criteria and metrics Subsystem, item, and components targets should utilize MRL 8 and/or MRL 9 criteria and metrics
6740 Metri	CS
 6741 6742 6743 	Manufacturing and quality production representative and pilot line environments have been documented and placed on contract, and are being used for process demonstrations and maturations, verifications and validations, qualifications, first articles, etc.
6744 6745	• Provisions for DCMA or program surveillance of contractor and supply chain "proof-of- builds" and/or "product/process walkthroughs" are on contract
 6746 6747 6748 6749 	Demonstrations of manufacturing and quality processes in a production representative environment, at a minimum, or a more mature environment based on the maturity of the design, have been assessed throughout the supply chain and document implementation for CDR of mature processes in accordance with industry best practices, including those for:
6750 6751 6752 6753 6754 6755 6756	 Equipment (e.g., accuracy, calibration, age and condition, suitability, capacity, reliability) Workforce (i.e., training, skills, and certifications) Human factors (i.e., noise, vibrations, ergonomics) Environmental conditions (i.e. temperature, humidity, air quality) Testing and test equipment Capability to meet the cost, schedule, and performance requirements Estimates of costs, yields, rates, etc.
6757 • 6758 6759 6760 • 6761 6762	Risks, issues, and impacts of the manufacturing environment (e.g., production representative, etc.) on manufacturing and quality processes have assessed and recommended mitigation plans developed and documented for both the contractor and the supply chain for CDR. Data has been collected from process demonstrations and production of components and items in a production representative environment throughout the supply chain and documented as supporting verification, validation, and authentication of M&S for CDR.
6763	• Data is under configuration control
6764 • 6765 6766	Manufacturing and Quality Plans have been updated based on demonstrations of manufacturing and quality processes in a production representative environment for CDR including:
6767 6768 6769	 All manufacturing and quality risks and issues PFMEAs on all manufacturing and quality processes Updated plans to achieve pilot line process capability targets
6770 • 6771	A system-level MRL assessment has been conducted to confirm key manufacturing and quality processes are sufficiently mature by CDR.
6772 6773	 System-level meets MRL 7 target (criteria and metrics) Subsystem, item, and components meet MRL 8 and/or MRL 9

4. Engineering and Manufacturing Development (EMD) Phase

6774	Tools	
6775	•	MRL Assessment using Process Capability and Control Thread
6776	٠	Production Part Approval Process (PPAP)
6777	•	Process Capability Assessment
6778	Resou	rces
6779	٠	AS6500, Manufacturing Management Program, NOV 2014
6780	٠	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
6781		Sep 2016
6782	•	DoDI 5000.02
6783	٠	MRL Deskbook Version 2016
6784	•	ISO 9000
6785	нд	Demonstrate Manufacturing Maturity on Pilot Line
0705	11.4	Demonstrate Manufacturing Maturity on Filot Line
6786	Manu	facturing and Quality Tasks
6787	٠	Assess the progress and status of pre-CDR mitigations (i.e., production representative
6788		environment) for risks, issues, and impacts during pilot line demonstrations of manufacturing
6789		and quality processes, procedures, and schedules.
6790		• Update or develop mitigation plans for LRIP
6791	٠	Assess demonstrations of manufacturing processes in an environment with all of the key
6792		production realism elements required to manufacture production configuration items,
6793		subsystems or systems that meet design requirements in low-rate production (i.e., pilot line)
6794		including:
6795		• Equipment (e.g., accuracy, calibration, age and condition, suitability, capacity, reliability)
6796		• Personnel skill levels
6797		• Facilities, storage and handling, waste disposal, etc.
6798		o Hazmat
6799		• Security and safety
6800		• Materials and components
6801		• Work instructions and processes (e.g., cleaning, heat treating, ESD protection, clean
6802		rooms, etc.)
6803		o Tooling
6804		• Testing and test equipment
6805		• Environmental conditions (e.g., temperature control, cleanliness, lighting etc.)
6806		• Costs, yields, rates, etc.
6807	٠	Collect data from pilot line demonstrations of manufacturing and quality processes and
6808		production line manufacturing and quality processes for components and items to support
6809		verification, validation, and authentication of system-level M&S for PRR and Milestone C.

4. Engineering and Manufacturing Development (EMD) Phase

6810 6811	•	Verify that the contractor conducts process capability studies that meet program targets ($C_{pk}s$) to include:
6812 6813		 All manufacturing processes for KCs and critical characteristics Process capability studies conducted throughout the supply chain
6814 6815	•	Based on process capability targets and pilot line results, update the comprehensive Manufacturing and Quality Plans for P&D to
6816 6817 6818 6819		 Maintain currency of manufacturing and quality M&S Maintain all manufacturing and quality risks, issues, and mitigations status Update PFMEAs for all manufacturing and quality processes from pilot line changes Update plans for achieving LRIP process capability targets in P&D
6820 6821	•	Ensure key manufacturing and quality processes are sufficiently mature by conducting a MRL assessment to support PRR and Milestone C.
6822 6823		 System-level target should utilize MRL 8 criteria and metrics Subsystem, item, and components targets should utilize MRL 9 criteria and metrics
6824 6825 6826 6827	•	Ensure Government surveillance of contractor and supply chain key and/or critical manufacturing processes for compliance to best practices or AS6500 (depending on contract). Ensure all policies, procedures, processes, work instructions, data, plans, metrics, tooling, equipment and documentation are under program configuration management and control.
6828	Metri	CS
6828 6829 6830 6831 6832	Metri •	cs Progress of production representative environment mitigations for risks, resolution of issues, and associated impacts have been assessed and status and completeness has been documented during pilot line demonstrations of manufacturing and quality processes, procedures, and schedules.
6828 6829 6830 6831 6832 6833 6833	Metri	 Progress of production representative environment mitigations for risks, resolution of issues, and associated impacts have been assessed and status and completeness has been documented during pilot line demonstrations of manufacturing and quality processes, procedures, and schedules. Mitigation plans for ongoing risks and issues (i.e., LRIP) have been updated and documented.
6828 6829 6830 6831 6832 6833 6834 6835 6836 6837 6838	Metri •	 Progress of production representative environment mitigations for risks, resolution of issues, and associated impacts have been assessed and status and completeness has been documented during pilot line demonstrations of manufacturing and quality processes, procedures, and schedules. Mitigation plans for ongoing risks and issues (i.e., LRIP) have been updated and documented. Demonstrations of manufacturing and quality processes have been assessed for impacts and documented with data collected for capability studies (See H.4) in a pilot line environment with all elements required to manufacture items, subsystems or systems (configuration controlled) that meet design requirements in LRIP including:
6828 6829 6830 6831 6832 6833 6834 6835 6836 6837 6838 6837 6838 6839 6840 6841 6842 6843 6844	Metrie •	 Progress of production representative environment mitigations for risks, resolution of issues, and associated impacts have been assessed and status and completeness has been documented during pilot line demonstrations of manufacturing and quality processes, procedures, and schedules. Mitigation plans for ongoing risks and issues (i.e., LRIP) have been updated and documented. Demonstrations of manufacturing and quality processes have been assessed for impacts and documented with data collected for capability studies (See H.4) in a pilot line environment with all elements required to manufacture items, subsystems or systems (configuration controlled) that meet design requirements in LRIP including: Equipment (e.g., accuracy, calibration, age and condition, suitability, capacity, reliability) Personnel skill levels Facilities, storage and handling, waste disposal, etc. Hazmat Security and safety Materials and components

6847 6848 6849 6850		 Tooling Testing and test equipment Environmental conditions (e.g., temperature control, cleanliness, lighting etc.) Costs, yields, rates, etc.
6851 6852 6853 6854	•	Data collected from pilot line demonstrations and production line processes supports verification, validation, and authentication of system-level M&S for PRR and Milestone C. Contractor and supply chain process capability data has been collected and analyzed, and meets program pilot line targets (C _{pks}) including:
6855 6856		 All processes for KCs and critical characteristics Supply chain process capabilities for subsystems, items, and components
6857 6858	•	The comprehensive Manufacturing and Quality Plans for P&D have been updated based on process capability targets and pilot line results including:
6859 6860 6861 6862		 Manufacturing and quality M&S Manufacturing and quality risks, issues, and mitigations status Updated PFMEAs for all manufacturing and quality process changes Updated plans to achieve LRIP process capability targets in P&D
6863 6864	•	An MRL assessment has been conducted and documented to meet targets to support PRR and Milestone C:
6865 6866		 System-level target meets MRL 8 criteria and metrics Subsystem, item, and components targets meets MRL 9 criteria and metrics
6867 6868 6869 6870 6871	•	DCMA is providing Government surveillance of contractor and supply chain key and/or critical manufacturing processes for compliance to best practices or AS6500 (depending on contract). Program configuration control system includes, tracks, and documents all policies, procedures, processes, work instructions, data, plans, metrics, tooling, equipment and
6872 6873	Tools	documentation (i.e., CDRLs).
6874	•	Pilot Line Demonstration and Assessment
6875	Resou	rces
6876 6877 6878	•	AS6500, Manufacturing Management Program, Nov 2014 MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016 DoD 5000.02
6879	•	MRL Deskbook Version 2016

4. Engineering and Manufacturing Development (EMD) Phase

6880 H.5 Validate Yields and Rates

6881 Manufacturing and Quality Tasks

6882 Collect up-to-date data from system and subsystem pilot line demonstrations of • 6883 manufacturing and quality processes, and production line manufacturing and quality data for 6884 components and items as the basis for yield and rate analyses to validate "as is" status. 6885 0 Rate of quality processes (actual time to complete) vs. planned 6886 • Quality data actuals vs. estimated 6887 • Ouality process yield actuals vs. planned 6888 • Changes in processes (actual vs. planned) o Cost of quality actuals vs. desired 6889 6890 Validate all manufacturing and quality learning curves for the system and subsystems based • 6891 on pilot line results, contractor and supply chain improvements, program progress to date to include: 6892 6893 Timing for processes, kitting, idle, takt, cycle, re-work, etc. 0 6894 Planning and scheduling 0 6895 • Throughput (yield and rates) 6896 • Labor efficiency and ergonomics 6897 • Improvements in materials, methods, processing, equipment, tools, automation (i.e., 6898 manufacturing technology) • Materials handling, transportation, and storage (including WIP) 6899 • Supply chain changes 6900 Standardization and common processes 6901 6902 As a potential impact on yields and rates, validate completeness of all related risk mitigation • 6903 activities or acceptance of these risks (included in the joint Risk, Issue, and Opportunity 6904 Management Process), including: 6905 0 Key and critical manufacturing processes including embedding software (KCs) 6906 Supply chain, materials and sourcing, including multiple 0 6907 o Facilities, tooling, and equipment 6908 • Testing, test equipment, and in-process tests 6909 o System security, safety, and hazardous materials management • Economic feasibility 6910 6911 o Schedule (i.e., IMP/IMS) o Manufacturing capability, obsolescence, and sustainment 6912 6913 Evaluate all yields and rates from pilot line and lower level production against pilot line and • 6914 LRIP targets, goals, and projections. 6915 • Validate achievement of targets (e.g., pilot line, LRIP, etc.) 6916 Refine yields and rates required for LRIP 6917 Based on results of analyses develop and implement improvement plans as required 0

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 6919 Up-to-date data from system and subsystem pilot line demonstrations of manufacturing and quality processes, and production line manufacturing and quality data for components and items has been collected and documented in the program configuration controlled management system as the basis for yield and rate analyses to validate "as is" status including: 6924 Rate of quality processes (actual time to complete) vs. planned 6925 Quality data actuals vs. estimated 6926 Quality process yield actuals vs. planned 6927 Changes in processes (actual vs. planned) 6928 Cost of quality actuals vs. desired 6929 All manufacturing and quality learning curves for the system and subsystems based on collected and documented pilot line results, contractor and supply chain improvement resul and program progress to date have been updated and include: 6933 Planning and scheduling 6934 Throughput (yield and rates) Labor efficiency and ergonomics 	6918	etrics
 6924 Rate of quality processes (actual time to complete) vs. planned 6925 Quality data actuals vs. estimated 6926 Quality process yield actuals vs. planned 6927 Changes in processes (actual vs. planned) 6928 Cost of quality actuals vs. desired 6929 All manufacturing and quality learning curves for the system and subsystems based on collected and documented pilot line results, contractor and supply chain improvement resul and program progress to date have been updated and include: 6932 Timing for processes, kitting, idle, takt, cycle, re-work, etc. 6933 Planning and scheduling Throughput (yield and rates) Labor efficiency and ergonomics 	6919 6920 6921 6922 6923	• Up-to-date data from system and subsystem pilot line demonstrations of manufacturing and quality processes, and production line manufacturing and quality data for components and items has been collected and documented in the program configuration controlled management system as the basis for yield and rate analyses to validate "as is" status including:
 All manufacturing and quality learning curves for the system and subsystems based on collected and documented pilot line results, contractor and supply chain improvement resul and program progress to date have been updated and include: Timing for processes, kitting, idle, takt, cycle, re-work, etc. Planning and scheduling Throughput (yield and rates) Labor efficiency and ergonomics 	6924 6925 6926 6927 6928	 Rate of quality processes (actual time to complete) vs. planned Quality data actuals vs. estimated Quality process yield actuals vs. planned Changes in processes (actual vs. planned) Cost of quality actuals vs. desired
 6932 o Timing for processes, kitting, idle, takt, cycle, re-work, etc. 6933 o Planning and scheduling 6934 o Throughput (yield and rates) 6935 o Labor efficiency and ergonomics 	6929 6930 6931	• All manufacturing and quality learning curves for the system and subsystems based on collected and documented pilot line results, contractor and supply chain improvement results, and program progress to date have been updated and include:
 6936 o Improvements in materials, methods, processing, equipment, tools, automation (i.e., manufacturing technology) 6938 o Materials handling, transportation, and storage (including WIP) 6939 o Supply chain changes 6940 o Standardization and common processes 	 6932 6933 6934 6935 6936 6937 6938 6939 6940 	 Timing for processes, kitting, idle, takt, cycle, re-work, etc. Planning and scheduling Throughput (yield and rates) Labor efficiency and ergonomics Improvements in materials, methods, processing, equipment, tools, automation (i.e., manufacturing technology) Materials handling, transportation, and storage (including WIP) Supply chain changes Standardization and common processes
 Risk mitigation activities have been validated as satisfactory (or program has accepted these risks) and have been analyzed and the documented impacts on yields and rates are acceptable, including: 	6941 6942 6943	• Risk mitigation activities have been validated as satisfactory (or program has accepted these risks) and have been analyzed and the documented impacts on yields and rates are acceptable, including:
 6944 o Key and critical manufacturing processes including embedding software (KCs) 6945 o Supply chain, materials and sourcing, including multiple 6946 o Facilities, tooling, and equipment 6947 o Testing, test equipment, and in-process tests 6948 o System security, safety, and hazardous materials management 6949 o Economic feasibility 6950 o Schedule (i.e., IMP/IMS) 6951 o Manufacturing capability, obsolescence, and sustainment 	6944 6945 6946 6947 6948 6949 6950 6951	 Key and critical manufacturing processes including embedding software (KCs) Supply chain, materials and sourcing, including multiple Facilities, tooling, and equipment Testing, test equipment, and in-process tests System security, safety, and hazardous materials management Economic feasibility Schedule (i.e., IMP/IMS) Manufacturing capability, obsolescence, and sustainment
 All yields and rates from pilot line and lower level production products have been validated to meet pilot line targets: 	6952 6953	• All yields and rates from pilot line and lower level production products have been validated to meet pilot line targets:
 6954 o Analyses support or indicate achievability of LRIP targets, goals, and projections with 6955 o Improvement plans have been developed and implemented, as required 	6954 6955 6956	 Analyses support or indicate achievability of LRIP targets, goals, and projections with refinements as required Improvement plans have been developed and implemented, as required

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6957	ools
6958	• Yield Rate Assessment
6959	esources
6960	AS6500, Manufacturing Management Program, Nov 2014
6961	• AS9100 QUALITY SYSTEMS – REQUIREMENTS FOR AVIATION, SPACE, AND
6962	DEFENSE ORGANIZATIONS, SEP 2016
6963	AS9103 Variation Management of Key Characteristics
6964	MRL Deskbook Version 2016

6965 I. QUALITY MANAGEMENT

6966 An effective quality management system is required for operationally safe, suitable and effective 6967 weapon systems. A quality management system should be compliant with industry standards ISO 9001 or AS9100 and is foundational to producing products that meet contractual requirements. The 6968 6969 quality system ensures the as-delivered configuration is the same as the as-designed and as-tested 6970 configuration. The quality system serves as the management and control function, requiring controls 6971 over requirements reviews, design inputs, verification and validation of design outputs, and control 6972 of design changes. It also requires monitoring and measuring of processes and products to ensure 6973 they conform to requirements. An effective quality system is absolutely critical to ensuring delivered 6974 products meet all of the requirements of the approved design.



6975

Most contractors have Quality Management Systems (QMSs) certified to industry standards (best 6976 6977 practices) and should not need assessment for compliance as ongoing audits are part of the 6978 certification process. Program should assess that the contractor's QMS supports and aligns with Program strategy, objectives, goals, and the contract. This will involve the use of process audits as to 6979 whether the contractor's and supply chain activities, resources, and behaviors are being managed 6980 6981 efficiently and effectively including participation of DCMA, KCs control and management, use of 6982 acceptance testing, application of Statistical Process Controls (SPC), etc. which are more than just 6983 evaluations of the sequential steps and interactions of a process within the QMS. Similarly, these 6984 audits should be conducted on the supply chain as necessary.

The Manufacturing and Quality Strategies should require quality assessments of the manufacturingprocesses to ensure they have been effectively demonstrated in an appropriate environment, such as a

4. Engineering and Manufacturing Development (EMD) Phase

pilot line, prior to Milestone C. Revision to the quality strategy, plans, and objectives may berequired based on the results of process audits and quality assessments.

6989 For CDR, initial product baseline documentation for quality, included in the Quality Strategy and 6990 Plans, should be sufficient, complete, and adequate to enable inspections and testing of all 6991 components, hardware, and embedded software throughout the supply chain. The system-level CDR 6992 assesses the system design as captured in product specifications for each subsystem, item, and 6993 component in the system's initial product baseline, and helps ensure that each has been captured in 6994 the detailed design and quality documentation. Assessment of the allocated baseline against the 6995 initial product baseline should assure that quality parameters (e.g., tolerance, process capability 6996 indices, etc.) for considerations such as weight, power, cooling, etc. have been appropriately 6997 specified in the detailed design. This includes drawings and specifications with tolerances and test 6998 points under configuration control for all KCs, CSIs, and CAIs having been completed.

6999 A system-level Functional Configuration Audit (FCA) should be conducted to assess performance of

the system against the functional baseline, and may be conducted in conjunction with the system-

7001 level System Verification Review (SVR). Quality and quality personnel should be an integral

element in both the FCA and the SVR. The main difference between the two activities is that asystem-level FCA focuses primarily on verification of the functional baseline, while SVR assesses

system-level reaction of the functional baseline, while SVR assesses
 system functionality as well as other details to include program readiness to proceed into the

Production and Deployment phase. This includes assessments for quality of all program, contractor,and supply chain policies, processes, and procedures.

The system-level FCA should assess the collected data, test results, analysis results, and M&S output and accuracy of the system after completion of development testing and pilot line, and verifies that actual system performance satisfies quality requirements. For quality requirements that cannot be completely verified during pilot line, tests or simulations using approved methods can provide valid data that LRIP performance will be met with acceptable risks.

The SVR should address all changes or additions generated since CDR to ensure the as-tested

7013 product on the pilot line includes all Engineering Change Proposals, specification change notices and

revisions, interface control changes, and all manufacturing and quality process changes.

As the pilot line environment incorporates all key equipment, personnel skill levels, materials,

components, work instructions, tooling, etc. required to manufacture the product, quality analyses

should be performed during pilot lines to provide verification and validation of actual yields, rates,

and costs to be realized during LRIP. The environment should utilize production processes forecasted

to be used in LRIP. Based on quality analyses of program, contractor, and supply chain, quality

assessments of maturity, quality analyses of affordability and quality costs, quality risks, issues, and

7021 opportunities, all demonstrate that the manufacturing and quality processes and capabilities required

for production have matured with high confidence of success in building production configurationproducts in the P&D phase.

4. Engineering and Manufacturing Development (EMD) Phase

The combination of a robust quality management system and advanced quality and defect prevention
 practices are critical to successful program execution, and it is mandated under Federal Acquisition

7026 Regulation (FAR) Part 46.202-4.

1.1 7027 **Assess Contractor Quality Management System** 7028 Manufacturing and Quality Tasks 7029 Assess the contractor's corporate strategic vision, objectives, policies, plans, processes, and • 7030 procedures for alignment to the contracted program needs and industry best practices (e.g., 7031 AS9100, ISO 9000, etc.) for quality both in-house and in suppliers' facilities to include: 7032 • Established quality policy, at the highest level in the company, based on industry best 7033 practices, which commits to continuously improving processes and exceeding customer 7034 expectations 7035 o Organizational direction and values regarding quality are communicated throughout the 7036 supply chain 7037 o Management provides structures and resources supporting full implementation of the 7038 quality management system 7039 o Management solicits quantitative and qualitative feedback on the effectiveness and 7040 efficiency of quality management system and takes actions based on that feedback 7041 • Procedures for internal reviewing of the quality management system periodically with 7042 goals and objectives throughout the organization for customer satisfaction, and 7043 continuous improvement 7044 o Procedures independent reporting channels for quality functions and audits 7045 • Management accountability with emphasis on quality results and customer satisfaction 7046 Conduct a process audit of the contractor's QMS including assessment of: • 7047 Quality processes and supply chain quality including: 0 7048 Role and participation of DCMA (Contractor and supply chain) 7049 • KCs control and management 7050 . Acceptance testing including software 7051 In-process and final inspection functionality 7052 Statistical process controls, rates, and yields (and management of same) 7053 Execution of and adherence to quality plans including control plans and quality 7054 improvement plans 7055 Certification processes (e.g., flight safety, man-ratings, etc.) 7056 Continuous process improvement results 7057 Software quality assurance results 7058 Data storage, management, and security (physical and cyber) • 7059 Management of safety, environmental, transportation, storage, etc. 7060 Use of COTS items, GOTS items, and NDIs

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7061 7062 7063	 GFE/ radiat Intert 	GFP management (e.g., controlled products, test ranges, specialized equipment, ion test facilities, etc.)
7064 7065	• Processes CAIs, and	for management, control, and monitoring of KPPs, KSAs, and KCs, CSIs, and their integration into the QMS.
7066 7067	• FRACAS material	processes for sufficiency and adequacy including results of dispositions (i.e., eview boards and processes)
7068	 QMS imp 	pacts on tasks, costs, schedules, and outcomes
7069 7070	 QMS con product s 	pliance to standards and best practices (e.g., AS9100, ISO 9000, industry tandards, MIL-STDs, etc.)
7071 7072	 Planning, System p 	integration, and execution of the Risk, Issue, and Opportunity Management rocesses
7073 7074	• Request DCM and supply cl	IA support and assistance to assess adequacy and completeness of contractor nain QMSs application to system, subsystems, items, and components.
7075	Metrics	
7076	• Contractor's	and supply chain Quality Management Systems (QMSs) have been analyzed
7077	and assessed	for alignment to contracted program needs and industry best practices,
7078	including:	
7079	• An establ	ished quality policy, at the highest level in the company, based on industry best
7080 7081	practices, expectation	which commits to continuously improving processes and exceeding customer
7082	• An proce	ss established for communication of organizational direction and values
7083	regarding	quality throughout the supply chain
7084	0 Managen	ent structures and resources supporting full implementation of the quality
7085	managem	ent system
7086	o Managen	ient solicitation of, and action on, quantitative and qualitative feedback on the
7087	o Procedur	ess and efficiency of quanty management system
7089	establishe	ed goals and objectives throughout the organization for customer satisfaction and
7090	continuo	is improvement
7091	o Procedure	es for independent reporting of quality functions and audits
7092	o Managen	ent accountability with emphasis on quality results and customer satisfaction
7093	• Results from	the above analyses of corporate strategic vision, objectives, policies, plans,
7094	processes, an	d procedures have been documented in the Acquisition Strategy (AS),
/095	Manufacturin	g and Quality Plans, the SEP, program documentation for CDR, and other
7096	appropriate p	rogram documentation.
7097 7008	 Process audit been conduct 	s (adequacy and sufficiency) of the contractor's and supply chain QMISs have ad and results documented for undates to the Quality Strategy and Plan (See I 2)
7090	including.	et and results documented for updates to the Quanty Strategy and I fail (See 1.2)
	meraam5.	

7100		0	Role and participation of DCMA (Contractor and supply chain)
7101		0	Control and management of KCs, CSIs, and CAIs
7102		0	Acceptance testing including software
7103		0	Effectiveness of in-process and final inspections
7104		0	Application and effectiveness of statistical process controls
7105		0	Management of processes for measurement of rates and yields
7106		0	Execution of and adherence to quality plans including control plans and quality
7107			improvement plans
7108		0	Certification processes (e.g., flight safety, man-ratings, etc.)
7109		0	Continuous process improvements and results
7110		0	Software quality assurance and results
7111		0	Data storage, management, and security (physical and cyber)
7112		0	Safety, environmental, transportation, storage, etc. management, processes, and
7113			procedures
7114		0	For use of COTS items, GOTS items, and NDIs
7115		0	Management, control, and security of GFE/GFP (e.g., controlled products, test ranges,
7116			specialized equipment, radiation test facilities, etc.)
7117		0	Internal and supply chain audits, verification of results, and any subsequent corrective
7118			actions
7119		0	Processes for management, control, and monitoring of Key Performance Parameters
7120			(KPPs), KSAs, and KCs, CSIs, and CAIs, and their integration into the QMS.
7121		0	FRACAS processes for sufficiency and adequacy including results of dispositions (i.e.,
7122			material review boards and processes)
7123		0	Impacts on tasks, costs, schedules, and outcomes
7124		0	Compliance to standards and best practices (e.g., AS9100, ISO 9000, industry product
7125			standards, MIL-STDs, etc.)
7126		0	Risk, Issue, and Opportunity Management System processes for planning, integration,
7127			and execution with the QMS
7128	•	DC	CMA support and assistance has been requested and the Letter of Delegation has been
7129		acc	cepted for assessment of adequacy and completeness of contractor and supply chain QMSs
7130		app	blication to system, subsystems, items, and components.
7131	Tools		
7132	•	ISC	O 9001 OMS Audit Checklist
7133	•	AS	9100 Audit Checklist
7134	•	Ma	unufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread
/101		1010	indiactaring readiness herer rissessment (inith) Questionnare for the Quarty thread
7135	Resou	rces	
7136	•	AS	9100 Quality Systems – Requirements For Aviation Space And Defense Organizations
7137	-	Sei	p 2016
		~ ~	

7138 7139	•	AS9145 Requirements for Advanced Product Quality Planning and Production Part Approval Process
7140	•	ISO 9001:2015, Quality Management System
7141	•	MRL Deskbook Version 2016
7142	•	MIL-HDBK-896A
7143	•	DoD Risk, Issue, and Opportunity Management Guide, Jun 2015
7144	1.2	Assess and Revise Quality Strategy
7145	Manu	facturing and Quality Tasks
7146 7147	•	Update and revise the program Quality Management Strategy based on the contractor's QMS, and quality strategy and plans to include:
7148 7149		• The contractor's strategy and plan to address compliance to established industry standards and best practices (e.g., AS9100, ISO 9000, etc.)
7150		• Alternatively the contractor's quality management strategy and plans should address:
7151		 Leadership responsibilities and requirements
7152		 Quality management system requirements and planning
7153		 Support and resource management requirements
7154		 Operational requirements (e.g., risk management, design and development,
7155		purchasing, etc.)
7156		 Risks, issues, and opportunities
7157		 Performance evaluation including measurement, analysis, and improvement
/158		requirements
7159	•	Update and revise the program Quality Management Strategy and Plan based on the results
7160		from process audits (adequacy and sufficiency) of the contractor's and supply chain QMSs
7161		conducted (See I.1).
7162	٠	Develop required contract modifications or updates to ensure alignment of contractor with
7163		program Quality Management Strategies and Plans based on results of quality audits
7164		conducted. (See I.1)
7165	•	Manufacturing and quality should conduct internal audits at planned intervals to ensure the
/100		program quality management system conforms to the program's requirements and is
/10/	•	Manufacturing and quality should raview and ravies program quality objectives for adequacy
7160	•	and sufficiency at the appropriate levels, and for the appropriate processes to meet program
7170		objectives. The quality objectives should take into account applicable requirements and be
7171		
/1/1		• Consistent with the quality policy
/1/2 7172		o inteasurable
/1/3 717/		o Communicated
7174 7175		• Undated as appropriate
1113		o opuaida, as appropriate

7176 7177	Manufacturing and quality should verify and update the pr Strategy and Quality Plan to ensure they include:	rogram Quality Management
7178 7179 7180 7181 7182 7183 7184 7185 7186 7186 7187	 All required quality technologies and processes (state requirements, metrics, and the frequency of review Compliance with FAR 52.246-11, Higher-Level Contr The quality aspects of contractor compliance to indust (i.e., AS6500) Management, measurement, and control of key and critical Addresses use of and appropriate quality requirements non-developmental items (NDIs) and their incorporati shock and vibe requirements beyond normal COTS de Requirements for supply chain: 	of the art), unique product quality ract Quality Requirements ry best manufacturing practices itical characteristics and processes for COTS items, GOTS items, and on into the contractor's QMS (i.e., esign envelope)
7188 7189 7190 7191 7192 7193	 Focused supplier quality management requirement Quality management planning Use of best practices and standards (e.g., AS9100, Metrics and review frequency Solutions, tools, techniques, and procedures Use of Government furnished quality and testing e 	ts ISO 9000, etc.) equipment and assets
7194 7195 7196	 Appropriate agreements, delegations and contracts wit and/or DLA throughout the supply chain Software and firmware development quality assurance 	th other agencies, e.g. the DCMA e and configuration management
7197 7198 7199	Manufacturing and quality should assess the program's quality planned intervals for continuing suitability, adequacy, effective strategic direction of the program. The assessment should	ality management system, at ectiveness, and alignment with the include:
7200 7201 7202	 Status of actions from previous assessments Changes in external and internal issues that are relevan Performance and effectiveness of the QMS, including: 	nt to the QMS
7203 7204 7205 7206 7207 7208	 Extent to which quality objectives have been met Process performance and conformity of products Nonconformities and corrective actions Monitoring and measurement results Audit results Performance of the supply chain 	
7209 7210 7211	 Adequacy of resources Effectiveness of actions taken to address risks, issues, Opportunities for improvement 	and opportunities

4. Engineering and Manufacturing Development (EMD) Phase

7212	Metrics
7213 7214	• Program Quality Management Strategy has been updated based on assessments of the contractor's QMS, and contractor quality strategy and plans to include:
7215 7216 7217	 The contractor's strategy and plan to address compliance to established industry standards and best practices (e.g., AS9100, ISO 9000, etc.) Alternatively, the contractor's quality management strategy and plans to address:
7218 7219 7220 7221 7222 7223 7224 7225	 Leadership responsibilities and requirements Quality management system requirements and planning Support and resource management requirements Operational requirements (e.g., risk management, design and development, purchasing, etc.) Risks, issues, and opportunities Performance evaluation including measurement, analysis, and improvement requirements
7226 7227	• Program Quality Management Strategy and Plan has been revised based on the results from process audits (adequacy and sufficiency) of the contractor's and supply chain QMSs.
7228 7229 7230	 Recommended contract modifications or updates have been submitted to program management to ensure alignment of contractor with program Quality Management Strategies and Plans with program strategies and plans
 7231 7232 7233 7234 7235 7236 	 Manufacturing and quality have conducted internal audits as planned and documented the program quality management system effective implementation, conformance, and support of the program's requirements, or corrective actions, as appropriate. Manufacturing and quality have reviewed, documented, and will maintain documentation on the adequacy and sufficiency of program quality objectives to meet program objectives. The quality objectives take into account applicable requirements and are:
7237 7238 7239 7240 7241	 Consistent with the quality policy Measurable Monitored Communicated Updated, as appropriate
7242 7243	• Manufacturing and quality have verified and updated where necessary the program Quality Management Strategy and Quality Plan ensuring inclusion of:
7244 7245 7246 7247 7248 7248	 All required quality technologies and processes (state of the art), unique product quality requirements, metrics, and the frequency of review Compliance with FAR 52.246-11, Higher-Level Contract Quality Requirements The quality aspects of contractor compliance to industry best manufacturing practices (i.e., AS6500)
/249	• Management, measurement, and control of key and critical characteristics and processes

7286	•	AFMC Instruction 63-145 Manufacturing and Quality (Draft)
7285	•	DSMC Acquisition Strategy Guide, Dec 1999
7284	•	AS6500, Manufacturing Management Program, Nov 2014
7283	Resou	rces
1282	•	Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread
7281	•	AS9100 Audit Checklist
7280	•	A SO 100 Audit Checklist
1219	•	Acquisition Strategy Template
7278	Tools	A
7277		• Opportunities for improvement
7276		• Effectiveness of actions taken to address risks, issues, and opportunities
7275		• Adequacy of resources
7274		 Performance of the supply chain
7273		• Audit results
7272		 Monitoring and measurement results
7271		 Nonconformities and corrective actions
7270		 Process performance and conformity of products
7269		 Extent to which quality objectives have been met
1200		o renomance and effectiveness of the Qivis, including.
1201 7268		• Changes in external and internal issues that are relevant to the QIVIS • Performance and effectiveness of the OMS including:
7266 7267		 Status of actions from previous assessments Changes in external and internal issues that are relevant to the OMS
7066		• Status of actions from provious accessments
7265		direction of the program including:
7264	•	system for continuing suitability, adequacy, effectiveness, and alignment with the strategic
7263	•	Manufacturing and quality have assessed and documented the program's quality management
7262		• Software and firmware development quality assurance and configuration management
7261		and/or the Defense Logistics Agency (DLA) throughout the supply chain
7260		• Appropriate agreements, delegations and contracts with other agencies, e.g., the DCMA
7259		 Use of Government furnished quality and testing equipment and assets
7258		 Solutions, tools, techniques, and procedures
7257		 Metrics and review frequency
7256		 Use of best practices and standards (e.g., AS9100, ISO 9000, etc.)
7255		 Quality management planning
7254		 Focused supplier quality management requirements
7253		• Requirements for supply chain:
7252		normal COTS design envelope)
7251		incorporation into the contractor's QMS (i.e., shock and vibe requirements beyond
7250		• Appropriate quality requirements for COTS items, GOTS items, and NDIs and their

4. Engineering and Manufacturing Development (EMD) Phase

7287 7288	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
7280		Sep 2010
7200	•	EAD 52 246 11 Quality Management System
7290	•	FAR 52.240-11, Quality
7291	•	MRL Deskbook Version 2016
1292	•	DAG Chapter 14.3.1.3.6 Quality Plans
7293	I.3	Evaluate supply chain Quality
7294	Manu	facturing and Quality Tasks
7295	•	Ensure that the contractor supplier management system for subsystems, items, and
7296		components requires QMS processes and procedures are in alignment with industry best
7297		practices (e.g., AS9100, ISO 9000, etc.) to include elements such as:
7298		 Management responsibility requirements
7299		 Quality management system requirements
7300		• Resource management requirements
7301		• Product Realization requirements (e.g., risk management, design and development,
7302		purchasing, etc.)
7303		• Risks, issues, and opportunities
7304		 Measurement, analysis, and improvement requirements
7305	٠	Assess the contractor's supply chain management system capabilities for performance of
7306		manufacturing and quality processes and procedures in accordance with industry best
7307		manufacturing practices (i.e., AS6500) including:
7308		• Effectiveness of prime and subcontractor communications and interactions to include:
7309		• Flow down of cost, schedule, and performance requirements to suppliers and timely
7310		notification of changes
7311		 Design and engineering changes traceability and compliance
7312		 Quality data exchange, analysis, storage, and traceability processes
7313		 The joint Risk, Issue, and Opportunity Management System
7314		 Responses, status, and reports for cost, schedule, and performance actuals
7315		 Corrective and preventative actions and program feedback
7316		• KCs and critical characteristics (CSIs and CAIs) management
7317		• Supplier risk, issue, and opportunity, and mitigation management processes for quality
7318		(e.g., technical, schedule, material, facility, scale-up, financial impacts, etc.)
7319		 Make/buy processes for supplier quality performance and impacts
7320		• Qualification, approval, and removal processes for suppliers, monitoring and tracking of
7321		supplier performance, and periodic re-assessment
7322		• Utilization of processes and procedures for prevention and/or detection of counterfeit
7323		parts and materials (i.e., adherence to AS5553, AS6174, and AS9100)

7324		• Verification of suppliers processes and procedures to control quality, including suppliers
7325		performing key and/or critical manufacturing processes and changes to those processes
7326		 Process control plans for variability reduction
7327		• Statistical control of process capabilities (i.e., C _{pk} s)
7328		• Production process verification
7329		• Predictive indicators to provide early detection of potential quality problems
7330		• Subsystem, item, and component First Article Inspections (FAIs) and First Article Tests
7331		(FATs)
7332		• Continuous manufacturing surveillance and effective metrics to monitor, evaluate, verify,
7333		improve processes, and prevent defects
7334	•	Collect and analyze supply chain quality data from the production representative
7335		environment for subsystems, items, and components and utilize analyses results to develop
7336		recommended improvement plans.
7337	•	Ensure control plans are in place for management of KCs.
7338	•	Ensure development of test and inspection plans underway for EMD prototypes.
7220		
/339	wetric	CS
7340	•	Contractor's supplier management system for subsystems, items, and components has been
7341		assessed and results document QMS processes and procedures compliance with industry best
7342		practices (e.g., AS9100, ISO 9000, etc.) to include elements such as:
7343		• Management responsibility requirements
7344		• Quality management system requirements
7345		• Resource management requirements
7346		• Product Realization requirements (e.g., risk management, design and development,
7347		purchasing, etc.)
7348		• Risks, issues, and opportunities
7349		• Measurement, analysis, and improvement requirements
7350	•	Contractor's supply chain management system has been assessed and the results document
7351		compliance with industry best manufacturing practices (i.e., AS6500) including:
7352		• Effective prime and subcontractor communications and interactions including:
7353		Elow down of cost schedule and performance requirements to suppliers and timely
7354		notification of changes
7355		 Design and engineering changes traceability and compliance
7356		 Design and engineering enanges inaccountry and compliance Quality data exchange analysis storage and traceshility processes
7350		 Quanty data exchange, analysis, storage, and traceability processes The joint Rick Issue, and Opportunity Management System
7359		 The joint Kisk, issue, and opportunity Management System Besponses status and reports for cost schedule and performance actuals
7350		 Responses, status, and reports for cost, schedule, and performance actuals Corrective and preventative actions and program feedback
1337		- Concerve and preventative actions and program reducate
7360		 Management of KCs and critical characteristics (CSIs and CAIs)

4. Engineering and Manufacturing Development (EMD) Phase

7361		• Risk, issue, and opportunity, and mitigation management processes for quality (e.g.,
7362		technical, schedule, material, facility, scale-up, financial impacts, etc.)
7363		• Make/buy processes that include supplier quality performance
7364		• Supplier management and monitoring that includes qualification, approval, performance,
7365		and removal processes with periodic re-assessment
7366		• Processes and procedures for prevention and/or detection of counterfeit parts and
7367		materials (i.e., adherence to AS5553, AS6174, and AS9100)
7368		• Suppliers processes and procedures for control of quality, key and/or critical
7369		manufacturing processes, and changes
7370		 Process control plans for variability reduction
7371		• Statistical control of process capabilities (i.e., C _{pk} s)
7372		 Production process verification
7373		• Use of predictive indicators to provide early detection of potential quality problems
7374		 FAIs and FATs for subsystems, items, and components
7375		• Manufacturing surveillance and effective metrics to monitor, evaluate, verify,
7376		continuously improve processes, and prevent defects
7377	•	Quality data from the supply chain for production representative subsystems, items, and
7378		components has been collected and analyzed and recommended improvement plans have
7379		been developed and documented.
7380	•	Control plans for management of KCs have been completed and are in place, and are being
7381		tracked by the contractor.
7382	٠	Test and Inspection plans are being developed and documented for EMD prototypes.
7383	Tools	
7303	10013	
/384	•	Supplier QA Questionnaire
7385	•	ISO 9001 QMS Audit Checklist
7386	•	AS9100 Audit Checklist
7387	٠	Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread
7388	•	AS6081 Counterfeit Electronic Parts; Avoidance Protocol, Distributors
7389	Resou	rces
7390	•	AS6500, Manufacturing Management Program, Nov 2014
7391	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
7392		Sep 2016
7393	•	ISO 9001:2015, Quality Management System
7394	•	Risk, Issue, and Opportunity Guide, Jun 2015
7395	•	AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition,
7396		Sep 2016
7397	•	AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materiel.
7398		Jul 2014
7399	•	MRL Deskbook Version 2016

7400 I.4 Support Critical Design Review (CDR)

7401 Quality Tasks

7402 Ensure Quality Strategy and Plan, including initial product baseline documentation for • 7403 quality, is sufficient, complete, and adequate to enable inspections and testing of components, 7404 hardware, and embedded software. 7405 0 Ensure all KCs, CSIs, and CAIs have completed drawings and specifications with 7406 tolerances and test points under configuration control 7407 Ensure all product data essential for component quality has been released 0 For CDR, provide quality inputs on program, contractor, and supply chain implementation 7408 • status of industry best practices (e.g., ISO 9000, AS9100, and other standards on quality 7409 7410 management and quality management systems). 7411 Ensure all quality design trade studies and assessments are completed and incorporated into • 7412 the design for CDR. 7413 Ensure quality enhancement efforts ongoing for optimized integrated system (e.g. Design 0 7414 for Inspection and Testability, Design for Six Sigma, etc.) 7415 • Ensure all subsystem, item, and component CDRs are complete and the results impacting 7416 quality available for the system CDR. 7417 Analyze the results of design maturity assessments (See E.6) including all appropriate 0 7418 reviews (e.g., All CDRs, PPRs, PCAs, FCAs, etc.) for closure or approval of quality 7419 related risks, issues, and opportunities 7420 • Ensure quality inputs to the schedule (IMP/IMS) are up-to-date and are executable with 7421 acceptable risks. 7422 • Ensure quality plans, activities, and processes are executable within the existing quality 7423 budget to support the approved initial product baseline and critical path. 7424 • Ensure all key and critical manufacturing processes process control plans, have been 7425 analyzed, updated, and approved for the capability to meet design tolerances. 7426 • Analyze contractor quality plans for materials, facilities, equipment, test facilities and 7427 equipment, and tooling to support the pilot line requirements. 7428 • Analyze the contractor FRACAS for adequacy to meet needs based on the Quality Plan. 7429 • Analyze quality plans for adequacy and capability of achieving manufacturing readiness level 7430 8 by initial production. 7431 Analyze results of contractor and key supply chain assessments (e.g., sourcing, materials, • 7432 subsystems, items, components, lead-times, quality management, ESOH, etc.) for quality 7433 risks, issues, and opportunities and appropriate mitigation plans. 7434 • Analyze the assessments of adequacy and completeness of quality requirements validation 7435 activities (See E.6) which included prototypes and demonstrations in a representative 7436 environment at the system, subsystem, item, and component levels for design maturity. 7437 Include demonstrations of quality processes in a representative environment Ο

7438	• Include demonstrations of quality processes for KCs, CSIs, and CAIs
7439 7440 7441 7442 7443 7444 7445	 Provide quality inputs to the Life Cycle Support Plan for CDR. Ensure contractor quality management systems for manufacturing and quality metrics and data collection and tracking to the component level are in place and functional. Ensure the TEMP incorporates all subsystems, items, and components into plans for tests, test facilities, and test equipment. Ensure the quality considerations and aspects of contractor's plans and inputs are up-to-date and approved for CDR, including:
7446 7447 7448 7449 7450 7451 7452	 Parts and Materials (Management) Plan (PMP) Configuration Management Plan (CMP) Software Development Plan (embedded software) Quality Assurance Plan PPP SEMP TEMP
7453 7454 7455 7456 7457 7458	 Analyze and update subsystem, item, and component quantity estimates based on program system requirements, component yield and rate data, and results from prototype demonstrations. Ensure quality design improvements have been implemented in the system design and/or specifications according to the joint government/contractor schedule (See E.4). Provide up-to-date cost of quality inputs to the program budget and the CARD.
7459 7460	 Update and allocate quality (production) cost models to subsystem, item, and component levels, and track against targets
7461 7462 7463	• Ensure adequacy and completeness of mitigation activities for mitigation of quality risks, issues, and opportunities in the joint Government/ contractor Risk, Issue, and Opportunity Management System, including quality risks to:
7464 7465 7466 7467	 Key and critical manufacturing processes including embedding software Materials and sourcing Supply chain including multiple sources Production rates and yields
7468 7469 7470	 Facilities Special tooling development Tests and demonstrations
7471 7472 7473	 Security System safety and hazardous materials management Economic feasibility
7474 7475 7476	 Schedule (i.e., IMP/IMS) Manufacturing capability obsolescence Manufacturing capability sustainment

7477	Metrics
7478 7479 7480	• Quality Strategy and Plan, including initial product quality baseline, has been documented for CDR as sufficient, complete, and adequate to enable inspections and testing of components, hardware, and embedded software.
7481 7482 7483	 All KCs, CSIs, and CAIs have completed drawings and specifications with tolerances and test points under configuration control All product data essential for component quality has been released
7484 7485 7486 7487 7488	 Quality inputs on program, contractor, and supply chain implementation status of industry best practices (e.g., ISO 9000, AS9100, and other standards on quality management and quality management systems) has been documented and provided for CDR. All quality design trade studies and assessments have been completed and the results have been documented into the design for CDR.
7489	• Continuous quality enhancement efforts are in place and monitored
7490 7491	• All subsystem, item, and component CDRs are complete and all results impacting system quality are documented and available for CDR.
7492 7493	 Documented results from all design maturity reviews with closures and/or acceptances of quality related risks, issues, and opportunities are included
7494 7495 7496	• Quality inputs to the schedule (IMP/IMS) are documented up-to-date and executable with acceptable risks.
7496 7497 7498	• Quality plans, activities, and processes have been analyzed and are executable within the existing quality budget and the results support the approved initial product baseline and critical path.
7499 7500	• All key and critical manufacturing processes process control plans, have been analyzed, updated, and approval documented for the capability to meet design tolerances for CDR
7501 7502	• Contractor quality plans have been analyzed for materials, facilities, equipment, test facilities and equipment, and tooling and document the capability to support the pilot line.
7503 7504	 Contractor FRACAS has been analyzed for adequacy and documented to meet needs based on the program Quality Plan.
7505	• Contractor and Government Quality Plans have been analyzed and the results document the
7506	adequacy and capability to achieve manufacturing readiness level 8 by initial production.
7507	• Contractor and key supply chain assessments (e.g., sourcing, materials, subsystems, items,
7508	results analyzed and document required mitigation plans for quality risks issues and
7510	opportunities.
7511	• Adequacy and completeness of quality requirements validation activities (See E.6) which
7512	included prototypes and demonstrations in a representative environment at the system,
7513	subsystem, item, and component levels have been analyzed and assessed for design maturity
7514	and results provided for CDR.

4. Engineering and Manufacturing Development (EMD) Phase

7515 7516		 Demonstrations included quality processes in a representative environment Demonstrations included quality processes for KCs, CSIs, and CAIs
7517 7518	•	Quality inputs to the Life Cycle Support Plan have been developed and documented for CDR.
7519 7520 7521	•	Contractor quality management systems for manufacturing and quality metrics and data collection and tracking to the component level have been assessed for adequacy, are documented as in place and functional.
7522 7523	•	Tests, test facilities, and test equipment for all subsystems, items, and components have been documented in the TEMP for CDR.
7524 7525 7526 7527 7528 7529 7530 7531	•	 Contractor's quality plans and inputs are up-to-date and approved for CDR, including: Parts and Materials (Management) Plan (PMP) Configuration Management Plan (CMP) Software Development Plan (embedded software) Quality Assurance Plan PPP SEMP TEMP
7532 7533 7534 7535 7536 7537 7538	•	Subsystem, item, and component quantity estimates have been analyzed and updated based on program system requirements, component yield and rate data, and prototype demonstrations and provided as input for CDR. Quality design improvements have been implemented in the system design and/or specifications according to the joint government/contractor schedule (See E.4). Up-to-date cost of quality inputs have been documented and provided for the program budget and for the CARD.
7539 7540		• Updated and allocated quality cost models to subsystem, item, and component levels have been included, and track against targets
7541 7542 7543	•	Adequacy and completeness of quality risk mitigation activities have been assessed and documented in the joint Government/ contractor Risk, Issue, and Opportunity (RIO) Management System, including quality risks to:
7544 7545 7546 7547 7548 7549 7550 7551 7552 7553		 Key and critical manufacturing processes including embedding software Materials and sourcing Supply chain including multiple sources Production rates and yields Facilities Special tooling development Tests and demonstrations Security System safety and hazardous materials management Economic feasibility
/554		• Schedule (i.e., IMP/IMS)

4. Engineering and Manufacturing Development (EMD) Phase

7555		• Manufacturing capability obsolescence
/220		• Manufacturing capability sustainment
7557	Tools	
7558	•	Critical Design Review Checklist
7559	Resou	rces
7560	•	AS65000
7561	•	Defense Acquisition Guide (DAG) Chapter 3-3.3.5 Critical Design Review
7562	•	IEEE 15288.2
7563	•	MRL Deskbook Version 2016
7564	1.5	System and Program Configuration Audits
7565	Qualit	y Tasks
7566	•	Ensure quality personnel participate in and support program, contractor, and supply chain
7567		system audits to be performed in accordance with the process focused requirements in
7568		AS9101 for (but not limited to):
7569		 Risk, Issue, and Opportunity System
7570		 Supply chain management system
7571		 Development test operations and evaluations
7572		 Quality Management System
7573		• Development (hardware and software)
7574		• Production control
7575		• Security (physical and cyber)
15/6		• ESOH
1311		 Hazardous and/or special materials Human Machine Interface
7570		• FVM system
7580		• Transportation handling and storage
7581		• Workforce management
7582		o Facilities
7583		• Documentation and data management
7584	•	Ensure quality personnel participation in, inputs to, and support of the Functional
7585		Configuration Audit (FCA) to include:
7586		• Support to program and the contractor agreements that development is complete and data
7587		from development tests (DTs), analyses, and simulations are sufficient to achieve
7588		performance goals
7589		• Provide quality input to:
7590		 Verification of performance to the baseline
		Man for the state of the Management Data of Way 1.1.

4. Engineering and Manufacturing Development (EMD) Phase

7591 7592 7593 7594	 The verification traceability documentation for each manufacturing and quality requirement The validity and the completeness of embedded software and associated documentation
7595 7596 7597 7598 7599 7600 7601 7601 7602 7603 7604 7605	 Verify all approved engineering change proposals (ECP), requests for deviation, and requests for waiver impacting manufacturing and quality have been incorporated into the Manufacturing and Quality Plans Verification that all KCs, CSIs, and CAIs are identified, managed, and included in the Verification Cross-Reference Matrix (VCRM) Ensure quality provides support to verification activities and tasks to include: Ensuring each requirement listed in the VCRM is traceable and has been verified with test data, analysis, and/or inspection Ensuring demonstration manufacturing and quality processes to provide the capability to satisfy TPMs, KPPs and KSAs thresholds
7605 7606	 Review of acceptance test reports and deficiencies with root cause and closed corrective actions
7607 • 7608 7609 7610 7611 • 7612	 Ensure quality participates in the Change Configuration Boards (CCBs) to ensure changes are in accordance with program direction, program Quality Strategy, and are consistent with industry quality standards and best practices, supplier instructions, processes and procedures, etc. Participate in and support the System Verification Review (SVR) including: Provide verification that all manufacturing and quality CDR action items have been
7613 7614	 closed and any corrective actions have been successfully completed Provide quality inputs on:
7615 7616 7617 7618 7619 7620 7621 7622 7623 7624 7625 7626 7627	 Verification of requirements from all system, subsystem, item, and component quality test data and analyses Verification of performance to the function baseline based on quality data Verification through analysis of quality data the adequate management and integrity of all critical program information (CPI) (e.g., performance data, yield and rate data, etc.) Verification that quality risks are included in the Risk, Issue, and Opportunity Management process and mitigation plans Demonstration of system capability to meet all TPMs, KPPs, and KSAs (thresholds) based on all available quality test data, analysis, and inspection Required certification activities Support and maintenance analyses for incorporation into the LCSP Risks of operational test failures during IOT&E
7628 7629	 Provide quality inputs to: Ensure adequate quality processes and quality metrics are in place
	and and James James Learners and James and an hand

7630 7631 7632 7633 7634 7635 7635 7636 7637 7638 7639	 Analysis of contractor's SEMP for appropriate incorporation of quality activities and data collection, analysis, and storage Detailed planning and schedules with required resources for proceeding into LRIP and IOT&E Updates of the SEP and contractor's SEMP for the production and deployment (P&D) phase The CARD for up-to-date cost of quality inputs The LCSP The TEMP (i.e., up-to-date) The Configuration Management Plan (CMP) (i.e., up-to-date)
7640	Metrics
7641 7642 7643	• Quality personnel have participated in and supported program, contractor, and supply chain system audits (IAW AS9101) that document meeting the process focused requirements for (but not limited to):
7644 7645 7646 7647 7648 7649 7650 7651 7652 7653 7654 7655 7656 7657 7658	 Risk, Issue, and Opportunity System Supply chain management system Development test operations and evaluations Quality Management System Development (hardware and software) Production control Security (physical and cyber) ESOH Hazardous and/or special materials Human Machine Interface EVM system Transportation, handling, and storage Workforce management Facilities Decumentation and data management
7659 7660	 Quality personnel have supported and participated in, and provided inputs to the FCA to include:
7661 7662 7663 7664	 Documented support to program and the contractor agreements that development is complete and data from development tests (DTs), analyses, and simulations are sufficient to achieve performance goals Documented quality inputs to:
7665 7666 7667	 Verification of performance to the baseline The verification traceability documentation for each manufacturing and quality requirement

4. Engineering and Manufacturing Development (EMD) Phase

7668 7669	 The validity and the completeness of embedded software and associated documentation 	
7670 7671 7672	• Verification that all approved ECPs, requests for deviation, and requests for waiver impacting manufacturing and quality have been documented in the Manufacturing and Quality Plans	
7673 7674 7675	 Verification that all KCs, CSIs, and CAIs have been identified, managed, and documented, and are included in the Verification Cross-Reference Matrix (VCRM) Documented input to verification activities and tasks which included: 	
7676 7677 7678 7679 7680 7681	 Each requirement's (listed in the VCRM) traceability and verification with test data analysis, and/or inspection Demonstrations of manufacturing and quality processes for meeting TPMs, KPPs a KSAs thresholds Review of acceptance test reports and deficiencies with root cause and closed corrective actions 	, nd
7682 7683 7684 7685 7686 7687	Quality personnel continue to support and participate in CCBs to ensure quality changes are in accordance with program direction, program Quality Strategy, and are consistent with industry quality standards and best practices, supplier instructions, processes and procedure etc. Quality personnel have participated in and provided documented inputs to the SVR including:	€ :S,
7688 7689 7690	 Verification that all manufacturing and quality CDR action items have been closed and any corrective actions have been successfully completed Quality inputs on: 	
7691 7692 7693 7694 7695 7696 7697 7698 7699 7700 7701 7702	 Verification of requirements from all system, subsystem, item, and component quality test data and analyses Verification of performance to the function baseline based on quality data Verification through analysis of quality data the adequate management and integrity of all CPI (e.g., performance data, yield and rate data, etc.) Verification that quality risks are included in the Risk, Issue, and Opportunity Management process and mitigation plans Demonstration of system capability to meet all TPMs, KPPs, and KSAs (thresholds based on all available quality test data, analysis, and inspection Required certification activities status Support and maintenance analyses results for incorporation into the LCSP Risks of operational test failures during IOT&E 	√))
7703 7704 7705 7706 7707	 Quality inputs that ensure adequate quality processes and quality metrics are in place Results of analyses of contractor's SEMP for appropriate incorporation of quality activities and data collection, analysis, and storage Quality inputs to detailed planning and schedules with required resources for proceeding into LRIP and IOT&E 	đ

7708 7709 7710 7711 7712 7713 7714 7715		 Updates of the SEP and contractor's SEMP for the production and deployment (P&D) phase Updates to the: CARD for the cost of quality LCSP TEMP CMP SEP
7716	Tools	
7717	•	Functional Configuration Audit checklist
7718	Resou	rces
7719	•	AS6500, Manufacturing Management Program, Nov 2014
7720	•	AS9100 Quality Systems – Requirements for Aviation, Space, and Defense Organizations,
7721		Sep 2016
7722	•	AS9101 Quality Management Systems – Audit Requirements for Aviation, Space, and
7723		Defense Organizations
7724	•	IEEE 15288.2
7725	•	ISO 9000
7726	•	Defense Acquisition Guide (DAG) Chapter 3-3.3.6 System Verification Review/System
7727		Configuration Audit
7728	1.6	Assess Pilot Line
7729	Manu	facturing and Quality Tasks
7730	•	Assess contractor and supply chain pilot lines and demonstrations for quality verification and
7731		validation efforts including:
7732		 Quality processes and procedures including continuous improvement efforts
7733		• Quality surveillance and quality data collection and analyses (including supply chain data
7734		for items and components)
7735		• Quality and process controls in place (e.g. plans, audits, process capabilities ($C_{pk}s$),
7736		Statistical Process Control (SPC), FRACAS, etc.)
7737		• Adequacy and completeness of acceptance and qualification testing for LRIP
7738		• All quality instructions, sequencing, in-process tests, and test procedures (including those in such instructions)
1139		in work instructions)
7740		Quality scheduling and control Quality model and simulations
7741		Quality model and simulations Ouality workforce canabilities
7743		• Junity workforce capabilities
5,173		- Implementations of quarty technologies

7744	• Tooling, work holding fixtures, jigs, etc. for inspection and test
7745	• Test equipment and test facilities (including Special Test Equipment/Special Inspection
7746	Equipment (STE/SIE) validation in accordance with plans)
7747	• Quality processes for transportation, storage, and handling equipment
7748	• Potential requirements for additional quality tools, equipment, and software
7749	• Safety of quality processes and procedures
7750	• Quality of ESOH processes and procedures
7751	• Quality of security processes, procedures, capabilities, and compliance
7752	 Impacts from direct and indirect infrastructure
7753	 Mitigation results of quality and adequacy of risks and issues resolutions
7754	• Quality costs (and impacts to schedule and performance)
7755	 Quality of materials' sources and selections
7756	• Quality of embedded software (integration)
7757 •	Analyze quality processes performed during the pilot lines operations, (including
7758	simulations) to include:
7759	\circ Rate of quality processes (actual time to complete) vs. planned
7760	• Quality data actuals vs. estimated
7761	• Quality process yield actuals vs. planned
7762	• Changes in processes (actual vs. planned)
7763	 Cost of quality actuals vs. desired
• • •	Assess process control plans, including all plans for process control of key and critical
7764 • 7765	Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line.
7764 • 7765 • 7766 •	Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections
7764 • 7765 7766 • 7767	Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information
7764 • 7765 • 7766 • 7767 • 7768 •	Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line.
7764 • 7765 • 7766 • 7767 • 7768 • 7769 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc.
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 • 7771 • 7772	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate:
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 • 7771 • 7772 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate:
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 • 7771 • 7773 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate: All Production Process Verifications (PPVs) performed Implementation of manufacturing technology solutions (including ManTach)
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 • 7771 • 7773 • 7774 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate: All Production Process Verifications (PPVs) performed Implementation of manufacturing technology solutions (including ManTech) Attainability of KCs (will be capable and under process control for L DID)
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 • 7771 • 7773 • 7775 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate: All Production Process Verifications (PPVs) performed Implementation of manufacturing technology solutions (including ManTech) Attainability of KCs (will be capable and under process control for LRIP) Data callected for the Verichility Peduction process
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 • 7771 • 7773 • 7775 • 7776 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate: All Production Process Verifications (PPVs) performed Implementation of manufacturing technology solutions (including ManTech) Attainability of KCs (will be capable and under process control for LRIP) Data collected for the Variability Reduction program
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 • 7771 • 7773 • 7775 • 7776 • 7777 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate: All Production Process Verifications (PPVs) performed Implementation of manufacturing technology solutions (including ManTech) Attainability of KCs (will be capable and under process control for LRIP) Data should demonstrate progress to metrics
7764 • 7765 • 7767 • 7767 • 7768 • 7769 • 7770 • 7771 • 7773 • 7774 • 7776 • 7777 • 7777 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate: All Production Process Verifications (PPVs) performed Implementation of manufacturing technology solutions (including ManTech) Attainability of KCs (will be capable and under process control for LRIP) Data collected for the Variability Reduction program Data should demonstrate progress to metrics Include updates based on process improvements
7764 • 7765 • 7766 • 7767 • 7768 • 7769 • 7770 • 7771 • 7773 • 7775 • 7776 • 7777 • 7778 • 7779 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate: All Production Process Verifications (PPVs) performed Implementation of manufacturing technology solutions (including ManTech) Attainability of KCs (will be capable and under process control for LRIP) Data collected for the Variability Reduction program Data should demonstrate progress to metrics Include updates based on process improvements All FAIs and FATs against specifications, drawings, models, etc.
7764 • 7765 • 7767 • 7767 • 7768 • 7769 • 7770 • 7771 • 7773 • 7773 • 7775 • 7776 • 7777 • 7778 • 7779 • 7780 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate: All Production Process Verifications (PPVs) performed Implementation of manufacturing technology solutions (including ManTech) Attainability of KCs (will be capable and under process control for LRIP) Data collected for the Variability Reduction program Data should demonstrate progress to metrics Include updates based on process improvements All FAIs and FATs against specifications, drawings, models, etc. Continuous improvement plans.
7764 • 7765 • 7767 • 7767 • 7768 • 7769 • 7770 • 7771 • 7773 • 7773 • 7775 • 7776 • 7777 • 7778 • 77781 •	 Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required quality outputs (e.g., data, in-process inspections and tests, process capability indices, etc.) based on build-to documentation and information gathered during the pilot line. Verify updated work instructions, processes, drawings, etc. Include KCs and their control plans Assess quality outputs from the pilot line and demonstrations for adequacy and completeness and validate: All Production Process Verifications (PPVs) performed Implementation of manufacturing technology solutions (including ManTech) Attainability of KCs (will be capable and under process control for LRIP) Data collected for the Variability Reduction program Data should demonstrate progress to metrics Include updates based on process improvements All FAIs and FATs against specifications, drawings, models, etc. Continuous improvement plans. Include assessment of quality targets (gaps)

4. Engineering and Manufacturing Development (EMD) Phase

- 7782 Provide quality input for a Letter of Delegation to DCMA for support to, witness of, and • 7783 assessment of demonstrations, pilot line operations, FAIs and/or FATs, etc.
- 7784 Metrics 7785 Quality assessments of contractor and supply chain pilot lines and demonstrations have been • 7786 conducted and the results document verification and validation of the following for the 7787 program Quality Strategy and Plans and the PRR: 7788 Quality processes and procedures including continuous improvement efforts 0 7789 Quality surveillance and quality data collection and analyses (including supply chain 0 7790 data) 7791 • Quality and process controls in place 7792 Adequacy and completeness of acceptance and qualification testing for LRIP 0 7793 All quality instructions, sequencing, in-process tests, and test procedures 0 7794 Quality scheduling and control 0
- 7795 0 Quality model and simulations
- 7796 Quality workforce capabilities 0
- 7797 Implementations of quality technologies 0 7798
 - Tooling, work holding fixtures, jigs, etc. for inspection and test 0
- 7799 Test equipment and test facilities (including STE/SIE) 0
 - Quality processes for transportation, storage, and handling equipment 0
- Potential requirements for additional quality tools, equipment, and software 7801 0
- 7802 Safety of quality processes and procedures 0
- 7803 Quality of ESOH processes and procedures 0
- 7804 0 Quality of security processes, procedures, capabilities, and compliance
- 7805 Impacts from direct and indirect infrastructure 0
- 7806 Mitigation results of quality and adequacy of risks and issues resolutions 0
- 7807 • Quality costs (impacts to schedule and performance)
- 7808 • Quality of materials' sources and selections
- 7809 Quality of embedded software (integration) 0
- 7810 Pilot line quality process results, including simulations, have been analyzed and utilized for • 7811 recommended updates to plans and targets including:
- 7812 0 Rate of quality processes (actual time to complete)
- Quality data targets 7813
- 7814 Process yields

7800

- 7815 Process changes
- 7816 • Cost of quality
- 7817 Assessments of pilot line process control plans, including all plans for process control of key 7818 and critical processes, for adequacy and completeness have been conducted and results 7819 utilized to recommend updates to plans, process capability indices (C_{pks}), SPC processes,
- 7820 FRACAS processes, and other metrics, etc.

4. Engineering and Manufacturing Development (EMD) Phase

7821 7822 7823	•	All work instructions have been assessed for required quality outputs incorporating all up-to- date build-to documentation and information gathered during the pilot line and recommended changes documented and provided to Configuration Management.
7824		• Include KCs and their control plans
7825 7826	•	Quality outputs from the pilot line and demonstrations have been assessed for adequacy and completeness and document validation of:
7827 7828 7829 7830		 All PPVs Implementation of manufacturing technology solutions (including ManTech) Attainability of KCs (will be capable and under process control for LRIP) Data collected for the Variability Reduction program
7831 7832		Data should demonstrate progress to metricsInclude updates based on process improvements
7833 7834		 All FAIs and FATs against specifications, drawings, models, etc. Continuous improvement plans.
7835		 Include assessment of quality targets (gaps)
7836 7837	•	A Letter of Delegation has been approved and provided to DCMA for support to, witness of, and assessment of demonstrations, pilot line operations, FAIs and/or FATs, etc.
7838	Tools	
7839 7840 7841	• •	ISO 9001 QMS Audit Checklist AS9100 Audit Checklist Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread
7842 I	Resou	rces
7843 7844 7845	•	AS6500, Manufacturing Management Program, Nov 2014 AS9100 Quality Systems – Requirements for Aviation, Space, and Defense Organizations, Sep 2016
7846 7847	•	AS9145 Requirements for Advanced Product Quality Planning and Production Part Approval Process
7848 7849	•	ISO 9001:2015, Quality Management System MRL Deskbook Version 2016
7850	•	MIL-HDBK-896A

• DoD Risk, Issue, and Opportunity Management Guide, Jun 2015

7852 I.7 Finalize Quality Strategy and Plan for LRIP

7853 Manufacturing and Quality Tasks

7854 Based on analyses of quality processes performed for the pilot line, verify and validate the • 7855 quality processes capability for LRIP (including simulations) and update the Quality Strategy and Plan accordingly to include: 7856 7857 Rate of quality processes (actual time to complete) vs. planned 0 7858 • Quality data actuals vs. estimated 7859 • Ouality process yield actuals vs. planned 7860 • Changes in processes o Cost of quality actuals vs. desired 7861 • Potential requirements for additional equipment 7862 • Continuous improvement process and requirements 7863 7864 Ensure process control plans, including all plans for process control for key and critical • 7865 processes, are updated from pilot line and in place for LRIP. Verify Quality Strategy and Plan are updated based on all build-to documentation from the 7866 • pilot line, including KCs and critical characteristics and their control plans for LRIP. 7867 7868 • Include updates based on process capability data collected for those processes affecting 7869 KCs and critical characteristics 7870 • Include process stability data for key and critical processes and provide estimates for 7871 those with insufficient data 7872 Adjust Quality Strategy and Plan based on validated data collected for the Variability • 7873 Reduction program 7874 Data should indicate progress to metrics 0 7875 Include updates based on process improvements 0 7876 Update Quality Strategy and Plan to include all First Article Inspections and First Article Tests (completed with plans in place to correct findings). 7877 7878 Ensure that the Quality Strategy and Plan for LRIP requires: • 7879 0 Includes Letter of Delegations for DCMA support at the appropriate levels of the supply 7880 chain 7881 • Adequate acceptance and qualification testing 7882 • Continuous collection and periodic review of quality data to identify areas for 7883 improvement (i.e., Continuous Process Improvement (CPI)). Supplier risk and issue mitigation planning complete and being implemented 7884 0 7885 • Periodic supplier process control verification and validation 7886 • Periodic assessment of Variability Reduction processes 7887 o Implementation of Six Sigma, lean manufacturing processes, etc.

7888	•	Based on contractor's manufacturing and quality system verification and validation efforts,
7889		including pilot line and demonstrations, and direct and indirect infrastructure, update the
7890		Program Quality Strategy and Plan (i.e., AS6500) including:
7891		 Quality processes including continuous improvement efforts
7892		• Quality surveillance and quality data collection and analyses (including supply chain data
7893		for items and components)
7894		• All quality instructions, sequencing, in-process tests, and procedures (including those in
7895		work instructions)
7896		• Process capabilities (C _{pk} s) and process control plans
7897		• Quality scheduling and control
7898		• Quality model and simulations
7899		• Quality workforce capabilities
7900		 Implementations of quality technologies
7901		• Tooling, work holding fixtures, jigs, etc. for inspection and test
7902		• Test equipment and test facilities (including Special Test Equipment/Special Inspection
7903		Equipment validation in accordance with plans)
7904		• Quality processes for transportation, storage, and handling equipment
7905		• Safety of quality processes and procedures
7906		 Quality of ESOH processes and procedures
7907		• Quality of security processes, procedures, capabilities, and compliance
7908		 Mitigation results of quality and adequacy of risks and issues resolutions
7909		• Quality costs (and impacts to schedule and performance)
7910		 Quality of materials' sources and selections
7911		• Quality of embedded software (integration)
7912	٠	Based on quality analyses of program progress and assessments of maturity, affordability and
7913		costs, availability and capability, risks, issues, and opportunities, develop recommendations
7914		for sourcing and options for LRIP including:
7915		 Emerging technology advancements in materials and processes
7916		• Changes in Government statute, policy, and regulations
7917		• Changes in business climate conditions (e.g., mergers and acquisitions, failures, etc.)
7918		• Changes in environmental impacts (e.g., natural disasters, etc.)
7919		 Diminishing Manufacturing Sources and Material Shortages
7920	٠	Ensure contractor's quality plans, policies, and procedures are consistent with program plans
7921		for program Plans for Product Improvement for LRIP.
7922	•	Based on pilot line operations, demonstrations, and simulations, update all quality risks,
7923		issues, and mitigation plans for LRIP.
7924	•	Ensure mitigations of current risks and issues are on track and/or do not introduce new risks
7925		and issues to the program for LRIP.

4. Engineering and Manufacturing Development (EMD) Phase

Based on the results of the Pilot Line build, finalize the Technical Data Package (TDP)
 including applicable technical data such as models, drawings, associated lists, specifications,
 standards, performance requirements, quality assurance provisions, software documentation
 and packaging details.

7930 Metrics

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- Pilot line quality processes have been analyzed and the results document verification and
 validation of LRIP quality processes capability. Quality Strategy and Plan has been updated
 accordingly including:
- 7934
 o
 Rate of quality processes
- 7935oQuality data7936oProcess yields
- 7937 o Process changes
- 7938 o Cost of quality
- 7939 Requirements for additional equipment
- 7940 Requirements for continuous process improvement
- Assessments of process control plans, including all plans for process control of key and critical processes, for adequacy and completeness have been conducted and results utilized to recommend updates to LRIP plans, process capability indices (C_{pks}), SPC processes, FRACAS processes, and other metrics, etc.
- LRIP Quality Strategy and Plan have been updated:
- 7946 o Based on all build-to documentation from the pilot line, to include all KCs and their
 7947 control plans for LRIP:
- 7948Process capability updates
 - Process stability estimates (if data insufficient)
- 7950 o Based on validated data collected for the Variability Reduction program
 - Data depicts progress to metrics
 - Updates include process improvements
- 7953 To include results of all FAIs and FATs
 - Plans in place to correct findings
- Based on contractor's manufacturing and quality system verification and validation efforts,
 including pilot line and demonstrations, and direct and indirect infrastructure, the updated
 LRIP Quality Strategy and Plan documents and includes:
- 7958 o Letters of Delegation for DCMA support at the appropriate levels of the supply chain
 7959 o Requirements for acceptance and qualification testing
 7960 o Quality surveillance and quality data collection and analyses (including surply chain data)
- 7960oQuality surveillance and quality data collection and analyses (including supply chain data7961for items and components)

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4. Engineering and Manufacturing Development (EMD) Phase

7962 7963		• Quality processes including CPI with continuous quality data collection and periodic
7964		 Mitigation results of quality and adequacy of risks and issues resolutions
7965		 Up-to-date supplier risk and issue mitigation plans and actions
7966		• Periodic supplier process control verification and validation
7967		 Periodic assessment of Variability Reduction processes
7968		• Implementation of Six Sigma, lean manufacturing processes, etc.
7969		• All quality instructions, sequencing, in-process tests, and procedures (including those in
7970		work instructions)
7971		• Process capabilities (C _{pk} s) and process control plans
7972		• Quality scheduling and control
7973		• Quality model and simulations
7974		• Quality workforce capabilities
7975		• Implementations of quality technologies
7976		• Tooling, work holding fixtures, jigs, etc. for inspection and test
7977		• Test equipment and test facilities (including Special Test Equipment/Special Inspection
7978		Equipment validation in accordance with plans)
7979		• Quality processes for transportation, storage, and handling equipment
7980		• Safety of quality processes and procedures
7981		• Quality of ESOH processes and procedures
7982		• Quality of security processes, procedures, capabilities, and compliance
7983		• Quality costs (and impacts to schedule and performance)
7984		• Quality of materials' sources and selections
7985		• Quality of embedded software (integration)
7986	٠	Recommendations for sourcing and options for LRIP have been developed and documented
7987		based on quality analyses of program progress and assessments of maturity, affordability and
7988		costs, availability and capability, risks, issues, and opportunities, including:
7989		• Emerging technology advancements in materials and processes
7990		• Changes in Government statute, policy, and regulations
7991		• Changes in business climate conditions (e.g., mergers and acquisitions, failures, etc.)
7992		• Changes in environmental impacts (e.g., natural disasters, etc.)
7993		 Diminishing Manufacturing Sources and Material Shortages
7994	•	Contractor's quality plans, policies, and procedures have been assessed and recommendations
7995		and changes have been documented to maintain consistency with program $P^{3}I$ plans for
7996		LRIP.
7997	•	All updated quality risks, issues, and mitigation plans have been documented and provided
7998		for the joint program/Contractor Risk, Issue, and Opportunity Management System for LRIP.
7999		• Mitigations of current risks and issues are assessed to be on track and do not introduce
8000		new risks and issues to the program for LRIP

4. Engineering and Manufacturing Development (EMD) Phase

8001 8002 8003 8004	•	Based on the results of the pilot line and demonstrations, final quality input to the TDP has been provided, including applicable technical data such as models, drawings, associated lists, specifications, standards, performance requirements, quality assurance provisions, software documentation and packaging details.
8005	Tools	
8006	•	Acquisition Strategy Template
8007	•	ISO 9001 QMS Audit Checklist
8008	•	AS9100 Audit Checklist
8009	٠	Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread
8010	Resou	rces
8011	•	AS6500, Manufacturing Management Program, Nov 2014
8012	•	MIL-HDBK-896A
8013	•	DSMC Acquisition Strategy Guide, Dec 1999
8014	•	AFMC Instruction 63-145 Manufacturing and Quality (Draft)
8015	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
8016		Sep 2016
8017	•	ISO 9001:2015, Quality Management System
8018	•	FAR 52.246-11, Quality
8019	•	MRL Deskbook Version 2016
8020	•	DAG Chapter 14.3.1.3.6 Quality Plans

8021 J. MANUFACTURING WORKFORCE

Workforce skills identification and plans provide inputs to program planning. Workforce planning
should align the skills required to the scope of the effort required to develop, field, and sustain the
system. To determine the scope of the manufacturing and quality workforce plans necessary for the
system during EMD, the following considerations should be analyzed and understood, including the
Work Breakdown Structure (WBS), the contractor's make/buy plans and manufacturing and quality
plans, processes, and procedures, the risks, issues, and opportunities and associated plans, the
IMP/IMS, and other supporting resources.





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- 8030 A comprehensive assessment of contractor manufacturing plans for system development is necessary
- to understand the requirements for workforce skills, capabilities, training, and certifications. In
4. Engineering and Manufacturing Development (EMD) Phase

- support of pilot line workforce requirements, contractor plans should be assessed for human resource
- 8033 policies, processes, and procedures, forecasts for the number of workers, skills and capabilities, etc.
- Additionally, the current training, certifications, and education, sourcing availability and stability,
- 8035 demographics of the contractor and supply chain should be evaluated for adequacy, as well as their
- capability and capacity to expand the workforce, through hiring, training, and certification, for pilotline and LRIP.
- Based on contractor execution of the pilot line and the manufacturing and quality workforce results,
 update the program workforce plans contained in the Manufacturing and Quality Strategies for
 required skills, capabilities, training, and certifications for LRIP in the P&D phase.
- 8041 J.1 Assess Workforce for Pilot Line

8042 Manufacturing and Quality Tasks

- Assess the contractor's Manufacturing and Quality Plans for manufacturing, quality, and
 supporting pilot line workforce requirements for adequacy and capacity to meet program
 requirements and schedule including:
- 8046oHuman resource policies, processes, and procedures to include forecasting and
scheduling
- 8048 o Number of workers by category by schedule
- 0 Skillsets and capabilities by category by schedule
- 8050 Current level and forecasting for training, certifications, and education
- 8051 Capacity and capability to train, certify, etc.
- 8052 o Labor regulations, relations, union agreements, etc.
- 8053 Labor Sourcing internal and external
- 8054oLabor availability and stability (e.g., local unemployment, competition for skills,
turnover, etc.)
- 0 Demographics (e.g., citizenship, retirement eligibility, etc.)
- 8057 o Security
- Assess contractor's facility and personnel statistics (e.g., turnover, accidents, ESOH violations, etc.) and Manufacturing and Quality Plans for manufacturing and quality workforce risks, issues, and opportunities.

8061 Metrics

- Contractor's Manufacturing and Quality Plans has been assessed and documents the
 adequacy and capacity of manufacturing, quality, and supporting pilot line workforce to meet
 program requirements and schedule, and/or recommended changes, including:
- 8065oHuman resource policies, processes, and procedures to include forecasting and8066scheduling
- 8067 Number of workers by category by schedule

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8068		• Skillsets and capabilities by category by schedule
8069		• Current level and forecasting for training, certifications, and education
8070		• Capacity and capability to train, certify, etc.
8071		• Labor regulations, relations, union agreements, etc.
8072		• Labor Sourcing – internal and external
8073		• Labor availability and stability (e.g., local unemployment, competition for skills,
8074		turnover, etc.)
8075		• Demographics (e.g., citizenship, retirement eligibility, etc.)
8076		o Security
8077	•	Contractor's facility and personnel statistics and Manufacturing and Quality Plans have been
8078		assessed for manufacturing and quality workforce risks, issues, and opportunities with results
8079		and recommendations documented for the joint Risk, Issue, and Opportunity Management
8080		Plan.
8081	Tools	
8082	•	Assembly Chart Analysis
8083	•	Bottleneck Analysis (Theory of Constraints)
8084	٠	Capacity Planning Worksheet
8085	•	Critical Chain Project Management
8086	٠	Forecasting and Regression Analysis
8087	•	Learning Curve Estimator
8088	•	Line of Balance Template
8089	٠	Manufacturing Resource Planning (MRPII)
8090	•	MRL assessment using Manufacturing Management thread
8091	•	Route Sheet Analysis
8092	•	Shop Floor Manufacturing Plan Analysis
8093	•	SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
8094	•	Work Measurement Analysis
8095	•	Workforce Planning Tools (SAP/Oracle/MRPII)
8096	Resou	rces
8097	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
8098	•	AS6500, Manufacturing Management Systems
8099	•	AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations,
8100		Sep 2016
8101	•	ISO 9001:2015, Quality Management System
8102	•	Manufacturing Resource Planning (MRP II)

4. Engineering and Manufacturing Development (EMD) Phase

8103 J.2 Assess Workforce for LRIP

8104 Manufacturing and Quality Tasks

- Based on pilot line results, assess the updated contractor's Manufacturing and Quality Plans for manufacturing, quality, and supporting LRIP and FRP workforce scale-up requirements for adequacy and capacity to meet program requirements and schedule including updates to the following:
- 8109
 Human resource policies, processes, and procedures to include forecasting and scheduling
 8111
 Number of workers by category by schedule
 8112
 Skillsets and capabilities by category by schedule
 8113
 Current level and forecasting for training, certifications, and education
 8114
 Capacity and capability to train, certify, etc.
- 8115 o Labor regulations, relations, union agreements, etc.
- 8116 o Sourcing internal and external
- 8117 o Labor availability and stability (e.g., local unemployment, competition for skills,
 8118 turnover, etc.)
- 0 Demographics (e.g., citizenship, retirement eligibility, etc.)
- 8120 o Security
- Update contractor's facility and personnel statistics (e.g., turnover, accidents, ESOH violations, etc.) for manufacturing and quality workforce risks, issues, and opportunities.

8123 Metrics

- Based on pilot line results, the updated contractor's Manufacturing and Quality Plans for
 manufacturing, quality, and supporting LRIP and FRP scaled-up workforce has been assessed
 and documents the adequacy and capacity to meet program requirements and schedule,
 and/or recommended updates to the following:
- 8128oHuman resource policies, processes, and procedures to include forecasting and
scheduling
- 8130oNumber of workers by category by schedule
- 8131 o Skillsets and capabilities by category by schedule
- 8132 Current level and forecasting for training, certifications, and education
- 8133 Capacity and capability to train, certify, etc.
- 8134 o Labor regulations, relations, union agreements, etc.
- 8135 o Sourcing internal and external
- 8136 o Labor availability and stability (e.g., local unemployment, competition for skills, turnover, etc.)
- 8138 O Demographics (e.g., citizenship, retirement eligibility, etc.)
- o Security

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4. Engineering and Manufacturing Development (EMD) Phase

Contractor's updated facility and personnel statistics and Manufacturing and Quality Plans
 have been assessed for manufacturing and quality workforce risks, issues, and opportunities
 with results and recommendations documented for the joint Risk, Issue, and Opportunity
 Management Plan.

8144 **Tools**

8145	Assembly Chart Analysis
8146	Bottleneck Analysis (Theory of Constraints)
8147	Capacity Planning Worksheet
8148	Critical Chain Project Management
8149	Forecasting and Regression Analysis
8150	Learning Curve Estimator
8151	Line of Balance Template
8152	Manufacturing Resource Planning (MRPII)
8153	MRL assessment using Manufacturing Management thread
8154	Route Sheet Analysis
8155	Shop Floor Manufacturing Plan Analysis
8156	• SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
8157	Work Measurement Analysis
8158	Workforce Planning Tools (SAP/Oracle/MRPII)
8159	Resources
8160	• MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
8161	AS6500, Manufacturing Management Systems
8162	• AS9100 Quality Systems – Requirements For Aviation, Space, And Defense Organizations
8163	Sep 2016
8164	ISO 9001:2015, Quality Management System
8165	Manufacturing Resource Planning (MRP II)
8166	MRL Deskbook Version 2016

8167 K. FACILITIES

8168 Based upon the results of PDR and program progress during early EMD, manufacturing and quality

- 8169 personnel should assess the contractor and supply chain facility and tooling plans developed for the
- 8170 pilot line and LRIP. This should include pre-CDR assessments of proposed production (e.g., pilot
- 8171 line, LRIP, FRP, etc.) facilities, and an update to the Manufacturing and Quality Strategies and Plans
- 8172 for EMD and future phases.

4. Engineering and Manufacturing Development (EMD) Phase

MS B CDD	AS Updates	SEP TEMP Updates Updates	CDR TRR Pilot	SVR/FCA PRR CPD
K. Facilities	K.1 Assess Facilities	K.2 Assess Tooling, Test, &	· · ·	K.3 Assess Facilities, Tooling, and Test Equipment for LRIP

8173

8174 Based on the system design and results of assessments of existing assets, new facilities, tools, and 8175 equipment may be required to meet rates and schedules. Additionally, depending on final CDR

8176 design, new materials, new technologies, new processes, and new tooling and equipment may be

8177 required. The program and the contractor(s) need to address the assessment results, current and

8178 known future facility workload (i.e., other programs), and any new requirements, and plan

8179 accordingly for the capability and capacity to develop, produce, maintain, and support the program

8180 throughout the supply chain.

8181 The assessments conducted for EMD should include subcontractors and key suppliers identified in

the contractor's Manufacturing Management Plan, which should include tooling and facilities plans

8183 with utilization, and any relocation/consolidation considerations, schedules, and requirements for

8184 manufacturing maturity. These assessments should be conducted on-site and can be included as part

8185 of the MRL assessment. These should include all "special test equipment" and "special tooling" as

8186 defined in FAR 2.101 in assessments conducted.

8187 The results of these assessments should identify and document risks, issues, and opportunities arising

8188 from facility and tooling shortfalls and document the required planning for mitigation. Prior to CDR

8189 and pilot line, the program Tooling Plan for facilities, tooling, equipment, and test equipment (part of

8190 the Manufacturing and Quality Strategies and Plans) should be finalized along with the associated

risk and issue mitigation actions. Final validation of manufacturing and quality plans must be

8192 accomplished prior to CDR, prior to execution of a pilot line.

8193 Facilities, tooling, equipment, and test equipment requirements, resource requirements, and schedules

should be re-assessed based on results of pilot line demonstrations and assessments for LRIP and

8195 FRP. Using the actual data collected from pilot line assess equipment capability, capacity, and

availability for scale-up. Additionally, assess manufacturing and quality operations and

8197 environmental requirements, floor space utilization and expansion requirements, facility data

- 8198 requirements, and equipment maintenance requirements for LRIP and FRP. Focused attention on
- 8199 facilities, tooling, equipment, and test equipment in EMD will decrease risk and can be a major factor
- 8200 in avoiding or preventing cost overruns and schedule delays for LRIP and FRP.

4. Engineering and Manufacturing Development (EMD) Phase

8201 K.1 Assess Facilities

8202 Manufacturing and Quality Tasks

- Identify facility and resource requirements by phase and schedule (e.g., pilot line, LRIP, and FRP) to include the following:
- 8205 o Current facility availability, capacity (including surge), capitalization plan, and expansion
 8206 potential
- 8207 o Equipment capability, capacity, and availability (machines, processes, storage, etc.) and 8208 scale-up
- 8209 o Floor space requirements (including feeding, storage, transportation, re-work, work-in 8210 process, etc.) and expansion
- Manufacturing facility data requirements (e.g., infrastructure, handling, communications, processing, storage, security, etc.)
- 8213 Maintenance requirements (facilities and spares)
- Assess contractor's Manufacturing, Quality, and supply chain Plans for proposed facilities
 and required resources for pilot line and plan for LRIP to include:
- 8216 Current and future facility availability and capacity
- 8217 Equipment capability, capacity, and availability (machines, processes, storage, etc.)
- 8218oFloor space requirements (including feeding, storage, transportation, re-work, work-in-8219process, etc.) and planned expansion
- 8220 Maintenance requirements (facilities and spares)

8221 Metrics

- Facility requirements have been assessed by phase and schedule (e.g., pilot line, LRIP, and FRP) and documents the following for CDR:
- 8224oCurrent facility availability, capacity (including surge), capitalization plan, and expansion8225potential
- 8226oEquipment capability, capacity, and availability (machines, processes, storage, etc.) and8227scale-up
- 8228oFloor space requirements (including feeding, storage, transportation, re-work, work-in-8229process, etc.) and expansion
- Manufacturing facility data capability and capacity (e.g., infrastructure, handling, communications, processing, storage, security, etc.)
- 8232 Maintenance requirements (facilities and spares)
- Contractor's Manufacturing, Quality, and supply chain Plans for proposed facilities and
 resources for pilot line and LRIP have been assessed and the results and recommendations
 documented for CDR including:
- 8236 Current and future facility availability and capacity
- 8237 Equipment capability, capacity, and availability (machines, processes, storage, etc.)

Manufacturing and Quality Management Body of Knowledge

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4. Engineering and Manufacturing Development (EMD) Phase

8238 8239 8240		 Current floor space (including feeding, storage, transportation, re-work, work-in-process, etc.) and required expansion Maintenance requirements (facilities and spares)
8241	Tools	
8242 8243 8244	•	Manufacturing Readiness Level (MRL) Assessment Questionnaire, Facilities thread DCMA Production Planning and Control Risk Assessment Checklist DCMA Manufacturing Systems Risk Assessment (MSRA) Checklist
0245	Deere	
8245	Resou	rces
8246	٠	DoDI 5000.02
8247	•	AS6500, Manufacturing Management Systems
8248	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
8249	•	DCMA-INST-204 Manufacturing and Production Pisk Issue and Opportunity Management Guide
8251	•	MRL Deskbook Version 2016
8252	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
8253		Reporting
8254	К.2	Assess Tooling, Test, and Inspection Equipment
8255	Manut	facturing and Quality Tasks
8255 8256 8257	Manut •	facturing and Quality Tasks Develop manufacturing and quality equipment, tooling, test and inspection equipment maintenance strategy:
8255 8256 8257 8258 8259	Manut •	 facturing and Quality Tasks Develop manufacturing and quality equipment, tooling, test and inspection equipment maintenance strategy: Include processes and procedures in accordance with industry best practices (i.e., AS9100)
8255 8256 8257 8258 8259 8260 8261	Manut •	 facturing and Quality Tasks Develop manufacturing and quality equipment, tooling, test and inspection equipment maintenance strategy: Include processes and procedures in accordance with industry best practices (i.e., AS9100) Include objectives and requirements for tooling, testing, funding, resources, and scheduling
8255 8256 8257 8258 8259 8260 8261 8262	Manut •	 facturing and Quality Tasks Develop manufacturing and quality equipment, tooling, test and inspection equipment maintenance strategy: Include processes and procedures in accordance with industry best practices (i.e., AS9100) Include objectives and requirements for tooling, testing, funding, resources, and scheduling Update the TMRR Tooling Plan for:
8255 8256 8257 8258 8259 8260 8261 8262 8263 8263 8264	Manut •	 facturing and Quality Tasks Develop manufacturing and quality equipment, tooling, test and inspection equipment maintenance strategy: Include processes and procedures in accordance with industry best practices (i.e., AS9100) Include objectives and requirements for tooling, testing, funding, resources, and scheduling Update the TMRR Tooling Plan for: Tooling and Special Test Equipment/Special Inspections Equipment requirements for development (i.e., pilot line ramp up to LRIP, ramp up to FRP)
8255 8256 8257 8258 8259 8260 8261 8262 8263 8264 8265 8266 8267 8266 8267 8268 8269 8270 8271	Manuf •	 facturing and Quality Tasks Develop manufacturing and quality equipment, tooling, test and inspection equipment maintenance strategy: Include processes and procedures in accordance with industry best practices (i.e., AS9100) Include objectives and requirements for tooling, testing, funding, resources, and scheduling Update the TMRR Tooling Plan for: Tooling and Special Test Equipment/Special Inspections Equipment requirements for development (i.e., pilot line ramp up to LRIP, ramp up to FRP) Limited quantity or soft tooling Necessary only for development (pilot) Necessary for Operations and Sustainment support Available government assets (GFE)

4. Engineering and Manufacturing Development (EMD) Phase

8273 8274 8275 8276 8277 8278 8279	 Jigs, dies, fixtures, molds, patterns, taps, gauges, and all components of these items (including foundations and similar improvements) Requirements for identification, calibration, frequency, and traceability to international or national measurement standards Requirements for collection, monitoring, and maintenance of data and a register for validation purposes Requirements for safeguarding from adjustments, damage, or deterioration
8280 8281 8282 8283 8284 8285	 Use and application of single or multipurpose integrated specialized test equipment (STE/SIE) (e.g., engineered, designed, fabricated, or modified to accomplish special purpose testing for the program including items, assemblies of equipment including interconnected or interdependent, foundations and similar improvements, etc.) Use and application of GFE, COTS, etc. Tooling and STE/SIE test and validation plans (including demonstrations)
8286 • 8287 8288 • 8289	Ensure that production tooling and test equipment design and development efforts are underway. Perform a manufacturing and quality assessment of the contractor's and supply chain tooling, test, and inspection equipment resources provided for:
8290 8291	 Suitability for the specific type of monitoring and measurement activities required Maintenance and accountability to required standards with appropriate documentation
8292 • 8293 8294	Assess contractor and supply chain demonstrations of tooling and STE/SIE for subsystems, item, and components in the appropriate production environment (e.g., representative, pilot line, production line) for functionality, sufficiency, and capacity.
8295 Metri	ics
8296 • 8297	Manufacturing and quality has developed an equipment, tooling, test and inspection equipment maintenance strategy to be implemented in the Tooling Plan for CDR, to include:
8298 8299 8300 8301	 Processes, procedures, and demonstrations that implement industry best practices (i.e., AS9100) Policy, objectives, goals, and desired outcomes for tooling, testing, funding, resourcing, and scheduling
8302 • 8303	The TMRR Tooling Plan has been updated for CDR and documented in the Manufacturing and Quality Plans to include:
8304 8305 8306	 Detailed requirements for tooling and STE/SIE for pilot line ramp up to LRIP and LRIP ramp to FRP (e.g., soft, hard, development, production, O&S, GFE, etc.) Detailed requirements for:
8307 8308 8309 8310	 Jigs, dies, fixtures, molds, patterns, taps, gauges, and all components of these items (including foundations and similar improvements) Identification, calibration, frequency, and traceability to international or national measurement standards

8311 8312 8313 8314 8315 8316		 Collection, monitoring, and maintenance of data and a register for validation purposes Safeguarding from adjustments, damage, or deterioration single or multipurpose integrated STE/SIE Use and application of COTS, etc. Test and validation plans (including demonstrations)
8317	•	Production tooling and test equipment design and development efforts have been approved
8319 8320	•	Contractor's and supply chain tooling, test, and inspection equipment resources have been assessed for adequacy and completeness and results document for CDR:
8321 8322 8323		 Suitability for the specific type of monitoring and measurement activities required Maintenance and accountability to required standards with appropriate documentation maintained as evidence of fitness for purpose
8324 8325 8326 8327	•	Contractor and supply chain demonstrations of tooling and STE/SIE for subsystems, item, and components in the appropriate production environment (e.g., representative, pilot line, production line) have been assessed for functionality, sufficiency, and capacity and document completion of validation plans.
8328	Tools	
8329	٠	DCMA Production Planning and Control Risk Assessment Checklist
8330	•	DCMA Manufacturing Systems Risk Assessment (MSRA) Checklist
8331	•	Rough Cut Capacity Planning Spreadsheet
8332	•	Material Requirements Planning
8333	•	Capacity Requirements Planning Assessment Worksheet
8334	•	Bottleneck Analysis (Theory of Constraints)
8335	•	Critical Chain Project Management
8336	•	Manufacturing Resource Planning (MRPII)
8337	•	Manufacturing Readiness Level (MRL) Assessment Questionnaire, Facilities thread
8338	•	Plant Design and Facility Layout Software Evaluation Tools
8339	Resou	rces
8340	٠	AS9100
8341	٠	ISO 9000
8342	٠	FAR Part 2, §2.101 Definitions
8343	٠	AS6500, Manufacturing Management Program, Nov 2014
8344	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
8345	•	Manufacturing Resource Planning (MRP II)
8346	٠	DCMA-INST-204 Manufacturing and Production
8347	•	MRL Deskbook Version 2016

8348 K.3 Assess Facilities, Tooling, and Test Equipment for LRIP

8349 Manufacturing and Quality Tasks

8350 • 8351	Based on pilot line demonstrations and assessments, assess facilities, facilities resource requirements, and facilities schedules for LRIP and FRP to include the following:
8352 8353 8354 8355 8356 8357 8358 8359 8360 8361 8362	 Current facilities availability, capacity (including surge), and expansion requirements Facilities capitalization plan Equipment capability, capacity, and availability (machines, processes, storage, etc.) and scale-up Manufacturing operations and environmental requirements (e.g., noise, lighting, vibrations, temperature, humidity, cleanliness, dust, foreign object detection (FOD), etc.) Floor space utilization (including processes and requirements for feeding, storage, transportation, re-work, work-in-process, etc.) and expansion requirements Manufacturing facility data requirements (e.g., infrastructure, handling, communications, processing, storage, security, etc.) Manufacturing equipment maintenance requirements (facilities, spares, and frequency)
8363 • 8364	Assess contractor's Manufacturing, Quality, and supply chain Plans for proposed facilities and required facilities resources for LRIP and FRP to include:
8365 8366 8367 8368 8369 8370 8371 8372 8373	 Current and future facility availability and capacity Equipment capability, capacity, and availability (machines, processes, storage, etc.) and requirements for additional resources Environmental and manufacturing operations (regulatory and program) requirements (e.g., noise levels, lighting levels, vibration and isolation, temperature and humidity control, cleanliness requirements, FOD and preventions requirements, etc.) Floor space utilization (including processes and requirements for feeding, storage, transportation, re-work, work-in-process, etc.) and expansion requirements Maintenance requirements (facilities and spares)
8374 • 8375 8376 • 8377	Support assessments of manufacturing work place safety for compliance with applicable statutes, regulations, and policies. Assess results of manufacturing and quality equipment, tooling, test and inspection equipment maintenance strategy demonstration and adequacy on the pilot line for:
8378 8379 8380	 Processes and procedures implementation according to industry best practices (i.e., AS9100) Tooling, testing, resources, and scheduling meeting requirements
8381 • 8382 8383 • 8384	In accordance with validation plans, validate tooling and STE/SIE based pilot line demonstrations and results. Based on pilot line demonstrations and results, update the program Tooling Plan for LRIP to include:

8385 8386		• Tooling and STE/SIE requirements for ramp up to LRIP and FRP (e.g., soft, hard, development production O S GEE etc.)
8387		• Updated detailed requirements for:
8388		 Jigs, dies, fixtures, molds, patterns, taps, gauges, and all components of these items (including foundations and similar improvements)
8300		(including foundations and similar improvements)
8391		measurement standards
8392		 Collection, monitoring, and maintenance of data and a register for validation
8393		purposes
8394		 Safeguarding from adjustments, damage, or deterioration (physical security)
8395		 Digital safeguarding from tampering (cyber security)(i.e., Additive Manufacturing
8396		software and firmware)
8397		 Tooling and STE/SIE test, validation maintenance, and re-validation plans
8398 8399		 Use and application of single or multipurpose integrated STE/SIE Use and application of GFE, COTS, etc.
8400 8401	•	Ensure that LRIP tooling, inspection, and test equipment efforts are complete, and FRP tooling and test equipment efforts are underway.
8402	•	Based on pilot line demonstrations and results, update the manufacturing and quality
8403		assessment of the contractor's and supply chain tooling, test, and inspection equipment LRIP
8404		resources for:
8405 8406		 Suitability for the specific type of monitoring and measurement activities required Maintenance and accountability to required standards with appropriate documentation
8407 8408 8409 8410	•	Based on pilot line demonstrations and results, update the assessment of contractor and supply chain tooling and STE/SIE for subsystems, item, and components in the appropriate production environment (e.g., production line for LRIP or FRP) for functionality, sufficiency, and capacity.
8411	Metric	S
8412 8413 8414 8415	•	Facilities, facilities resource requirements, and facilities schedules have been assessed with recommended changes and updates implemented. Based on pilot line demonstrations and implementation of changes, manufacturing facilities have been assessed as adequate for LRIP with plans are in place for transition to FRP including:
8416		• Current facilities availability and capacity (including surge) with expansion requirements
8417		• Facilities capitalization plan
8418		• Equipment capability, capacity, and availability (machines, processes, storage, etc.) with
8419		scale-up
8420		• Manufacturing operations and environmental conditions (e.g., power, noise, lighting,
8421		vibrations, temperature, humidity, cleanliness, FOD, dust, etc.)
8422		• Floor space utilization (including processes and requirements for feeding, storage,
8423		transportation, re-work, work-in-process, etc.) with expansion requirements

8424 8425 8426	 Manufacturing facility data capability and capacity (e.g., infrastructure, handling, communications, processing, storage, security, etc.) Manufacturing equipment maintenance (facilities, spares, and frequency)
8427 • 8428 8429	Contractor's Manufacturing, Quality, and supply chain Plans for proposed facilities and required facilities resources have been assessed for adequacy and completeness for LRIP and FRP and recommended changes and updates have been documented for:
8430 8431 8432 8433 8434 8435 8435 8436 8437 8438	 LRIP and future FRP facility availability and capacity Equipment capability, capacity, and availability (machines, processes, storage, etc.) and requirements for additional and/or future resources Environmental and manufacturing operations (regulatory and program) requirements (e.g., noise levels, lighting levels, vibration and isolation, temperature and humidity control, cleanliness requirements, FOD and preventions requirements, etc.) Floor space utilization (including processes and requirements feeding, storage, transportation, re-work, work-in-process, etc.) and expansion requirements Maintenance requirements (facilities and spares)
 8439 8440 8441 8442 8443 8444 	 Work place safety has been assessed, with manufacturing and quality support, for compliance with applicable statutes, regulations, and policies and required changes have been documented and implemented. Equipment, tooling, test and inspection equipment maintenance strategy has been demonstrated on the pilot line and results assessed as adequate and/or recommendations and changes documented in the Manufacturing and Quality Plans for:
8445 8446 8447	 Implementation of processes and procedures according to industry best practices (i.e., AS9100) Meeting requirements for tooling, testing, resources, and scheduling
8448 • 8449 • 8450 • 8451 • 8452 •	Based pilot line demonstrations and results, tooling and STE/SIE has been validated In accordance with validation plans and results and/or recommended changes have been documented in the Quality Plan and implemented. Based on pilot line demonstrations and results, the program Tooling Plan for LRIP has been assessed and updated for necessary changes including:
8453 8454 8455	 Tooling and STE/SIE requirements for ramp up to LRIP and FRP (e.g., soft, hard, development, production, O&S, GFE, etc.) Updated detailed requirements for:
8456 8457 8458 8459 8460 8461 8462	 Jigs, dies, fixtures, molds, patterns, taps, gauges, and all components of these items (including foundations and similar improvements) Identification, calibration, frequency, and traceability to international or national measurement standards Collection, monitoring, and maintenance of data and a register for validation purposes Safeguarding from adjustments, damage, or deterioration (physical security)

8463 8464 8465		 Digital safeguarding from tampering (cyber security)(i.e., Additive Manufacturing software and firmware) Tooling and STE/SIE test, validation maintenance, and re-validation plans
8466 8467 8468 8469 8470		 Use and application of single or multipurpose integrated STE/SIE (e.g., engineered, designed, fabricated, or modified to accomplish special purpose testing for the program including items, assemblies of equipment including inter-connected or interdependent, foundations and similar improvements, etc.) Use and application of GFE, COTS, etc.
8471 8472	•	LRIP tooling, inspection, and test equipment efforts, proven on a pilot line, have been assessed, are complete and/or additional requirement identified for LRIP
8473 8474		• FRP tooling and test equipment efforts are underway, and documented up-to-date in the Tooling Plan, the IMP/IMS, and the TEMP.
8475 8476 8477	•	Based on pilot line demonstrations and results, contractor's and supply chain tooling, test, and inspection equipment LRIP resources have been assessed and recommended changes and updates have been documented for:
8478 8479 8480 8481		 Capability to perform the specific type of monitoring and measurement activities required by the program Meeting required standards for maintenance and accountability with appropriate documentation
8482 8483 8484 8485	٠	The assessment of contractor and supply chain tooling and STE/SIE has been updated for all subsystems, items, and components with results of demonstrations for functionality, sufficiency, and capacity in the appropriate production environments. Recommendations for changes and additional updates have been documented.
8486 8487		 Incomplete or insufficient demonstrations of capability are documented for independent assessment according to statute
8488	Tools	
8489	٠	DCMA Production Planning and Control Risk Assessment Checklist
8490	•	DCMA Manufacturing Systems Risk Assessment (MSRA) Checklist
8491	٠	Rough Cut Capacity Planning Spreadsheet
8492	•	Material Requirements Planning
8493	•	Capacity Requirements Planning Assessment Worksheet
8494	•	Bottleneck Analysis (Theory of Constraints)
8495	٠	Critical Chain Project Management
8496	٠	Manufacturing Resource Planning (MRPII)
8497	٠	Manufacturing Readiness Level (MRL) Assessment Questionnaire, Facilities thread
8498	•	Plant Design and Facility Layout Software Evaluation Tools

4. Engineering and Manufacturing Development (EMD) Phase

8499	Resources
8500	• FAR Part 2, §2.101 Definitions
8501	 AS6500, Manufacturing Management Program, Nov 2014
8502	• MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
8503	Manufacturing Resource Planning (MRP II)
8504	DCMA-INST-204 Manufacturing and Production
8505	• AS9100 QUALITY SYSTEMS – REQUIREMENTS FOR AVIATION, SPACE, AND
8506	DEFENSE ORGANIZATIONS, SEP 2016
8507	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
8508	Reporting
8509	MRL Deskbook Version 2016
8510	• Public Law 114-328

8511 L. MANUFACTURING MANAGEMENT/CONTROL

The Manufacturing Strategy and Plan are major aspects of development, test, initial production, and other activities essential for program success. With the potential for a new contractor or contractors responsible for engineering and manufacturing development through completion of pilot line production, updated manufacturing and quality strategies will be required. This begins with an assessment of the contractor(s), and their supply chain(s), manufacturing plans for adequacy and alignment with the program Acquisition Strategy (AS).



8518

8519 Manufacturing is a complex combination of resources consisting of facilities, materials, machines,

8520 manpower, methods, measurement systems, and capital that are utilized in converting or

transforming raw materials and component parts into end products. The contractor must have an

effective combination of people and systems in order to plan for, monitor, and control these

8523 manufacturing resources, as well as a well-structured manufacturing management system. This

requires effective implementation of industry best practices. Assessment of the contractor's

8525 manufacturing management system (and quality management system) should be performed against

the recognized industry best practices (e.g., AS6500, ISO 9000, AS9100, etc.).

8527 Many acquisition programs experience difficulties in smoothly transitioning from development to

- 8528 production and fielding supportable systems. Assessments of the contractor's manufacturing strategy
- 8529 and planning should ensure adequacy and sufficiency of their manufacturing planning and capability

4. Engineering and Manufacturing Development (EMD) Phase

- to perform the final design and manufacturing work scope to achieve production. These should
- 8531 include processes, procedures, and work instructions encompassing the supply chain and supply
- 8532 chain communications, KCs control and management, management, control, and monitoring of
- KPPs, KSAs, CSIs, and CAIs, process control plans, control or avoidance of obsolescent items, highrisk sources, counterfeit parts and materials, etc. Additionally, the government requires
- risk sources, counterfeit parts and materials, etc. Additionally, the government requires
 implementation of cyber threat protection measures and manufacturing control systems which
- 8536 include safeguarding manufacturing and quality information, designed in systems protection, supply
- 8537 chain risks, software assurance, hardware assurance, anti-counterfeit practices, anti-tamper (AT), and
- 8538 security-related activities such as physical security and industrial security. Implementing all of these
- 8539 protections and controls is the basis for maintaining the currency of the program Manufacturing
- 8540 Strategy and Plans.
- 8541 For CDR, initial product baseline documentation for manufacturing, included in the Manufacturing
- 8542 Strategy and Plans, should be sufficient, complete, and adequate to enable manufacture of all
- components and hardware with embedded software throughout the supply chain on a pilot line.

At CDR manufacturing capability and capacity of the contractor and supply chain are assessed for

- 8545 the system design for each subsystem, item, and component in the system's initial product baseline.
- This assessment should include all key and critical manufacturing processes, and their process control plans, for definition, characterization, and currency to the detailed design, and the capability
- to meet requirements. Additionally, the assessments should include contractor plans for meeting
 schedule, rates, yields, long-lead procurement requirements, demonstration requirements, safety and
 security, test, etc. on a pilot line.
- The Government and contractor designated pilot lines should be assessed for production realism and
 affordability in production of the system, subsystem, items, and components. Verification and
 validation of contractor and supply chain manufacturing plans, processes, and procedures should be
 analyzed during the demonstrations. Additionally, process control plans, work instructions, facilities,
 tooling, manufacturing data output, etc. should be included. Based upon these assessments and
- 8556 demonstrations, the Manufacturing Strategy and Plan should be updated, and the Technical Data
- 8557 Package should be finalized for LRIP

8558 L.1 Assess Contractor Manufacturing Management System

- 8559 Manufacturing and Quality Tasks
- Assess the contractor's Manufacturing Management Strategy and Plan for:
- 8561 o Incorporation of industry and government manufacturing and quality best practices (e.g.,
 8562 AS6500, AS9100, ISO 9000, MIL-HDBK-896A, etc.)
- 8563 Compliance with policy directives and regulations
- o The Risk, Issue and Opportunity Management plans

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8565	0	Development and incorporation of enabling manufacturing technologies (e.g., advanced
8566		simulations, additive technologies, etc.)
8567	0	Development and incorporation of system required technologies (and constraints)
8568	0	Requirements and schedules for manufacturing development projects
8569	0	Design feasibility, methodology, and producibility initiatives
8570	0	Planned rates and schedules (includes processes, surges, tooling, make/buy, etc.)
8571	0	Management of key and critical characteristics
8572	0	Configuration management and control
8573	0	Costs and schedule requirements including Integrated Master Plan and Integrated Master
8574		Schedule (IMP/IMS) with critical path
8575	0	Management of materials, including critical and controlled, lead-times, long-lead,
8576		sourcing, risks, and issues
8577	0	Management of the supply chain
8578	0	Development plans and methodologies (e.g., prototypes, competitive, dual source, co-
8579		production, etc.)
8580	0	Processes and process capability control requirements
8581	0	Workforce needs, capabilities, training, certifications, availability, etc.
8582	0	Facilities, Tooling, and Test Equipment (including GFE and assets) requirements
8583	0	Acceptance testing
8584	0	Environmental, security, and safety requirements
8585 •	As	sess and audit (where necessary) the contractor's Manufacturing Management System
8586	(M	MS) capability to perform the final design and manufacturing work scope in accordance
8587	wi	th industry best practices (e.g., AS6500, AS9100, ISO 9000, etc.) and program policies,
8588	ob	jectives, and goals including:
8580		Effective implementation and integration of the OMS processes throughout the MMS and
8500	0	Effective implementation and integration of the QWS processes throughout the WWS and supply chain to include (See I 1):
8390		supply chain to include (See 1.1).
8591		 Organization direction, values, policies, and procedures
8592		 Management commitment, resources, communications, feedback, and accountability
8593	0	Effectiveness of program and contractor communication and interaction processes to
8594		include:
8595		• Cost schedule and performance requirements and timely polification of changes
8596		 Manufacturing data management processes (to include responses status and reports)
8597		for cost schedule and performance actuals)
8598		 Integration of risk issue, and opportunity management processes
8599		 Failures corrective and preventative actions communication processes
8600		 Specification and production of prototypes
0.000		
8601	0	Design analyses for manufacturing to include:
8602		 Producibility and manufacturing feasibility
8603		 Failure mode analyses

8604		• KCs
8605 8606	0	Risk, issue, and opportunity management processes (to include quality, technical, schedule, material, facility, scale-up, financial impacts, and audits if necessary, etc.)
8607	0	Processes, procedures, and work instructions for the following:
8608 8609 8610 8611 8612 8613 8614 8615 8616 8617 8618 8619 8620 8621 8622 8623 8624		 KC control, management, and inclusion in the Technical Data Package (TDP) Management, control, and monitoring of Key Performance Parameters (KPPs), Key System Attributes (KSAs), and KCs, CSIs, and CAIs Process control plans including statistical process controls, rates, yields, and management of process capabilities (C_{pk}s) Make/buy (to include performance and impacts) Control or avoidance of items and components that could become obsolete or are from a diminishing or fragile manufacturing source Control or avoidance of sources that are sole, single, foreign, or vulnerable to interruption, interference, or compromise Prevention and/or detection of counterfeit parts and materials (See AS5553 and AS6174) Continuous process improvement (CPI) Effective metrics management to include monitoring, evaluating, and verifying Conduct of Process Failure Modes Effects Analysis (PFMEA) on critical manufacturing processes Support of the FRACAS and the associated corrective actions (i.e., manufacturing
8625		process changes)
8626 8627	0	Supply chain management system that tracks and reports supplier performance and supplier quality assessment processes
8628 8629 8630	0	A system for manufacturing verification that verifies the proposed production processes, tooling, and test equipment meet program requirements (including Special Tooling and Special Test Equipment)
8631 8632	0	Systematic manufacturing self-assessments and supply chain assessments to measure progress in manufacturing maturation and risk and issue reduction
8633 8634	0	MRL assessments throughout the supply chain and independent assessments as required by statute.
8635	0	Manufacturing management processes including roles and responsibilities for:
8636 8637 8638 8639 8640 8641		 Materials management and control, including availability and lead-times Data storage, management, and security (physical and cyber) Safety, environmental, transportation, storage, etc. COTS items, GOTS items, and NDIs GFE/GFP (e.g., controlled products, test ranges, specialized equipment, radiation test facilities, etc.)
8642 8643	0	Production Process Verifications (PPVs) that verify manufacturing processes, tooling, and equipment are statistically capable of producing required parts and assemblies

4. Engineering and Manufacturing Development (EMD) Phase

8644 8645 8646 8647 8648		 Variability Reduction (VR) plan for incorporation of mature processes and techniques Manufacturing software and firmware management processes and integration (including the program Software Development Plan (SDP), and Software Configuration Management Plan (SCMP) Manufacturing processes for inclusion of in-process and acceptance tests encompassing:
8649 8650 8651 8652 8653		 Prototypes, first articles, hardware, software, and firmware First Article Inspections (FAIs)/First Article Tests (FATs) Test procedures including test equipment Quality plans including control plans and quality improvement plans (included in the TEMP)
8654 8655	•	Assess the contractor's MMS processes for the management, execution, and maintenance of the Integrated Master Plan and Integrated Master Schedule (IMP/IMS).
8656		• Include MMS impacts on critical path, schedule, costs, and outcomes
8657 8658 8659	•	Assess the contractor's MMS for capability to support a Life-Cycle Support Plan (if required) which includes planning for production, developmental and operational test, deployment, and life-cycle sustainment.
8660 8661 8662	•	Verify the contract and the subcontractor management plan includes right of access for both the contractor and the Government to supplier facilities and documentation, where applicable.
8663 8664	•	Request DCMA support and assistance to assess in conducting assessments and audits of contractor and supply chain MMSs.
8665	Metric	S
8666 8667 8668	•	The contractor's Manufacturing Management Strategy and Plan have been assessed and the results document the inclusion of the following for use in updating appropriate program documentation (See L.2):
8669 8670		 Incorporation of industry and government manufacturing and quality best practices (e.g., AS6500, AS9100, ISO 9000, MIL-HDBK-896A, etc.)
8671		 Compliance with policy directives and regulations
8672		• The Risk, Issue and Opportunity Management plans
8674		• Development and incorporation of enabling manufacturing technologies (e.g., advanced simulations, additive technologies, etc.)
8675		• Development and incorporation of system required technologies (and constraints)
8676		 Requirements and schedules for manufacturing development projects
8677		• Design feasibility, methodology, and producibility initiatives
8678		• Planned rates and schedules (includes processes, surges, tooling, make/buy, etc.)
8679		• Management of key and critical characteristics
8680		• Configuration management and control
8681		• Costs and schedule requirements including Integrated Master Plan and Integrated Master
8682		Schedule (IMP/IMS) with critical path

4. Engineering and Manufacturing Development (EMD) Phase

8683	• Management of materials, including critical and controlled, lead-times, long-lead,
8684	sourcing, risks, and issues
8083 9696	• Management of the supply chain • Development plans and methodologies (a.g. metotymes, commetitive, dual course, co
0000 9697	o Development plans and methodologies (e.g., prototypes, competitive, dual source, co-
8087	production, etc.)
8688	• Processes and process capability control requirements
8689	• Workforce needs, capabilities, training, certifications, availability, etc.
8690	• Facilities, Tooling, and Test Equipment (including GFE and assets) requirements
8691	• Acceptance testing
8692	• Environmental, security, and safety requirements
8693 •	Contractor's Manufacturing Management System (MMS) has been assessed for the capability
8694	to perform the final design and manufacturing work in accordance with industry best
8695	practices and program policies, objectives, and goals; the assessment results are documented
8696	in program Manufacturing Strategy, Plans, and other program processes and procedures, and
8697	include the following:
8698 8699	• Documented implementation and integration of the QMS processes throughout the MMS and supply chain to include (See I.1):
8700	 Organization direction, values, policies, and procedures
8701	 Management commitment, resources, communications, feedback, and accountability
8702	• Verified implementation of effective program and contractor communication and
8702	interaction processes to include:
8704	 Cost, schedule, and performance requirements and timely notification of changes
8705	 Manufacturing data management processes (to include responses, status, and reports
8706	for cost, schedule, and performance actuals)
8707	 Integration of risk, issue, and opportunity management processes
8708	 Failures, corrective, and preventative actions, communication processes
8709	 Specification and production of prototypes
8710	• Documented design analyses for manufacturing including analyses for:
8711	 Producibility and manufacturing feasibility
8712	 Failure modes
8713	 KCs and associated manufacturing processes
8714	• Documented risk, issue, and opportunity management and mitigation processes (to
8715	include quality, technical, schedule, material, facility, scale-up, financial impacts, and
8716	audits if necessary, etc.)
8717	• Documented and implemented processes, procedures, and work instructions for:
8718	• KC control management and inclusion in the Technical Data Package (TDP)
8710	 Management control and monitoring of KDPs KSAs and KCs CSIs and CAIs
8720	Process control plans including statistical process controls rates violds and
0720 9701	- i focess control plans including statistical process controls, fates, yields, all management of process comphilities (C + a)
0/21	management of process capadinties (C _{pk} s)

8722	 Make/buy (to include performance and impacts)
8723	 Control or avoidance of items and components that could become obsolete or are
8724	from a diminishing or fragile manufacturing source
8725	• Control or avoidance of sources that are sole, single, foreign, or vulnerable to
8726	interruption, interference, or compromise
8727	 Prevention and/or detection of counterfeit parts and materials (See AS5553 and
8728	AS6174)
8729	 Continuous process improvement (CPI)
8730	 Effective metrics management to include monitoring, evaluating, and verifying
8731	 Conduct of Process Failure Modes Effects Analysis (PFMEA) on critical
8732	manufacturing processes
8733	 Support of the FRACAS and the associated corrective actions (i.e., manufacturing
8734	process changes)
8735	• A functional supply chain management system that tracks and reports supplier
8736	performance and supplier quality assessment processes
8737	• A system for manufacturing verification that is in place and documents proposed
8738	production processes, tooling, and test equipment that meet program requirements
8739	(including Special Tooling and Special Test Equipment)
8740	• Documented systematic process for manufacturing self-assessments and supply chain
8741	assessments to measure progress in manufacturing maturation and risk and issue
8742	reduction
8743	• Documented process for performing MRL assessments throughout the supply chain and
8744	independent assessments as required by statute.
8745	• Documented manufacturing management processes including roles and responsibilities
8746	for:
8747	 Materials management and control, including availability and lead-times
8748	 Data storage, management, and security (physical and cyber)
8749	 Safety, environmental, transportation, storage, etc.
8750	 COTS items, GOTS items, and NDIs
8751	• GFE/GFP (e.g., controlled products, test ranges, specialized equipment, radiation test
8752	facilities, etc.)
8753	• Documented systematic application of PPVs ongoing to verify manufacturing processes,
8754	tooling, and equipment are statistically capable of producing required parts and
8755	assemblies
8756	• Documented VR plan for application of mature processes and techniques
8757	• Documented management processes for manufacturing software and firmware, and
8758	integration (including the program SDP, and SCMP)
8759	• Documented manufacturing processes for in-process and acceptance tests that
8760	encompass:
8761	Prototypes, first articles, hardware, software, and firmware
8762	 FAIs and FATs
0,02	

4. Engineering and Manufacturing Development (EMD) Phase

	Test procedures (including test equipment)Quality plans including control plans and quality improvement plans (in the TEMP)
•	Contractor's MMS processes for the management, execution, and maintenance of the IMP and IMS have assessed and approved.
	• MMS impacts on critical path, schedule, costs, and outcomes have been included
•	Contractor's MMS has been assessed and the results document the capability to support a Life-Cycle Support Plan.
•	access for both the contractor and the Government to supplier facilities and documentation, when necessary.
•	DCMA support and assistance in conducting assessments and audits of contractor and supply chain MMSs has requested through a Letter of Delegation
Tools	
٠	Manufacturing Readiness Level (MRL) Assessment Questionnaire for the Manufacturing
	Management and Control thread
•	Material Management and Accounting System Audit
Resou	rces
٠	AS6500, Manufacturing Management Program, Nov 2014
•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
•	DFAR 242.72 Contractor Material Management and Accounting System
•	MRL Deskbook Version 2016
•	AS5553 Counterfeit Electronic Parts 2013
•	AS6174 Counterfeit Material 2012
•	IEEE 15288, Systems and Software Engineering, 2015
•	Public Law 114-328
L.2	Update Manufacturing Strategy and Plan
Manu	facturing and Quality Tasks
•	Update the manufacturing inputs to the program Manufacturing Strategy and Plan
	(government) for EMD based on the results of assessment of the contractor's Manufacturing Strategy and Plans and to include:
	• Implementation of industry and government manufacturing and quality best practices
	o implementation of industry and government instructuring and quarty best practices
	• Tools • • • • • • • • • • • • • • • • • • •

8798	0	Requirements for the EMD AS and RFP	
8799	0	Government IB risk and issue mitigation plans (complementary to contractor plans)	
8800	0	The joint Risk, Issue and Opportunity Management plans	
8801	0	Implementation of enabling manufacturing technologies (e.g., advanced simulations,	
8802		additive technologies, etc.)	
8803	0	Implementation of system required technologies (and constraints)	
8804	0	Requirements and schedules for implementing ManTech projects	
8805	0	Requirements for Intellectual Property management and control, and impacts to the TDP	
8806	0	Results of producibility initiatives	
8807	0	Planned rates and schedules (includes processes, surges, tooling, make/buy, etc.)	
8808	0	Management of key and critical characteristics	
8809	0	Costs, schedule, budgets, and affordability requirements including Integrated Master Plan	
8810		and Integrated Master Schedule (IMP/IMS) with critical path	
8811	0	Updates to requirements for program management of materials, including critical and	
8812		controlled, lead-times, long-lead, sourcing, risks, and issues (e.g., sole, single, foreign,	
8813		counterfeit, obsolescence, etc.)	
8814	0	Updates to requirements for and approach to program management of the supply chain,	
8815		including supplier performance, characteristics, and constraints (e.g., sole, single, foreign,	
8816		etc.)	
8817		 Including DCMA and DLA support and data 	
8818	0	Updates for schedule contingencies, variances, and risks	
8819	0	Updates to program plans and methodologies for prototypes, competitive or dual sources,	
8820		co-production, etc.	
8821	0	Updates to program requirements for process capability control	
8822	0	Additional program workforce requirements for program personnel capabilities, SMEs,	
8823		training, certifications, availability, etc.	
8824	0	Updates to program GFE and assets requirements for facilities, tooling, and test	
8825		equipment	
8826	0	Manufacturing updates for the program Manufacturing Plan and schedule (IMP/IMS) for	
8827		integration of independent or Service testing (DoD)	
8828	0	Updates to manufacturing requirements for environmental, security, and safety	
8879	Rа	sed on results of assessments of the contractor's MMS and plans for security provide	
8830	una	dated manufacturing inputs to:	
0050	up		
8831	0	Program Manufacturing Strategy and Plan for industrial security and anti-tamper	
8832		including risks, issues, processes, industrial control systems, resources, organization, and	
8833		metrics	
8834	0	Program security (physical, digital, and cyber) strategies, plans, processes, and	
8835		procedures (e.g., SSE, COMSEC, and PPP)	

8836	•	Based on results of assessments and audits, update manufacturing inputs to manufacturing
8837		requirements in the Life-Cycle Support Plan for the program and updates the program
8838		Manufacturing Strategy accordingly.
8839	•	Based on results of assessments of the contractor's MMS and plans, provide manufacturing
8840		updates for the program Manufacturing Strategy and AS to include appropriate agreements,
8841		delegations, and contracts with other agencies (e.g., DCMA, DLA, etc.) for support and
8842		inputs.
8843	•	Based on results of assessments provide updates to manufacturing inputs for the program
8844		Configuration Management Plan.
8845	•	Based on results of assessments of the contractor's Manufacturing Management Plan (MMS)
8846		and program/technical plans, provide manufacturing recommendations for required contract
8847		modifications or updates to ensure alignment of contractor with program Manufacturing
8848		Management Strategy and Plans (See I.1 and L.1).
8849	•	Based on monitoring of post-PDR manufacturing and quality mitigation measures, provide
8850		manufacturing updates for the program Manufacturing Strategy to address status or
8851		completion of all mitigation measures for all gaps, risks, and issues (See E.6).
8852	Metric	S
8853	•	Updated manufacturing inputs to the Program Manufacturing Strategy and Plan (government)
8854		for EMD have been documented and provided based on the results of assessments of the
8855		contractor's Manufacturing Strategy and Plans including:
8856		• Implementation of industry and government manufacturing and quality best practices
8857		(e.g., AS6500, AS9100, ISO 9000, MIL-HDBK-896A, etc.)
8858		• Requirements for compliance with policy directives and regulations
8859		• Requirements for the EMD AS and RFP
8860		• Plans for Government IB risk and issue mitigation (complementary to contractor plans)
8861		 Plans for the joint Risk, Issue and Opportunity Management System
8862		• Implementation of enabling manufacturing technologies (e.g., advanced simulations,
8863		additive technologies, etc.)
8864		• Implementation of system required technologies (and constraints)
8865		• Requirements and schedules for implementing ManTech projects
8866		• Requirements for Intellectual Property management and control, and impacts to the TDP
8867		• Results of producibility initiatives
8868		• Planned rates and schedules (includes processes, surges, tooling, make/buy, etc.)
8869		 Management of key and critical characteristics
8870		• Costs, schedule, budgets, and affordability requirements including Integrated Master Plan
8871		and Integrated Master Schedule (IMP/IMS) with critical path
8872		• Requirements for program management of materials, including critical and controlled,
8873		lead-times, long-lead, sourcing, risks, and issues (e.g., sole, single, foreign, counterfeit,
8874		obsolescence, etc.)

8875 8876		• Requirements for and approach to program management of the supply chain, including supplier performance, characteristics, and constraints (e.g., sole, single, foreign, etc.)
8877		 Including DCMA and DLA support and data
8878		• Schedule contingencies, variances, and risks
8879		• Program plans and methodologies for prototypes, competitive or dual sources, co-
8880		production, etc.
8881		• Program requirements for process capability control
8882		• Additional program workforce requirements for program personnel capabilities, SMEs,
8883		training, certifications, availability, etc.
8884		• Program GFE and assets requirements for facilities, tooling, and test equipment
8885		• Manufacturing updates for the Program Manufacturing Plan and schedule (IMP/IMS) for
8886		integration of independent or Service testing (DoD)
8887		• Requirements for manufacturing environmental, security, and safety
8888	•	Updated manufacturing inputs have been provided from documented results of assessments
8889		of the contractor's MMS and plans for security including updates to:
8890		• Program Manufacturing Strategy and Plan for industrial security and anti-tamper
8891		including risks, issues, processes, industrial control systems, resources, organization, and
8892		metrics
8893		• Program security (physical, digital, and cyber) strategies, plans, processes, and
8894		procedures (e.g., SSE, COMSEC, and PPP)
8895	٠	Updated manufacturing inputs have been provided from documented results of assessments
8896		and audits for manufacturing requirements in the Life-Cycle Support Plan for the program,
8897		and update the Program Manufacturing Strategy accordingly.
8898	•	Up-to-date manufacturing inputs have been provided for and documented in the Program
8899		Configuration Management Plan.
8900	•	Manufacturing recommendations for required contract modifications or updates have been
8901		documented and provided to Program management to ensure alignment of contractor with
8902		Program Manufacturing Management Strategy and Plans (See I.1 and L.1).
8903	•	Monitoring of post-PDR manufacturing and quality mitigation measures is ongoing and has
8904		provided documented manufacturing updates for the Program Manufacturing Strategy that
8905		address status of all mitigation measures (See E.6).
8906	•	Manufacturing updates have been documented and provided for the Program Manufacturing
8907		Strategy and AS to include appropriate agreements, delegations, and contracts with other
8908		agencies (e.g., DCMA, DLA, etc.) for support and input.
8909	Tools	
8910	•	Acquisition Strategy Template
8911	•	Manufacturing Readiness Level (MRL) assessment questionnaire using Manufacturing
8912		Management/Control thread

4. Engineering and Manufacturing Development (EMD) Phase

8913 Resources

8914	•	AS9100 QUALITY SYSTEMS - REQUIREMENTS FOR AVIATION, SPACE, AND
8915		DEFENSE ORGANIZATIONS, SEP 2016
8916	•	
8917	•	Acquisition Plan Preparation Guide, Jan 2009
8918	•	DSMC Acquisition Strategy Guide, Dec 1999w
8919	•	MRL Deskbook Version 2016
8920	•	DoDI 5000.02
8921	•	Service specific policies and regulations (i.e., AFI 63-145)
8922	•	DoDI 5000.02, Enclosure 14 Cybersecurity
8923	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
8924		Reporting
8925	•	IEEE 15288, Systems and Software Engineering, 2015
8926	•	AS6500, Manufacturing Management Program, Nov 2014
8927	•	MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016
8928	•	NIST 800-82 Guide to Industrial Control Systems Security
8929	•	NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information
8930		Systems and Organizations
8931	L.3	Evaluate Program/System supply chain Management
8932	Manu	facturing Tasks
8933	٠	Ensure that the contractor supply chain management system for subsystems, items, and
8934		components requires MMS processes and procedures are in alignment with industry best
8935		practices (i.e., AS6500) to include elements such as:
8936		 Manufacturing Management System
8937		o Design Analysis for Manufacturing including producibility analyses, KCs, and Failure
8938		Mode Effects Analyses (DFMEA and PFMEA)
8939		• Manufacturing Risk Identification including manufacturing feasibility and MRL
8940		assessments, and Production Readiness Reviews
8941		 Manufacturing Planning including:
8942		 Supply chain and material management
8943		 Manufacturing technology development
8944		 Manufacturing cost
8945		 Modeling and simulations
8946		 Manufacturing system verification
8947		 Manufacturing workforce
8948		 Tooling, test equipment and facilities

- Tooling, test equipment and facilities •
- Manufacturing Operations Management including: 8949

8950 8951 8952 8953 8954 8955 8956 8957 8958 8959	 Production Scheduling and Control Manufacturing Surveillance Continuous Improvement Process Control Plans Process Capabilities PPVs FAIs and FATs Sub-tier supplier management Sub-tier supplier quality
8960	manufacturing processes and procedures including:
8961 8962	 Effectiveness of contractor, supplier, and sub-tier communications and interactions including:
8963 8964 8965 8966 8967 8968 8969	 Flow down of cost, schedule, and performance requirements to sub-tier suppliers and timely notification of changes Design and engineering changes traceability and compliance Manufacturing data exchange, analysis, storage, and traceability processes The joint Risk, Issue, and Opportunity Management System Responses, status, and reports for cost, schedule, and performance actuals Corrective and preventative actions and feedback
8970 8971 8972 8973	 KCs and critical characteristics (CSIs and CAIs) management Supplier and sub-tier risk, issue, and opportunity mitigation management processes for manufacturing (e.g., schedule, material, facility, scale-up, financial impacts, etc.) Make/buy processes for supplier and sub-tier manufacturing capability, capacity.
8974 8975 8976	 Processes for supplier and oue der manaratening explicitly, explicitly, performance, and impacts Qualification, approval, re-qualification, and removal processes for suppliers, monitoring and tracking of supplier performance, and periodic re-assessment
8977 8978 8979 8980	 Supplier and sub-tier manufacturing assistance and mentoring program Utilization of processes and procedures for prevention and/or detection of counterfeit parts and materials (i.e., adherence to AS5553, AS6174, and AS9100) Verification of suppliers and sub-tier manufacturing processes and procedures, especially
8981 8982	 suppliers performing key and/or critical manufacturing processes Manufacturing process control plans
8983 8984 8985	 Appropriate application of statistical control techniques for manufacturing Predictive processes and systems to provide early detection of manufacturing issues (e.g., tooling wear indicators, tracking, predictive and preventative maintenance, etc.)
8987 • 8988	 Continuous manufacturing surveillance and effective metrics Collect and analyze supply chain manufacturing data from the subsystems, items, and component production to:
8989	 Develop and recommend manufacturing process improvements

8990	• Meet planned rates and sche	dules (includes processes, surges, tooling, make/buy, etc.)
8991 8992	• Assess the supply chain for man including:	ufacturing security processes, plans, and procedures
8993 8994 8995	 Industrial security and anti-t resources, organization, and Physical, digital, and cyber security and cyber security and cyber security and sec	amper for risks, issues, processes, industrial control systems, metrics security (associated with SSE, COMSEC, and PPP)
8996 8997	• Assess the supply chain for imply processes and requirements for:	ementation and compliance with Program manufacturing
 8998 8999 9000 9001 9002 9003 9004 	 Configuration Management ESOH Environmental, safety, hazar Testing, qualifications, and o The LCSP Facilities and tooling (GFE/o Request DCMA perform Governmental 	rdous materials, waste handling, etc. certifications (e.g., TEMP, etc.) GFP) ment surveillance of supplier and sub-tier compliance to
9005	manufacturing management prop	gram contract requirements.
9006	Metrics	
9007 9008 9009 9010	 Contractor's supply chain (for supprocedures have been assessed f documented recommendations f AS6500): 	absystems, items, and components) MMS processes and or implementation of industry best practices, with or changes if necessary, for the following elements (See
9011 9012	o Manufacturing Management	System
	 Design Analysis for Manufa 	cturing
9013 9014 9015	 Design Analysis for Manufa Producibility analyses KCs Failure Mode Effects Ar 	cturing nalyses (DFMEA and PFMEA)
9013 9014 9015 9016	 Design Analysis for Manufa Producibility analyses KCs Failure Mode Effects Ar Manufacturing Risk Identified 	cturing alyses (DFMEA and PFMEA) cation
9013 9014 9015 9016 9017 9018 9019	 Design Analysis for Manufa Producibility analyses KCs Failure Mode Effects Ar Manufacturing Risk Identifie Manufacturing feasibility MRL assessments Production Readiness Residuation 	cturing nalyses (DFMEA and PFMEA) cation y assessments eviews
9013 9014 9015 9016 9017 9018 9019 9020	 Design Analysis for Manufa Producibility analyses KCs Failure Mode Effects Ar Manufacturing Risk Identifie Manufacturing feasibility MRL assessments Production Readiness Resonance Manufacturing Planning inclusion 	cturing nalyses (DFMEA and PFMEA) cation y assessments eviews luding supply chain:

4. Engineering and Manufacturing Development (EMD) Phase

9027		 Tooling, test equipment and facilities
9028	0	Manufacturing Operations Management including:
9029		 Production Scheduling and Control
9030		Manufacturing Surveillance
9031		 Continuous Improvement
9032		 Process Control Plans
9033		 Process Capabilities
9034		 PPVs
9035		 FAIs and FATs
9036		 Sub-tier supplier management
9037		 Sub-tier supplier management Sub-tier supplier quality
2021		Sub tor supplier quality
9038 •	Co	ntractor's supply chain management system has been assessed for specific capabilities in
9039	per	formance of manufacturing processes and procedures and documented for adequacy,
9040	cor	npleteness, and sufficiency including:
9041	0	Communications effectiveness for contractor, supplier, and sub-tier interactions
9042		including:
9043		• Flow down of cost, schedule, and performance requirements to sub-tier suppliers and
9044		timely notification of changes
9045		 Design and engineering changes traceability and compliance
9046		 Manufacturing data exchange, analysis, storage, and traceability processes
9047		 The joint Risk, Issue, and Opportunity Management System
9048		 Responses, status, and reports for cost, schedule, and performance actuals
9049		 Corrective and preventative actions and feedback
9050	0	Management of KCs and critical characteristics (CSIs and CAIs)
9051	0	Mitigation management processes for supplier and sub-tier risks, issues, and
9052		opportunities for manufacturing (e.g., schedule, material, facility, scale-up, financial
9053		impacts, etc.)
9054	0	Make/buy processes for supplier and sub-tier manufacturing capability, capacity,
9055		performance, and impacts
9056	0	Processes for qualification, approval, re-qualification, and removal of suppliers,
9057		monitoring and tracking of supplier performance, and periodic re-assessment
9058	0	Supplier and sub-tier manufacturing assistance and mentoring program
9059	0	Processes and procedures for prevention and/or detection of counterfeit parts and
9060		materials (i.e., adherence to AS5553, AS6174, and AS9100)
9061	0	Processes and procedures for verification of suppliers and sub-tier manufacturing,
9062		especially suppliers performing key and/or critical manufacturing processes
9063	0	Manufacturing process control plans
9064	0	Application of statistical control techniques for manufacturing
9065	0	Predictive processes and systems to provide early detection of manufacturing issues (e.g.,
9066		tooling wear indicators, tracking, predictive and preventative maintenance, etc.)

9067		• Continuous manufacturing surveillance and effectiveness of metrics
9068 9069	•	Supply chain manufacturing data has been collected from the subsystems, items, and component production and has been assessed with recommendations provided for:
9070 9071		 Manufacturing process improvements Meeting and/or improving planned rates and schedules
9072 9073	•	Supply chain has been assessed for manufacturing security processes, plans, and procedures and results document compliance with Program requirements including:
9074 9075 9076		 Industrial security and anti-tamper for risks, issues, processes, industrial control systems, resources, organization, and metrics Physical, digital, and cyber security (associated with SSE, COMSEC, and PPP)
9077 9078	•	Supply chain has been assessed for implementation of Program manufacturing processes and document compliance with Program requirements and/or recommendations for updates for:
9079 9080 9081 9082 9083		 Configuration Management ESOH Environmental, safety, hazardous materials, waste handling, etc. Testing, qualifications, and certifications (e.g., TEMP, etc.) The LCSP Easilities and tealing (CEE/CEP)
9084 9085 9086 9087	•	DCMA Letter of Delegation has been sent for performance of Government surveillance of supplier and sub-tier compliance to manufacturing management program contract requirements.
9088	Tools	
9089	•	Supply Chain Assessment
9090	Resou	rces
9091 9092 9093 9094 9095	•	DoD supply chain Management Guide, March 2016 AS6500, Manufacturing Management Program, Nov 2014 AS9100 QUALITY SYSTEMS – REQUIREMENTS FOR AVIATION, SPACE, AND DEFENSE ORGANIZATIONS, SEP 2016 ISO 9001 Quality Management Systems
9096 9097	•	IEEE 15288.2, System and Software Engineering, 2015 DFARS 246.870. Contractors' Counterfeit Electronic Part Detection and Avoidance
9098 9099	•	AS5553 Counterfeit Electronic Parts DFARS 252.246-7008, Sources of Electronic Parts
9100 9101	•	DoDI 5000.02, Enclosure 14 MIL-STD-882
9102	•	NIST 800-82 Guide to Industrial Control Systems Security

9103	•	AS6174
9104	•	DFARS 252.228-7001, Ground and Flight Risk
9105	•	DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance
9106		System
9107	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
9108		Reporting
9109	•	NIST 800-82 Guide to Industrial Control Systems Security
9110	•	NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information
9111		Systems and Organizations
9112	L.4	Support CDR
9113	Manu	facturing and Quality Tasks
9114	•	For CDR, provide manufacturing inputs on Program, contractor, and supply chain
9115		implementation status of industry best practices (i.e., AS6500).
9116	•	Ensure initial product baseline documentation for manufacturing is sufficient, complete, and
9117		adequate to enable component manufacturing, hardware fabrication and software
9118		implementation to proceed.
9119		• Ensure all KCs, CSIs, and CAIs have completed drawings and specifications under
9120		configuration control
9121		• Ensure all product data essential (e.g., drawings, specifications, etc.) for component
9122		manufacturing has been released
9123	•	Ensure all manufacturing design trade studies and manufacturing producibility assessments
9124		are completed and incorporated into the design for CDR.
0125		• Ensure manufacturing producibility process enhancement efforts ongoing for optimized
9125		integrated system (e.g. Design for Manufacturability Design for Assembly, etc.)
9120		integrated system (e.g. Design for Manufacturability, Design for Assembly, etc.)
9127	•	Ensure all subsystem, item, and component CDRs are complete, with any open
9128		manufacturing action items and associated risks understood, and the results available for the
9129		system CDR.
9130	•	Ensure manufacturing input to the schedule (IMP/IMS) is up-to-date and is executable with
9131		acceptable risks.
9132	•	Ensure manufacturing plans, activities, and processes are executable within the existing
9133		manufacturing budget to support the approved initial product baseline and critical path.
9134	•	Ensure all key and critical manufacturing processes, including process control plans, have
9135		been defined, characterized, updated for the detailed design, and the capability to meet
9136		requirements has been determined.
9137	٠	Assess manufacturing plans for adequacy and capability to achieve manufacturing readiness
9138		level 8 by initial production.

9139 9140	•	Assess plans for long-lead procurement requirements and incorporate results into procurement plans.
9141 9142 9143	•	Analyze and update subsystem, item, and component quantity estimates based on program system requirements, component yield and rate data, and results from prototype demonstrations.
9144 9145 9146	•	Analyze the assessments of adequacy and completeness of manufacturing requirements validation activities (e.g., prototypes and demonstrations in the appropriate environment) of the system, subsystem, item, and component levels for manufacturing maturity including:
9147 9148 9149		 Demonstrations of manufacturing processes in the appropriate environment (for the product level) Demonstrations of manufacturing processes for KCs, CSIs, and CAIs
9150 9151 9152 9153 9154	•	Provide manufacturing inputs to the LCSP for CDR. Ensure contractor manufacturing management systems for manufacturing metrics, data collection, and tracking to the component level are in place and functional. Ensure the manufacturing considerations and aspects of contractor's plans and inputs are up-to-date and approved for CDR, including:
9155 9156 9157 9158 9159 9160 9161 9162 9163		 Parts and Materials (Management) Plan (PMP) Configuration Management Plan (CMP) Software Development Plan (embedded software) Quality Assurance Plan (embedded software) Safety Plan ESOH, environmental, and security plans PPP SEMP SEMP TEMP
9164 9165 9166 9167	•	Ensure the contractor's SEMP incorporates all Program requirements, certification requirements, interfaces and interdependencies, etc. to support manufacturing of subsystems, items, and components. Provide up-to-date manufacturing inputs to the Program budget and the CARD.
9168 9169		 Update and allocate manufacturing and quality (production) cost models to subsystem, item, and component levels, and track against targets
9170 9171 9172 9173	•	Analyze results of contractor and key supply chain assessments (e.g., sourcing, materials, subsystems, items, components, lead-times, quality, manufacturing management, ESOH, etc.) to ensure identification of manufacturing risks, issues, and opportunities with associated mitigation plans.
9174 9175 9176	•	Ensure adequacy and completeness of mitigation activities for mitigation of manufacturing risks, issues, and opportunities in the joint Government/ contractor Risk, Issue, and Opportunity (RIO) Management System, including:
9177		• Key and critical manufacturing processes including embedding software

9178	• Materials and sourcing
9179	 Supply chain including multiple sources
9180	• Production rates and yields
9181	• Facilities
9182	• Special tooling development
9183	• Tests and demonstrations
9184	• Security (physical and cyber)
9185	• System safety, ESOH, and hazardous materials management
9186	• Schedule (i.e., IMP/IMS)
9187	 Manufacturing capability obsolescence
9188	 Manufacturing capability sustainment
9189 9190	• Assess contractor production control and materials planning systems for adequacy to support pilot line.
9191	 Assess contractor make/buy decisions and BOM sufficiency to support pilot line
9192	 Assess contractor manufacturing processes and procedures for materials facilities
9193	equipment, test facilities and equipment, and tooling to support the pilot line.
9194	• Ensure the Manufacturing Strategy and Plan are updated based on the all assessments, audits.
9195	demonstrations, tests, etc. and the results conducted to date.
0106	Metrics
9190	
9190 9197	 Manufacturing inputs on Program, contractor, and supply chain implementation status of
9190 9197 9198	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR.
9190 9197 9198 9199	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the
9190 9197 9198 9199 9200	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and
9190 9197 9198 9199 9200 9201	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed.
9190 9197 9198 9199 9200 9201 9202	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under
9190 9197 9198 9199 9200 9201 9202 9202 9203	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control
9190 9197 9198 9199 9200 9201 9202 9203 9203 9204	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component
9190 9197 9198 9199 9200 9201 9202 9203 9204 9205	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released
9190 9197 9198 9199 9200 9201 9202 9203 9204 9205 9206	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released
9190 9197 9198 9199 9200 9201 9202 9203 9204 9205 9206 9206 9207	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released All manufacturing design trade studies and manufacturing producibility assessments results have been reviewed for adequacy and completeness and are documented in the design for
9190 9197 9198 9199 9200 9201 9202 9203 9204 9205 9206 9207 9208	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released All manufacturing design trade studies and manufacturing producibility assessments results have been reviewed for adequacy and completeness and are documented in the design for CDR
9190 9197 9198 9199 9200 9201 9202 9203 9204 9205 9206 9207 9208	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released All manufacturing design trade studies and manufacturing producibility assessments results have been reviewed for adequacy and completeness and are documented in the design for CDR.
 9190 9197 9198 9199 9200 9201 9202 9203 9204 9205 9206 9207 9208 9209 	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released All manufacturing design trade studies and manufacturing producibility assessments results have been reviewed for adequacy and completeness and are documented in the design for CDR. Manufacturing producibility process enhancement efforts are ongoing for the optimized
9190 9197 9198 9199 9200 9201 9202 9203 9204 9205 9206 9207 9206 9207 9208 9209 9210	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released All manufacturing design trade studies and manufacturing producibility assessments results have been reviewed for adequacy and completeness and are documented in the design for CDR. Manufacturing producibility process enhancement efforts are ongoing for the optimized integrated system (e.g. Design for Manufacturability, Design for Assembly, etc.)
9190 9197 9198 9199 9200 9201 9202 9203 9204 9205 9206 9207 9206 9207 9208 9209 9210 9211	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released All manufacturing design trade studies and manufacturing producibility assessments results have been reviewed for adequacy and completeness and are documented in the design for CDR. Manufacturing producibility process enhancement efforts are ongoing for the optimized integrated system (e.g. Design for Manufacturability, Design for Assembly, etc.) All subsystem, item, and component CDRs have been completed:
9190 9197 9198 9199 9200 9201 9202 9203 9204 9205 9204 9205 9206 9207 9208 9209 9209 9210 9211 9212	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released All manufacturing design trade studies and manufacturing producibility assessments results have been reviewed for adequacy and completeness and are documented in the design for CDR. Manufacturing producibility process enhancement efforts are ongoing for the optimized integrated system (e.g. Design for Manufacturability, Design for Assembly, etc.) All subsystem, item, and component CDRs have been completed: Open manufacturing action items are tracked and monitored in the joint RIO System
 9190 9197 9198 9199 9200 9201 9202 9203 9204 9205 9206 9207 9208 9209 9210 9211 9212 9213 	 Manufacturing inputs on Program, contractor, and supply chain implementation status of industry best practices (i.e., AS6500) have been documented and provided for CDR. Initial product baseline documentation has been assessed for CDR and documents the completeness and adequacy to allow component manufacturing, hardware fabrication and software implementation to proceed. All KCs, CSIs, and CAIs have completed drawings and specifications under configuration control All product data essential (e.g., drawings, specifications, etc.) for component manufacturing has been released All manufacturing design trade studies and manufacturing producibility assessments results have been reviewed for adequacy and completeness and are documented in the design for CDR. Manufacturing producibility process enhancement efforts are ongoing for the optimized integrated system (e.g. Design for Manufacturability, Design for Assembly, etc.) All subsystem, item, and component CDRs have been completed: Open manufacturing action items are tracked and monitored in the joint RIO System All risks understood with mitigation plans documented, in progress, and status available

4. Engineering and Manufacturing Development (EMD) Phase

9215 9216	•	Manufacturing has provided up-to-date and executable inputs for the schedule and the critical path for the IMP/IMS with acceptable risks.
9217 9218 9219	•	Manufacturing plans, activities, and processes have been assessed and documented as executable within the existing manufacturing budget in support of the approved product baseline and critical path.
9220 9221 9222	•	All key and critical manufacturing processes, including process control plans, have been documented to include characterization, up-to-date detailed design, and capability and capacity to meet Program requirements.
9223 9224 9225	•	Manufacturing plans to achieve manufacturing readiness level 8 by initial production have been assessed for adequacy and are documented in the Program Manufacturing Plan. Long-lead procurement requirements and plans have been assessed and results have been incompared into the Manufacturing Plan.
9220 9227 9228 9229 9230 9231 9232	•	Results from prototype demonstrations (e.g., component yield and rate data) have been analyzed and updates to subsystem, item, and component quantity estimates to meet Program system requirements have been documented in the Manufacturing Plan for CDR. Manufacturing requirements validation activities (e.g., prototypes and demonstrations in the appropriate environment of the system, subsystem, item, and component levels) have been assessed and the results document the manufacturing maturity. Assessments included:
9232 9233 9234 9235		 Demonstrations of manufacturing processes in the appropriate environment (for the product level) Demonstrations of manufacturing processes for KCs, CSIs, and CAIs
9236 9237 9238 9239 9240 9241 9242	•	Manufacturing inputs to the LCSP have been documented and provided CDR. Contractor manufacturing management systems for manufacturing metrics, data collection, and tracking to the component level have been assessed, are in place and functional, and the results document adequacy and sufficiency for CDR and pilot line. Contractor's plans and inputs have been assessed for manufacturing considerations and aspects, are documented up-to-date, and have been approved for CDR, including the following plans:
9243 9244 9245 9246 9247 9248 9249 9250 9251		 Parts and Materials (Management) Plan (PMP) Configuration Management Plan (CMP) Software Development Plan (embedded software) Quality Assurance Plan Safety Plan ESOH, environmental, and security plans PPP SEMP TEMP
9252 9253 9254	•	Contractor's SEMP has been assessed and documentation shows incorporation of all Program requirements, certification requirements, interfaces and interdependencies, etc. for manufacturing of subsystems, items, and components in support of CDR.

4. Engineering and Manufacturing Development (EMD) Phase

9255	•	Up-to-date manufacturing inputs have been provided for the Program budget and the CARD.
9256 9257		 Manufacturing and quality (production) cost models have been updated and document allocation and tracking to subsystem, item, and component levels
9258 9259 9260 9261	•	Contractor and key supply chain assessment results have been analyzed and document adequacy and completeness of identification and mitigation activities and plans for manufacturing risks, issues, and opportunities with associated mitigation plans in the joint Government/ contractor Risk, Issue, and Opportunity (RIO) Management System, including:
9262 9263 9264 9265 9266 9267 9268 9269 9270 9271 9272 9273		 Key and critical manufacturing processes including embedding software Materials and sourcing Supply chain Production rates and yields Facilities Special tooling development Tests and demonstrations Security (physical and cyber) System safety, ESOH, and hazardous materials management Schedule (i.e., IMP/IMS) DMSMS Manufacturing sustainment
9274 9275	•	Contractor's capability, capacity, and adequacy to support the pilot line has been assessed and the results documented for CDR to include the following:
9276 9277 9278 9279 9280 9281 9282 9283		 Production control systems Materials planning systems Make/buy decisions Bill of Materials Manufacturing processes and procedures Materials Facilities, equipment, tooling Tests, test facilities and equipment
9284 9285	•	Manufacturing Strategy and Plan have been updated for CDR based on the all assessments, audits, demonstrations, tests, etc. and the results conducted to date.
9286	Tools	
9287	•	Critical Design Review Checklist
9288	Resou	rces
9289	•	AS6500, Manufacturing Management Program, Sep 2016
9290	•	Defense Acquisition Guide (DAG) Chapter 3-3.3.5 Critical Design Review
9291	٠	IEEE 15288.2, System and Software Engineering, 2015

4. Engineering and Manufacturing Development (EMD) Phase

- MRL Deskbook Version 2016
- 9293 L.5 Execute Pilot Line

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- 9294 Manufacturing and Quality Tasks
- Assess the contractor designated pilot lines for production realism and affordability of
 elements required to manufacture systems, subsystems, items, and components to include
 evaluation of:
- 9298 Manufacturing readiness for manufacture of equipment
 - Materials, components, and tooling availability,
- 9300 o Adequacy of workforce skill levels, facilities, materials, work instructions, processes,
 9301 tooling, temperature, cleanliness, lighting etc.
- 9302 Capability to meet design requirements for LRIP
- 9303 o Production processes (little or no reliance on laboratory environment or personnel, i.e.,
 9304 non-production resources)
- 9305 Capability and capacity to meet rate production (ramp-up to FRP)
- 9306 Capability and capacity to meet program objectives for cost and schedule
- Ensure contractor and supply chain manufacturing plans, processes, and procedures are demonstrated, verified, and validated on the pilot line in accordance with industry best practices (i.e., AS6500) to include the following:
- 9310 Continuous process improvement efforts
- 9311 o Manufacturing surveillance, data collection, and analyses (including supply chain data for items and components)
- 9313oManufacturing process controls in place (e.g. plans, process capabilities (C_{pk}s), Statistical9314Process Control (SPC), etc.)
- 9315 Adequacy and completeness of acceptance processes for LRIP
 - All manufacturing work instructions, sequencing, and in-process tests (including quality test points and procedures)
- 9318 Manufacturing scheduling, work flow, and optimization
- 9319 Manufacturing resource planning, and scheduling
- 9320 Physical and functional interfaces
- 9321 Manufacturing models and simulations
- 9322 Manufacturing workforce capabilities, skills, and training
- 9323 Implementations of manufacturing technologies including ManTech
- 9324 o Tooling, work holding fixtures, jigs, etc.
- 9325 Manufacturing equipment and facilities (including GFE, etc.)
- 9326 Manufacturing processes for movement, storage, and handling equipment
- 9327 Manufacturing safety processes and procedures
- 9328 Manufacturing ESOH processes and procedures
- 9329 Manufacturing security processes, procedures, capabilities, and compliance
- 9330 Impacts from direct and indirect infrastructure

Manufacturing and Quality Management Body of Knowledge

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9331 9332 9333 9334		 Mitigation results for manufacturing risks and issues resolutions Manufacturing cost changes (and impacts to schedule and performance) Adequacy of materials sources and selections Integration (manufacturing processes) of embedded software 			
9335 9336	•	Analyze manufacturing processes performed during the pilot lines operations, (including simulations) to include:			
9337 9338 9339 9340 9341		 Rate of manufacturing processes (actual time to complete) vs. planned Manufacturing data actuals vs. estimated Process yield actuals vs. planned Changes in processes (actual vs. planned) Cost of manufacturing actuals vs. desired 			
9342 9343 9344 9345	•	Assess process control plans, including all plans for process control of key and critical processes, for adequacy and completeness on the pilot line. Assess all work instructions for required outputs and changes based on build-to documentation and information gathered during the pilot line.			
9346 9347		 Verify updated work instructions, processes, drawings, etc. Include KCs, Critical Manufacturing Processes, and their control plans 			
9348	٠	Assess manufacturing output from the pilot line for adequacy and completeness and validate:			
9349 9350 9351		 All Production Process Verifications (PPVs) performed Attainability of KCs (will be capable and under process control for LRIP) Manufacturing data collected for the Variability Reduction program 			
9352 9353		Data should demonstrate progress to metricsInclude updates based on process improvements			
9354 9355 9356		 All FAIs and FATs against specifications, drawings, models, etc. Requirements for design changes and process changes identified during pilot line operations, testing, and qualification 			
9357 9358 9359	•	Capture the results of manufacturing processes, demonstrated on a pilot line, as inputs to the system MRL assessment, PRR, and to the Industrial Base Capabilities Considerations that are required for Milestone C.			
9360 9361 9362 9363	•	Based on the results of the Pilot Line build, finalize the Technical Data Package including applicable technical data such as models, drawings, associated lists, specifications, standards, performance requirements, quality assurance provisions, software documentation and packaging details.			
9364 9365	•	Provide manufacturing input for a Letter of Delegation to DCMA for support to, witness of, and assessment of demonstrations, pilot line operations, FAIs and/or FATs, etc.			
9366	Metrics				
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9367	• Co	ntractor designated pilot lines have been assessed and documented in an MRL assessment			
9368	and	for for PRR for production realism and affordability of elements required to manufacture			
9369	sys	stems, subsystems, items, and components to include evaluation of:			
9370	0	Manufacturing readiness for manufacture of equipment			
9371	0	Materials, components, and tooling availability,			
9372	0	Adequacy of workforce skill levels, facilities, materials, work instructions, processes,			
9373		tooling, temperature, cleanliness, lighting etc.			
9374	0	Capability to meet design requirements for LRIP			
9375	0	Production processes (little or no reliance on laboratory environment or personnel, i.e.,			
9376		non-production resources)			
9377	0	Capability and capacity to meet rate production (ramp-up to FRP)			
9378	0	Capability and capacity to meet program objectives for cost and schedule			
9379	• Co	ntractor and supply chain manufacturing plans, processes, and procedures have been			
9380	dei	nonstrated on a pilot line and the results documented in the Program management			
9381	inf	ormation system and/or Contract Data Requirements List (CDRL) to validate industry best			
9382	pra	actices were followed to include:			
9383	0	Continuous process improvement efforts			
9384	0	Manufacturing surveillance, data collection, and analyses (including supply chain data for			
9385		items and components)			
9386	0	Manufacturing process controls in place (e.g. plans, process capabilities (C _{pk} s), Statistical			
9387		Process Control (SPC), etc.)			
9388	0	Adequacy and completeness of acceptance processes for LRIP			
9389	0	All manufacturing work instructions, sequencing, and in-process tests (including quality			
9390		test points and procedures)			
9391	0	Manufacturing scheduling, work flow, and optimization			
9392	0	Manufacturing resource planning, and scheduling			
9393	0	Physical and functional interfaces			
9394	0	Manufacturing models and simulations			
9395	0	Manufacturing workforce capabilities, skills, and training			
9396	0	Implementations of manufacturing technologies including ManTech			
9397	0	Tooling, work holding fixtures, jigs, etc.			
9398	0	Manufacturing equipment and facilities (including GFE, etc.)			
9399	0	Manufacturing processes for movement, storage, and handling equipment			
9400	0	Manufacturing safety processes and procedures			
9401	0	Manufacturing ESOH processes and procedures			
9402	0	Manufacturing security processes, procedures, capabilities, and compliance			
9403	0	Impacts from direct and indirect infrastructure			
9404	0	Mitigation results for manufacturing risks and issues resolutions			
9405	0	Manufacturing cost changes (and impacts to schedule and performance)			
9406	0	Adequacy of materials sources and selections			

9407		• Integration (manufacturing processes) of embedded software
9408 9409	•	Manufacturing processes performed during the pilot lines operations, (including simulations) were assessed for actuals against plans and the results documented for:
9410 9411 9412 9413 9414		 Rates Manufacturing data Process yields Changes in processes Costs of manufacturing
9415 9416 9417	•	Process control plans, including all plans for process control of key and critical processes, have been assessed on the pilot line and the results document adequacy and completeness for PRR and LRIP.
9418 9419 9420	•	Based on build-to documentation and information gathered during the pilot line, all work instructions have been assessed and updated for required outputs and changes and results documented for PRR.
9421 9422 9423 9424		 Updated work instructions, processes, drawings, etc. have been verified completeness and accuracy KCs, Critical Manufacturing Processes, and their control plans have been validated and documented
9425 9426	•	Pilot line output has been assessed for adequacy and completeness and documentation for PRR and LRIP shows verification and validation of:
9427 9428 9429		 All Production Process Verifications (PPVs) Attainability of KCs (i.e., capable and under process control for LRIP) Variability Reduction program
9430 9431		Data demonstrates progress to metricsIncludes all process improvements
9432 9433		 All FAIs and FATs completed (e.g., specifications, drawings, models, etc.) Design and process required by pilot line operations, testing, and qualification
9434 9435 9436	•	Results of manufacturing processes, demonstrated on a pilot line, have been documented as manufacturing inputs to the system MRL assessment, PRR, and to the Industrial Base Capabilities Considerations that are required for Milestone C.
9437 9438 9439 9440	•	Based on the results of the Pilot Line build, the TDP has been updated and finalized to include all applicable technical data (e.g., models, drawings, associated lists, specifications, standards, performance requirements, quality assurance provisions, software documentation, and packaging details).
9441 9442	•	Manufacturing input for a Letter of Delegation to DCMA has been provided to obtain support to, witness of, and assessment of demonstrations, pilot line operations, FAIs, or FATs, etc.

9443	Tools	
9444	•	Manufacturing Readiness Assessment, Material Management thread
9445	Resou	rces
9446	•	AS6500, Manufacturing Management Program, Nov 2014
9447	•	MIL-HDBK-896A. Manufacturing Management Program Guide
9448	•	DoDI 5000 02
9449	•	MRL Deskbook Version 2016
9450	L.6	Finalize Manufacturing Strategy and Plan for LRIP
9451	Manut	facturing and Quality Tasks
0452		Undate and finalize the Program Manufacturing Strategy and Plan for Production and
9432	•	Deployment (P&D) to include undates for:
9433		Deproyment (F&D) to include updates for.
9454		• Results from pilot line and the resulting manufacturing updates
9455		 Results from FAIs, FATs, and FRACAS activities
9456		 Findings, results, and direction from the SVR/FCA
9457		o Final TDP
9458		• Requirements from the CPD
9459		 Findings from the MRL assessment
9460		• Direction and results from a completed PRR (e.g., date, open items, issues, etc.)
9461		• Requirements for P&D from the RFP
9462		 The joint Risk, Issue, and Opportunity System
9463		 Maturity and plans for manufacturing development
9464		 Manufacturing maturity and plans for system required new technologies
9465		 Results of pilot line design updates and producibility improvements
9466		 Results from continuous process improvement efforts
9467		 Management of Intellectual Property and data rights
9468		• Actual rates and schedules (includes processes, tooling, make/buy, etc.)
9469		 Verification and validation of models and simulations
9470		• Estimates for Learning Curves, LRIP (subsequent ramp-up to rate), surges, etc.
9471		• Changes to management of KCs and critical characteristics and associated processes
9472		• Manufacturing inputs on costs, schedule, budgets, affordability requirements, and
9473		IMP/IMS critical path
9474		o Management of materials (e.g., critical and controlled, lead-times, long-lead, sourcing,
9475		risks, issues, sole, single, foreign, counterfeit, obsolescence, etc.)
9476		• DMSMS strategies and plans
9477		• Use of COTS items, GOTS items, NDIs, and GFE/GFP (e.g., controlled products, test
9478		ranges, specialized equipment, test facilities, etc.)
9479		• Finalized process capability requirements

9480	0	Requirements for in-process and acceptance tests, test procedures, and test equipment					
9481		(hardware and software)					
9482 9483	0	Program and contractor workforce needs, capabilities, training, certifications, availability,					
9484	0	hanges in contractor facilities manufacturing equipment and tooling and test					
9485	0	uninges in contractor factures, manufacturing equipment and tooling, and test					
9485	~	Processes and procedures for prevention and/or detection of counterfait parts and					
9487	0	materials					
9488	0	FSOH environmental security and safety requirements					
9489	0	Management of ITAR and anti-tamper					
9490	0	Plans for manufacturing cyber threat protection measures including risks processes					
9491	0	industrial control systems, resources, metrics, and design considerations					
9492 • 9493	En pra	sure the Program Manufacturing Strategy for P&D includes industry best manufacturing actices (in accordance with AS6500) to include:					
9494	0	Manufacturing Management System					
9495	0	Design for Manufacturing including:					
9496		 Producibility analyses 					
9497		 KCs 					
9498		 Failure Mode Effects Analyses (DFMEA and PFMEA) 					
9499	0	Manufacturing Risk Identification including:					
9500		 Manufacturing feasibility assessments 					
9501		 MRL assessments 					
9502		 Production Readiness Reviews 					
9503	0	Manufacturing Planning including:					
9504		 Supply chain and material management 					
9505		 Manufacturing technology development 					
9506		 Manufacturing costs 					
9507		 Modeling and simulations 					
9508		 Manufacturing system verification 					
9509		 Manufacturing workforce 					
9510		 Tooling, test equipment and facilities 					
9511	0	Manufacturing Operations Management including:					
9512		 Production Scheduling and Control 					
9513		 Manufacturing Surveillance 					
9514		 Continuous Improvement 					
9515		 Process Control Plans 					
9516		 Process Capabilities 					
9517		• PPVs					
9518		 FAIs and FATs 					

9519	 Sub-tier supplier management
9520 9521 9522 9523	 Update the Program Manufacturing Management Strategy and Plan for manufacturing management of software and firmware. Provide updated manufacturing inputs to the PPP for considerations of contractor compliance risks and issues for P&D.
9524 9525 9526 9527 9528 9529	 Update the Program Manufacturing Strategy and Plan for P&D for required agreements, delegations, and contracts with other agencies (e.g., DCMA, DLA, National Test Facilities, etc.). Update the Manufacturing Strategy and Plan to include the contractual definition and agreement to manufacturing environments for LRIP and Full-Rate Production (FRP). Ensure the WBS adequately defines the tasks to be accomplished for LRIP in P&D.
9530 9531 9532	• Based on manufacturing analyses of Program progress and assessments of maturity, affordability and costs, availability and capability, risks, issues, and opportunities, develop recommendations for sourcing and options for LRIP including:
9533 9534 9535 9536 9537	 Emerging technology advancements in materials and processes Changes in Government statute, policy, and regulations Changes in business climate conditions (e.g., mergers and acquisitions, failures, etc.) Changes in environmental impacts (e.g., natural disasters, etc.) Diminishing Manufacturing Sources and Material Shortages (DMSMS)
9538 9539 9540 9541	 Ensure contractor's manufacturing plans, policies, and procedures are consistent with Program plans for Program Plans for Product Improvement (P³I) for LRIP. Based on pilot line operations, demonstrations, and simulations, update all manufacturing risks, issues, and mitigation plans for LRIP.
9542 9543	• Ensure mitigations of current risks and issues are on track and/or do not introduce new risks and issues to the Program for LRIP.
9544 9545 9546 9547	• Based on the results of the Pilot Line build, finalize the Technical Data Package (TDP) including applicable technical data such as models, drawings, associated lists, specifications, standards, performance requirements, quality assurance provisions, software documentation and packaging details.
9548 M	etrics
9549 9550	• Program Manufacturing Strategy and Plan has been updated for P&D and includes and documents the following:
9551 9552 9553 9554 9555 9556	 Results from pilot line and the resulting manufacturing updates Results from FAIs, FATs, and FRACAS activities Findings, results, and direction from the SVR/FCA Final TDP Requirements from the CPD Findings from the MRL assessment

9557	0	Direction and results from a completed PRR (e.g., date, open items, issues, etc.)						
9558	0	Requirements for P&D from the RFP						
9559	0	The joint Risk, Issue, and Opportunity System						
9560	0	Maturity and plans for manufacturing development						
9561	0	Ianufacturing maturity and plans for system required new technologies						
9562	0	Results of pilot line design updates and producibility improvements						
9563	0	Results from continuous process improvement efforts						
9564	0	Management of Intellectual Property and data rights						
9565	0	Actual rates and schedules (includes processes, tooling, make/buy, etc.)						
9566	0	Verification and validation of models and simulations						
9567	0	Estimates for Learning Curves, LRIP (subsequent ramp-up to rate), surges, etc.						
9568	0	Changes to management of KCs and critical characteristics and associated processes						
9569	0	Manufacturing inputs on costs, schedule, budgets, affordability requirements, and						
9570		IMP/IMS critical path						
9571	0	Management of materials (e.g., critical and controlled, lead-times, long-lead, sourcing,						
9572		risks, issues, sole, single, foreign, counterfeit, obsolescence, etc.)						
9573	0	DMSMS strategies and plans						
9574	0	Use of COTS items, GOTS items, NDIs, and GFE/GFP (e.g., controlled products, test						
9575		ranges, specialized equipment, test facilities, etc.)						
9576	0	Finalized process capability requirements						
9577	0	Requirements for in-process and acceptance tests, test procedures, and test equipment						
9578		(hardware and software)						
9579	0	Program and contractor workforce needs, capabilities, training, certifications, availability,						
9580		etc.						
9581	0	Changes in contractor facilities, manufacturing equipment and tooling, and test						
9582		equipment requirements						
9583	0	Processes and procedures for prevention and/or detection of counterfeit parts and						
9584		materials						
9585	0	ESOH, environmental, security, and safety requirements						
9586	0	Management of ITAR and anti-tamper						
9587	0	Plans for manufacturing cyber threat protection measures, including risks, processes,						
9588		industrial control systems, resources, metrics, and design considerations						
9589 •	Pro	ogram Manufacturing Strategy for P&D documents the requirements for and the						
9590	imj	plementation of industry best manufacturing practices including:						
9591	0	Manufacturing Management System						
9592	0	Design for Manufacturing including:						
9593		 Producibility analyses 						
9594		• KCs						
9595		 Failure Mode Effects Analyses (DFMEA and PFMEA) 						
9596	0	Manufacturing Risk Identification including:						

4. Engineering and Manufacturing Development (EMD) Phase

9597 9598 9599		 Manufacturing feasibility assessments MRL assessments Production Readiness Reviews
9600		• Manufacturing Planning including:
9601 9602 9603 9604 9605 9606 9607		 Supply chain and material management Manufacturing technology development Manufacturing costs Modeling and simulations Manufacturing system verification Manufacturing workforce Tooling, test equipment and facilities
9608		 Manufacturing Operations Management including:
9609 9610 9611 9612 9613 9614 9615 9616		 Production Scheduling and Control Manufacturing Surveillance Continuous Improvement Process Control Plans Process Capabilities PPVs FAIs and FATs Sub-tier supplier management
9617	٠	Program Manufacturing Management Strategy and Plan has been updated and documents
9618		manufacturing management of software and firmware.
9619 9620	٠	Updated manufacturing inputs have been documented and provided for the PPP for evaluations of contractor's capability for compliance, ricks, and issues for P&D
9020 9621	•	Program Manufacturing Strategy and Plan documents undated requirements for P&D
9622		agreements, delegations, and contracts with other agencies (e.g., DCMA, DLA, National Test
9623		Facilities, etc.).
9624	٠	Manufacturing Strategy and Plan documents the contractual definition of and agreement to
9625		manufacturing environments for LRIP and Full-Rate Production (FRP).
9626 9627	•	Contractor WBS has adequately defined and documented the tasks to be accomplished for
9627	•	Recommendations for sourcing and options for I RIP have been developed and documented
9629	-	based on manufacturing analyses of Program progress and assessments of maturity,
9630		affordability and costs, availability and capability, risks, issues, and opportunities, including:
9631		• Emerging technology advancements in materials and processes
9632		• Changes in Government statute, policy, and regulations
9633		• Changes in business climate conditions (e.g., mergers and acquisitions, failures, etc.)
9634		• Changes in environmental impacts (e.g., natural disasters, etc.)
9635		 Diminishing Manufacturing Sources and Material Shortages (DMSMS)

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9636	•	Contractor's manufacturing plans, policies, and procedures have been assessed and
9637		recommendations and changes have been documented to maintain consistency with Program
9638		P ³ I plans for I RIP
0620	•	All undeted manufacturing risks issues and mitigation plans have been documented and
9039	•	An updated manufacturing fisks, issues, and mitigation plans have been documented and
9640		provided for the joint Program/Contractor Risk, Issue, and Opportunity Management System
9641		for LRIP.
9642		• Mitigations of current risks and issues are assessed to be on track and do not introduce
9643		new risks and issues to the Program for LRIP
9644	•	Based on the results of the pilot line and demonstrations, final manufacturing input to the
9645		TDP has been provided including applicable technical data such as models drawings
9646		associated lists specifications standards performance requirements quality assurance
9647		provisions software documentation and packaging details
7047		provisions, sortware documentation and packaging details.
9648	Tools	
9649	٠	Manufacturing Readiness Level (MRL) Assessment Questionnaire for the Manufacturing
9650		Management and Control thread
9651	•	AS6500 Manufacturing Management Program Assessment
9652	•	Material Management and Accounting System Audit
9653	Resou	rces
0654		AS6500 Manufacturing Management Program Son 2016
9034	•	MIL UDDK 206A. Manufacturing and Quality Program. Aug 2016
9033	•	MIL-HDBK-896A, Manufacturing and Quanty Program, Aug 2016
9656	•	DFAR 242.72 Contractor Material Management and Accounting System
9657	•	MRL Deskbook Version 2016
9658	•	AS9100, Quality Management System, Sep 2016
9659	•	ASISO5553, Counterfeit Electronic Parts, 2013
9660	•	AS6174, Counterfeit Material, 2012
9661	•	IEEE 15288, Systems and Software Engineering, 2015

5. Production and Deployment (P&D) Phase

2 Introduction

9

Congress and the Government Accountability Office (GAO) are concerned about manufacturing and production. They understand that a lack of attention to this function increases program and system risk and is the major factor in cost overruns and schedule delays. The following items are common production risks that can greatly affect cost, schedule and performance if the program office is not proactive in managing them.

- Unstable requirements and too many engineering changes
 - Unstable production rates and quantities
- 10 Insufficient process proofing
- 11 Insufficient material characterization
- Changes in proven materials, processes, subcontractors, vendors, and components
- 13 Lack of producibility consideration
- 14 Configuration management
- 15 Subcontractor management
- Special tooling and test equipment
- 17 These risks can occur early in the program's life, not just during production.
- 18 Department of Defense Instruction (DoDI) 5000.02, Operation of the Defense Acquisition System,
- 19 identifies the policies and principles that guide all defense acquisition programs to include the
- 20 following manufacturing related policy excerpt: "PMs shall provide knowledge about key aspects of
- 21 a system at key points in the acquisition process. They shall reduce manufacturing risk and
- 22 demonstrate producibility prior to full-rate production."
- 23 For manufacturing, the final acquisition role is to execute the manufacturing plan. This means to
- execute the plan in a way that reflects the design intent while ensuring repeatable processes and
- 25 focusing on continuous improvement. Since the very earliest acquisition phases manufacturing has
- 26 been working on the manufacturing plan and getting ready for production.
- 27 At Milestone C, key manufacturing readiness considerations include:
- Industrial base viability
- Design stability
- 30 Process maturity
- 31 Supply chain management
- Quality management
- Facilities
- Manufacturing skills availability

- 35 The Milestone C review should provide the status of assessments of manufacturing processes and
- 36 highlight the steps needed to progress from an Engineering and Manufacturing Development (EMD)
- 37 manufacturing environment to an Low-Rate Initial Production (LRIP) environment.
- 38 For the Full-Rate Production (FRP) decision review Acquisition Strategy update, the Program
- 39 Management Office (PMO) should identify remaining risks prior to a production go-ahead decision.
- 40 Key considerations should include industrial base viability, design stability, process maturity, supply
- 41 chain management, quality management, and facilities and manufacturing skills availability. Sources
- 42 of data could include technical reviews and audits, Program Status Reviews (PSRs), pre-award
- 43 surveys, Production Readiness Reviews (PRR), Industrial Capabilities Assessments (ACA), trade-
- 44 off studies, tooling plans, make or-buy plans, manufacturing plans, and bills of material. Important
- 45 outputs include actions to reduce or handle remaining risks.
- 46 Figure 5-1 shows the P&D manufacturing and quality activities.
- 47

P&D	AS SEP TEMP Updates Updates Updates
CPD	LRIP OTRR IOT&E
A. DoD Acq. System	A.1 Provide Mfg. Updates to AS A.2 Support Program Mgmt. Reviews
B. Defense Contracting System	B.1 Provide Input to FRP RFP B.2 Provide Inputs to FRP SSP B.3 Provide Award Fee Criteria Performance Tracking B.4 Provide Mfg. Incentives Criteria Tracking B.5 Validate & Track Proposed Learning Curves
C. Surveillance System	C.1 Conduct Mfg./QA Performance Meetings Program Reviews
D. Technology & Industrial Base (IB)	D.1 Conduct Industrial D.2 Assess Mfg. D.3 Assess CTE D.4 Complete D.5 Perform IC D.6 Conduct IB Technology Voids Process Limitations ManTech Projects Analysis Risk Mitigation
E. Design	E.1 Assess E.2 Complete E.3 Conduct E.4 Design IPT Design IPT Matter Keylew Close Out Stabilize Demo Build Build Build Build Stabilize Demo KC Build B
F. Cost/Funding	F.1 Update Mfg. Cost Estimate F.2 Update Mfg. Cost Drivers w/Actuals F.3 Develop Mfg. Cost Mitigation/Maturation Plan F.2 Update Mfg. Budget
G. Materials Management	G.1 Manage Materials Cost G.2 Manage Materials Risk G.3. Identify Scale-Up Risk G.4 Review Contractor SCM Program G.5 Analyze Material Lead Times G.6 Investigate Alt. Sources G.7 Identify Alt. Sources G.8 Document DTC G.9 Review Critical Sources
H. Process Capability/Control	H.1 Mature Process Capability Studies H.3 Mature Critical Mfg. Processe Risk Reduction
I. Quality Management	I.1 Update I.2 Apply Quality I.3. Evaluate Quality Strategy Strategy Supplier Quality
J. Mfg. Workforce	J. 1 Verify Critical Skills Availability for LRIP Availability for FRP
K. Facilities	K.1 Assess Facility Availability K.2 Evaluate Special Tooling, Test, & Inspection Equipment
L. Manufacturing Mgmt./Control	L.1 Conduct Mfg. Planning L.2 Execute LRIP/FRP Mfg. Strategy
<u> </u>	



Figure 5-1. P&D Phase Manufacturing and Quality Activities

- 50 Specific requirements must be identified for inclusion in the statement of work for the production
- 51 phase. The particular requirements reflect the areas that have been determined to be of importance,
- 52 given the acquisition strategy of the program. Typical areas to be considered for inclusion are:
- Manufacturing management systems

5. Production and Deployment (P&D) Phase

- Work measurement
- Manufacturing data (including manufacturing plan updates)
- Initial production facilities
- Production and material control systems
- Manufacturing reporting systems (especially line of balance)
- Control of subcontractors and vendor
- 60 Make or Buy program
- 61 Government Furnished Property
- System audit
- 63 Technical data
- 64 Competition

Incentives may be included to motivate contractors to improve performance and control costs. Thebenefits attainable through use of multiyear contracting should also be explored.

- 67 The purpose of P&D is to produce items for the warfighter that will achieve operational capability
- and satisfy mission needs. In order to achieve those goals, the items being produced must have

69 achieved design stability, had their technologies matured and their manufacturing processes must be

- capable, stable and under control. There are essentially two related production efforts during the PD
- 71 phase: LRIP and FRP. LRIP is often identified as up to 10% of the estimated production volume.
- 72 LRIP typically demonstrates the production of articles beyond a pilot line environment. These items
- are typically built in a pilot line environment. All systems engineering/design requirements should
- have been met such that there are minimal system changes. Major system design features are stable
- and have been proven in test and evaluation. Materials are available to meet planned rate production
- schedules. Manufacturing process capability in a low-rate production environment is at an
- appropriate quality level to meet design key characteristic tolerances. Production risk monitoring is
- ongoing. LRIP cost targets have been met, and learning curves have been analyzed with actual data.
- 79 The cost model has been developed for the FRP environment and reflects the impact of continuous
- 80 improvement.
- 81 P&D phase objectives include all of the following:
- The production of authorized quantities; on time and within budget.
- To conduct technical reviews:
- 84 Integrated baseline review
- Operational test readiness review
- Physical configuration audit
- To create the following documents:
- 88 Acquisition baseline
- 89 Capability Production Document
- Systems Engineering Plan (SEP)

5. Production and Deployment (P&D) Phase

- Test and Evaluation Master Plan (TEMP)
- Programmatic Environmental, Safety and Occupational Health Evaluation (PESHE)Product
 support elements
- To achieve LRIP
- 95 To achieve FRP
- To refine logistics support plans
- 97 Important Manufacturing Considerations include:
- 98 Complete initial production facilities
- 99 Execute the manufacturing program
- 100 Integrate spares production
- 101 Maintain P
- 102 production surveillance
- Provide and support proposal efforts
- 104 Accomplish Value Engineering
- 105 Support technical reviews
- Accomplish second sourcing/component breakout
- 107 Complete Industrial Preparedness Planning
- Plan for the system transition/deployment/support
- 109 Develop inputs to key documents

110 A. DEPARTMENT OF DEFENSE (DOD) ACQUISITION SYSTEM



111

- 112 The Milestone C Decision will generally be either an LRIP or Limited Deployment and Operational
- 113 Test decision followed by an FRP or Full Deployment Decision (FDD). The initial production
- decision, based primarily on developmental testing results and usually also informed by an
- 115 operational assessment, commits the resources (i.e., authorizes proceeding to award the contract(s))
- required to enter production and begin deployment of the product. Evidence from testing that the
- 117 product design is stable is the critical consideration for this decision. The commitment to enter
- 118 production is very expensive and difficult to reverse.

119 Acquisition Strategy (AS)

- 120 At the end of the EMD, all of the information necessary to plan the detailed manufacturing
- 121 operations for the system should have been available. This information should be described in a

5. Production and Deployment (P&D) Phase

122 manufacturing plan covering the issues of manufacturing organization, make or buy planning,

- subcontract management, resources and manufacturing capability, and the detailed fabrication and
- assembly planning. The plan should also describe the types of GFP required and the specific need
- dates for it. The contractor management control systems, including those for configuration
 management, the control of subcontractors and manufacturing performance evaluation should be
- described in sufficient detail for the program management office to determine their expected utility.
- 128 The plan developed should also include consideration of the potential requirements for industrial
- 129 preparedness planning, including surge capability during the production phase and the post
- 130 production phase requirements for support to employment of the system in combat situations. The
- 131 development of this formal manufacturing plan contributes value to the program from two
- 132 standpoints. The primary benefit accrues from the fact that the contractor has to crystallize the
- 133 manufacturing planning to a point where it can be described in the detail required. The secondary
- benefit is the usability the plan provides to the program management office personnel. It serves as a
- 135 basis for a structured review of the contractor approach, the expected cost of the production phase
- 136 effort, and a fuller assessment of manufacturing risk. Where such a plan is not developed during the
- 137 EMD Phase there is often unnecessarily high cost and schedule turbulence at the front end of and
- 138 indeed throughout the production phase. Also, if there is no detailed plan in place there can be no
- 139 effective Program Office monitoring, assessing, scheduling review, testing, etc. In effect there is no
- 140 production program.

141 **Program Management Reviews**

142 Sources of data used to inform industrial and manufacturing readiness include: technical reviews and

- audits, Program Status Reviews, pre-award surveys, Production Readiness Reviews, Industrial
- 144 Capabilities Assessments, trade-off studies, tooling plans, make-or-buy plans, manufacturing plans,
- 145 and bills of material. An important output includes actions to reduce or address any remaining risks.

146 A.1 Provide All Manufacturing Updates to Acquisition Strategy

14/ Ivianufacturing and Quality 1	asks
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- Validate production quantities per year and the total planned production quantity.
- Finalize and validate the Production Plan.
- Ensure manufacturing risk assessments, configuration audits, production schedule reviews
 and production deliveries and events (including long lead, and multiple suppliers) are on the
 Program Schedule.
- Ensure all industrial base and any manufacturing/production risks and mitigation efforts are
 scheduled, funded and actively worked.
- Ensure specific breakout efforts for each major component or sub-system are being worked.
- Ensure the Manufacturing/Quality Organization or Lead is being effectively utilized.
- Validate all remaining or developing IB constraints, how they are being managed, and the plan and schedule for future assessments.

159 • 160 • 161 • 162 • 163 • 164 • 165 • 166 • 167 •	Estimate any risk of industry being unable to provide program design or manufacturing capabilities at planned cost and schedule. Validate the Manufacturing Management System and the Quality Management Systems being used in production and ensure they are minimizing cost, schedule, and performance risks throughout the product life cycle. Validate the make-or-buy approach and maintain access to competitive suppliers. Maintain and keep current a list of critical items and their sources. Ensure/verify all manufacturing processes have been effectively demonstrated in a manufacturing environment appropriate to the type of production that this program requires.
168 169 170 171 172 173 174 175 176 177	 The manufacturing environment should incorporate all of the key elements (equipment, personnel skill levels, materials, components, work instructions, tooling, etc.) required to produce production configuration items, subsystems or systems that meet design requirements in rate production To the maximum extent practical, the environment should utilize the same rate manufacturing processes scheduled to be used in production The Acquisition Strategy should thoroughly describe the production phase planning to assess and demonstrate that the manufacturing processes/capabilities required for production have been matured to a high enough level of confidence to ensure producing production configuration products in the production phase
178 • 179 180 181 182 183 184 185 186 187 188 189 •	 Ensure the Milestone C Acquisition Strategy reflects planned efforts that results in completion of manufacturing development and demonstrates: No significant manufacturing risks All manufacturing processes are under control An approved Capability Production Document (CPD) Adequate and efficient manufacturing capability Produces the minimum quantity necessary to provide production or production-representative articles for Initial Operational Test and Evaluation (IOT&E) Establishes an initial production baseline for the system Provides for an orderly increase in the production rate for the system Permits the collection of statistical process control data
190 191 192 193 194 195 196 197 198	 quantity changes in response to contingency needs. Consider these items in developing the strategy: Technology and Industrial Base, including small business Design Cost and Funding Materials Process Capability and Control Quality Management Manufacturing Personnel

5. Production and Deployment (P&D) Phase

199	0	Facilities
200	0	Manufacturing Management

201 Metrics

202 203 204 205		Have scheduled production quantities per year and the total planned production quantity been validated? Have these quantities been approved by all effected parties such as Testing, Contracting, Engineering, Manufacturing Planning, Subcontract Management, etc.?
206 207 208		Have you ensured that all manufacturing risk assessments, configuration audits, production schedule reviews and production deliveries and events (including long lead, and multiple suppliers) are on the Program Schedule?
209 210	•	Have you ensured that all industrial base and all remaining manufacturing/production risks and mitigation efforts are scheduled, funded and are being actively worked?
211 212		Have you ensured there are specific breakout efforts for each major component or sub-system are being worked?
213 214		Have you ensured the Manufacturing/Quality Organization or Lead is an active member of your team and are being effectively utilized?
215 216		Have you validated all remaining or developing IB constraints, how they are being managed, and the plan and schedule for future assessments?
217 218		Have you ensured all estimates of the risk of industry being unable to provide program design or manufacturing capabilities at your planned cost and schedule?
219 220	•	Have you validated that the Manufacturing Management System and the Quality Management Systems being used during production and ensured they are minimizing cost,
221 222 223	•	schedule, and performance risks throughout the product life cycle? Have you validated the make-or-buy approach and are you maintaining access to competitive suppliers?
224	•	Do you maintain and keep a current list of critical items and their sources?
225		Have you ensured/verified that all manufacturing processes have been effectively
226 227]	demonstrated in a manufacturing environment appropriate to the type of production that this program requires?
228		• During Production the manufacturing environment should incorporate all of the key
229		elements (equipment, personnel skill levels, materials, components, work instructions,
230		that meet design requirements in rate production
231		• To the maximum extent practical, the LRIP environment should utilize the same rate
233		manufacturing processes scheduled to be used in production
234		• The Acquisition Strategy should thoroughly describe the production phase planning to
235		assess and demonstrate that the manufacturing processes/capabilities required for
236		production have been matured to a high enough level of confidence to ensure producing
237		production configuration products in the production phase

238 239	•	Have you ensured the Milestone C Acquisition Strategy reflects planned efforts that results in completion of manufacturing development and demonstrates:
240 241 242 243 244 245 246 247 248		 No significant manufacturing risks All manufacturing processes are under control; An approved Capability Production Document; Adequate and efficient manufacturing capability; Produces the minimum quantity necessary to provide production or production-representative articles for IOT&E Establishes an initial production base for the system; Provides for an orderly increase in the production rate for the system; Permits the collection of statistical process control data?
249 250 251	•	Have you ensured the Acquisition Strategy addresses an adequate approach to making production rate and quantity changes in response to contingency needs? Have you considered these items in developing the strategy:
252 253 254 255 256 257 258 259 260		 Technology and Industrial Base, including small business, Design, Cost and Funding, Materials, Process Capability and Control, Quality Management, Manufacturing Personnel, Facilities, Manufacturing Management?
261	Tools	
262 263 264 265 266 267	•	 Acquisition Strategy Outline Integrated Master Plan/Integrated Master Schedule: Use MicroSoft Project Risk Management Plan Template; SEP Outline SEP Outline Manufacturing Plan Quality Assurance Plan
268 269 270 271 272 273 274	• • • •	Test and Evaluation Master Plan Outline Life Cycle Sustainment Plan Outline AS6500 Manufacturing Management System Checklist AS9100 Quality Management System Checklist ISO 9001 Quality Management System Checklist Manufacturing Readiness Level (MRL) Assessment Checklist Technology Readiness Level (TRL) Assessment Checklist

5. Production and Deployment (P&D) Phase

Industrial Base Assessment Survey Form Defense Contract management Agency (DCMA)
 Industrial Analysis Center

277 Resources

278 Acquisition Strategy Guide, DSMC, Dec 1999 • 279 Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct 2005 280 281 • SEP Outline, Apr 2011 282 • IEEE15288, System and Software Engineering, 2015 Test and Evaluation Management Guide, Dec 2012 283 • 284 • Life Cycle Sustainment Plan Content Guide 285 • DoDI 5000.02, Enclosure 2, 6.d., Jan 2017 286 AS6500 Manufacturing Management Program MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016 287 • 288 AS9100 Quality Systems – Aerospace, Sep 2016 • 289 • ISO 9001, Quality Management System, Sep 2016 290 MRL Deskbook Version 2016 • 291 Risk, Issue and Opportunity Management Guide, Jun 2015 • 292 • TRA Deskbook, Apr 2012 293 DoDI 4200.15, Manufacturing Technology (ManTech) Program, Dec 2003 • 294 DoD 5000.60-H DoD Handbook: Assessing Defense Industrial Capabilities, Apr 1996 •

295 A.2 Support Program Management Reviews

Sources of data used to inform industrial and manufacturing readiness include: technical reviews and
audits, Program Status Reviews, pre-award surveys, Production Readiness Reviews, Industrial
Capabilities Assessments, trade-off studies, tooling plans, make-or-buy plans, manufacturing plans,
and bills of material. An important output includes actions to reduce or address any remaining risks.

- 300 Manufacturing and Quality Tasks
- Identify any actual or potential quality, and/or manufacturing producibility risks associated
 with the proposed design during any review.
- Recommend mitigation plans for all quality and manufacturing risks identified during any review.
- Analyze all proposed design documentation submitted in support of reviews by applying
 design for manufacture and design for assembly principles to identify potential producibility
 risks associated with the proposed design change.
- In Production your key manufacturing readiness considerations include:
- 309 o Industrial base viability,
- o Design stability,

311		• Change Control
312		• Manufacturing process maturity,
313		• Supply chain management,
314		• Quality management,
315		• Facilities, and
316		 Manufacturing skills availability.
317	•	Other sources of industrial and manufacturing readiness data include:
318		• Technical reviews and audits,
319		• Program Status Reviews,
320		• Pre-award surveys,
321		 Production Readiness Reviews,
322		 Industrial Capabilities Assessments,
323		• Trade-off studies,
324		• Tooling plans,
325		• Make-or-buy plans,
326		• Manufacturing plans, and
327		• Bills of material.
328		• An important output includes actions to reduce or address any remaining risks.
329	Metri	cs
330	•	Have you identified any actual or potential quality, and/or manufacturing producibility risks
330 331	•	Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review?
330 331 332	•	Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that
330 331 332 333	•	Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review?
 330 331 332 333 334 	•	Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by
 330 331 332 333 334 335 	•	Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential
 330 331 332 333 334 335 336 	•	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change?
 330 331 332 333 334 335 336 337 	•	Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production:
 330 331 332 333 334 335 336 337 338 	• • •	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production: Industrial base viability,
 330 331 332 333 334 335 336 337 338 339 	•	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production: Industrial base viability, Design stability,
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 330 331 332 333 334 335 336 337 338 339 340 341 	•	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production: Industrial base viability, Design stability, Change Control Manufacturing process maturity,
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 330 331 332 333 334 335 336 337 338 339 340 341 342 343 	•	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production: Industrial base viability, Design stability, Change Control Manufacturing process maturity, Supply chain management, Quality management,
 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 	•	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production: Industrial base viability, Design stability, Change Control Manufacturing process maturity, Supply chain management, Quality management, Facilities, and
 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 	•	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production: Industrial base viability, Design stability, Change Control Manufacturing process maturity, Quality management, Facilities, and Manufacturing skills availability?
 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 	•	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production: Industrial base viability, Design stability, Change Control Manufacturing process maturity, Supply chain management, Facilities, and Manufacturing skills availability? Have you considered these other sources of industrial and manufacturing readiness data
 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 	•	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production: Industrial base viability, Design stability, Change Control Manufacturing process maturity, Supply chain management, Facilities, and Manufacturing skills availability? Have you considered these other sources of industrial and manufacturing readiness data during Production:
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 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 	•	 Have you identified any actual or potential quality, and/or manufacturing producibility risks associated with the proposed design during any review? Have you any recommend mitigation plans for any quality and/or manufacturing risks that you identified during any review? Have you analyzed all proposed design documentation submitted in support of reviews by applying design for manufacture and design for assembly principles to identify potential producibility risks associated with the proposed design change? Have you considered these key manufacturing readiness considerations during Production: Industrial base viability, Design stability, Change Control Manufacturing process maturity, Supply chain management, Facilities, and Manufacturing skills availability? Have you considered these other sources of industrial and manufacturing readiness data during Production: Technical reviews and audits, Program Status Reviews,

5. Production and Deployment (P&D) Phase

350		• Pre-award surveys,
351		 Production Readiness Reviews,
352		 Industrial Capabilities Assessments,
353		• Trade-off studies,
354		• Tooling plans,
355		• Make-or-buy plans,
356		• Manufacturing plans, and
357		• Bills of material?
358	Tools	
359	•	Operational Test Readiness Review Checklist
360	•	Production Readiness Review (PRR) Checklist (FRP Decision)
361	•	Manufacturing Readiness Assessment (MRA) Checklist
362	•	Technology Readiness Assessment (TRA) Checklist
363	•	Industrial Base Capability Assessment
364	Resou	irces
365	٠	Test and Evaluation Management Guide, Dec 2012
366	•	AS6500 Manufacturing Management Program
367	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
368	•	AS9100 Quality Systems – Aerospace, Sep 2016
369	•	ISO 9001, Quality Management System, Sep 2016
370	•	MRL Deskbook Version 2016
371	•	TRA Deskbook, Apr 2012
372	•	Risk, Issue and Opportunity Management Guide, Jun 2015
373	•	IEEE 15288.2, IEEE Standard for Technical Reviews and Audits on Defense Programs
374	•	Defense Manufacturing Management Guide for Program Managers, Chapter 3.7.4 Technical
375		Reviews, and Chapter 12.5 Technical Reviews and Audits

376 DODI 5000.60H Defense Industrial Capabilities Assessments •

B. DEFENSE CONTRACTING SYSTEM 377



378

379 Specific requirements must be identified for inclusion in the Request for Proposal (RFP)/statement of

380 work for the production phase. The particular requirements reflect the areas that have been

5. Production and Deployment (P&D) Phase

- determined to be of importance, given the acquisition strategy of the program. Typical areas to be
- 382 considered for inclusion are:
- Manufacturing management systems,
- Work measurement,
- Manufacturing data (including manufacturing plan updates),
- Initial production facilities,
- Production and material control systems,
- Manufacturing reporting systems (especially line of balance),
- Control of subcontractors and vendor,
- Make or Buy program,
- Government Furnished Property,
- System audit,
- Technical data, and
- **•** Competition.

395 **B.1.** Provide Input to Request for Proposal Full-Rate Production (RFP) (FRP)

396 (Provide topics, request data, etc. to the following proposal responses that you would expect the397 contractor to include in their proposals.)

398	Manufacturing and Quality Tasks
399 400	• The following RFP planning data topics should have significant Manufacturing, Industrial Base and Quality inputs.
401	 Manufacturing Management Plan.
402	 Quality Assurance Management Plan.
403	 Producibility Engineering Plan.
404	 Manufacturing and Producibility Trade Studies.
405	 Manufacturing Technology Investments.
406	• Award Fee/Incentive Fee Criteria.
407	• Make/Buy Plan.
408	• Technical Reviews (MRAs/PRR).
409	 Material Availability/Long Lead Procurement Analysis.
410	 Technical Data/Manufacturing Data.
411	 Process Capability Study.
412	 Work Measurement/Learning Curve Analysis.
413	 Manufacturing Reporting and Control Systems.
414	• Contractor maintained cost data/libraries associated with manufacturing processes and
415	technologies.
416	• Contractor maintained Cost of Quality data available.

417	Metri	CS
418	•	Have you provided significant Manufacturing, Industrial Base and Quality inputs to these
419		RFP planning data topics?
420		• Manufacturing Management Plan.
421		 Quality Assurance Management Plan.
422		• Producibility Engineering Plan.
423		• Manufacturing and Producibility Trade Studies.
424		• Manufacturing Technology Investments.
425		• Award Fee/Incentive Fee Criteria.
426		• Make/Buy Plan.
427		• Technical Reviews (MRAs/PRR).
428		• Material Availability/Long Lead Procurement Analysis.
429		• Technical Data/Manufacturing Data.
430		• Process Capability Study.
431		• Work Measurement/Learning Curve Analysis.
432		• Manufacturing Reporting and Control Systems.
433		• Contractor maintained cost data/libraries associated with manufacturing processes and
434		technologies.
455		o Contractor maintained Cost of Quanty data available.
436	Tools	
437	•	AS6500, Manufacturing Management System Checklist
438	•	AS9100, Quality Management System Checklist, Sep 2016
439	•	ISO 9001, Quality Management System Checklist, Sep 2016
440	•	IEEE 15288, System and Software Engineering, 2015
441	•	IG5315.204-5(b) Section L Guide and Template
442	•	IG5315.204-5(c) Section M Guide and Template
113	Resou	rces
444	Resou	
444	•	AS6500, Manufacturing Management System
445	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
446	•	AS9100, Quality Management System, Sep 2016
447	•	ISO9000, Quality Management System, Sep 2016
448	٠	IEEE 15288, System and Software Engineering, 2015
449	•	IG5315.204-5(b) Section L Guide
450	•	IG5315.204-5(c) Section M Guide
451	٠	MRL Deskbook Version 2016

5. Production and Deployment (P&D) Phase

452 **B.2.** Provide Inputs to Source Selection Plan (SSP) for Full-Rate Production

453 Capability reviews such as manufacturing capability reviews are a useful tool available during source

selections to assess the offerors' capability in selected critical process areas. Capability reviews may

455 be the appropriate means for evaluating program-specific critical processes such as systems

engineering, software development, configuration management, etc. The reviews would be useful to

- 457 supplement process past performance data to ascertain the risks in selecting a given offeror and to
- 458 assist in establishing the level of government oversight needed to manage the process-associated
- risks if that offeror is awarded the contract. The trade-off in determining whether or not to do acapability review would be the criticality of the process versus the time and resources to do the
- review versus the availability, adequacy, and currency of an offeror's process past performance data.
- 462 Manufacturing and Quality Tasks
- The following are some of the Manufacturing/Industrial Base/Quality inputs that should be included in a Production Source Selections Plan (SSP). However these are just some of the more universal inputs. Each program should spend significant time in identifying the appropriate inputs for their particular program.
- 467 o Manufacturing Readiness.
- Investments in advanced manufacturing technology production equipment, processes, and
 organization of work systems that build on workers' skill and experience, and work force
 skill development.
- 471 o Tooling, special tooling, special test equipment.
- 472 o Material handling, management, availability.
- 473 o Production capability and efficiency.
- 474 o Quality Management.
- 475 o Subcontractor Management.

476 Metrics

- 477 Have you made Manufacturing/Industrial Base/Quality inputs in your Production SSP? While • 478 these are just some of the more universal inputs. You should spend significant time in 479 identifying the appropriate inputs for your program. 480 • Have you made "Manufacturing Readiness" a topic in the SSP? 481 • Have you asked the contractor to address "Investments in advanced manufacturing 482 technology production equipment, processes, and organization of work systems that build 483 on workers' skill and experience, and work force skill development" in their response to 484 your RFP? 485
- 485 o Have you made "tooling, special tooling, special test equipment" a topic the contractor
 486 must address in their response to your RFP?
- 487 o Have you made "material handling, management and availability" a topic in your SSP
 488 input?
- 489 Have you made "production capability and efficiency" a topic in your SSP input?

Manufacturing and Quality Management Body of Knowledge

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5. Production and Deployment (P&D) Phase

490		• Have you made "Quality Management" a topic in your SSP input?
491		• Have you made "Subcontractor Management" a topic in your SSP input
492	Tools	
493	•	Source Selection Plan Template, (see applicable service document)
494	•	AS6500, Manufacturing Management System Checklist
495	•	AS9100, Quality Management System Checklist
496	•	ISO 9001, Quality Management System Checklist
497	•	IEEE 15288, System and Software Engineering
498	Resou	rces
499	•	DoD Source Selection Procedures Memo, Apr 2016
500	•	DoD Source Selection Procedures, Mar 2016
501	•	MIL-HDBK 2450, DoD Handbook for Preparation of Statement of Work, 1996
502	•	Source Selection Plan Guide, Apr 2017
503	•	AS6500, Manufacturing Management System
504	•	AS9100, Quality Management System, Sep 2016
505	•	ISO 9001, Quality Management System, Sep 2016
506	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
507	•	ISO 9001, Quality Management System
508	•	IEEE 15288, System and Software Engineering, 2015
509	•	DFARS 252.242-7004, Material Management and Accounting System (MMAS)
510	•	MIL-STD-882, DoD System Safety, May 2012
511	B.3.	Provide Award Fee Criteria Performance Tracking
510	Contro	ate should produce measurable performence outcomes that sumulatively contribute

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

517 Manufacturing and Quality Tasks

- The following lists some of the performance tracking measures that could be used on most
 production programs. Not all are appropriate to every program and too many on any program
 can lead to micro management of a program and lower effectiveness and efficiency.
 However, having some on any program are critical.
- 522 o Producibility packages released (#/%).
- 523 Materials characterized in production representative environment (#/%).
- 524 o Manufacturing Cost Reduction Efforts.

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525	0	Manufacturing Maturation Plan Risks Burned Down.
526	0	Variation/Variability Reduction efforts (initial yield rates/downward trend).
527	0	Manufacturing Processes defined and characterized.
528	0	Quality metric targets (such as SRR reductions).
529	0	Schedule performance.
530	Metrics	
531	• H	lave you ensured that the appropriate measures are included on your program?
532 533	0	Are you tracking your Producibility Packages released (#/%) against the anticipated total?
534 535	0	Are you tracking your Materials Characterized in production representative environment (#/%) against the anticipated total?
536	0	Are you tracking your Manufacturing Cost Reduction Efforts?
537	0	Are you tracking your Manufacturing Maturation Plan Risks burned down?
538 539	0	Are you tracking your Variation/Variability Reduction Efforts (Initial Yield Rates/Downward Trend)?
540	0	Are you tracking your Manufacturing Processes Defined and Characterized against the
541		anticipated total?
542	0	Are you tracking your Quality metric targets (such as SRR reductions) against the
543		anticipated total?
544	0	Are you tracking your Schedule performance?
545	Tools	
546	• A	ward Fee Template, (see applicable service templates)
547	Resource	es
548	• A	ir Force Award Fee Guide, Oct 2008 (Army and Navy guides available)
549	• S	ection L Guide, IG5315.204-5(b)
550	• S	ection M Guide, IG5315.204-5(c)
551	• A	S6500, Manufacturing Management System
552	• 19	SO 9001, Quality Management System, Sep 2016
553	• N	IRL Deskbook Version 2016
554	B.4. Pro	ovide Manufacturing Incentives Criteria Tracking
555	Manufac	cturing and Quality Tasks
556 557 558 559	• T u a: e:	The following lists some of the manufacturing incentives tracking measures that could be sed on most production programs. Not all are appropriate to every program and too many on ny program can lead to micro management of a program and lower effectiveness and fficiency. However, having some on any program are critical.

5. Production and Deployment (P&D) Phase

560	0	Organize for/incorporate quality and producibility.
561	0	Develop producibility infrastructure (software tools, training, design guides).
562	0	Investments in modern manufacturing methods and equipment (hardware and software).
563	0	Production cost reductions.
564	0	Quality Improvement goals.
565	Metrics	
566 567 568 569	• H. ap of ar	ave you included manufacturing incentives tracking measures on your program? Not all are propriate to every program and too many on any program can lead to micro management a program and lower effectiveness and efficiency. However, having some on any program e critical.
570 571	0 0	Have you organized your program for and quality and incorporated producibility? Have you developed producibility infrastructure (software tools, training, design guides)
572 573 574	0	for your program? Have you made investments in modern manufacturing methods and equipment (hardware and software) in your program?
575	0	Have you incorporated production cost reductions in your program?
576	0	Have you developed and are you tracking Quality Improvement goals in your program?
577	Tools	
578	• A	ward/Incentive Fee Plan
578 579	• A	ward/Incentive Fee Plan s
578 579 580	 A Resource Fe 	ward/Incentive Fee Plan s ederal Acquisition Regulation (FAR) Subpart 16.4 Incentive Contracts
578579580581	 A Resource Fe D 	ward/Incentive Fee Plan s ederal Acquisition Regulation (FAR) Subpart 16.4 Incentive Contracts oD/NASA Incentive Contracting Guide
 578 579 580 581 582 	 A Resource Fe De A 	ward/Incentive Fee Plan s ederal Acquisition Regulation (FAR) Subpart 16.4 Incentive Contracts oD/NASA Incentive Contracting Guide ward Fee Guide (see service specific guides)
 578 579 580 581 582 583 	 A Resource Fe Do A So 	ward/Incentive Fee Plan s ederal Acquisition Regulation (FAR) Subpart 16.4 Incentive Contracts oD/NASA Incentive Contracting Guide ward Fee Guide (see service specific guides) ociety of Automotive Engineers (SAE) AS6500, Manufacturing Management System
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578 579 580 581 582 583 584 585 586 587 588	 A Resource Fe Do A So In 20 M B.5. Val Cost Redu 	 s ederal Acquisition Regulation (FAR) Subpart 16.4 Incentive Contracts oD/NASA Incentive Contracting Guide ward Fee Guide (see service specific guides) ociety of Automotive Engineers (SAE) AS6500, Manufacturing Management System ternational Organization for Standardization (ISO) 9001, Quality Management System, Sep RL Deskbook Version 2016 iidate and track proposed Learning Curves action Initiatives (CRIs) should be formally documented and the documentation must
578 579 580 581 582 583 584 585 586 587 588 588 589	 A Resource Fe Do A So In 20 M B.5. Val Cost Redu include th 	 s ederal Acquisition Regulation (FAR) Subpart 16.4 Incentive Contracts oD/NASA Incentive Contracting Guide ward Fee Guide (see service specific guides) ociety of Automotive Engineers (SAE) AS6500, Manufacturing Management System ternational Organization for Standardization (ISO) 9001, Quality Management System, Sep RL Deskbook Version 2016 lidate and track proposed Learning Curves action Initiatives (CRIs) should be formally documented and the documentation must e baseline ("before" implementation) costs and "after" costs, as well as the nonrecurring
578 579 580 581 582 583 584 585 586 587 588 589 590	 A Resource Fe Do A So In 20 M B.5. Val Cost Redu include th costs to in 	 s ederal Acquisition Regulation (FAR) Subpart 16.4 Incentive Contracts oD/NASA Incentive Contracting Guide ward Fee Guide (see service specific guides) ociety of Automotive Engineers (SAE) AS6500, Manufacturing Management System ternational Organization for Standardization (ISO) 9001, Quality Management System, Sep 016 RL Deskbook Version 2016 idate and track proposed Learning Curves action Initiatives (CRIs) should be formally documented and the documentation must e baseline ("before" implementation) costs and "after" costs, as well as the nonrecurring
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578 579 580 581 582 583 584 585 586 587 588 589 590 591 592	 A Resource Fe D A So In 20 M B.5. Val Cost Reduinclude that were 	 ward/Incentive Fee Plan s ederal Acquisition Regulation (FAR) Subpart 16.4 Incentive Contracts oD/NASA Incentive Contracting Guide ward Fee Guide (see service specific guides) ociety of Automotive Engineers (SAE) AS6500, Manufacturing Management System ternational Organization for Standardization (ISO) 9001, Quality Management System, Sep 016 RL Deskbook Version 2016 iidate and track proposed Learning Curves action Initiatives (CRIs) should be formally documented and the documentation must e baseline ("before" implementation) costs and "after" costs, as well as the nonrecurring mplement the initiative. difficult to distinguish initiatives that are "over and above" the historical learning curves already used to estimate the program costs. Historical learning curves usually include some

new CRIs is to determine if they are truly over and above what has been done in the past. Generally,

5. Production and Deployment (P&D) Phase

595 initiatives that reduce the scope of work can be considered over and above, but ones that improve the 596 efficiency of the work must be more carefully evaluated.

597 Manufacturing and Quality Tasks

- 598 Significant effort must be initiated determining what should be an appropriate learning curve • 599 for the program. The large dollar amounts that go into the production effort for a relatively 600 short period of time make the learning curve an important aspect of any cost reduction effort. 601 Any changes to processes or design or materials at this stage will significantly impact the 602 overall program cost by negating the previous process learning and lowering the curve. To be effective the learning curve must first establish expected cost and time then using the 603 scheduled effort how much each item or lot should cost and how much less each successive 604 item should cost. Without this base lining an effective and accurate learning curve is not 605 606 possible.
- Establish the learning curve based on appropriate factors such as:
- 608 o Worker learning
- 609 o Supervisor learning
- 610 o Reductions in crowded workstations
- 611 o Tooling improvements
- 612 Design producibility improvements
- 613 o Improved work methods
- 614 o Improved planning and scheduling
- 615 o Increased lot sizes
- 616 o Reduced engineering change activity
- 617 o Reduction in scrap and rework
- 618 Better operation sequencing and synchronizations
- Using previous cost models and actuals establish the expected cost of the first items.
- Using the learning curve formula establish how much cost reduction is possible using
 expected schedule, production amounts, and process times.
- Apply the curve against the program schedule and determine the expected cost reductions.

623 Metrics

- Based on the above factors:
- 625 Are your processes stable?
- 626 Are your materials stable?
- 627 o Is your schedule stable?
- 628 Can you determine an appropriate learning curve and base line?

629 **Tools**

- Learning Curve Estimator
- Manufacturing Cost Estimating Worksheet

5. Production and Deployment (P&D) Phase

632 Resources

- IEEE 15288.2, System and Software Engineering, 2015
- 634 Defense Manufacturing Management Guide for Program Managers, Chapter 9.8 Learning
 635 Curve
- Learning Curve Methodology for Cost Analysis, Oct 1967
- 637

638 C. SURVEILLANCE SYSTEM



640 C.1. Conduct Manufacturing/Quality Assurance (QA) Performance Meetings

641 Compliance to a standard such as ISO 9001 or AS9100, does not, in itself, guarantee product or

642 service quality. These standards are management system standards that identify requirements for

643 processes within an organization, describe expected tasks and outcomes, and explain how the

644 processes and tasks integrate to produce required inputs and outputs. Standards are meant to enable

645 the organization to develop a set of processes that, if done by qualified persons using appropriate

tools and methods with appropriate leadership involvement, will enable a capability for delivering

- 647 high quality products or services.
- 648 Product or service quality is achieved through the implementation of a strategic plan to integrate all
- business and technical functions that result in the consistent application of proven, capable processes
- 650 within an organization. Managers must ensure that all management systems are working toward the
- same goals and are not creating conflicting or dysfunctional behavior. Implementing a standard is of
- 652 little use if the financial system rewards individuals for delivering non-conforming products/services.
- Because everything a contractor does should be related to the quality of its products or services, a
- 654 contractor's quality management system should be the basis for integrating all other management
- 655 systems within an enterprise.

656 Manufacturing and Quality Tasks

Include quality management as a selection factor and look for the following elements of a qualitymanagement system in proposals:

- Effective policies and procedures that encourage the use of the quality system;
- Organizations with defined authorities and responsibilities;

- 661 Objectives to drive people, processes, and the system; • Method to analyze and resolve quality problems; 662 • 663 Metrics that reflect desired outcomes: • 664 Interacting processes to transform inputs into outputs; and • Records as evidence of what happened. 665 • 666 Evaluate Manufacturing and Quality Impacts of Factors such as: 667 • **Technical Performance Production Performance** 668 • 669 • Quality Assurance 670 *Finance • 671 *Accounting • 672 Government Property Control • 673 **Transportation and Packaging** • 674 *Security • 675 Plant Safety • 676 Environmental/Energy Compliance • 677 *Flight Operations/Safety • 678 *Other functional areas should be included in reviews. It is important to understand how 679 these non-manufacturing areas can and will impact the manufacturing function. 680 Metrics 681 Have you used quality management as a proposal selection factor and did you find the following 682 elements of a quality management system in the proposals you evaluated? 683 Effective policies and procedures that encouraged the use of the quality system; • 684 Evidence that organizations have defined authorities and responsibilities for quality; • 685 • Written quality objectives and goals to drive people, processes, and the quality system; 686 Did you find evidence of methods to be used to analyze and resolve quality problems; • Established detailed metrics that reflect desired program outcomes; 687 • 688 Are there interacting processes that will transform inputs into outputs; and • 689 Are there records that are maintained that establish evidence of what happened. • 690 You should evaluate impact of the following factors on Manufacturing and Quality: 691 **Technical Performance** •
 - 692•Production Performance
 - 693• Quality Assurance
 - 694 *Finance
 - 695 *Accounting
 - 696 Government Property Control
 - Transportation and Packaging

5. Production and Deployment (P&D) Phase

698	•	*Security
699	•	Plant Safety
700	•	Environmental/Energy Compliance
701	٠	*Flight Operations/Safety
702		
703		*While all of these are not Manufacturing and Quality factors they can each have a severe
704		impact.
705	Tools	
706	•	DCMA Program Assessment Report
707	Resou	rces
708	•	DCMA-INST-204 Manufacturing and Production
709	•	DCMAINST-205, Major Program Support
710	•	DCMAINST-207, Engineering Surveillance
711	•	DCMAINST-219, SCM Risk Management
712	•	DCMAINST-309, Government QA Surveillance Planning
713	•	DCMAINST-401, Industrial Analysis
714	•	AS6500, Manufacturing Management Program
715	•	AS9100, Quality Management System, 2015
716	•	ISO9001, Quality Management System, 2015
717	•	IEEE 15288.2, Systems and Software Engineering, 2015
718	•	DD 1423, Contract Data Requirements List
719	C.2.	Participate in Program Reviews
720	The Pr	ogram Support Assessment (PSA) is conducted to provide insight into current and future
721	progra	m execution through detailed analysis using the "Defense Acquisition Program Support
722	(DAPS	S) Methodology." OSD system assessment teams apply the DAPS methodology to Major

723 Defense Acquisition Programs (MDAPs) approaching a Defense Acquisition Board (DAB) review.

DAPS, however, is also a powerful self-assessment tool for the program manager to use for technical

- evaluation of a program's systems engineering process details and health.
- The DAPS methodology addresses the systems engineering policies set forth by the Defense
- Acquisition Executive. These policies foster effective systems engineering practices on all programs,
- helping the program manager attain success in the acquisition and support life cycle. The thorough
- application of the DAPS methodology can contribute to improved balance of cost, schedule,
- performance, and risk.
- 731 The DAPS Methodology is a guidebook for conducting PSRs that will assist program managers
- 732 prepare for Milestone A, B, and C decision reviews. It contains a listing of programmatic and

5. Production and Deployment (P&D) Phase

- technical areas, sub-areas, and factors, developed to be both broad in scope, as well as specific
- (detailed) enough to enable application to programs of all types. The DAPS methodology was
- constructed from numerous documents in the Defense acquisition community, and exploits the expert
- knowledge of "greybeard" human resources with years of acquisition experience in both government
- and industry. Sources include the Software Engineering Institute's Capability Maturity Model and
- 738 Capability Maturity Model Integration, NAVAIR Systems Engineering Technical Resources
- 739 Handbook, Air Force assessment guidance, Manufacturing Best Practices/Willoughby Templates,
- OSD Acquisition guidelines and policies, and many subject matter experts from across the DoD
- 741 community.

742 Manufacturing and Quality Tasks

- Conduct Production Program Assessments:
- 744 o Technical Performance
- 745 o Production Performance
- 746oQuality Assurance
- 747 o *Finance
- 748 o *Accounting
- 749oGovernment Property Control
- 750 o Transportation and Packaging
- 751 o *Security
- 752oPlant Safety
- 753 o Environmental/Energy Compliance
- 754 o *Flight Operations/Safety
- *Other functional areas should be included in the reviews. It is important to understand
 how these non-manufacturing areas can and will impact the manufacturing function.
- Identify, capture, and address any manufacturing concerns identified during testing.

759 Metrics

755

- Are Manufacturing and Quality personnel participating in the appropriate System Engineering
- 761 Technical Reviews and Program Management Reviews?... There are many other reviews that can
- also be used to get an understanding of how the program is progressing. While your immediate
- concern is the Manufacturing and Quality area, your insight may provide other technical experts with
- a valuable perspective and bring out other program aspects that may not be readily visible.
- Ensure technical experts in the following areas are available to support your reviews:
- 766• Technical Performance
- Production Performance
- 768• Quality Assurance
- *Finance

5. Production and Deployment (P&D) Phase

- 770 *Accounting
- Government Property Control
- Transportation and Packaging
- *Security
- Plant Safety
- Environmental/Energy Compliance
- *Flight Operations/Safety
- Have you identified, captured, and addressed all manufacturing concerns identified during testing?
- These issues are of paramount concern at this time. They will frequently lead to design changes to
- "fix" the problem in production. These are some of the most critical cost and schedule breakers youwill have to deal with.

781 **Tools**

• DCMA Program Assessment Report

783 **Resources**

- DCMA-INST-204 Manufacturing and Production
- DCMA--INST-205, Major Program Support
- DCMA--INST-207, Engineering Surveillance
- DCMA--INST-219, SCM Risk Management
- DCMA--INST-309, Government QA Surveillance Planning
- DCMA--INST-401, Industrial Analysis

790 D. TECHNOLOGY AND INDUSTRIAL BASE



791

792 The EMD Acquisition Strategy should have highlighted the strategy for assessing the manufacturing 793 processes to ensure they have been effectively demonstrated in an appropriate environment, such as a 794 pilot line environment, prior to Milestone C. The manufacturing environment should incorporate key

elements (equipment, personnel skill levels, materials, components, work instructions, tooling, etc.)

required to produce production configuration items, subsystems or systems that meet design

requirements in low-rate production. To the maximum extent practical, the environment should

tilize rate production processes using production processes forecasted to be used in LRIP.

- The Acquisition Strategy should strategically describe the EMD phase planning to assess and
- 800 demonstrate that the manufacturing processes/capabilities, required for production will have been
- 801 matured to a level of high confidence for building production configuration products in the P&D
- 802 phase.
- 803 For Milestone C, key manufacturing readiness considerations include:
- 804 industrial base viability
 805 design stability
 806 process maturity
 807 supply chain management
 808 quality management
- facilities
- manufacturing skills availability
- 811 The development of the Acquisition Strategy should include results of industrial base capability
- 812 (public and private) analysis to design, develop, produce, support, and, if appropriate, restart an
- 813 acquisition program. This includes assessing manufacturing readiness and effective integration of
- 814 industrial capability considerations into the acquisition process and acquisition programs ensuring the
- 815 sufficient maturity before production begins. For applicable products, the Acquisition Strategy
- should also address the approach to making production rate and quantity changes in response to
- 817 contingency needs.
- 818 Consider these items in developing the strategy:
- Technology and Industrial Base, including small business
- 820 Design
- Cost and Funding
- Materials
- Process Capability and Control
- Quality Management
- Manufacturing Personnel
- Facilities
- Manufacturing Management
- 828 Sources of data to inform industrial and manufacturing readiness could include; technical reviews
- 829 and audits, Program Status Reviews, pre-award surveys, Production Readiness Reviews, Industrial
- 830 Capabilities Assessments, trade-off studies, tooling plans, make-or-buy plans, manufacturing plans,
- and bills of material. An important output includes actions to reduce or address any remaining risks.
- 832 The Milestone C Acquisition Strategy should provide the status of the assessments of the
- 833 manufacturing processes highlight needed steps to progress from an EMD manufacturing
- 834 environment to an LRIP environment.

5. Production and Deployment (P&D) Phase

- 835 For the FRP Decision Review Acquisition Strategy update, the Program should identify remaining
- risks prior to a production go-ahead decision. Key considerations should include industrial base
- viability, design stability, process maturity, supply chain management, quality management, and
- facilities and manufacturing skills availability. Sources of data could include technical reviews and
- audits, Program Status Reviews, pre-award surveys, Production Readiness Reviews, Industrial
- 840 Capabilities Assessments, trade-off studies, tooling plans, make-or-buy plans, manufacturing plans,
- and bills of material. Important outputs include actions to reduce or handle remaining risks.

842 D.1. Industrial Capabilities (IC) Assessment

- 843 The program office should assess the impact of programmatic decisions on the national and
- international NTIB supporting U.S. defense to satisfy the requirements of 10 USC 2440 and DFARSubpart 207.1.

846 Manufacturing and Quality Tasks

- 847 Overall Industrial Capabilities Assessments (ICAs) should address critical sub-tier, as well as prime
 848 contractor capabilities and should include:
- New and unique capabilities that must be developed or used to meet program needs;
- Identifying DOD investments needed to create new or enhance existing industrial
 capabilities. This includes any new capability (e.g. skills, facilities, equipment, etc.);
- Identifying new manufacturing processes or tooling required for new technology.
- Funding profiles must provide for up front development of manufacturing processes/tooling
 and verification that new components can be produced at production rates and target unit
 costs;
- Identifying exceptions to FAR Part 45, which requires contractors to provide all property
 (equipment, etc.) necessary to perform the contract;
- Program context in overall prime system and major subsystem level industry sector and market;
- Strategies to address any suppliers considered to be vulnerable;
- Risks of industry being unable to provide new program performance capabilities at planned cost and schedule;
- Alterations in program requirements or acquisition procedures that would allow increased use
 of non-developmental or commercial capabilities;
- Strategies to deal with product or component obsolescence, given DOD planned acquisition
 schedule and product life;
- Strategies to address reliability issues (i.e., tampering, potential interrupted delivery from non-trusted sources, etc.) associated with commercial components for sensitive applications; and

5. Production and Deployment (P&D) Phase

870 871	• Strategies to utilize small business, including small disadvantaged business, women- owned small business, veteran-owned small business, service-disabled veteran-owned small business
872	and small businesses located in Historically Underutilized Business Zones.
873	 Industrial Capability Assessment has been completed and all issues mitigated.
874	• Industrial capability is in place to support LRIP.
875	 Industrial capability will be in place to support Production.
876	• Assess the labor/facility availability by understanding labor contracts and facility leases for
8//	the production schedule.
878	• Industrial capability to support LRIP/Production has been analyzed. Sole/single/foreign
8/9	sources stability is being assessed/monitored.
880	• Conduct Logistics analysis.
881 882	• Investigate manufacturing, re-manufacturing, and overhaul opportunities which have high potential impact for reducing life cycle costs and depot operations.
883 884 885	• Assess the impact of programmatic decisions on the national and international technology and industrial base. Overall Industrial Capabilities Assessments (ICAs) should address critical sub-tier, as well as prime contractor capabilities and should include:
886 887 888 889 890 891 892	 new and unique capabilities that must be developed or used to meet program needs identify DoD investments needed to create new or enhance existing industrial capabilities. This includes any new capability (e.g. skills, facilities, equipment). identify new manufacturing processes or tooling required for new technology. funding profiles must provide for up front development of manufacturing processes/tooling and verification that new components can be produced at production rates and target unit costs.
893 894	• Assess the overall prime system and major subsystem level industry sector and market strategies to address any suppliers considered to be vulnerable
895 896	 Assess risks of industry being unable to provide new program performance capabilities at planned cost and schedule.
897	 Assess alterations in program requirements or acquisition procedures that would allow
898	increased use of non-developmental or commercial capabilities
899 900	 Assess strategies to deal with product or component obsolescence, given DoD planned acquisition schedule and product life
901	Metrics
902 903	In your overall Industrial Capabilities Assessments (ICAs) have you addressed critical sub-tier, as well as prime contractor capabilities and did you verify that:
904 905	• All new and unique capabilities that must be developed or used to meet program needs will be available?
906 907	• Did you identify all DOD investments needed to create new or enhance existing industrial capabilities? This includes any new capability (e.g. skills, facilities, equipment, etc.).

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5. Production and Deployment (P&D) Phase

908 • 909 • 910 911 912 • 913 914 •	Did you identify all new manufacturing processes or tooling required for new technology? Have you ensured that funding profiles provide for up front development of manufacturing processes/tooling and verification that new components can be produced at production rates and target unit costs? Did you identify any exceptions to FAR Part 45, which require contractors to provide all property (equipment, etc.) necessary to perform the contract? Have you identified all program context in the overall prime system and major subsystem
915 916 917 918	level industry sector and market? Have you identified any strategies to address any suppliers considered to be vulnerable? Have you identified any risks of industry being unable to provide new program performance canabilities at planned cost and schedule?
919 920 921 922	Have you identified any alterations in program requirements or acquisition procedures that would allow increased use of non-developmental or commercial capabilities? Have you identified adequate strategies to deal with product or component obsolescence, given DOD planned acquisition schedule and product life?
923 • 924 925 926	Have you identified adequate strategies to address reliability issues (i.e. , tampering, potential interrupted delivery from non-trusted sources, etc.) associated with commercial components for sensitive applications; and
926 • 927 928 929	business, women- owned small business, veteran-owned small business, service-disabled veteran-owned small business and small businesses located in Historically Underutilized Business Zones?
930 • 931 • 932 • 933	Has your Industrial Capability Assessment been completed and all issues mitigated? Have you verified that the required industrial capability is in place to support LRIP? Have you ensured that the required industrial capability will be in place to support Production?
934 • 935 936 • 937 •	Have you assessed the labor/facility availability by understanding labor contracts and facility leases for the production schedule?Has the industrial capability to support LRIP/Production been analyzed?Are all sole/single/foreign sources stability issues being assessed/monitored?
938 • 939 940	 Have you conducted a thorough logistics analysis? Have you investigated manufacturing, re-manufacturing, and overhaul opportunities which have high potential impact for reducing life cycle costs and depot operations?
941 • 942 943 • 944	Have you assessed the impact of programmatic decisions on the national and international technology and industrial base? Have you ensured your Industrial Capabilities Assessments (ICAs) address critical sub-tier, as well as prime contractor capabilities and includes:
945 946 947	 Any new and unique capabilities that must be developed or used to meet program needs? Identity of all DoD investments needed to create new or enhance existing industrial capabilities?

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948 949 950 951 952	 This includes any new capability (e.g. skills, facilities, equipment). Identity of all new manufacturing processes or tooling required for new technology? Planned funding profiles which provide for up front development of manufacturing processes/tooling and verification that new components can be produced at production rates and target unit costs?
953 954 955 956 957 958 959 960	 Have you assessed the overall prime system and major subsystem level industry sector and market strategies to address any suppliers considered to be vulnerable? Have you assessed risks of industry being unable to provide new program performance capabilities at planned cost and schedule? Have you assessed alterations in program requirements or acquisition procedures that would allow increased use of non-developmental or commercial capabilities? Have you assessed strategies to deal with product or component obsolescence, given DoD planned acquisition schedule and product life?
961	Tools
962	Industrial Base Assessment Survey Form, DCMA Industrial Analysis Center
963	MRL Assessment Checklist for Technology and Industrial Base thread
964	Resources
965	• 10 USC 2440, Technology and Industrial Base
966	• 10 2501, National Security Objectives Concerning National Technology and Industrial Base
967	• 10 2503, Analysis of the Technology and Industrial Base
968	DoDI 5000.60H Defense Industrial Capabilities Assessments
969	MRL Deskbook Version 2016
970	D.2. Manufacturing Technology Voids
971	The objective of the ManTech program is to improve performance while reducing acquisition cost by
972	developing, maturing and transitioning advanced manufacturing technologies. The manufacturing
973	feasibility assessment should identify high risk manufacturing process areas that may require
974	investments in ManTech or other programs. These investments must be identified early so that these
975	manufacturing capabilities will be matured on time to support rate production.
976	Manufacturing and Quality Tasks
977	• Ensure no new ManTech voids have surfaced.
978	• Evaluate ongoing ManTech efforts and determine if they can be applied to your program.
979	Metrics
980	• Have you ensured no new ManTech voids have surfaced?
5. Production and Deployment (P&D) Phase

981 982	• Have you evaluated ongoing ManTech efforts to determin program in time for Production?	e if they can be applied to your
983	Tools	
004		
984	• Army Man Lech Proposal Rating spreadsheet	
985	• Man Leon Phase I project questionnaire	
980	• MRL Assessment Checklist for Technology and Industrial	Base thread
987	IRL Assessment Checklist	
988	Resources	
989	Defense Production Act, Title III	
990	• DoDD 4200.15, ManTech	
991	• DoDI 5000.02	
992	MRL Deskbook Version 2016	
993	• Defense Manufacturing Management Guide for PMs, Cha	pter 8, Technology Development
994	and Investments	
995	• Technology Readiness Assessment Guidance, Apr 2011	
996	• Service ManTech guidance, e.g. Air Force Technology an	d Transition Strategy Guidebook,
997	Nov 2010	
998	D.3. CTE Process Limitations	
000	If a platform or system depends on specific technologies to meet s	wstem operational threshold
1000	requirements in development production operation and sustainm	pent and if the technology or its
1000	application is either new or novel then that technology is consider	red a critical or enabling
1002	technology.	
1003	Manufacturing and Quality Tasks	
1004	These critical technology elements (CTEs) are evaluated to assess	technology maturity.
1005	• Ensure all CTE limitations have been identified and all CT	TE risks have associated mitigation

- 1006 efforts.
- 1007 Metrics
- Have you ensured all CTE limitations have been identified and all CTE risks have associated mitigation efforts?
- 1010 **Tools**
- 1011 Producibility Assessment Worksheet (PAWs)
- 1012 Technology Readiness Assessment
- 1013 TRL Calculator

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5. Production and Deployment (P&D) Phase

• MRL Assessment Checklist for Technology and Industrial Base thread

1015 **Resources**

- 1016 NAVSO P-3687Producibility Systems Guidelines, Dec 1999Technology Readiness
 1017 Assessment Deskbook, Jul 2009
- 1018 Technology Readiness Assessment Guidance, Apr 2011
- DoDI 5000.02, 5d(4)(b)3. And 5d(4)(c)
- Defense Acquisition Program Support Methodology, Ver. 3.0
- MRL Deskbook Version 2016

1022 D.4. ManTech Projects

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. Technologies with generic application required for defense systems and having
high technical and financial risk characterize the projects with the highest priority for ManTech
funding.

1028 Manufacturing and Quality Tasks

- 1029 ManTech projects demonstrate production application of emerging technologies.
- Ensure primary manufacturing technology efforts are concluding, and improvement efforts are continuing.
- Ensure required manufacturing technology development solutions have been demonstrated in
 LRIP.
- Validate required manufacturing technology solutions before the FRP decision.

1035 Metrics

1036	٠	Have you ensured all primary manufacturing technology efforts are concluding, and
1037		improvement efforts are continuing?
1038	•	Have you ensured all required manufacturing technology development solutions have been
1039		demonstrated in LRIP?
1040	•	Have you validated all required manufacturing technology solutions before the FRP
1041		decision?
1042	Tools	
1043	•	Army ManTech Proposal Rating spreadsheet
1044	•	ManTech Phase I project questionnaire
1045	•	MRL Assessment Checklist for Technology and Industrial Base thread
1046	•	TRL Assessment Checklist

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5. Production and Deployment (P&D) Phase

1047 **Resources**

1048 Defense Production Act. Title III DoDD 4200.15, ManTech 1049 1050 DoDI 5000.02 • 1051 • MRL Deskbook Version 2016 1052 • Defense Manufacturing Management Guide for PMs, Chapter 8, Technology Development 1053 and Investments 1054 Technology Readiness Assessment Guidance, Apr 2011 Service ManTech guidance, e.g. Air Force Technology and Transition Strategy Guidebook, 1055 1056 Nov 2010

1057 **D.5. IC Analysis**

- 1058 Industrial Base Assessments are conducted using a standardized questionnaire which they send out to
- 1059 companies of interest and they complete the survey. After the survey has been completed a small
- 1060 team visits the company to follow-up on the questions and to get a tour of the facilities.

1061 Manufacturing and Quality Tasks

- The ICA questionnaire addresses some of the following IB considerations:
- 1063 o Suppliers name, location, etc.
- 1064 o Company Ownership (public or private)
- 1065 o Facility Size and other facility information
- 1066 o Sales and sales backlog
- 1067oDistribution or Sales Mix (% government vs commercial)
- 1068 o DOD Programs Supported
- 1069 o Significance of Current Program to overall sales
- 1070 o Maturity of product technology
- 1071 o Production Status
- Industry Status (consolidations, rising or falling market, etc.)
- 1073 Unique or Critical Manufacturing Processes
- Technology Issues (Obsolescence, etc.)
- Vendor or Supply Chain issues
- 1076 Industrial Base Risks
- 1077 Production Rate
- Ensure all Industrial Capabilities risk has been identified and all IC risks have associated mitigation efforts.

1080 Metrics

Did the ICA addresses the following IB considerations?
Suppliers name, location, etc.
Company Ownership (public or private)

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5. Production and Deployment (P&D) Phase

1084	 Facility Size and other facility information
1085	• Sales and sales backlog
1086	 Distribution or Sales Mix (% government vs commercial)
1087	 DOD Programs Supported
1088	 Significance of Current Program to overall sales
1089	 Maturity of product technology
1090	 Production Status
1091	• Did the ICA address Industry Status (consolidations, rising or falling market, etc.)?
1092	• Did the ICA address Unique or Critical Manufacturing Processes?
1093	• Did the ICA address Technology Issues (Obsolescence, etc.)?
1094	• Did the ICA address Vendor or Supply Chain issues?
1095	• Did the ICA address Industrial Base Risks?
1096	• Did the ICA address Production Rate?
1097	• Have you insured all Industrial Capabilities risk have been identified and all IC risks have
1098	associated mitigation efforts?
1099	Tools
1100	Industrial Base Assessment Survey Form, DCMA Industrial Analysis Center
1101	MRL Assessment Checklist for Technology and Industrial Base thread
1102	Resources
1103	• 10 USC 2440, Technology and Industrial Base
1104	• 10 2501, National Security Objectives Concerning National Technology and Industrial Base
1105	• 10 2503, Analysis of the Technology and Industrial Base
1106	DoDI 5000.60H Defense Industrial Capabilities Assessments
1107	MRL Deskbook Version 2016
1108	D.6. IB Risk Mitigation
1109	Manufacturing and Quality Tasks
1110	• Develop potential alternate sources as necessary
1111	 Ensure needed sources are available multi-sourcing where cost-effective or necessary to
1112	mitigate risk.
1113	 Industrial capability available to support modifications upgrades surge and other potential
1114	manufacturing requirements.
	······································
1115	Metrics
1116	• Have you developed potential alternate sources as necessary?
1117	• Have you ensured needed sources will be available, multi-sourcing where cost-effective or
1118	necessary to mitigate risk?

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5. Production and Deployment (P&D) Phase

- Have you ensured sufficient industrial capability will be available to support modifications,
- 1120 upgrades, surge and other potential manufacturing requirements?

1121 **Tools**

• Manufacturing/QA Risk Mitigation Plan (no Template available)

1123 **Resources**

- DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities, Part II, Chapter 5
 Identify and evaluate Alternative Actions, Apr 1996
- MRL Deskbook Version 2016, Chapter 5.2 Development of a Manufacturing Maturation
 Plan

1128 **E. DESIGN**

1129



1130 E.1. Manufacturing Capability

1131 The development of the Acquisition Strategy should include results of industrial base capability 1132 (public and private) analysis to design, develop, produce, support, and, if appropriate, restart an 1133 acquisition program. This includes assessing manufacturing readiness and effective integration of 1134 industrial capability considerations into the acquisition process and acquisition programs. For 1135 applicable products, the Acquisition Strategy should also address the approach to making production 1136 rate and quantity changes in response to contingency needs. Consider these items in developing the 1137 strategy:

- 1138 Technology and Industrial Base, including small business,
- 1139 Design,
- Cost and Funding,
- Materials,
- Process Capability and Control,
- Quality Management,
- Manufacturing Personnel,
- Facilities, and
- Manufacturing Management.

5. Production and Deployment (P&D) Phase

1147	Manufact	uring and Quality Tasks
1148	• En	sure the contractors' manufacturing capability covers:
1149	0	All required manufacturing processes and techniques,
1150	0	All design producibility risks.
1151	0	Manufacturing capability has a high probability of meeting delivery dates.
1152	0	Manufacturing capability provides for minimal impact of critical and long-lead time
1153		material.
1154	0	Manufacturing capability ensures all production equipment will be available.
1155	0	Manufacturing capability provides accurate production unit cost goals.
1156	0	Capability includes cost and production schedule estimates updated with actuals to
1157		support management reviews.
1158	0	All alternatives have adequate manufacturing feasibility and cost and schedule impact
1159		analyses that support trade-offs.
1160	0	Capability includes recommendations for anticipated production testing and
1161		demonstration efforts.
1162	0	Prior producibility improvements analyzed for effectiveness during LRIP.
1163	Metrics	
1164	• Ha	ve you checked the contractors' manufacturing capability to ensure it covers:
1165	0	All required manufacturing processes and techniques?
1166	0	All design producibility risks?
1167	0	The necessary manufacturing capability that has a high probability of meeting delivery
1168		dates? Level?
1169	0	The necessary manufacturing capability that provides for minimal impact of critical and
1170		long-lead time material?
1171	0	The necessary manufacturing capability that ensures all production equipment will be
1172		available?
1173	0	The necessary manufacturing capability that provides accurate production unit cost
1174		goals?
1175	0	The necessary manufacturing capability that includes cost and production schedule
1176		estimates updated with actuals to support management reviews?
1177	0	Have you ensured that all alternatives have adequate manufacturing feasibility and cost
1178		and schedule impact analyses that support trade-offs?
1179	0	The necessary manufacturing capability includes recommendations for anticipated
1180		production testing and demonstration efforts?
1181	0	Have you ensured all prior producibility improvements have been analyzed for
1182		enectiveness during LKIP?
1183	Tools	

- Manufacturing Readiness Assessment Checklist, Design thread 1184 •
- Design for Manufacturing and Assembly (DFMA) Assessment 1185 ٠

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5. Production and Deployment (P&D) Phase

- Design for Six Sigma
- 1187 Design of Experiments
- 1188 Robust Design
- Tolerance Design
- Design Failure Modes and Effects Analysis (DFMEA)
- Process Failure Modes and Effects Analysis (PFMEA)

1192 **Resources**

- MRL Deskbook Version 2016
 Principles and Guidelines for Design for Manufacturing and Assembly, July 2014
 Design for Six Sigma Memory Jogger
 Taguchi Robust Design/Six Sigma Guide
- MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016
- MIL-STD-1629, Procedures for Performing a Failure Mode, Effects and Criticality Analysis

1199 E.2. Producibility Planning Completed

1200 Producibility is an engineering function directed toward generating a design which is compatible

- 1201 with the manufacturing capability of the proposed factory floor. It is often considered the most
- 1202 important determinant of product cost, due to the effect on both production and sustainment costs.
- 1203 The Technology Development contract should have required that the contractor develop a
- 1204 Producibility Plan and producibility criteria to guide the design effort. The plan should describe
- 1205 specifically what activities will be accomplished in each phase, the responsible organization, and the
- 1206 management controls that will be established to ensure successful accomplishment. The Program
- 1207 Management Office should review the plan with a focus on the realism, completeness and clarity of
- 1208 the planning accomplished by the contractor. Formal submission of the plan may be required by the
- 1209 contract or may be reviewed at the contractor facility.
- 1210 Producibility criteria should reflect a blending of general criteria (such as minimum parts count) and
- 1211 specific criteria applicable to the type of equipment being developed. The producibility program will
- be effective if the design engineers understand and apply the producibility design criteria. Each
- 1213 competing design needs to be evaluated from a producibility standpoint. Producibility evaluations
- 1214 will serve as a basis for estimating the likely manufacturing cost and assessing the level of
- 1215 manufacturing risk of the system. Results of these assessments should support the development of
- 1216 specific contractual provisions for the EMD phase.
- 1217 Ignoring producibility can lock the acquisition program into design solutions which can only be
- 1218 accomplished at unnecessarily high levels of production cost or design changes which can entail
- 1219 substantial technical, cost and schedule risk during production.

5. Production and Deployment (P&D) Phase

1220	Manufacturing and Quality Tasks
1221 1222 1223	 As the design evolves its producibility should be subjected to regular review. Contractor's detailed producibility trade studies used knowledge of key design characteristics and related manufacturing process capability.
1224	 All producibility improvements implemented into system design and specifications.
1225 1226	• Known producibility issues have been resolved and pose minimum risk for LRIP and no risk for FRP.
1227	 Contractor's producibility enhancement efforts (e.g. DFX) completed for optimized
1228	integrated system.
1229	• Contractor's design producibility evaluated for such factors as:
1230 1231 1232 1233	 Liberal tolerances (dimensions, mechanical, electrical); Use of materials that provide optimum machinability, formability and weldability; Shapes and forms designed for castings, stampings, extrusions, etc., that provide maximum economy;
1234	• Inspection and test requirements that are the minimum needed to assure desired quality
1235	and maximum usage of available and standard inspection equipment;
1230	• Assembly by efficient, economical methods and procedures, and • Minimized requirements for complex or expensive manufacturing tooling or special
1237	skills
1200	
1239	Metrics
1240	• Have you regularly reviewed the producibility of the evolving design?
1241	• Have you reviewed the contractor's detailed producibility trade studies to ensure they used
1242	knowledge of key design characteristics and the related manufacturing process capability?
1243	• Ave you ensured that all producibility improvements have been implemented into the latest
1244	• Have all known producibility issues been resolved and ensured they impose minimum risk
1245 1246	• Have an known producibility issues been resolved and ensured they impose minimum risk for LRIP and no risk for FRP?
1247 1248	• Have you ensured the contractor's producibility enhancement efforts (e.g. DFX) have been completed for optimized integrated system?
1249	• Have you evaluated the contractor's design producibility efforts for such factors as:
1250	• Liberal tolerances (dimensions, mechanical, electrical);
1251	• Use of materials that provide optimum machinability, formability and weldability;
1252 1253	 Snapes and forms designed for castings, stampings, extrusions, etc., that provide maximum economy;
1254	• Inspection and test requirements that are the minimum needed to assure desired quality
1255	and maximum usage of available and standard inspection equipment;
1256	 Assembly by efficient, economical methods and procedures; and
1257	• Minimized requirements for complex or expensive manufacturing tooling or special
1258	skills?

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5. Production and Deployment (P&D) Phase

1259	Tools	
1260	•	Producibility Engineering and Planning (PEP) Data Item Description
1261	Resou	rces
1262	•	IEEE15288.2, System and Software Engineering, 2015
1263	•	NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy, Dec 1999
1264	•	MIL-HDBK-727, Design Guidance for Producibility, Apr 1984
1265	•	Producibility Engineering Standard Practice Manual, US Army Belvoir R&D Center, Sep
1266		1993
1267	•	Defense Manufacturing Management Guide for Program Managers, Chapter 7.6
1268		Producibility Engineering and Planning (PEP)

1269 E.3. Producibility Assessments

1270 DOD policy on major system acquisitions makes producibility considerations a requirement prior to

1271 the start of Technology Development. The Alternative Systems Review should have included

1272 producibility assessments of the design concepts. Producibility assessments and engineering should

1273 be a part of the ongoing systems engineering process. DoDI 5000.02 states that "design for

1274 producibility" shall be a part of the Engineering and Manufacturing Development phase. DODD

5000.01 states that the PM shall "reduce manufacturing risk and demonstrate producibility" prior toFRP.

1277 History has demonstrated that as the complexity of systems increases, so does the acquisition cost.

1278 Therefore, producibility programs are necessary as a management means for assuring that practicality

1279 is addressed and that the cost increases associated with the growing complexity of systems are

1280 minimized. It should be recognized that the producibility analysis accomplished by the PMO must be

1281 performed by a team of specialists assembled from the program office: and supporting organizations.

1282 One functional organization cannot possibly accomplish the total producibility effort without

assistance from other functional organizations. Consequently, the PMO approach to organizing for

1284 producibility is of prime importance to a successful defense system.

- 1285 Manufacturing and Quality Tasks
- Ongoing Producibility Assessments conducted on current efforts including additional efforts if necessary.
- 1288 o At the enterprise level (including infrastructure software tools, design guides, training, 1289 and policies).
- 1290 On a product-by-product level (including trade studies, and design principles reduce 1291 part count, use of common parts, ease of assembly, and simplicity of fabrication).
- Producibility issues/risks discovered in LRIP have been mitigated and pose no significant
 risk for FRP.

5. Production and Deployment (P&D) Phase

1294	Metrics
1295 1296	 Have you conducted ongoing Producibility Assessments on current efforts including additional efforts if necessary?
1297	• Have these assessments been conducted;
1298 1299 1300 1301 1302 1303	 At the enterprise level (including infrastructure – software tools, design guides, training, and policies)? On a product-by-product level (including trade studies, and design principles – reduce part count, use of common parts, ease of assembly, and simplicity of fabrication)? Producibility issues/risks discovered in LRIP have been mitigated and pose no significant risk for FRP?
1004	
1304	loois
1305	Producibility Assessment Worksheet
1306	Resources
1307	AS6500, Manufacturing Management Program
1308	AS9100, Quality Management System
1309	• ISO 9001, Quality Management System, 2015
1310	• IEEE15288.2, System and Software Engineering, 2015
1311	• NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy, Dec 1999
1312	• MIL-HDBK-727, Design Guidance for Producibility, Apr 1984
1313	• Producibility Engineering Standard Practice Manual, US Army Belvoir R&D Center, Sep
1314	1993
1315	E.4. Participate in Design IPT

1316 Major programs are organized around core design team, usually comprised of 20-50 of the

1317 contractor's best engineers. This core design team makes 90-95% of all critical decisions. If

1318 manufacturing is not one of their primary concerns then manufacturing issues will be delegated to

1319 secondary teams.

1320 The contractor will follow the government's lead. If the PM, IPT and Technical Director do not ask

1321 manufacturing questions then the contractor receives the message that these issues are secondary. In

1322 addition, CDRLs, in and of themselves, do not result in effective concrete action nor will they replace

1323 effective communication.

1324 Manufacturing and Quality Tasks

- Ongoing Design IPT demonstrates that:
- 1326 Producibility has been assessed and integrated with other design activities.

5. Production and Deployment (P&D) Phase

1327		• Key and critical manufacturing assembly and test processes have been identified,
1320		e All ricks (technology, manufacturing, software development, and sustainment) have been
1329		assessed.
1331		• Metrics and data to assess, monitor, manage and control the transition process have been
1332		developed.
1333		• Manufacturing and quality engineers participate on engineering IPTs.
1334	•	Ensure the product design is stable.
1335 1336		 Design changes are few and generally limited to those required for continuous improvement or in reaction to obsolescence.
1337 1338	•	Ensure the pilot-line conditions represent a robust enough production environment to be used to validate LRIP manufacturing needs.
1339	Metrie	CS
1340	•	Have the ongoing Design IPT demonstrated that:
1341		• Producibility has been assessed and integrated with other design activities.
1342		• Key and critical manufacturing assembly and test processes have been identified,
1343		evaluated and matured?
1344		• All risks (technology, manufacturing, software development, and sustainment) have been
1345		assessed?
1346		• Metrics and data to assess, monitor, manage and control the transition process have been
1347		developed?
1348		• Manufacturing and quality engineers participate on engineering IPTs.
1349	•	Have you ensured that the current product design is stable?
1350	•	Have you ensured that design changes are few and generally limited to those required for
1351		continuous improvement and or in reaction to obsolescence?
1352	•	Have you ensured that the pilot-line conditions represent a robust enough production
1353		environment to be used to validate LRIP manufacturing needs?
1354	Tools	
1355	•	Design for Manufacturing and Assembly (DFMA)
1356	•	SEP assessment
1357	•	Integrated Master Plan/Integrated Master Schedule template
1358	•	Manufacturing Readiness Assessment Checklist, Design thread
1359	Resou	rces
1360	•	Design for Six Sigma Memory Jogger

• SEP Outline, Apr 2011

5. Production and Deployment (P&D) Phase

- Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct 2005
- MRL Deskbook version 2016

1365 E.5. Assess Design Maturity

DOD acquisition programs face a high risk of failure at the outset of the design process. While some level of risk associated with a new technical concept may be unavoidable, historically this risk has been magnified by the misunderstanding of the industrial design disciplines necessary to turn the concept into a mature product. The government and its contractors must share equal responsibility for this misunderstanding. The contractor's proposal and government source selection process provide the last cost-effective opportunity to ensure application of these critical disciplines during design and the achievement of design maturity.

1373 A mature design meets operational requirements without additional government or contractor

1374 intervention - no further field modifications or additional equipment and spares are required to

1375 overcome design shortfalls. In the factory, design maturity might be indicated by the tapering off of

1376 Engineering Change Proposal (ECP) traffic, once the test phase is underway, if it can be assumed

1377 that contract requirements are being met. But what constitutes design maturity at the conclusion of

1378 the design effort before entering the formal test phase? This is the question faced at the Critical

1379 Design Review (CDR), when a decision to proceed with fabrication of formal test articles must be

1380 made, a decision on which this matter of risk hangs.

1381 It must be economically feasible to manufacture a quality product at a specified rate and to deliver1382 end items capable of achieving the performance and reliability inherent in the design.

1383 This design requirement is not always well understood and historically has taken a back seat to the

1384 more popular objective of high performance. The results of this neglect have ranged from factory

rework rates in excess of 50 percent to the suspension of government acceptance of end items

1386 pending major redesign for producibility. A strong producibility emphasis early in design will

- 1387 minimize the time and cost required for successful transition to production.
- 1388 Manufacturing and Quality Tasks
- Continue design maturity assessments. Ensure that all:
- 1390 o Product data required for Pilot-Line component manufacturing completed.
- 1391 Pilot-Line product requirements and features have been defined.
- 1392 o Product data essential for subsystem/system Pilot-Line has been released.
- 1393 All enabling/critical components have been demonstrated on the Pilot-Line.
- 0 Design maturity metrics have been applied to the planned Production Line.

5. Production and Deployment (P&D) Phase

1395 Metrics

As you continue design maturity assessments. You must ensure that all:
Product data required for Pilot-Line component manufacturing is completed?
Pilot-Line product requirements and features have been defined?
Product data essential for subsystem/system Pilot-Line has been released?
All enabling/critical components have been demonstrated on the Pilot-Line?
All design maturity metrics have been applied to the planned Production Line?

1402 **Tools**

- Design for Six Sigma
- Manufacturing Readiness Level Assessment Questionnaire, Design thread

1405 **Resources**

- DoD MIL-STD 882E, System Safety
- MRL Deskbook version 2016

1408 E.6. Review the contractor's preliminary Key Characteristics (KCs)

1409 The reliability of the as-built product is bounded by the inherent reliability of the design and in the 1410 control of quality of key and critical characteristics.

1411 A Key Characteristic (KC) is a feature of a material, process, or part (includes assemblies) whose

1412 variation within the specified tolerance has a significant influence on product fit, performance,

- 1413 service life, or manufacturability.
- 1414 A Critical Characteristic is any feature throughout the life cycle of a Critical Safety Item (CSI), such
- 1415 as dimension, tolerance, finish, material or assembly, manufacturing or inspection process, operation,
- 1416 field maintenance, or depot overhaul requirement that if nonconforming, missing or degraded may
- 1417 cause the failure or malfunction of a CSI. CSIs are parts whose failure could have catastrophic
- 1418 consequences. In general terms, a CSI's failure could cause loss of life, serious injury or permanent
- 1419 disability, loss of a weapon system, or substantial equipment damage.

1420 Manufacturing and Quality Tasks

- Design KCs have been identified and any mitigation plans developed.
- All KCs are controlled in LRIP to appropriate quality levels.

1423 Metrics

Have you ensured all design KCs have been identified and any necessary mitigation plans developed?

5. Production and Deployment (P&D) Phase

• Have you ensured all KCs are controlled in LRIP to appropriate quality levels for	
1427 production?	
1428 • Process Capability Ratio or Cp	
• Demonstrated Process Capability or Cpk	
1430 Tools	
• MRL Assessment Checklist for Process Capability and Control thread	
1432 • Critical to Quality Tree	
1433 • Failure Mode and Effects Analysis	
 Process Capability Analysis Worksheet 	
1435 • Producibility Assessment Checklist	
• Technology Readiness Level Assessment Checklist	
1437 Resources	
1438 • MRL Deskbook Version 2016	
• DoD AS6500, Manufacturing Management Program	
• AS9100, Quality Assurance Management	
• MIL-STD-1629, Procedures for Performing a Failure Mode, Effects and Criticali	ty Analysis
• NAVSO P-3687 Producibility System Guidelines, Dec 1999	
• Technology Level Assessment Guidance, Apr 2011	

1444E.7Ensure MFG and Quality Support inputs to Critical Design Review (CDR) have1445been implemented.

1446 DoDI 5000.02 requires that PMs and their technical staff to, "Develop an affordable and executable

- 1447 manufacturing process during the Engineering and Manufacturing Development (EMD) Phase." The
- 1448 Post-CDR assessment will include a demonstration that the "maturity of critical manufacturing
- 1449 processes has been accomplished. EMD shall end when "manufacturing processes have been
- 1450 effectively demonstrated in a pilot line environment" prior to Milestone C.
- 1451 The CDR is conducted to ensure that the system under review can proceed into system fabrication,
- 1452 demonstration, and test, and can meet the stated performance requirements within cost (program

1453 budget), schedule (program schedule), risk, and other system constraints. At this time Producibility

- 1454 Engineering activities should be complete.
- 1455 The CDR assesses the system final design as captured in product specifications for each
- 1456 configuration item in the system (product baseline), and ensures that each product in the product
- 1457 baseline has been captured in the detailed design documentation.

1458 Manufacturing and Quality Tasks

• Typical manufacturing and quality CDR concerns include:

5. Production and Deployment (P&D) Phase

1460		0	That the system product baseline has been established and documented to enable
1461			hardware fabrication to proceed with proper configuration management.
1462		0	Adequate processes and metrics are in place for the program to succeed.
1463		0	All the known risks are understood and manageable for testing in support of
1464			developmental and operational evaluation objectives.
1465		0	The program schedule is executable (technical/cost risks).
1466		0	The program is executable with the existing budget and the approved product baseline.
1467		0	The detailed design is producible within the production budget.
1468		0	The updated Cost Analysis Requirements Description (CARD) is consistent with the
1469			approved product baseline.
1470		0	The updated cost estimate fits within the existing budget.
1471		0	Key product characteristics that have the most impact on system performance, assembly,
1472			cost, reliability, and sustainment or safety are identified.
1473		0	The critical manufacturing processes that affect the key characteristics have been
1474			identified and their capability to meet design tolerances determined.
1475		0	Process control plans have been developed for critical manufacturing processes.
1476		0	Manufacturing processes have been demonstrated in a production representative
1477			environment.
1478		0	Detailed trade studies and system producibility assessments are complete.
1479		0	Materials and tooling are available to meet LRIP/FRP schedule.
1480		0	System production cost models have been updated, allocated to subsystem level, and
1481			tracked against targets.
1482		0	Long lead procurement plans are in place and the supply chain has been validated.
1483		0	All product data essential for component manufacturing has been released.
1484		0	Design change traffic does not impact LRIP.
1485	•	Ma	ior product design features and configuration are stable.
1486	•	Ph	vsical Configuration Audit (PCA) or equivalent completed.
1487	•	Ma	intenance of production equipment translates to downtime and is accounted for in
1488	-	det	ermining the availability of the equipment and contingency plans
1100		uct	entities are availability of the equipment and containgency plans.
1489	Metric	cs	
1490	•	Du	ring the CDR your typical manufacturing and quality concerns include:
1491		0	Have you ensured that the system product baseline has been established and documented
1492			to enable hardware fabrication to proceed with proper configuration management?
1493		0	Have you ensured that adequate processes and metrics are in place for the program to
1494			succeed?
1495		0	Have you ensured that all the known risks are understood and manageable for testing in
1496			support of developmental and operational evaluation objectives?
1497		0	Have you ensured that the program schedule is executable in lite of (technical/cost risks)?
1498		0	Have you ensured that the program is executable within the existing budget and the
1499			approved product baseline?

5. Production and Deployment (P&D) Phase

1500		0	Have you ensured that the detailed design is producible within the production budget?
1501		0	Have vou ensured that the updated Cost Analysis Requirements Description (CARD) is
1502			consistent with the approved product baseline?
1503		0	Have you ensured that the updated cost estimate fits within the existing budget?
1504		0	Have you ensured that key product characteristics that have the most impact on system
1505			performance, assembly, cost, reliability, and sustainment or safety have been identified?
1506		0	Have you ensured that the critical manufacturing processes that affect the key
1507			characteristics have been identified and their capability to meet design tolerances have
1508			been determined?
1509		0	Have you ensured that process control plans have been developed for critical
1510			manufacturing processes?
1511		0	Have you ensured that manufacturing processes have been demonstrated in a production
1512			representative environment?
1513		0	Have you ensured that detailed trade studies and system producibility assessments have
1514			been completed?
1515		0	Have you ensured that all materials and tooling are available to meet LRIP/FRP
1516			schedule?
1517		0	Have you ensured that system production cost models have been updated, allocated to
1518			subsystem level, and tracked against targets?
1519		0	Have you ensured that long lead procurement plans are in place and the supply chain has
1520			been validated?
1521		0	Have you ensured that all product data essential for component manufacturing has been
1522			released?
1523		0	Have you ensured that design change traffic does/will not impact LRIP?
1524	•	Ha	ve you ensured that major product design features and configuration are stable?
1525	•	Ha	ve you ensured that the Physical Configuration Audit (PCA) or equivalent has been
1526		coi	mpleted?
1527	•	Ha	ve you ensured that the maintenance of production equipment translates to downtime and
1528		is a	accounted for in determining the availability of the equipment and contingency plans?
1529	Tools		
1530	•	Cr	itical Design Review Checklist and Assessment
1531	Resou	rces	i
1532	•	Do	D Defense Acquisition Guide (DAG) Chapter 3-3.3.5 Critical Design Review

1533 E.8. Update to Systems Engineering Plan (SEP)

1534 Manufacturing and Quality Tasks

- 1535 The following information sources provide important inputs to the Production &Deployment phase1536 systems engineering process and should contain manufacturing considerations:
- Acquisition Program Baseline;
- 1538 Capability Production Document;
- 1539 SEP
- Test and Evaluation Master Plan;
- Programmatic Environmental, Safety, and Occupational Health Evaluation (PESHE).
- Product Support Elements.
- Program Schedule (PRR/Production Lot/Phases).
- Technical Risks and Mitigation Planning (Production/Manufacturing/Quality).
- Manufacturing and Quality Roles and Responsibilities of IPTs (Team Details Name, Chair, Membership, Roles, Responsibility, and Authority, Products and Metrics).
- Planned Activities for the Next Phase (including manufacturing maturity).
- All modifications, upgrades, Diminishing Manufacturing Sources and Material Shortages
 (DMSMS) and other changes assessed for producibility.
- Technical Review Process (Manufacturing Purposes/Criteria).
- Manufacturing and Quality TPMs/Metrics to be used to identify and manage risks.
- Manufacturing Design Considerations (Include Trade Study Criteria).
- Engineering Tools (such as Producibility/Throughput Analysis, Line of Balance, factory and process modeling and simulation tools, and quality assurance tools) are available and in use.

1555 Metrics

- 1556 Have you used the following information sources to provide important inputs to the Production and
- 1557 Deployment phase systems engineering process and that they contain manufacturing considerations:
- Acquisition Program Baseline?
- Capability Production Document?
- 1560 SEP?
- Test and Evaluation Master Plan?
- Programmatic Environmental, Safety, and Occupational Health Evaluation (PESHE)?
- Product Support Elements?
- Program Schedule (PRR/Production Lot/Phases)?
- Technical Risks and Mitigation Planning (Production/Manufacturing/Quality)?
- Manufacturing and Quality Roles and Responsibilities of IPTs (Team Details Name, Chair, Membership, Roles, Responsibility, and Authority, Products and Metrics)?
- Planned Activities for the Next Phase (including manufacturing maturity)?

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5. Production and Deployment (P&D) Phase

1569	• All modifications, upgrades, Diminishing Manufacturing Sources and Material Shortages
1570	(DMSMS) and other changes assessed for producibility?
1571	• Technical Review Process (Manufacturing Purposes/Criteria)?
1572	• Manufacturing and Quality TPMs/Metrics to be used to identify and manage risks?
1573	• Manufacturing Design Considerations (Include Trade Study Criteria)?
1574	• Engineering Tools (such as Producibility/Throughput Analysis, Line of Balance, factory and
1575	process modeling and simulation tools, and quality assurance tools) are available and in use?
1576	Tools
1577	• SEP Outline
1578	• Manufacturing Plan (included I n the SEP)
1579	• Quality Assurance Plan (included in the SEP)
1580	Critical to Customer/Critical to Quality Tree
1581	Producibility Assessment Worksheet
1582	Resources
1583	• DoD TAB B - SEP Outline Version 3.0 - Final V4 (provided by OSD)
1584	• SEP Outline, Apr 2011
1585	MRL Deskbook Version 2016
1586	AS6500, Manufacturing Management Program
1587	• AS9100, Quality Management System, 2015
1588	• ISO 9001, Quality Management System, 2015
1589	• NAVSO P-3687, Producibility System Guidelines, Dept. of the Navy, Dec 1999
1590	E.9 Develop Detailed Production Design
1591	One of the most important elements of any production design is the definition of the
1592	manufacturing resources. No matter how good a design may be, it is useless if system or product

1592 intallated ing resources. No matter now good a design may be, it is discess it system of product
 1593 cannot be built. It is therefore essential that availability of manufacturing resources be a
 1594 consideration during the design review process. Manufacturing engineers should be a part of
 1595 each design team to assure adequate consideration of availability of required manufacturing

1596 resources.

1597 Manufacturing resources should not be limited to manufacturing methods, but should include

1598 materials, capital, manufacturing technology, facilities, qualified labor, and the management

1599 structure to effectively integrate them. The successful competitor, of the production phase will

1600 depend upon the efficient application of the full spectrum of these resources to the task of febriating and delivering the defense system design

1601 fabricating and delivering the defense system design.

1602 Manufacturing and Quality Tasks

Ensure detailed design drawings, bills of material and product and process specifications are completed by release of design to manufacturing.

5. Production and Deployment (P&D) Phase

1605 1606 1607 1608 1609 1610 1611	 Participate in design reviews to assure that the contractor is complying with the desirequirements and meeting the cost/design goals. Ensure the final design definition is the result of the performance requirements, the of the testing accomplished, producibility studies and other design influences. Ensure that the design is specified to a very low level of detail so that the required p phase processes and resources can be identified and obtained. Design producibility improvements demonstrated in LRIP/FRP. 	ign outcomes production
1612	letrics	
 1613 1614 1615 1616 1617 1618 1619 1620 1621 1622 	 Have you ensured detailed design drawings, bills of material and product and process specifications are completed by release of design to manufacturing? Have you participated in design reviews to assure that the contractor is complying version design requirements and meeting the cost/design goals? Have you ensured the final design definition is the result of the performance requires the outcomes of the testing accomplished, producibility studies and other design inf. Have you ensured that the design is specified to a very low level of detail so that the production phase processes and resources can be identified and obtained? Have you ensured that design producibility improvements have been demonstrated LRIP/FRP? 	ss with the ements, fluences? e required in
1623	pols	
1624 1625 1626	 Design for Manufacturing and Assembly (DFMA) SEP Outline Manufacturing Readiness Level Assessment Questionnaire, Design thread 	
1627	esources	
1628	• SEP Outline, Apr 2011	
1629	• MIKL Deskbook version 2016	
1630	10 Develop Production Work Breakdown Structure	

1631 The planning, execution and control of the production phase activities require that the work be 1632 divided into manageable tasks that are compatible with the existing manufacturing and performance 1633 measurement systems. Often, the work breakdown structure (WBS) used during the development 1634 phases will not be appropriate for the production phase. Consequently, the contractor should, as a 1635 basis for production planning, identify the WBS which is to be used. While this was may differ from 1636 the EMD structure, the two should be such that production phase costs can be related to the 1637 development WBS. This is critical for those programs which have utilized a design-to-unit production cost management approach during development. 1638

5. Production and Deployment (P&D) Phase

1639	Manufacturing and Quality Tasks
1640 1641 1642	• Develop the Production WBS to ensure planning, execution and control of the production phase activities are compatible with the existing manufacturing and performance measurement systems.
1643 1644	• Ensure the contractor identifies the Production WBS such that production phase costs can be related to the development WBS.
1645	Metrics
1646 1647 1648	• During the development of the Production WBS have you ensured planning, execution and control of the production phase activities are compatible with the existing manufacturing and performance measurement systems?
1649 1650	• Ensure the contractor identifies the Production WBS such that production phase costs can be related to the development WBS?
1651	Tools
1652	Work Breakdown Standard review
1653	Resources
1654	MIL-STD-881 Work Breakdown Standard
1655	E.11 Design Stability
1656	For the FRP Decision Review Acquisition Strategy update, the Program should identify remaining
1657	risks prior to a production go-ahead decision. Key considerations should include industrial base
1658	viability, design stability, process maturity, supply chain management, quality management, and
1659	facilities and manufacturing skills availability. Sources of data could include technical reviews and
1661	audits, Program Status Reviews, pre-award surveys, Production Readiness Reviews, industrial Capabilities Assessments, trade-off studies, tooling plans, make- or-buy plans, manufacturing plans
1662	and bills of material. Important outputs include actions to reduce or handle remaining risks.
1663	Manufacturing and Quality Tasks
1664	• Product design and features during the Critical Design Review support a production decision.
1665	• Design change traffic should be minimal.
1666	• Detailed design of all product features and interfaces is complete.
1667	• All product data essential for product manufacturing has been released.
1668	• Final material selection completed and evaluated for producibility.
1669	• Product specifications/build-to packages are matured to the same level as the design.
1670	LRIP/FRP Build-to Packages are complete.

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5. Production and Deployment (P&D) Phase

1671 1672	•	System design has been validated through operational testing of LRIP items.
1672	•	Design change traine is infined.
1075	•	Ensure the design errors achieve effective and erricient manufacturing processes with the
1675	•	Ensure the design of the system facilitates the timely and effordable manufacturing costs.
1676	•	and delivery of a quality product to the customer
1070		and derivery of a quarty product to the customer.
1677	Metrio	CS CS
1678	•	Have you ensured that the product design and features during the Critical Design Review
1679		support a production decision?
1680		• Have you verified that design change traffic minimal?
1681	•	Have you ensured that the detailed design of all product features and interfaces is completed?
1682		• Have you verified that all product data essential for product manufacturing has been
1683		released?
1684	•	Have you verified that final material selection has been completed and evaluated for
1685		producibility?
1686	•	Have you verified that product specifications/build-to packages are matured to the same level
1687		as the design?
1688	•	Have you verified that LRIP/FRP Build-to Packages are complete?
1689	٠	Have you verified that system design has been validated through operational testing of LRIP
1690		items?
1691	٠	Have you verified that design change traffic is limited?
1692	•	Have you verified/ensured that the design efforts achieved effective and efficient
1693		manufacturing processes with the necessary process controls to satisfy requirements and
1694		minimize manufacturing costs?
1695	•	Have you verified/ensured that the design of the system facilitates the timely and affordable
1696		manufacture, assembly, and delivery of a quality product to the customer?
1697	Tools	
1698	•	Design for Six Sigma
1699	٠	Critical Path Template
1700	•	Manufacturing Readiness Level Assessment Questionnaire, Design thread
1701	Resou	rces
1702	٠	DoD MIL-STD 882E, System Safety
1703	٠	DoDI 42457-M, Willoughby Templates, Chapter 3 – Design
1704	٠	MRL Deskbook version 2016

5. Production and Deployment (P&D) Phase

E.12 Key Characteristics Proven 1705

1706 1707	The manufacturing strategy should include the criteria for determining which production processes will require proofing and the timing of such proofing activity. These processes are often identified		
1708	during a manufacturing risk assessment or during the design as Key Characteristics. Process proofing		
1709	can make a major contribution to risk reduction, but it may involve cost and/or potential schedule		
1710	impacts during the development phase. Maturing manufacturing processes should be documented in		
1711	a formal Manufacturing Maturation Plan.		
1712	Manufacturing and Quality Tasks		
1713	• Manufacturing processes re-assessed as needed for capability to test and verify potential		
1714	influence on Operations and Support.		
1715	• Potential KC risk issues have been identified and mitigated on pilot-line.		
1716	• Key Characteristics are attainable based upon pilot-line demonstrations.		
1717	Process producibility improvements ongoing.		
1718	• All KCs are controlled in FRP to appropriate quality levels.		
1719	Metrics		
1720	• Have you ensured that manufacturing processes are being re-assessed as needed for		
1721	capability to test and verify potential influence on Operations and Support?		
1722 1723	• Have you ensured that potential KC risk issues have been identified and mitigated on the pilot-line?		
1724	• Have you ensured that Key Characteristics are attainable based upon pilot-line		
1725	demonstrations?		
1726	• Have you ensured that process producibility improvements are ongoing?		
1727	• Have you ensured that all KCs are controlled in FRP to appropriate quality levels?		
1728	Process Capability Ratio or Cp		
1729	Demonstrated Process Capability or Cpk		
1730	Tools		
1731	MRL Assessment Checklist for Process Capability and Control thread		
1732	Critical to Quality Tree		
1733	Failure Mode and Effects Analysis		
1734	Process Capability Analysis Worksheet		
1735	Producibility Assessment Checklist		
1736	Resources		
1737	DoD AS6500, Manufacturing Management Program		

- AS9100, Quality Assurance Management 1738
- 1739 MRL Deskbook Version 2016 •

5. Production and Deployment (P&D) Phase

- MIL-STD-1629, Procedures for Performing a Failure Mode, Effects and Criticality Analysis
- NAVSO P-3687 Producibility System Guidelines, Dec 1999

1742 E.13 LRIP Build

- 1743 The Milestone C review should provide the status of assessments of manufacturing processes and
- 1744 highlight the steps needed to progress from an EMD manufacturing environment to an LRIP
- 1745 environment.

1756

1757

1746 Manufacturing and Quality Tasks

- LRIP describes the initial production effort needed to reduce the government's exposure in transitioning to FRP. It usually begins at the end of the EMD phase and often transitions from a pilot line to an LRIP then FRP production capability. To reduce risk during LRIP, manufacturing personnel must ensure that:
- new technologies are mature and ready to transition into the production units
 the detailed system design is complete with few engineering changes, and none t
- 1752othe detailed system design is complete with few engineering changes, and none that1753impact form, fit or function
- all manufacturing processes are capable and under statistical control, and there are no
 producibility risks
 - a complete definition of the fabrication and assembly tasks and they are transferred to the general factory work force
- 1758odetailed work instructions exist and a closely controlled system for changes to the1759documents used in the factory, such as drawings and process specifications
- required production planning documentation are based on a stable design, quantity
 requirements and delivery schedule
- engineering changes are controlled to minimize disruption to production documentationand planned manufacturing schedules
- Participate in the PCA which is usually conducted around the time of the FRP Decision. The
 PCA examines the actual configuration of an item being produced and confirms that:
- 1766 o the manufacturing processes,
- 1767 o quality control system,
- 1768 o measurement and test equipment,
- 1769 o and training are adequately planned, tracked, and controlled.
- 1770 And that the related design documentation matches the item as specified in the contract
- Ensure affordable and executable manufacturing process have been developed and
 demonstrated/proven. The PCA demonstrated that the maturity of critical manufacturing
 processes has been accomplished.
- Ensure all manufacturing processes have been effectively demonstrated during LRIP.

5. Production and Deployment (P&D) Phase

1775	Metrio	CS
1776	•	Have you ensured that:
1777 1778 1779 1780 1781		 New technologies are mature and ready to transition into the production units? The detailed system design is complete with few engineering changes, and none that impact form, fit or function? All manufacturing processes are capable and under statistical control, and there are no producibility risks?
1782 1783 1784 1785 1786 1787 1788 1789		 A complete definition of the fabrication and assembly tasks and they are transferred to the general factory work force? Detailed work instructions exist and a closely controlled system for changes to the documents used in the factory, such as drawings and process specifications? Required production planning documentation are based on a stable design, quantity requirements and delivery schedule? Engineering changes are controlled to minimize disruption to production documentation and planned manufacturing schedules?
1790 1791 1792 1793	•	You must participate in the PCA which is usually conducted around the time of the FRP Decision. During the PCA you must examine the actual configuration of an item being produced and confirm that:
1794 1795 1796 1797 1798		 The manufacturing processes, quality control system, Measurement and test equipment, and training are adequately planned, tracked, and controlled? And the related design documentation matches the item as specified in the contract?
1799 1800 1801 1802 1803 1804	•	Have you ensured affordable and executable manufacturing process have been developed and demonstrated/proven?Has the PCA demonstrated that the maturity of critical manufacturing processes has been accomplished?Have you ensured all manufacturing processes have been effectively demonstrated during LRIP?
1805	Tools	
1806 1807 1808 1809	• • •	Production Verification Test Production Part Approval Process (PPAP) Checklist Manufacturing Readiness Level Assessment, Design thread Integrated Master Plan/Integrated Master Schedule assessment
1810	Resou	rces
1811	٠	AS6500, Manufacturing Management System

5. Production and Deployment (P&D) Phase

- 1812 • DCMA Instruction 302, First Article and Production Lot Testing, Jan 2015
- 1813 AS/EN/SJAC9102, Aerospace First Article Inspection Requirement
- 1814 • DoDI 5000.02
- 1815 • IEEE 15288.2, System and Software Engineering, 2015
- 1816 MRL Deskbook Version 2016 •
- 1817 • DoD Integrated Master Plan and Integrated Master Schedule Preparation and Use Guide, Oct 1818 2005

1819 E.14 FRP Build

1820 For the FRP Decision Review Acquisition Strategy update, the program should identify remaining

- 1821 risks prior to a production go-ahead decision. Key considerations should include industrial base
- 1822 viability, design stability, process maturity, supply chain management, quality management, and
- 1823 facilities and manufacturing skills availability. Sources of data could include technical reviews and
- 1824 audits, Program Status Reviews, pre-award surveys, Production Readiness Reviews, Industrial
- 1825 Capabilities Assessments, trade-off studies, tooling plans, make- or-buy plans, manufacturing plans,
- 1826 and bills of material. Important outputs include actions to reduce or handle remaining risks.
- 1827

Manufacturing and Quality Tasks

- 1828 FRP is the highest level of production readiness. Manufacturing personnel must ensure that: • 1829 o engineering/design changes are few and generally limited to quality and cost 1830 improvements 1831 o system, components or items are in FRP and meet all engineering, performance, quality 1832 and reliability requirements 1833 • manufacturing process capability is at the appropriate quality level 1834 all materials, tooling, inspection and test equipment, facilities and manpower are in place 0 1835 and have met FRP requirements
- 1836 o rate production unit costs meet goals, and funding is sufficient for production at required 1837 rates
- 1838 o lean practices are well established and continuous process improvements are ongoing
- 1839 there are no significant manufacturing risk 0
- 1840 o manufacturing processes should be under statistical control if quantities warrant
- 1841 Identify remaining risks prior to FRP production go-ahead decision. Key considerations should include: 1842
- 1843 o industrial base viability, 1844 o design stability, 1845 o process maturity, 1846 o supply chain management, 1847 o quality management, and
- 1848 o facilities and manufacturing skills availability.

5. Production and Deployment (P&D) Phase

1849	0	Sources of this data could include:
1850	0	technical reviews and audits,
1851	0	Program Status Reviews,
1852	0	pre-award surveys,
1853	0	Production Readiness Reviews,
1854	0	Industrial Capabilities Assessments,
1855	0	trade-off studies,
1856	0	tooling plans,
1857	0	make-or-buy plans,
1858	0	manufacturing plans,
1859	0	and bills of material.
1860	Important	outputs include actions to reduce or handle remaining risks.
1861	• A	follow-on, tailored, PRR may be appropriate in the Production and Deployment phase for
1862	the	e prime contractor and major subcontractors if:
1863	0	Changes from the EMD phase and during the production stage of the design, in either
1864		materials or manufacturing processes, occur,
1865	0	Production start-up or re-start occurs after a significant shutdown period,
1866	0	Production start-up with a new contractor, or
1867	0	Relocation of a manufacturing site.
1007		6
1868	Metrics	
1868 1869	Metrics • Di	uring FRP, manufacturing personnel must ensure the highest level of production readiness:
1868 1869 1870	Metrics • Di	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to
1868 1869 1870 1871	Metrics • Dr o	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements?
1868 1869 1870 1871 1872	Metrics • Di o	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering,
1868 1869 1870 1871 1872 1873	Metrics • Dr o	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements?
1868 1869 1870 1871 1872 1873 1874	Metrics • Di o 0	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality
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1868 1869 1870 1871 1872 1873 1874 1875 1876	Metrics • Di o 0	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality level? Have you ensured that all materials, tooling, inspection and test equipment, facilities and
1868 1869 1870 1871 1872 1873 1874 1875 1876 1877	Metrics • Dr • 0 • 0 • 0 • 0	 uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality level? Have you ensured that all materials, tooling, inspection and test equipment, facilities and manpower are in place and have met FRP requirements?
1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878	Metrics • Di • • • • • • • • • • • • • • • • • • •	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality level? Have you ensured that all materials, tooling, inspection and test equipment, facilities and manpower are in place and have met FRP requirements? Have you ensured that rate production unit costs meet goals, and funding is sufficient for
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1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1879 1880	Metrics	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality level? Have you ensured that all materials, tooling, inspection and test equipment, facilities and manpower are in place and have met FRP requirements? Have you ensured that rate production unit costs meet goals, and funding is sufficient for production at required rates? Have you ensured that lean practices are well established and continuous process
1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1879 1880 1881	Metrics	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality level? Have you ensured that all materials, tooling, inspection and test equipment, facilities and manpower are in place and have met FRP requirements? Have you ensured that rate production unit costs meet goals, and funding is sufficient for production at required rates? Have you ensured that lean practices are well established and continuous process improvements are ongoing?
1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1879 1880 1881 1882	Metrics	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality level? Have you ensured that all materials, tooling, inspection and test equipment, facilities and manpower are in place and have met FRP requirements? Have you ensured that rate production unit costs meet goals, and funding is sufficient for production at required rates? Have you ensured that lean practices are well established and continuous process improvements are ongoing? Have you ensured that there are no significant manufacturing risks?
1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1879 1880 1881 1882 1883	Metrics	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality level? Have you ensured that all materials, tooling, inspection and test equipment, facilities and manpower are in place and have met FRP requirements? Have you ensured that rate production unit costs meet goals, and funding is sufficient for production at required rates? Have you ensured that lean practices are well established and continuous process improvements are ongoing? Have you ensured that there are no significant manufacturing risks? Have you ensured that manufacturing processes should be under statistical control if
1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1879 1880 1881 1882 1883 1884	Metrics	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality level? Have you ensured that all materials, tooling, inspection and test equipment, facilities and manpower are in place and have met FRP requirements? Have you ensured that rate production unit costs meet goals, and funding is sufficient for production at required rates? Have you ensured that lean practices are well established and continuous process improvements are ongoing? Have you ensured that there are no significant manufacturing risks? Have you ensured that manufacturing processes should be under statistical control if quantities warrant?
1868 1869 1870 1871 1872 1873 1874 1875 1876 1877 1878 1877 1878 1879 1880 1881 1882 1883 1884 1885	Metrics	uring FRP, manufacturing personnel must ensure the highest level of production readiness: Have you ensured that engineering/design changes are few and generally limited to quality and cost improvements? Have you ensured that system, components or items are in FRP and meet all engineering, performance, quality and reliability requirements? Have you ensured that manufacturing process capability is at the appropriate quality level? Have you ensured that all materials, tooling, inspection and test equipment, facilities and manpower are in place and have met FRP requirements? Have you ensured that rate production unit costs meet goals, and funding is sufficient for production at required rates? Have you ensured that lean practices are well established and continuous process improvements are ongoing? Have you ensured that there are no significant manufacturing risks? Have you ensured that manufacturing processes should be under statistical control if quantities warrant? ave you identified any remaining risks prior to the FRP production go-ahead decision?

5. Production and Deployment (P&D) Phase

1887 1888	 industrial base viability? design stability?
1889	\circ process maturity?
1890	\circ supply chain management?
1891	o quality management?
1892	• facilities and manufacturing skills availability?
1072	6 Tuennies and manufacturing skins avaluonity.
1893	• Did you include the following sources for this data:
1894	o technical reviews and audits?
1895	 Program Status Reviews?
1896	• pre-award surveys?
1897	 Production Readiness Reviews?
1898	 Industrial Capabilities Assessments?
1899	• trade-off studies?
1900	o tooling plans?
1901	• make-or-buy plans?
1902	 manufacturing plans?
1903	• and bills of material?
1904	Do your considerations of this data include actions to reduce or handle any remaining risks?
1905	• Have you considered a follow-on, tailored, PRR as entry criteria before entering the
1906	Production and Deployment phase for the prime contractor and major subcontractors?
1907	• This follow-on PRR might be appropriate if any of the following factors are present.
1908	• Do you anticipate changes from the EMD phase and during the production stage of the
1909	design, in either materials or manufacturing processes?
1910	• Do you anticipate production start-up or re-start occurring after a significant shutdown
1911	period?
1912	• Do you anticipate production start-up with a new contractor?
1913	• Do you anticipate relocation of a manufacturing site?
1014	
1914	10015
1915	Production Verification Test
1916	Production Part Approval Process (PPAP) Checklist
1917	Manufacturing Readiness Level Assessment, Design thread
1918	Integrated Master Plan/Integrated Master Schedule assessment
1919	Resources
1920	AS6500, Manufacturing Management System
1921	• DCMA Instruction 302. First Article and Production Lot Testing. Jan 2015
1922	• AS/EN/SIAC9102 Aerospace First Article Inspection Requirement
1922	 DoDI 5000.02
1743	

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5. Production and Deployment (P&D) Phase

- IEEE 15288.2, System and Software Engineering, 2015
- 1925 MRL Deskbook Version 2016
- DoD Integrated Master Plan and Integrated Master Schedule Preparation and Use Guide, Oct
 2005

1928 **F. COST/FUNDING**



1930 F.1 Update Manufacturing Cost Estimates

Manufacturing cost estimates for the production phase are normally based on the assumption that the
design is complete, that the manufacturing processes are known, and manufacturing operations will
be accomplished as planned. Any deviation from these assumptions could cause a growth in cost. As
such, time and conformance measures can give some indication of potential or real cost aberrations
since there is normally a direct correlation between late delivery or conformance problems and cost.
In addition, the following measures may also indicate the existence of cost problems:

- Scrap and rework rates,
- Percentage of out-of-station work,
- Supplier quality problems,
- Engineering change volume,
- Yield rates on manufacturing operations, and
- Reliability growth profiles.

1943 Manufacturing and Quality Tasks

- The initial manufacturing cost estimate has been updated to reflect the final definition of the system design and the completed manufacturing approach.
- These manufacturing cost estimates should be based upon application of detailed
 manufacturing standards to the operations to be performed and adjusted, as necessary, by
 realization factors and/or learning curves to develop the time phased manufacturing cost.
- If the contractor does not have a system for development and application of labor standards,
 strong consideration should be given to including a contract requirement for Work
 Measurement in the LRIP/FRP phase contract.
- FRP cost model updated with results of LRIP build.

5. Production and Deployment (P&D) Phase

1953 Metrics 1954 • Have you updated the initial manufacturing cost estimate to reflect the final definition of the 1955 system design and the completed manufacturing approach? 1956 • Have your updated manufacturing cost estimates been based upon application of detailed 1957 manufacturing standards to the operations to be performed and adjusted, as necessary, by realization factors and/or learning curves to develop the time phased manufacturing cost? 1958 • If the contractor does not have a system for development and application of labor standards, 1959 have you considered including a contract requirement for Work Measurement in the 1960 1961 LRIP/FRP phase contract? 1962 • Has your FRP cost model been updated with the results of LRIP build? 1963 Tools 1964 • Cost Analysis Requirements Description (CARD) template 1965 Cost and Lead Time Estimating Worksheet • • Cost/Schedule Control System Criteria (see EVM) 1966 1967 • Design to Cost Estimates 1968 • Manufacturing Cost Estimating Spreadsheet 1969 Manufacturing Readiness Level assessment for the Cost Thread •

1970 • See CAPE website for tools

1971 **Resources**

- MRL Deskbook Version 2016
- Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
 Program Managers, Chapter 9
- 1975 MIL-HDBK-766 Design to Cost
- Should-cost and Affordability Memo, Aug 2011
- DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
- 1978 CARD Website and process

1979 **F.2** Manufacturing Cost Drivers have been updated with actuals

1980 The cost to manufacture a weapon system or equipment results from a combination of the design, the

- 1981 physical facility, and the five M's (manpower, materials, methods, measurements, and machines)
- 1982 used to build the design and the management efficiency of the operation. As such, the manufacturing
- 1983 cost for a product should be viewed within the context of the factory in which the product will be
- 1984 built. Three other very significant cost factors will need to be identified to support the estimating
- 1985 activity, and these are rate, quantity and efficiency.

1986Manufacturing and Quality Tasks

• Manufacturing costs rolled up to system/subsystem level and tracked against targets.

5. Production and Deployment (P&D) Phase

• Detailed trade studies and engineering change requests supported by cost estimates.

1988

1989	•	Cost reduction and avoidance strategies implemented.
1990	•	Costs have been analyzed using pilot-line actuals and updated into manufacturing cost
1991		estimates to ensure target costs are achievable.
1992	•	Manufacturing cost analysis support proposed changes to requirements or configuration.
1993	•	All cost models updated with results of pilot line build.
1994	٠	LRIP cost goals met and learning curve analyzed with actual data.
1995	Metric	S
1996	•	Have your manufacturing costs been rolled up to the system/subsystem level and tracked
1997		against targets?
1998 1999	•	Have you ensured that all detailed trade studies and engineering change requests are supported by cost estimates?
2000	•	Have you ensured that cost reduction and avoidance strategies implemented?
2001	•	Have you ensured that costs have been analyzed using pilot-line actuals and updated into
2002		manufacturing cost estimates to ensure target costs are achievable?
2003	•	Have you ensured that manufacturing cost analysis support all proposed changes to
2004		requirements or configuration?
2005	•	Have you ensured that all cost models have been updated with results of pilot line build?
2006	•	Have you ensured that LRIP cost goals have been met and that learning curves are analyzed
2007		with actual data?
2008	Tools	
2009	•	Cost Analysis Requirements Description (CARD) template
2010	•	Cost and Lead Time Estimating Worksheet
2011	•	Cost/Schedule Control System Criteria (see EVM)
2012	•	Design to Cost Estimates
2013	•	Manufacturing Cost Estimating Spreadsheet
2014	•	Manufacturing Readiness Level assessment for the Cost Thread
2015	•	See CAPE website for tools
2016	Resour	rces
2017	•	MRL Deskbook Version 2016
2018	•	Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
2019		Program Managers, Chapter 9
2020	•	MIL-HDBK-766 Design to Cost
2021	•	Should-cost and Affordability Memo, Aug 2011
2022	•	DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
2023	•	CARD Website and process

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5. Production and Deployment (P&D) Phase

2024 F.3 Develop Manufacturing Cost Mitigation/Maturation Plan

2025 Production cost and production cost estimates change over time. In the early acquisition phases, cost 2026 estimating is probably based on analogy. That is, you compare the cost of the proposed new system 2027 with that of a similar system that you have experience with and have cost information on. At this 2028 point the estimate is not very accurate as the basis of the estimate is may only resemble the final 2029 product and much may change as you develop the new system thus driving changes in the cost 2030 model. Then as the program matures and moves through the acquisition life cycle, more and more is 2031 learned about the final product to the point you may move from analogy to parametric cost 2032 estimating. Parametric cost estimating uses a statistical analysis of two or more similar systems to 2033 develop cost estimating relationships. Again, as the program matures and more is known about the 2034 system as it transitions from development towards production, the cost estimating methodology 2035 moves towards engineering estimates. Engineering estimates are derived by summing detailed cost 2036 estimates of the individual work packages and adding appropriate burdens. Engineering estimates are

- 2037 usually determined by a contractor's industrial engineers, price analysts, and cost accountants.
- 2038 The final and most accurate cost estimating technique is the use of actuals. Actual cost estimating
- 2039 method uses the actual cost of the previous production lot adjusted for inflation, labor saving,
- 2040 material cost, technology changes and other factors. It generally comes at the end of the
- 2041 developmental cycle. An actual cost is a cost sustained in fact, on the basis of costs actually incurred
- and recorded in accomplishing the work performed within a given time period, as distinguished from
- 2043 forecasted or estimated costs.

2044	
2044	

Manufacturing and Quality Tasks

- Manufacturing cost models should include:
- 2046oThe ability to be used in design trades to assess the cost impacts of specific design2047changes, alternative production processes or process improvements;
- 2048oThe ability to incorporate the current, actual manufacturing costs into the production cost2049estimate; and
- 2050oThe ability to support Finance and Contracting processes (such as independent program2051estimates, proposal preparation, fact-finding and negotiations, budgeting, and what-ifs.)
- Develop Manufacturing Maturation Plans for any areas assessed that do not comply with the appropriate manufacturing readiness criteria.
- Touch labor efficiency analyzed to meet production rates and elements of inefficiency identified with plans in place for reduction.

2056 Metrics

Do your manufacturing cost models include:
 The ability to be used in design trades to assess the cost impacts of specific design changes, alternative production processes or process improvements?

Manufacturing and Quality Management Body of Knowledge

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5. Production and Deployment (P&D) Phase

2060 2061 2062 2063		 The ability to incorporate the current, actual manufacturing costs into the production cost estimate? The ability to support Finance and Contracting processes (such as independent program estimates, proposal preparation, fact-finding and negotiations, budgeting, and what-ifs)?
2064 2065 2066 2067	•	Have you developed Manufacturing Maturation Plans for any areas assessed that do not comply with the appropriate manufacturing readiness criteria? Have you analyzed all touch labor efficiency to meet production rates and elements of inefficiency identified with plans in place for reduction?
2068	Tools	
2069	•	Parametric, Engineering and Actual estimating
2070	•	CARD - Cost Analysis Requirements Description (see CAPE website for tools)
2071	•	Manufacturing Readiness Level Assessment Checklist. Cost and Funding Thread
2072	•	Cost and Lead Time Estimating Worksheet
2073	•	Cost/Schedule Control Systems Criteria (C/SCSC)
2074	•	Manufacturing Cost Estimating Worksheet
2075	•	Manufacturing Maturation Plan (no template available)
2076	Resou	irces
2077	•	10 USC Sec. 2334 Independent Cost Estimation and Cost Analysis
2078	•	DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
2079 2080	•	Public Law 114-328, §807, Cost, Schedule and performance of major defense acquisition programs
2081	•	CARD - Cost Analysis Requirements Description Template (See CAPE website for
2082		guidance)
2083	٠	Cost/Schedule Control Systems Criteria Reference Guide, Sep 1992
2084	•	DODI 5000.73 Cost Analysis Guidance and Procedures
2085	•	MRL Deskbook Version 2016
2086	F.4	Update Manufacturing Budget
2087	Manu	facturing and Quality Tasks
2088	•	Cost reduction initiatives ongoing.
2089	•	Program has reasonable budget estimate for FRP.
2090	•	Manufacturing costs and cost drivers associated with design alternatives considered in trade-
2091		off process.
2092	•	Update manufacturing cost drivers for "Should-Cost" models.
2093	•	Program has met their budget estimate for MRL 8 by MS C.
2094	•	All outstanding MRL 9 risk areas understood with approved mitigation plans in place.
2095	•	Program has reasonable budget estimate for reaching MRL 9 by the FRP decision point.

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5. Production and Deployment (P&D) Phase

2096	•	Estimate includes investment for LRIP and FRP.
2097	٠	Assess the affordability and executability of the manufacturing processes.
2098	•	Determine the risks to affordably install and execute required manufacturing processes for
2099		each identified prototype.
2100	•	Analyze the identified risks.
2101	•	Integrate the individual risks identified for each prototype into a cumulative assessment of
2102		the ability to affordably install and execute the proposed manufacturing processes.
2103	٠	Document and provide the cumulative assessment of the ability/risk to affordably install and
2104		execute the proposed manufacturing processes.
2105	•	Analyze of the adequacy, reasonableness and necessity of contractor-proposed manufacturing
2106		labor hours and material costs.
2107	•	Recommend quality and manufacturing cost reduction initiatives.
2108	•	Provide accurate cost performance versus target analysis and assessment of identified trends.
2109	•	Analyze the quality, manufacturing and production cost data against cost targets, and identify
2110		trends.
2111	•	Identify and provide quality, and manufacturing cost/funding estimates and recommendations
2112		on emerging requirements.
2113	•	Identify manufacturing investment opportunities and develop investment roadmaps for
2114		achieving the manufacturing development efforts.
2115	٠	Develop funding and budgeting request for quality and manufacturing initiatives.
2116		• Identify emerging quality and manufacturing initiatives.
2117		• Develop program estimates for applicable quality and manufacturing initiatives.
2118	٠	Develop and manage industrial base investment programs that create, expand or preserve
2119		assured, affordable, and commercially viable production capabilities and capacities for items
2120		essential for national defense.
2121	•	Cost models validated against actual FRP cost.
2122	•	FRP cost goals met.
2123	•	Production budgets sufficient for production at required rates and schedule to support funded
2124		program.
2125	Metric	CS CS
2126	•	Do you have Cost reduction initiatives that are ongoing?
2127	•	Have you ensured that the program has reasonable budget estimates for FRP.
2128	•	Have you ensured that the manufacturing costs and cost drivers associated with the design
2129		alternatives were considered in trade-off process?
2130	•	Have you updated manufacturing cost drivers for "Should-Cost" models?
2131	•	Have you ensured that the program has met their budget estimate for MRL 8 by MS C?
2132	•	Have you ensured that all the outstanding MRL 9 risk areas are understood with approved
2133		mitigation plans in place?

5. Production and Deployment (P&D) Phase

2134	•	Have you ensured that the program has reasonable budget estimates for reaching MRL 9 by the FPP decision point?
2135	•	Leve you ensured that the estimate includes investment for LDID and EDD?
2130	•	Have you ensured that the estimate includes investment for LKIP and FKP?
2137	•	Have you assessed the affordability and executability of the manufacturing processes?
2138	•	Have you determined the risks to affordably install and execute required manufacturing
2139		processes for each identified prototype?
2140	•	Have you analyzed the identified risks?
2141	•	Have you integrated the individual risks identified for each prototype into a cumulative
2142		assessment of the ability to affordably install and execute the proposed manufacturing
2143		processes?
2144	٠	Have you documented and provided the cumulative assessment of the ability/risk to
2145		affordably install and execute the proposed manufacturing processes?
2146 2147	•	Have you analyzed the adequacy, reasonableness and necessity of contractor-proposed manufacturing labor hours and material costs?
2148	•	Have you recommend quality and manufacturing cost reduction initiatives?
2149	•	Have you provided an accurate cost performance versus target analysis and assessment of
2150		identified trends?
2151	•	Have you analyzed the quality, manufacturing and production cost data against cost targets,
2152		and identified trends?
2153	•	Have you identified and provided quality, and manufacturing cost/funding estimates and
2154		recommendations based on emerging requirements?
2155	•	Have you identified manufacturing investment opportunities and developed investment
2156		roadmaps for achieving the manufacturing development efforts?
2157	•	Have you developed funding and budgeting requests for quality and manufacturing
2158		initiatives?
2159		• Have you identified emerging quality and manufacturing initiatives?
2160		• Have you developed program estimates for applicable quality and manufacturing
2161		initiatives?
2162	•	Have you developed and managed industrial base investment programs that create, expand or
2163		preserve assured, affordable, and commercially viable production capabilities and capacities
2164		for items essential for national defense?
2165	•	Have your cost models been validated against actual FRP cost?
2166	•	Have your FRP costs and goals met?
2167	•	Are your production budgets sufficient for production at required rates and schedule to
2168		support the funded program?
2169	Tools	
2170	•	Manufacturing Cost Estimating Spreadsheet
2171	•	Manufacturing Readiness Level Assessment Checklist, Cost and Funding Thread

Technology Readiness Level Assessment Checklist 2172 •

5. Production and Deployment (P&D) Phase

- MRL Deskbook Version 2016
- Technology Readiness Assessment Guidance, Apr 2011
- Public Law 114-328, §807

2177 G. MATERIALS MANAGEMENT

MSC					AS Updates	SEP Updates	TEMF Update	es		\wedge
	CPD	LRIP					0	TRR	IOT&E	FRPDR
2178	G. Materials Management	G.1 Manage Materials Cost Driver Factors	G.2 Manage Materials Risk	G.3. Identify Scale-Up Risk	G.4 Review Contractor SCM Program	G.5 Analyze Material Lead Times	G.6 Investigate Alt. Sources	G.7 Identify Alt. Sources	G.8 Document DTC	G.9 Review Critical Sources

2179 G.1. Update/Manage Materials Cost Driver Factors

2180	Manufacturing and Quality Tasks
2181	• Update cost drivers based on:
2182 2183 2184 2185 2186 2187 2188 2189	 Design requirements Material specifications and tolerances Projected rates/quantities (lot buys) Price stability Material maturities demonstrated on pilot-line build. Material specifications approved. Materials proven and validated during EMD as adequate to support LRIP/FRP. Material specification is stable.
2190	• Material is controlled to specification in LRIP.
2191 2192	• Methods for conserving critical and strategic materials and mitigating supply disruption risks and program impacts associated with those materials.
2193	Metrics
2194	• Have you updated cost drivers based on:
2195 2196 2197 2198 2199 2200 2201 2201 2202	 Design requirements? Material specifications and tolerances? Projected rates/quantities (lot buys)? Price stability? Material maturities demonstrated on pilot-line build? Material specifications that are approved? Materials proven and validated during EMD as adequate to support LRIP/FRP? Material specifications that are stable?

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- Have you validated that material is controlled to specification in LRIP?
- Have you verified methods for conserving all critical and strategic materials and
 mitigating supply disruption risks and program impacts associated with those materials?

2206 **Tools**

- Cost and Lead Time Estimating Worksheet
- Cost/Schedule Control System Criteria (see EVM)
- Cost, Schedule Control Systems Criteria (CSCSC)
- MRL assessment for the Material Management Thread
- Producibility Assessment

2212 **Resources**

- DoD Cost/Schedule Control System Criteria
 Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
- 2215 Program Managers, Chapter 9
- Producibility Systems Guidelines, NAVSO P-3687, Dec 1999
- Strategic and Critical Materials Stock Piling Act, as amended by PL 114-328, Dec 16
- MRL Deskbook Version 2016

2219 G.2. Manage Materials Risk

The area of component and material lead time is extremely critical to meeting program schedules and defining long lead and advanced buy requirements. The program office should maintain continuing visibility of the current status of and the forecast changes in lead times.

2223 Manufacturing and Quality Tasks

- Availability issues addressed to meet LRIP/FRP builds.
- All long lead procurement risk identified and mitigated.
- Obsolescence plan in place.
- Availability issues addressed to meet FRP builds.
- Long lead procurement initiated for LRIP/FRP.
- Effective supply chain management process in place.
- Assessment of critical first tier supply chain completed.
- Supply chain adequate to support LRIP/FRP.
- Assessment of critical second and lower tier supply chain completed.
- Critical make/buy decisions have been assessed.
- Contractor's make/buy decisions for all key and/or critical components analyzed.
- Make/buy decisions analyzed for ability of selected manufacturers, whether in factory or at vendor facility, to meet quality requirements, schedule and cost targets.
- Material availability risks minimalized.
- All special handling/storage/environmental compliance risks/issues mitigated.

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2239	•	All new materials have been characterized in a factory environment.
2240	•	All government-furnished equipment (GFE)/facilities/materials/property
2241	•	Materials proven and validated as adequate to support FRP.
2242	Metrie	CS
2243	•	Have you addressed all availability issues to meet LRIP builds?
2244	•	Have you identified and mitigated all long lead procurement risk?
2245	•	Do you have an obsolescence plan in place?
2246	•	Have you addressed all availability issues to meet FRP builds?
2247	•	Has long lead procurement been initiated for LRIP/FRP?
2248	•	Do you have an effective supply chain management process in place?
2249	•	Have you completed an assessment of the critical first tier supply chain?
2250	•	Is your supply chain adequate to support LRIP/FRP?
2251	•	Have you completed an assessment of the critical second and lower tier supply chain?
2252	•	Have all critical make/buy decisions been assessed?
2253	•	Have you analyzed the contractor's make/buy decisions for all key and/or critical
2254		components?
2255	•	Have you analyzed the make/buy decisions for the ability of selected manufacturers, whether
2256		in factory or at vendor facility, to meet quality requirements, schedule and cost targets?
2257	•	Have you minimalized material availability risks?
2258	•	Have you mitigated all special handling/storage/environmental compliance risks/issues?
2259	•	Have all new materials been characterized in a factory environment?
2260	•	Have all GFE/F/M/P been identified?
2261	•	Have all materials been proven and validated as adequate to support FRP?
2262	Tools	
2263	•	DCMA Material Management and Accounting System Audit
2265	•	PESHE Assessment/Template
2265	•	ISO 14001 Gap Analysis Toolkit
2266	•	DMSMS Product Life Cycle Assessment (Consult Defense Logistics Agency (DLA)
2260	•	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
2268	•	MRL Assessment Questionnaire for the Materials Thread
2269	•	Supply Chain Management Risk Assessment Checklist
2270	•	Producibility Assessment Worksheet
2270	•	TRL Assessment Questionnaire
2222	Pere	
	Resou	
2273	•	DFARS Subpart 242.7200 Contractor Material Management and Accounting System
2274	٠	ESOH in Acquisition Guide, Apr 2009

• ISO 14001 Environmental Management Systems 2275

2276	• DMSMS Guidebook, SD-22, Sep 2009
2277	DOD 5000.60 Defense Industrial Capabilities Assessments
2278	DOD 5000.60H Assessing Defense Industrial Capabilities
2279	DOD 4140.1-R Supply Chain Management Regulation
2280	 DoDM 4140.1 DoD Supply Chain Management Procedures, Feb 2014
2281	MRL Deskbook Version 2016
2282	Technology Readiness Assessment Guidance, Apr 2011
2283	Producibility Systems Guidelines, NAVSO P-3687, Dec 1999
2284	G.3. Identify Scale-Up Risk
2285	Manufacturing and Quality Tasks
2286	As early as technology development, key knowledge must be obtained on critical manufacturing
2287	processes, production scale-up efforts, and potential supply chain issues. Risk considerations should
2288	include:
2289	• Manufacturing processes and techniques not currently available;
2290	• Design producibility risks;
2291	• Probability of meeting delivery dates;
2292	• Potential impact of critical and long-lead time material;
2293	• Production equipment availability;
2294	• Production unit cost goal realism;
2295	• Cost and production schedule estimates to support management reviews;
2296	• Manufacturing feasibility and cost and schedule impact analyses to support trade-offs among
2297	alternatives;
2298	• Recommendations for anticipated production testing and demonstration efforts; and
2299	• Methods for conserving critical and strategic materials and mitigating supply disruption risks
2300	and program impacts associated with those materials.
2301	• All manufacturing processes and techniques are currently available and used on pilot-line.
2302	• There are no design producibility risks.
2303	• There are no production manpower constraints.
2304	• There are no capacity constraints.
2305	• There is a high probability of meeting delivery dates.
2306	• Potential impact of critical and long-lead time material is minimal.
2307	• There are no production equipment availability issues.
2308	 Production unit cost goal realism verified on pilot-line.
2309	• All cost and production schedule estimates support management estimates.
2310	• Manufacturing feasibility and cost and schedule impact analyses support all trade-offs among
2311	alternatives.
2312	• Supply chain is stable and adequate to support FRP.

5. Production and Deployment (P&D) Phase

•	Recommendations for anticipated production testing and demonstration efforts implemented.
٠	Special handling procedures applied in production representative environment.
•	Special handling procedures developed and annotated on work instructions for pilot line
	incorporated into production line.
	• Special handling procedures applied in production representative environment.
•	All special handling procedures demonstrated.
•	Special handling issues pose no significant risk for LRIP/FRP.
•	Special handling procedures applied in LRIP environment.
•	Special handling procedures demonstrated in LRIP.
٠	Special handling issues pose no significant risk for FRP.
•	Special handling procedures effectively implemented in FRP.
•	All work instructions contain special handling provisions as required.
•	Material is controlled to specification in FRP.
Metri	CS
Have y and po	you obtained key knowledge on critical manufacturing processes, production scale-up efforts, tential supply chain issues? You should include the following risk considerations:
•	Have you identified any manufacturing processes and techniques that are not currently
	available?
•	Have you identified any design producibility risks?
•	Have you identified a high probability of meeting delivery dates?
٠	Have you identified the potential impact of critical and long-lead time material?
•	Have you identified any production equipment availability issues?
•	Have you verified that all production unit cost goals are realistic?
•	Have you verified that all cost and production schedule estimates support management
	reviews?
•	Have you verified that all manufacturing feasibility and cost and schedule impact analyses
	that supports trade-offs among alternatives?
٠	Have you verified all recommendations for anticipated production testing and demonstration
	efforts?
٠	Have you validated all methods for conserving critical and strategic materials and mitigating
	supply disruption risks and program impacts associated with those materials?
•	Have you verified that all manufacturing processes and techniques are currently available and
	used on pilot-line?
٠	Have you verified that there are no design producibility risks?
٠	Have you verified that there are no production manpower constraints?
•	Have you verified that there are no capacity constraints?
٠	Have you verified that there is a high probability of meeting delivery dates?
٠	Have you verified that the potential impact of critical and long-lead time material is minimal?
٠	Have you verified that there are no production equipment availability issues?
	Metric Have y and po

5. Production and Deployment (P&D) Phase

2352	•	Have the production unit cost goal realism been verified on the pilot-line?
2353	•	Do all cost and production schedule estimates support management estimates?
2354	•	Do manufacturing feasibility and cost and schedule impact analyses support all trade-offs
2355		among alternatives?
2356	•	Is the supply chain stable and adequate to support FRP?
2357	•	Have the recommendations for anticipated production testing and demonstration efforts been
2358		implemented?
2359	•	Have special handling procedures been applied in a production representative environment?
2360	•	Have special handling procedures been developed and annotated on work instructions for the
2361	-	nilot line been incorporated into the production line instructions?
2301		phot line occur incorporated into the production line instructions.
2362		• Have the special handling procedures been applied in the production representative
2363		environment?
2364	•	Have all special handling procedures been demonstrated?
2365	•	Have you verified that special handling issues pose no significant risk for LRIP/FRP?
2366	•	Have special handling procedures been applied in the LRIP environment?
2367	•	Have special handling procedures been demonstrated in LRIP?
2368	•	Have you verified that special handling issues pose no significant risk for FRP?
2369	•	Have special handling procedures been effectively implemented in FRP?
2370	•	Do all work instructions contain special handling provisions as required?
2371	٠	Have you verified that material is controlled to specification in FRP?
2372	Tools	
2373		Cost and Lead Time Worksheet
2374		Producibility Assessment Worksheet
2375		Manufacturing Readiness Assessment Materials Thread
2376		ManTech Strategic Plan
2377	Resou	rces
2378		Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
2379		Program Managers, Chapter 9
2380		Producibility Systems Guidelines, NAVSO P-3687, Dec 1999
2381		MRL Deskbook Version 2016
2382		MRL Users Guide
2383		DoD Directive 4200.15, ManTech
2384		Air Force Technology Development and Transition Strategy Guidebook, Nov 2010
2385	G.4. R	eview Contractor Supply Chain Management (SCM) Program

2386 The DoD has many supply chains and these chains are a multibillion- dollar business. However,

2387 many SCM best practices have not been incorporated into the DOD supply chain uniformly because

- the DOD supply chain is a conglomeration of different supply chains managed under different
- 2389 organizational structures. Some of these supply chains have a logistics view and some have an

5. Production and Deployment (P&D) Phase

- 2390 acquisition view. In many cases, these different supply chains are linked only by the fact that they
- 2391 provide supplies to DOD personnel. Because the DOD supply chain is enormous, making it even slightly more efficient could result in tremendous cost savings.
- 2392

2393 **Manufacturing and Quality Tasks**

- 2394 Review SCM for: 2395 Strategic partnerships exist with vendors and suppliers. 0 2396 Stronger collaboration of information (especially forecasting data). 0 • Reducing lead times on the critical path. 2397 2398 • Reducing variability. 2399 • Supply Chain Planning. 2400 • Demand Planning. 2401 o Vendor Managed Inventory. o Supplier Management. 2402 2403 o Procurement. 2404 o Strategic Sourcing. 2405 o Warehouse Management. 2406 • Transportation Management.
 - Order Fulfillment. 2407
 - 2408 o Contract Management.
 - 2409 Effective supply chain management process in place.
 - 2410 Assessment of critical first tier supply chain completed. 0
 - 2411 Supply chain adequate to support LRIP/FRP.
 - 2412 Assessment of critical second and lower tier supply chain completed. 0
 - 2413 Supply chain proven and supports FRP requirements.
 - Metrics 2414
 - 2415 Have you reviewed SCM for the following considerations? • 2416 • Have you verified that strategic partnerships exist with vendors and suppliers? 2417 • Have you verified strong collaboration of information (especially forecasting data)? 2418 • Have you verified reductions in lead times on the critical path? 2419 • Have you verified reductions in variability? • Have you verified ongoing Supply Chain Planning? 2420 • Have you verified ongoing Demand Planning? 2421 2422 • Have you verified Vendor Managed Inventory levels? 2423 • Have you verified ongoing Supplier Management? o Have you verified strong Procurement policies and procedures? 2424 2425 • Have you verified ongoing Strategic Sourcing? 2426 • Have you verified ongoing Warehouse Management?

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2427 2428 2429		 Have you verified ongoing Transportation Management? Have you verified ongoing Order Fulfillment? Have you verified ongoing Contract Management?
2430	•	Have you verified that an effective supply chain management process is in place?
2431		• Have you completed an assessment of the critical first tier supply chain?
2432	•	Have you verified that the supply chain is adequate to support LRIP/FRP?
2433		• Have you completed an assessment of the critical second and lower tier supply chain?
2434	•	Have you verified that the supply chain has been proven and supports FRP requirements?
2435	Tools	
2436	٠	AS5553 Supply Chain Assessment
2437	•	DCMA Material Management and Accounting System Audit
2438	•	Manufacturing Readiness Assessment using the Material thread
2439	Resou	rces
2440	•	AS6500, Manufacturing Management Systems
2441	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
2442	٠	AS9100, Quality Management Systems
2443	•	ISO 9001, Quality Management Systems
2444	•	IEEE 15288.2, System and Software Engineering, 2015
2445	•	DFARS Subpart 242.7200 Contractor Material Management and Accounting System
2446	•	AS9103 Variation Management of Key Characteristics
2447	•	AS9133, Qualification Procedure for Aerospace Standard Parts
2448	•	AS5553, Counterfeit Electronics Parts
2449	٠	DFARS 246.870, Contractors' Counterfeit Electronic Part Detection and Avoidance
2450	•	DFARS 252.246-7007, Contractor Counterfeit Electronic Part Detection and Avoidance
2451		System
2452	•	DFARS 252.246-7008, Sources of Electronic Parts
2453	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
2454		Reporting
2455	٠	DoDI 5000.02, Enclosure 14
2456	٠	NIST 800-82 Guide to Industrial Control Systems Security
2457 2458	•	NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations

2459 **G.5. Analyze Materials Lead Time**

Production lead time is the time interval between when the item is put under contract and the initialdelivery of the first unit(s). Defense systems typically exhibit lead time volatility due to the

5. Production and Deployment (P&D) Phase

- complexity of the product and complexity of the acquisition process. Lead time analysis begins with
- the customers' need date. The start date for contractor activity is normally based on a setback from
- the customers' need date. The setback is dictated by the operation flow times and the material,
- component and tooling lead times. Often these lead times can be very long (over a year) and may
- require long lead funding. Lead times may include the time it takes to place orders for long lead
- 2467 materials, components and tooling, transportation time for those items, receiving/inspection,
- fabrication, assembly, inspection and testing, packaging and shipping. It will also include the wait
- time in the systems as work-in-progress as the item sits in a cue waiting for the next operation. In a
- 2470 complex manufacturing/assembly process with several different production paths, the critical path
- 2471 will dictate the lead time, which will be the longest path.
- 2472 When the lead time is in error, two possible problems exist. If the lead time estimate is excessive, the
- 2473 funds requirement will be established unnecessarily early. This may lead to an overstatement of the
- 2474 lead-time funding requirement and could result in funds being drawn unnecessarily from other areas
- of need. If the lead time estimate is understated, specific contractor activities could experience a start
- 2476 date that will not support the required delivery date without the expenditure of premium effort,
- 2477 resulting in higher than necessary program cost or even potential schedule slippage. The impact of
- lead time variations on a particular program can be minimized but requires management attention.
- 2479 Tools like JIT, Supplier Partnerships, Lean, Six Sigma and Theory of Constraints can be used to
- 2480 minimize the cycle time.
- 2481 Manufacturing and Quality Tasks
- No potential Long Lead Items issues.
- Analyze lead time fluctuations do not impact schedule.
- Ensure government funding is aligned with contractor long lead requirements.
- Long lead procurement initiated for LRIP/FRP.
- Long lead procurement initiated for FRP.
- Availability issues pose no significant risk for FRP.
- Long term agreements in place where practical.

2489 Metrics

- Have you verified that there are no potential Long Lead Items issues?
- Have you verified that an analysis of lead time fluctuations does not impact schedule?
- Have you ensured government funding is aligned with contractor long lead requirements?
- Have you verified that long lead procurement has been initiated for LRIP/FRP?
- Have you verified that long lead procurement initiated for FRP?
- Have you verified that material availability issues pose no significant risk for FRP?
- Have you verified that long term agreements are in place where practical?

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2497	Tools		
2498	Cost and Lead Time Estimating Worksheet		
2499	Resources		
2500 2501	 Integrated Master Plan and Integrated Master Schedule Preparation and Users Guide, Oct 2005 		
2502	 MRL Deskbook Version 2016, Materials Management thread 		
2503	G.6. Investigate Alternate Source Options – primarily a contractor function		
2504	Parts management is a design strategy that seeks to reduce the number of unique or specialized parts		
2505	used in a system (or across systems) to reduce the logistic footprint and lower total life-cycle costs.		
2506	In addition, it also will enhance the reliability of the system and mitigate parts obsolescence because		
2507	of Diminishing Manufacturing Sources and Material Shortages. Parts management is an important		
2508	design consideration and should be used whenever parts are not defined based on open systems		
2509	design interfaces or commercial off-the-shelf (COTS) items.		
2510	A part is one piece, or two or more pieces joined together, that is not normally subject to disassembly		
2511	without destruction or impairment of intended design use. A part is the lowest configuration item of		
2512	the system design that would be implemented and verified. Parts are defined in performance-based		
2513	terms by their form, fit, function, and interfaces.		
2514	The parts management strategy should cover the entire life cycle of a system and be based on the		

The parts management strategy should cover the entire life cycle of a system and be based on the fundamental systems engineering processes. The parts management strategy should also be evaluated at technical reviews, in particular, the Preliminary Design Review and Critical Design Review.

The SEP should address the parts management strategy, including the need for a parts management plan. A parts management plan typically includes the following:

- Specification of parts selection criteria based on objectives in the Acquisition Strategy Report and overall support strategy,
- Identification of a preferred parts list,
- Definition of the processes for conducting trade-off analysis, parts selection, inclusion of
 configuration identification status and related change decisions in the technical baseline, and
 approval and
- documentation of non-preferred parts, and
- Discussion of how parts management considerations will flow down to suppliers.
- 2527 Parts selection should be based on trade-off and cost-benefit analyses that are conducted in
- accordance with the program's parts strategy and management plan, as derived from the overall
- acquisition and sustainment strategies. Selected parts should be documented in a parts list, which is
- 2530 under configuration management of the overall technical baseline.

2531	Manufacturing and Quality Tasks
2532	• Understand quality, and manufacturing recommendations for the Diminishing Manufacturing
2533	Sources and Material Shortages (DMSMS) plan.
2534	Understand contractor's analysis of the Government and Industry Data Exchange Program
2535	(GIDEP) database for configuration items that are susceptible to DMSMS issues.
2536	• Review contractor's DMSMS recommendations for the program risk management plan.
2537	Metrics
2538	• Do you understand the quality, and manufacturing recommendations for the DMSMS) plan?
2539	• Do you understand the contractor's analysis of the GIDEP database for configuration items
2540	that are susceptible to DMSMS issues?
2541	Have you reviewed contractor's DMSMS recommendations for the program risk
2542	management plan?
2543	Tools
2544	Contractor Purchasing System Review
2545	DCMA Material Management and Accounting System Audit
2546	• Make or Buy Plans
2547	Resources
2548	• DFAR 15.407-2 Make or Buy Programs
2549	• DFARS Subpart 242.7200 Contractor Material Management and Accounting System
2550	Contractor Purchasing System Review (CPSR) Guidebook, May 2017
2551	MRL Deskbook Version 2016, Materials Management thread
2552	• AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
2553	• AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Material
2554	G.7. Work with contractor to identify Alternate Sources
2555	Manufacturing and Quality Tasks
2556	• Single/Sole/Foreign Sources identified.
2557	Potential alternative sources identified.
2558	• Qualification plans in place.
2559	Metrics
2560	• Have you identified Single/Sole/Foreign sources?
2561	• Have you identified potential alternative sources?
2562	• Do you have qualification plans in place?

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2563	Tools
2564	Contractor Purchasing System Review
2565 2566	 DCMA Material Management and Accounting System Audit Make or Buy Plans
2567	Resources
2568	• DFAR 15.407-2 Make or Buy Programs

- DFARS Subpart 242.7200 Contractor Material Management and Accounting System
- Contractor Purchasing System Review (CPSR) Guidebook, May 2017
- MRL Deskbook Version 2016, Materials Management thread
- AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
- AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Material

2574 G.8. Document Design to Cost (DTC)

The Design to Cost (DTC) approach was created in the mid-1970's as a cost cutting initiative. The underlying objective of DTC was to identify cost drivers early in the systems life cycle so that tradeoff decisions could be considered and ways to mitigate those costs identified. DTC accomplished this by making cost a design parameter by constraining design options to a fixed cost limit. The focus of DTC at that time was on designing the system to minimize development and production costs for a particular performance level with little or no attention given to reducing operating and support (O&S) costs.

2582 DTC is a management concept that historically emphasized cost-effective design (minimizing cost

2583 while achieving performance) and targeting an Average Unit Procurement Cost (AUPC). DTC

concentrates on the contractors' activities associated with tracking/controlling costs and performing

2585 cost-performance analyses/tradeoffs. Cost as an Independent Variable (CAIV) came along in 1996

and refocused DTC to consider cost objectives for the total life cycle of the program and to view

CAIV with the understanding it may be necessary to trade off performance to stay within costobjectives and constraints. DTC is now those actions that are undertaken to meet cost objectives

through explicit design activities. DTC has fallen into disuse since the development of CAIV and the emphasis on fixed price production contracts.

2591 Manufacturing and Quality Tasks

- Analyze costs using pilot-line system/sub-system actuals to ensure target costs are achievable.
- Update cost models with design requirements, material specifications and pilot-line results.

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2595	Metrics
2596 2597	• Have you analyzed costs using pilot-line system/sub-system actuals to ensure target costs are achievable?
2598 2599	• Have you updated cost models with design requirements, material specifications and pilot- line results?
2600	Tools
2601	• Cost Estimate (based on actuals)
2602	Resources
2603	GAO-09-3SP GAO Cost Estimating and Assessment Guide, Mar 2009
2604	• MIL-HDBK-766, Design to Cost, Aug 1989
2605	• Dept. of Army Design to Cost Handbook, Jan 1990
2606	• DFAR 207.103(B)(i)(i), Apply design to cost principles
2607	G.9. Review Critical Sources
2608 2609	Lead times for defense materials and components can be long and volatile. There are various reasons for this situation, such as:
2610	• Imbalances between capacity and demand;
2611	Competition from commercial suppliers;
2612	• Poor quality and lack of process improvement;
2613	Production bottlenecks;
2614	• Long testing cycles;
2615	• Raw materials not available;
2616	Long contracting process;
2617	• Lack of funding;
2618	• Transportation; and
2619	• Labor issues.
2620	Lead times are severely impacted by capacity limitations. As orders increase beyond existing
2621	capacity, the contractor has the option to increase capacity or to add new orders to backlog. For a
2622	contractor with a reasonably steady demand and no capacity expansion, increasing backlog increases

lead time. When these lead time increases are communicated to customers, their response to the lead

- time is to issue orders immediately to ensure material availability. With constant capacity, these new orders must also be added to backlog, which must then be reflected in increased lead time. As this
- self-fueling process, often called the lead time capacity syndrome, continues, a relatively small
- 2627 increase in demand can result in extremely large increases in lead times.

2628 Some commodities, like electronics, have long lead times. In the case of electronics, especially space 2629 qualified electronics it is the testing that makes the items have a long lead issue. Steady- state life

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- testing is performed to demonstrate the quality and reliability of devices by subjecting them to
- 2631 specified operational conditions over an extended period of time. The standard steady- state life test
- 2632 is 1,000 hours for many items. Corrosion testing can take up to 240 hours, and burn-in testing could
- 2633 be as long as 700 hours. Many space qualified electronic devices have a lead time measured in
- 2634 months, often due to testing requirements and lack of competition.
- 2635 Natural disasters, such as the earthquake and tsunami that hit Japan in 2011 displaced nearly half a
- 2636 million people and severely disrupted production operations in Japan for many industries. The impact
- 2637 to production was so severe that automobile production for Toyota, Honda and Nissan were all
- slowed down, even at U.S. plants due to the lack of parts.
- 2639 The area of component and material lead time is extremely critical to meeting program schedules and
- 2640 defining long lead and advanced buy requirements. The program office should maintain continuing
- 2641 visibility of the current status of and the forecast changes in lead times.
- 2642 **Ma**

Manufacturing and Quality Tasks

- Verify LRIP/FRP material availability.
- Conduct an assessment of the LRIP/FRP bill of materials using pilot-line activity.
- 2645 o Identify key and/or critical components in the LRIP/FRP Bill of Materials (BOM).
- 2646 Analyze key and/or critical components in the LRIP/FRP BOM for potential issues.
- Validate material maturity based on pilot-line.
- 2648oValidate that the properties and characteristics of the material to be used for the2649LRIP/FRP system meet requirements.
- 2650oDetermine that the material's properties and manufacturing characteristics are2651predictable.
- 2652 Assess the properties of the material for basic manufacturability.
- Develop mitigation strategies for quality and manufacturing related supply chain counterfeit
 and anti-tamper and related exportability risks.
- Conduct an assessment of the materials planning systems. Identify materials planning systems being employed by the contractor or facility.
- Update Critical Suppliers List.
- Program is in FRP with no significant material availability issues.

2659 Metrics

- Have you verified LRIP/FRP material availability?
- Have you conducted an assessment of the LRIP/FRP bill of materials using pilot-line activity?
- 2663 Have you identified key and/or critical components in the LRIP/FRP BOM?

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2664 2665		• Have you analyzed key and/or critical components in the LRIP/FRP BOM for potential issues?
2666	٠	Have you validated material maturity based on pilot-line actuals?
2667 2668 2669 2670 2671		 Have you validated that the properties and characteristics of the material to be used for the LRIP/FRP system meet requirements? Have you determined that the material's properties and manufacturing characteristics are predictable? Have you assessed the properties of the material for basic manufacturability?
2672 2673	•	Have you developed mitigation strategies for quality and manufacturing related supply chain counterfeit and anti-tamper and related exportability risks?
2674 2675	•	Have you conducted an assessment of the materials planning systems. Have you identified the materials planning systems being employed by the contractor or facility?
2676	•	Have you updated the Critical Suppliers List?
2677	٠	Have you verified that the program is in FRP with no significant material availability issues?
2678	Tools	
2679	٠	Contractor Purchasing System Review
2680	•	DCMA Material Management and Accounting System Audit
2681	Resou	irces
2682	٠	DFAR 15.407-2 Make or Buy Programs
2683	•	DFARS Subpart 242.7200 Contractor Material Management and Accounting System
2684	٠	Contractor Purchasing System Review (CPSR) Guidebook, May 2017
2685	•	MRL Deskbook Version 2016, Materials Management thread
2686	•	AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition
2687	•	AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Material
2688	•	Strategic and Critical Materials Stock Piling Act, as amended by PL 114-328, Dec 16
2689	•	MRL Deskbook Version 2016

5. Production and Deployment (P&D) Phase





2691

2692 H.1. Identify Required Process Capability

The purpose of the P&D Phase is to produce items for the warfighter that achieve operational capability and satisfy mission needs. In order to achieve those goals the items being produced must have achieved design stability, had their technologies matured and their manufacturing processes must be capable, stable and under control. There are essentially two related production efforts during the P&D phase: LRIP and FRP. LRIP is often identified as up to 10% of the estimated production volume.

2699

2700 LRIP typically demonstrates the production of articles beyond a pilot line environment. These items 2701 are typically built in a pilot line environment. All systems engineering/design requirements should 2702 have been met such that there are minimal system changes. Major system design features are stable 2703 and have been proven in test and evaluation. Materials are available to meet planned rate production schedules. Manufacturing process capability in a low-rate production environment is at an 2704 appropriate quality level to meet design key characteristic tolerances. Production risk monitoring is 2705 2706 ongoing. LRIP cost targets have been met, and learning curves have been analyzed with actual data. 2707 The cost model has been developed for FRP environment and reflects the impact of continuous 2708 improvement.

- 2709 It is essential to fully understand present and future process capabilities to ensure that, as new or
- 2710 improved processes mature, they can be readily introduced into manufacturing with no detrimental
- 2711 effects to producibility. Predicting future capabilities is especially important in markets like the
- 2712 electronics industry where product or process obsolescence forces the rapid development and use of
- 2713 new technology. Future process capabilities in this context means more than advanced, new
- 2714 processing techniques. It also means being cognizant of processes used by competitors or
- 2715 manufacturers in different industries and adapting those processes if, and when, it is appropriate.

2716 Manufacturing and Quality Tasks

Models/simulation verified by LRIP build, assists in management of LRIP, and determines
 that FRP requirements can be met.

27192720272127222723	•	Ensure manufacturing process documentation is being developed concurrently with the product specification to ensure the design is producible, supportable, and affordable. Ensure models/simulation were used to determine system constraints and identify improvement opportunities. Verify models/simulation with pilot-line builds.
2724		• Results used to improve process and determine that LRIP/FRP requirements can be met.
2725	•	Ensure manufacturing processes were demonstrated on a pilot-line.
2726		• Continue collecting or estimating process capability data.
2727	•	Ensure manufacturing processes have been verified for LRIP/FRP on a pilot-line.
2728		• Process Capability data from pilot line meets target.
2729	•	Verify process capability requirements have been refined.
2730	•	Models/simulation verified by FRP build. Production simulation models used as a tool to assist in management of FRP
2731	·	roduction simulation models used as a tool to assist in management of rice.
2732	Metri	CS
2733 2734	•	Have you verified that the LRIP Models/simulation assists in management of LRIP, and demonstrates that the FRP requirements can be met?
2735	•	Have you ensured that manufacturing process documentation is being developed concurrently
2736		with the product specification to ensure the design is producible, supportable, and affordable?
2738	•	Have you ensured models/simulation were used to determine system constraints and identify improvement opportunities?
2739	•	Have you verified the models/simulation with pilot-line builds?
2740 2741		• Have you used the results to improve process and determine that LRIP/FRP requirements can be met?
2742	•	Have you ensured that manufacturing processes were demonstrated on a pilot-line?
2743		• Have you continued collecting or estimating process capability data?
2744	•	Have you ensured manufacturing processes have been verified for LRIP/FRP on a pilot-line?
2745		• Have you verified that the Process Capability data from pilot line meets target?
2746	•	Have you verified process capability requirements have been refined?
2747	•	Have you verified models/simulation by the FRP build?
2748 2749	•	Have you verified production simulation models used as a tool to assist in management of FRP?
2750	Tools	
2751	•	MRL Assessment using Process Capability and Control Thread
2752	•	Critical to Quality Tree

5. Production and Deployment (P&D) Phase

2753	Resources		
2754 2755	 Capability-Based Assessment (CBA) Handbook, Mar 2014 MRL Deskbook Version 2016 		
2756	H.2. Initiate Process Capabilities Studies		
2757 2758 2759 2760	Manufacturing Process Capability Analysis determines the available manufacturing capacity and its capability to produce the desired end item without special controls. It is a critical activity in producibility analysis. This normally includes analysis of the degree of process variability, the causes of variability and the definition of methods to reduce it.		
2761	Manufacturing and Quality Tasks		
2762 2763 2764	 Manufacturing processes are stable, adequately controlled, capable, and have achieved program LRIP objectives. Evaluate yields and rates from pilot-line actuals against production targets and the results are 		
2765	used to feed improvement plans.		
2766	Validate pilot-line actuals support production targets.		
2767	• Refine yields and rates required to begin LRIP using pilot-line results. Update ongoing		
2768	 Improvement plans. Ensure key processes are identified and their status briefed at all major reviews 		
2105	Linsure ney processes are rachanded and their status criered at an importections.		
2770	Metrics		
2771 2772	• Have you verified that manufacturing processes are stable, adequately controlled, capable, and have achieved program LRIP objectives?		
2773 2774	• Have you evaluated yields and rates from pilot-line actuals against production targets and the results are used to feed improvement plans?		
2775	• Have you validated that pilot-line actuals support production targets?		
2776	• Have you verified and refined yields and rates required to begin LRIP using pilot-line		
2111	 Have you undeted ongoing improvement plans? 		
2779	 Have you updated ongoing improvement plans? Have you ensured key processes are identified and their status briefed at all major reviews? 		
2780	Tools		
2781	MRL Assessment using Process Capability and Control Thread		
2782	Process Capability Studies (Cp and Cpk assessment)		
2783	Producibility Assessment Worksheet (PAWs)		
2784 2785	 SIX Sigma Worksheet First Pass Vield Estimates Worksheet 		
2105			
2786	Resources		

• DoD-Wide Continuous Process Improvement (CPI)/Lean and Six Sigma Program, May 2008 2787

2788	•	DoD Continuous Process Improvement Transformation Guide, May 2006			
2789	•	Producibility Systems Guidelines, NAVSO P-3687, Dec 1999			
2790	MRL Deskbook Version 2016				
2791	H.3. N	Nature Critical Manufacturing Processes			
2792 2793 2794 2795 2796	DoDI and ex include accom demon	5000.02 requires that Program Managers and their technical staff; "Develop an affordable ecutable manufacturing" process during the EMD Phase. The Post-CDR assessment will e a demonstration that the "maturity of critical manufacturing processes has been plished. EMD shall end when "manufacturing processes have been effectively astrated in a pilot line environment" prior to Milestone C .			
2797	Manu	facturing and Quality Tasks			
2798 2799	•	Manufacturing processes are stable, adequately controlled, capable, and have achieved program FRP objectives.			
2800	٠	Manufacturing Process Demonstration includes the development of affordable and			
2801		executable manufacturing processes, the completion of system fabrication, production of test			
2802		articles so that you can demonstrate system integration, interoperability, supportability, safety			
2803	and utility.				
2804	•	Additional processes requirements may include such items as cleaning, heat treatment, clean			
2805	room controls, controlled testing and special handling (i.e., personal grounding requirements				
2806		for electronic components).			
2807	•	• All processes must be identified in the design documentation.			
2808	•	• Processes that contributed manufacturing risk to the program must be proofed on the pilot-			
2809		line.			
2810 2811		• Ensure that the pilot-line process can repeatedly produce conforming hardware within the cost and time constraints of the production phase			
2812		• Evaluate expected pilot-line process yields for each critical process and indicate the			
2813		statistical or other method used to maintain control of process performance.			
2814		• Ensure proofing is accomplished in an environment that simulates actual production			
2815		conditions (typically a pilot-line environment).			
2816		• These pilot-line conditions include the physical facilities, personnel and manufacturing			
2817		documentation.			
2818		• It may also be necessary for the contractor to establish training and certification programs			
2819		for the shop personnel to ensure that the pilot-line process capabilities can be attained on			
2820		a recurring basis.			
2821		• Environmental and safety regulations and standards are an integral part of the production			
2822		planning and are compliant with federal, state, and industry standards and laws. Their			
2823		effects on the cost of production operations are known.			

5. Production and Deployment (P&D) Phase

2824	Metrics
2825 2826 2827 2828 2829 2830 2831 2832 2833 2834 2835 2836	 Have you verified that manufacturing processes are stable, adequately controlled, capable, and have achieved program FRP objectives. Have you verified that Manufacturing Process Demonstration includes the development of affordable and executable manufacturing processes, the completion of system fabrication, production of test articles so that you can demonstrate system integration, interoperability, supportability, safety and utility. Have you verified that additional processes requirements may include such items as cleaning heat treatment, clean room controls, controlled testing and special handling (i.e., personal grounding requirements for electronic components). Have you verified that all processes that contributed manufacturing risk to the program must be proofed on the pilot-line.
2837 2838 2839 2840 2841 2842 2843 2844 2845 2846 2845 2846 2847 2848 2849 2850	 Have you ensured that the pilot-line process can repeatedly produce conforming hardware within the cost and time constraints of the production phase? Have you evaluated the expected pilot-line process yields for each critical process and indicate the statistical or other method used to maintain control of process performance? Have you ensured that proofing is accomplished in an environment that simulates actual production conditions (typically a pilot-line environment)? Have you verified that pilot-line conditions include the physical facilities, personnel and manufacturing documentation? Have you verified that it may be necessary for the contractor to establish training and certification programs for the shop personnel to ensure that the pilot-line process capabilities can be attained on a recurring basis? Have you verified that environmental and safety regulations and standards are an integral part of the production planning and are compliant with federal, state, and industry standards and laws and their effects on the cost of production operations are known?
2851 2852 2853 2854	 Tools MRL Assessment using Process Capability and Control Thread Production Part Approval Process (PPAP) Process Capability Assessment
2855	Resources
2856	MRL Deskbook Version 2016
2857	• DoDI 5000.02
2858	H.4. Focus on Manufacturing Risk Reduction

DOD has increased management focus on manufacturing and quality management throughout theprogram phases. There are significant costs associated with the manufacturing effort. These costs, to

5. Production and Deployment (P&D) Phase

a great degree, are inherent in the design. As a design evolves, certain costs become essentially fixed.

- 2862 Given the objective of minimizing cost and the existence of projections that indicate limited dollars
- are available for future manufacturing effort, it is vital that PMs identify costs at the point when they
- are being fixed. Understanding the cause and effect relationships between these early decisions
- 2865 provides the justification for early assessments.

- 2867 Variability experiments conducted to show FRP impact and potential for continuous 2868 improvement. 2869 • EMD typically includes the demonstration of production prototype articles or engineering 2870 development models. These items are typically built in a pilot-line environment. 2871 When the industrial capabilities are in place and the prototype items achieve their 2872 requirements as validated through testing, then the program can exit EMD and enter LRIP/Production. 2873 2874 • LRIP yield and rate targets achieved. • Yields and rates required to begin FRP refined using LRIP results. Yield improvements 2875 2876 ongoing. 2877 • FRP yield and rate targets achieved. 2878 • Yield improvements ongoing. 2879 Process capability goes beyond machine capability. Ensure it also includes the effects of 2880 changes in: 2881 o workers, 2882 o materials. 2883 o fabrication methods. 2884 o tooling and equipment, 2885 set-up, and other process conditions. 0 2886 Metrics 2887 Have you conducted variability experiments to show FRP impact and the potential for • 2888 continuous improvement? 2889 • Did EMD include the demonstration of production prototype articles or engineering 2890 development models? Were these items built in a pilot-line environment? 2891 • Were the industrial capabilities in place and the did the prototype items achieve their 2892 requirements as validated through testing, before the program exited EMD and entered 2893 LRIP/Production? 2894 • Were the LRIP yield and rate targets achieved? 2895 • Were the yields and rates required to begin FRP refined using LRIP results? Are yield
 - were the yields and fates required to begin FKF fermied using LKFF festils? All improvements ongoing?
 - Were FRP yield and rate targets achieved? Are yield improvements ongoing?
 - Does process capability extend beyond machine capability? Have you ensured it also
 includes the effects of changes in:

5. Production and Deployment (P&D) Phase

2900	o workers,	
2901	o materials,	
2902	o fabrication methods,	
2903	o tooling and equipment,	
2904	• set-up, and other process conditions?	
2905	Tools	
2906	LRIP demonstrated	
2907	• FRP demonstrated	
2908	Resources	
2909	AS6500 Manufacturing Management Program	
2910	• MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016	
2911	• DoDI 5000.02	
2912	• MRL Deskbook Version 2016, Process Capability and Control thread	

2913 QUALITY MANAGEMENT I.



I.1. Update Quality Strategy based on pilot-line results 2915

2916 Examine a program to determine if the design is ready for production and if the prime contractor and

2917 major subcontractors have accomplished adequate production planning without incurring

unacceptable risks that will breach thresholds of schedule, performance, cost, or other established 2918

2919 criteria. The Production Readiness Review examines risk; it determines if production or production

2920 preparations identify unacceptable risks that might breach thresholds of schedule, performance, cost,

or other established criteria. The review evaluates the full, production-configured system to 2921

determine if it correctly and completely implements all system requirements. The review determines 2922

2923 whether the traceability of final system requirements to the final production system is maintained.

2924 At this review, the Integrated Product Team (IPT) should review the readiness of the manufacturing

2925 processes, the quality management system, and the production planning (i.e., facilities, tooling and

2926 test equipment capacity, personnel development and certification, process documentation, inventory

2927 management, supplier management, etc.). A successful review is predicated on the IPT's

2928 determination that the system requirements are fully met in the final production configuration, and

2929 that production capability forms a satisfactory basis for proceeding into LRIP and FRP.

5. Production and Deployment (P&D) Phase

- 2930 The program manager should convene a PRR of the prime contractor and major subcontractors, as
- 2931 applicable. The PRR(s) should be conducted in an iterative fashion, concurrently with other technical
- reviews, such as the CDR, during the EMD phase. Periodic production readiness assessments should
- be conducted during System Capability and Manufacturing Process Demonstration to identify and
- 2934 mitigate risks as the design progresses. The 'final' PRR should occur at the completion of the EMD
- 2935 phase and the start of the Production and Deployment phase. The final PRR should assess the
- 2936 manufacturing and quality risk as the program proceeds into LRIP and FRP.
- 2937 Manufacturing and Quality Tasks
- 2938 Ensure the following quality of design attributes are represented as Key Performance Parameters:
- Performance,
- Reliability,
- Availability, and
- Maintainability
- Government-furnished information (GFI) is confirmed by the PMO to meet system
 requirements and to be available, complete, and supportable.
- 2945 Metrics
- Have you ensured the following quality of design attributes are represented as Key Performance Parameters?
- Performance,
- Reliability,
- Availability, and
- Maintainability
- GFI is confirmed by the PMO to meet system requirements and to be available, complete,
 and supportable?

2954 **Tools**

- 2955• Acquisition Strategy Template
- ISO 9001 QMS Audit Checklist
- AS9100 Audit Checklist
- Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread

2959 **Resources**

DSMC Acquisition Strategy Guide, Dec 1999
AFMC Instruction 63-145 Manufacturing and Quality (Draft)
AS9100, Quality Management System – Aerospace, Sep 2016
ISO 9001, Quality Management System, Sep 2016
FAR 52.246-11, Quality

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2965	MRL Deskbook Version 2016
2966	• DAG Chapter 14.3.1.3.6 Quality Plans
2967	I.2. Apply Quality Strategy
2968	For the FRP Decision Review Acquisition Strategy update, the Program Management Office should
2969	identify remaining risks prior to a production go-ahead decision. Key considerations should include
2970	industrial base viability, design stability, process maturity, supply chain management, quality
2971	strategy/management, and facilities and manufacturing skills availability. Sources of data could
2972	include technical reviews and audits, Program Status Reviews, pre-award surveys, Production
2973	Readiness Reviews, Industrial Capabilities Assessments, trade-off studies, tooling plans, make- or-
2974	buy plans, manufacturing plans, and bills of material. Important outputs include actions to reduce or
2975	handle remaining risks.
2976	Manufacturing and Quality Tasks
2977	• Quality targets verified on LRIP line.
2978	Continuous quality improvement ongoing.
2979	• Establish quality targets.
2980	• Collect and analyze quality data from the pilot-line and use results to feed improvement
2981	plans.
2982	• Assess quality targets against pilot-line. These results feed continuous quality improvements.
2983	• Quality targets verified on FRP line.
2984	• Planned non-developmental item (NDI) or COTS items have been determined to meet
2985	program system performance and sustainment requirements through a defined acceptance
2986	process.
2987	Metrics
2988	• Have you verified quality targets on the LRIP line?
2989	• Are continuous quality improvement activities ongoing?
2990	• Have you established quality targets?
2991	• Have you collected and analyzed quality data from the pilot-line and used the results to feed
2992	improvement plans?
2993	• Have you assessed quality targets against the pilot-line? Did you use these results to feed
2994	continuous quality improvements?
2995	• Have you verified quality targets on the FRP line?
2996	• Have you determined the planned NDI or COTS items meet program system performance
2997	and sustainment requirements through a defined acceptance process?
2998	Tools
2999	ISO 9001 QMS Audit Checklist

5. Production and Deployment (P&D) Phase

- AS9100 Audit Checklist
- Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread

3002 Resources

- AS9100, Quality Management System Aerospace, Sep 2016
 AS9145 Requirements for Advanced Product Quality Planning and Production Part Approval Process
 ISO 9001, Quality Management System, Sep 2016
 MRL Deskbook Version 2016
- 3008 MIL-HDBK-896A
- DoD Risk, Issue, and Opportunity Management Guide, Jun 2015

3010 I.3. Conduct Supplier Quality

3011 Compliance to a standard such as ISO 9001 (available for purchase), or AS9100, does not, in itself,

3012 guarantee product or service quality. These standards are management system standards that identify

3013 requirements for processes within an organization, describe expected tasks and outcomes, and

3014 explain how the processes and tasks integrate to produce required inputs and outputs. Standards are

3015 meant to enable the organization to develop a set of processes that, if done by qualified persons using

3016 appropriate tools and methods with appropriate leadership involvement, will enable a capability for

3017 delivering high quality products or services.

Product or service quality is achieved through the implementation of a strategic plan to integrate all
 business and technical functions that result in the consistent application of proven, capable processes
 within an organization. Managers must ensure that all management systems are working toward the

3021 same goals and are not creating conflicting or dysfunctional behavior. Implementing a standard is of

3022 little use if the financial system rewards individuals for delivering non-conforming products/services.

3023 Because everything a contractor does should be related to the quality of its products or services, a

3024 contractor's quality management system should be the basis for integrating all other management 3025 systems within an enterprise.

- 3026 Manufacturing and Quality Tasks
- Ensure acceptance testing of supplier products is adequate to begin FRP.
- Ensure supplier products have completed qualification testing and first article inspection.
- Ensure acceptance testing of supplier products is adequate to begin LRIP/FRP.
- Ensure Key Characteristics are being managed.
- Continuous quality improvement ongoing.

3032 Metrics

• Have you ensured acceptance testing of supplier products is adequate to begin FRP.

5. Production and Deployment (P&D) Phase

3034	• Have you ensured supplier products have completed qualification testing and first article	
3035	inspection.	
3036	• Have you ensured acceptance testing of supplier products is adequate to begin LRIP/FRP.	
3037	• Have you ensured Key Characteristics are being managed.	
3038	 Have you ensured continuous quality improvements are ongoing. 	
3039	Tools	
3040	Supplier QA Questionnaire	
3041	ISO 9001 QMS Audit Checklist	
3042	AS9100 Audit Checklist	
3043	Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread	
3044	Resources	
3045	 AS9100, Quality Management System – Aerospace, Sep 2016 	
3046	• ISO 9001, Quality Management System, Sep 2016	
3047	MRL Deskbook Version 2016	
3048	• DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs,	
3049	Jan 2017	
3050	• AS5553, Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition,	
3051	Sep 2016	
3052	• AS6174, Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materie	1,
3053	Jul 2014	
3054	MRL Deskbook Version 2016	

3055 J. MANUFACTURING WORKFORCE



3056 3057

3058 For either the LRIP or FRP Decision Review Acquisition Strategy update, the Program should 3059 identify remaining risks prior to the production go-ahead decision. Key considerations should 3060 include industrial base viability, design stability, process maturity, supply chain management, 3061 quality management, and facilities and manufacturing skills availability. Sources of data could 3062 include technical reviews and audits, Program Status Reviews, pre-award surveys, Production 3063 Readiness Reviews, Industrial Capabilities Assessments, trade-off studies, tooling plans, make-3064 or-buy plans, manufacturing plans, and bills of material. Important outputs include actions to 3065 reduce or handle remaining risks. Provide an assessment of manufacturing processes, including critical skills availability, and highlight the steps needed to progress from an EMD 3066

5. Production and Deployment (P&D) Phase

3067	manufacturing	environment	to an LRIP	environment	and to an FRP	environment.
	0					

3068J.1. LRIP/FRP Critical Skills Availability (Prime and Sub level) verified using Pilot-Line3069experience

3070 Manufacturing and Quality Tasks

- Identify LRIP/FRP manufacturing workforce resource requirements using pilot-line actuals.
- 3072 o Ensure required workforce availability forecast by monthly requirement against the
 3073 LRIP/FRP schedule.
- 3074 Ensure workforce training requirements forecast against the LRIP/FRP schedule.
- 3075 Review any union agreements to ensure workforce/schedule compatibility.
- Plans have been developed to achieve LRIP/FRP requirements.
- Plans are updated to achieve LRIP workforce requirements.
- LRIP/FRP workforce is trained in a pilot line environment.

3079 Metrics

- Have you identified LRIP/FRP manufacturing workforce resource requirements using pilot line actuals?
- 3082oHave you ensured required workforce availability forecast by monthly requirement3083against the LRIP/FRP schedule?
- 3084oHave you ensured workforce training requirements are forecast against the LRIP/FRP3085schedule?
- 3086 Have you reviewed any union agreements to ensure workforce/schedule compatibility?
- Have plans been developed to achieve LRIP/FRP requirements?
- Have plans been updated to achieve LRIP workforce requirements?
- Has the LRIP/FRP workforce been trained in a pilot line environment?

3090 **Tools**

3091 • Assembly Chart Analysis 3092 Bottleneck Analysis (Theory of Constraints) • 3093 Capacity Planning Worksheet 3094 Critical Chain Project Management 3095 • Forecasting and Regression Analysis 3096 Learning Curve Estimator • 3097 Line of Balance Template • 3098 Manufacturing Resource Planning (MRPII) • 3099 MRL assessment using Manufacturing Management thread • 3100 **Route Sheet Analysis** • 3101 Shop Floor Manufacturing Plan Analysis •

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5. Production and Deployment (P&D) Phase

3102 3103 3104	 Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis (Work Measurement Analysis Workforce Planning Tools (SAP/Oracle/MRPII)
3105 3106 3107 3108 3109 3110	 Resources MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016 AS6500, Manufacturing Management Systems AS9100, Quality Management System, Sep 2016 ISO 9001, Quality Management System, Sep 2016 Manufacturing Resource Planning (MRP II)
3111	J.2. LRIP Critical Skills Availability (Prime and Sub level) verified for Production
3112	Manufacturing workforce resource requirements identified for L RIP/ERP
3113 3114 3115 3116 3117	 Naturacturing workforce resource requirements identified for Ekri / FKF. Required workforce availability forecast by monthly requirement against the LRIP schedule. Workforce training requirements forecast against the LRIP schedule. Review any union agreements to ensure workforce/schedule compatibility.
 3118 3119 3120 3121 3122 3123 3124 	 Plans developed to achieve LRIP requirements. Plans updated to achieve FRP workforce requirements. LRIP personnel trained on pilot-line where possible. LRIP personnel requirements met. Implement plan to achieve FRP workforce requirements. FRP personnel requirements met. Production workforce skill sets maintained due to attrition of workforce.
3125	Metrics
3126	• Have manufacturing workforce resource requirements been identified for LRIP/FRP?
3127312831293130	 Are the required workforce availability forecast by monthly requirement against the LRIP schedule? Are the workforce training requirements forecast against the LRIP schedule? Have you reviewed any union agreements to ensure workforce/schedule compatibility?
 3131 3132 3133 3134 3135 3136 	 Have you developed plans to achieve LRIP requirements? Have you updated plans to achieve FRP workforce requirements? Have you ensured LRIP personnel are trained on pilot-line where possible? Have you ensured LRIP personnel requirements are met? Have you implemented a plan to achieve FRP workforce requirements? Have FRP personnel requirements been met?

5. Production and Deployment (P&D) Phase

3137	•	Have production workforce skill sets been maintained based on attrition of workforce?
3138	Tools	
3139	•	Assembly Chart Analysis
3140	•	Bottleneck Analysis (Theory of Constraints)
3141	•	Capacity Planning Worksheet
3142	•	Critical Chain Project Management
3143	•	Forecasting and Regression Analysis
3144	•	Learning Curve Estimator
3145	•	Line of Balance Template
3146	•	Manufacturing Resource Planning (MRPII)
3147	•	MRL assessment using Manufacturing Management thread
3148	•	Route Sheet Analysis
3149	•	Shop Floor Manufacturing Plan Analysis
3150	٠	SWOT Analysis
3151	•	Work Measurement Analysis
3152	•	Workforce Planning Tools (SAP/Oracle/MRPII)
3153	Resou	rces
3154	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
3155	•	AS6500, Manufacturing Management Systems
3156	•	AS9100, Quality Management System, Sep 2016
3157	•	ISO 9001, Quality Management System, Sep 2016
3158	•	Manufacturing Resource Planning (MRP II)
		-

3159 K. FACILITIES

MS	sc	AS SEP TEMP Updates Updates Update	
CPD	LRIP	01	RR IOT&E
K. Facilities	K.1 Assess Facility Availability		K.2 Evaluate Special Tooling, Test, & Inspection Equipment

3160 K. Facili

3161 Among the critical elements to be defined during EMD phase are the manufacturing processes which 3162 will be utilized to build the system. The sequence of manufacturing processes begins with the receipt 3163 of the raw material, where special handling and storage may be required. Additional processes 3164 requirements may include such items as cleaning, heat treatment, clean room controls, controlled 3165 testing and special handling (i.e., personal grounding requirements for electronic components). 3166 Identification of all processes must be a part of the design documentation. Where the selected 3167 processes contribute manufacturing risk to the program, the processes should be proofed during 3168 EMD. The purpose of proofing is to ensure that the process can repeatedly produce conforming

5. Production and Deployment (P&D) Phase

- 3169 hardware within the cost and time constraints of the production phase. It is important that the
- 3170 proofing be accomplished in an environment that simulates actual production conditions (typically a
- 3171 pilot line environment). These conditions include the physical facilities, personnel and manufacturing
- documentation. It may also be necessary for the contractor to establish training and certification
- 3173 programs for the shop personnel to ensure that the process capabilities can be attained on a
- 3174 recurring basis.

The production facilities and equipment planning include all key functional groups that play a role in production operations.

3177 K.1. Facility Availability (Prime and Sub level)

- 3178 One of the most important elements of any production design is the definition of the manufacturing
- 3179 resources. No matter how good a design may be, it is useless if system or product cannot be built. It
- 3180 is therefore essential that availability of manufacturing resources be a consideration during the design
- 3181 review process. Manufacturing engineers should be a part of each design team to assure adequate
- 3182 consideration of availability of required manufacturing resources.
- 3183 Manufacturing resources should not be limited to manufacturing methods, but should include
- 3184 materials, capital, manufacturing technology, <u>facilities</u>, qualified labor, and the management
- 3185 structure to effectively integrate them. The successful competitor, of the production phase will
- depend upon the efficient application of the full spectrum of these resources to the task of
- 3187 fabricating and delivering the defense system design.
- 3188 Manufacturing and Quality Tasks

3191

- Facility requirements identified for LRIP and Production using pilot-line actuals.
- 3190 Facility requirements include the following:
 - Machine/Process availability.
- Machine/Process floor space requirements (including
 2102
- 3193 feeding/storage/WIP/maintenance requirements).
- 3194
 Surge capability/requirements.
 3195
 Pilot-Line to LRIP to Production
 - Pilot-Line to LRIP to Production Ramp-Up requirements.
- Include critical Tooling/Special Tooling/Special Test Equipment requirements.
- Include Soft/Limited and Hard/Durable Tooling needs.
- These requirements should be time phased against the schedule to ensure they will meet the program's needs.
- Pilot-line facilities and capability demonstrated to fulfill LRIP/FRP requirements.
- Manufacturing facilities identified and plans developed to produce LRIP build.
- Manufacturing facilities adequate to begin LRIP.
- All tooling, test and inspection equipment proven in LRIP and requirements identified for
 FRP.

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5. Production and Deployment (P&D) Phase

3205	• Manufacturing equipment maintenance schedule demonstrated.
3206	• Plans in place to support transition to FRP.
3207	 Production facilities in place and capacity demonstrated to meet maximum FRP
3208	requirements.
3209	• The choice of facilities is flexible enough to accommodate growth and avoid relocation of
3210	production operations that could negatively affect the transition to FRP.
3211	• The choice of investment in new facilities factors in the impact of government changes in
3212	inventory objectives that often result in sustained low production rates for the life of the
3213	program.
3214	• Contingency planning is considered in the manufacturing facility planning effort.
3215	• Validate the physical layout of the production facilities dedicated to the program, including
3216	the flow of material, components, and product. Answer the following:
3217	• Does the layout plan maximizes efficiency, safety, and productivity and an encourage an
3218	environment that emphasizes cost-reduction?
3219	• Were computer-aided manufacturing tools used to design the manufacturing plant layout?
3220	• What was the process for determining the plant layout?
3221	• What internal disciplines within the company participated in the effort?
3222	• Does the program plan to use the "just-in-time" material supply approach?
3223	• How does this affect the plant layout?
3224	• How will the manufacturing facility accommodate growth or decreases in production
3225	rates?
3226	Metrics
3227	• Have you identified facility requirements for LRIP and Production using pilot-line actuals?
3228	• Have you ensured that facility requirements include the following:
3229	 Machine/Process availability?
3230	o Machine/Process floor space requirements (including feeding/storage/WIP/maintenance
3231	requirements)?
3232	• Surge capability/requirements?
3233	 Pilot-Line to LRIP to Production Ramp-Up requirements?
3234	 Critical Tooling/Special Tooling/Special Test Equipment requirements?
3235	 Include Soft/Limited and Hard/Durable Tooling needs?
3236	These requirements should be time phased against the schedule to ensure they will meet the
3236 3237	These requirements should be time phased against the schedule to ensure they will meet the program's needs
3236 3237 3238	These requirements should be time phased against the schedule to ensure they will meet the program's needsHave pilot-line facilities and capability been demonstrated to fulfill LRIP/FRP requirements?
3236 3237 3238 3239	 These requirements should be time phased against the schedule to ensure they will meet the program's needs Have pilot-line facilities and capability been demonstrated to fulfill LRIP/FRP requirements? Have manufacturing facilities been identified and plans developed to produce LRIP build?
3236 3237 3238 3239 3240	 These requirements should be time phased against the schedule to ensure they will meet the program's needs Have pilot-line facilities and capability been demonstrated to fulfill LRIP/FRP requirements? Have manufacturing facilities been identified and plans developed to produce LRIP build? Have you insured manufacturing facilities are adequate to begin LRIP?
3236 3237 3238 3239 3240 3241	 These requirements should be time phased against the schedule to ensure they will meet the program's needs Have pilot-line facilities and capability been demonstrated to fulfill LRIP/FRP requirements? Have manufacturing facilities been identified and plans developed to produce LRIP build? Have you insured manufacturing facilities are adequate to begin LRIP? Have all tooling, test and inspection equipment been proven in LRIP and all requirements

5. Production and Deployment (P&D) Phase

3243	•	Has the manufacturing equipment maintenance schedule been demonstrated?
3244	•	Have plans been put in place to support transition to FRP?
3245	•	Are production facilities in place and capacity demonstrated to meet maximum FRP
3246		requirements?
3247	•	Is the choice of facilities flexible enough to accommodate growth and avoid relocation of
3248		production operations that could negatively affect the transition to FRP?
3249	•	Does the choice of investment in new facilities factor in the impact of government changes in
3250		inventory objectives that often result in sustained low production rates for the life of the
3251		program?
3252	•	Has contingency planning been considered in the manufacturing facility planning effort?
3253	•	Have you validated the physical layout of the production facilities dedicated to the program,
3254		including the flow of material, components, and product?
3255	•	In validating the manufacturing facility planning effort did you consider the following:
3256		• Does the layout plan maximizes efficiency, safety, and productivity and an encourage an
3257		environment that emphasizes cost-reduction?
3258		• Were computer-aided manufacturing tools used to design the manufacturing plant layout?
3259		• What was the process for determining the plant layout?
3260		• What internal disciplines within the company participated in the effort?
3261		• Does the program plan to use the "just-in-time" material supply approach?
3262		• How does this affect the plant layout?
3263		• How will the manufacturing facility accommodate growth or decreases in production
3264		rates?
3265	Tools	
3266	•	Manufacturing Readiness Level Assessment Questionnaire, Facilities thread
3267	•	DCMA Production Planning and Control Risk Assessment Checklist
3268	•	DCMA Manufacturing Systems Risk Assessment (MSRA) Checklist
3269	Resou	rces
3270	•	DoDI 5000.02
3271	•	AS6500, Manufacturing Management Systems
3272	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
3273	•	MRL Deskbook Version 2016
3274	•	DCMA-INST-204 Manufacturing and Production
3275	٠	Risk, Issue, and Opportunity Management Guide

3276 K.2. Special Tooling, Test, and Inspection Equipment

3277 Special tooling and test equipment required for a program can be very expensive and take a long time
3278 to develop and procure. The general guidelines for planning for tooling and test equipment need to be
3279 established and established early. The issues include contractor investment, the level of rate tooling

3280 3281 3282	and test equipment to be utilized, the transition from limited life to rate tools and the degree of similarity between production test equipment and depot test equipment to be required. Also, guidelines for calibrating and maintaining tools and test equipment need to be set forth.				
3283	Manufacturing and Quality Tasks				
3284 3285	• Evaluate all documentation used to manage and account for Tooling, Special Tooling (ST), and Special Test Equipment (STE).				
3286 3287	 Documents directing tooling policy for proposed Tooling, ST and STE development including: 				
3288 3289 3290 3291 3292	 Limited/Soft Tooling Durable/Hard Tooling ST/STE needed for development and manufacture only. ST/STE having possible mission support utility. Already available government assets. 				
3293 3294 3295 3296 3297 3298 3299 3300 3301	 Tooling, Test and Inspection equipment proven on pilot-line and additional requirements identified for LRIP/FRP. Proven tooling, test and inspection equipment in place to support maximum FRP. The program ensures that adequate production test infrastructure, resources, and facilities are available. Planned equipment maintenance schedule achieved. Production tooling and STE/special inspection equipment (SIE) design and development efforts underway. Manufacturing equipment maintenance strategy developed and demonstrated on pilot-line. 				
3302	Metrics				
3303	• Have you evaluated all documentation used to manage and account for tooling, ST/STE.				
3304 3305	 Did you evaluate documents directing tooling policy for proposed Tooling, ST and STE development including: 				
3306 3307 3308 3309 3310	 Limited/Soft Tooling? Durable/Hard Tooling? ST/STE needed for development and manufacture only? ST/STE having possible mission support utility? Already available government assets? 				
3311 3312 3313 3314 3315 3316	 Have Tooling, Test and Inspection equipment been proven on pilot-line and any additional requirements identified for LRIP/FRP? Is proven tooling, test and inspection equipment in place to support maximum FRP? Did the program ensure that adequate production test infrastructure, resources, and facilities are available? Did you achieve the planned equipment maintenance schedule? 				

5. Production and Deployment (P&D) Phase

- 3317 Are Production Tooling and STE/SIE design and development efforts underway? •
- Have manufacturing equipment maintenance strategy been developed and demonstrated on 3318 • 3319 the pilot-line?

3320 Tools

- 3321 DCMA Production Planning and Control Risk Assessment Checklist •
- 3322 DCMA Manufacturing Systems Risk Assessment (MSRA) Checklist •
- 3323 Rough Cut Capacity Planning Spreadsheet •
- 3324 • Material Requirements Planning
- 3325 Capacity Requirements Planning Assessment Worksheet •
- 3326 Bottleneck Analysis (Theory of Constraints) •
- **Critical Chain Project Management** 3327 •
- 3328 Manufacturing Resource Planning (MRPII) •
- 3329 Manufacturing Readiness Level (MRL) Assessment Questionnaire, Facilities thread •
- 3330 Plant Design and Facility Layout Software Evaluation Tools •

3331 Resources

- 3332 FAR Part 2, §2.101 Definitions •
- 3333 AS6500, Manufacturing Management System, Sep 2016 •
- 3334 MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016 •
- 3335 • MRL Deskbook Version 2016
- Manufacturing Resource Planning (MRP II) 3336 •
- 3337 DCMA-INST-204 Manufacturing and Production •

MANUFACTURING MANAGEMENT/CONTROL 3338 L.



3339

3340 L.1. Manufacturing Planning

3341 Manufacturing involves the process of transforming raw materials into finished products. This

3342 transformation is accomplished through the use of contractor resources which can include basic raw

3343 materials, to expensive facilities, human skills, machines and capital investments. The purpose of

3344 manufacturing planning is the identification of these resources and their integration into a structure

3345 that provides the capability to achieve production objectives. The PM and the system contractor(s)

3346 need to identify the actions to develop that structure. The issue of manufacturing risk assessment and

5. Production and Deployment (P&D) Phase

3347 3348 3349 3350 3351 3352 3353	its application to the planning process must be described. Risk assessment is intended to identify gaps in capabilities so that the PM can identify investment strategies allocate resources against those risks and gasp. Risk assessment, one of the PM's significant manufacturing tasks during development - is an element which is required to be addressed throughout the acquisition life cycle and during the various technical reviews and in the milestone review process. The primary manufacturing planning and scheduling challenge to the PM involves measuring the qualitative and quantitative manufacturing resources required for production.				
3354	Manufacturing and Quality Tasks				
3355	Manufacturing plan updated for FRP.				
3356 3357 3358	 All of the information necessary to plan the detailed manufacturing operations for the system should be available to the contractor. This information must be described in a contractor's manufacturing plan covering: 				
3359 3360	 Manufacturing organization including who is responsible, organization charts, points of contact. 				
3361 3362 3363	 Manufacturing Management System including how materials and parts are ordered, structure order for parts and components, and track a project to produce the end item. How all manufacturing risks are being tracked and mitigated. 				
3364	• Manufacturing Management Program describing manufacturing strategy including:				
3365 3366 3367 3368 3369 3370	 Program manufacturing time-phased schedule, Manpower Plan, Industrial facilities capacity assessment, Surge and Mobilization capacity assessment, Manufacturing risk assessment, Capital investment commitment, 				
3371	 Manufacturing Program Planning including: 				
3372 3373	Producibility Program Plan,Make-or-Buy Criteria including considerations used in making decisions				
3374 3375 3376 3377 3378 3379 3380 3381	 Conservation of critical/strategic materials Reduction of critical forms and parts (reducing foreign dependency) Capacity to support normal production needs, surge, mobilization Risk reduction Second-sourcing of critical components including critical safety items Standardization of components and parts Trade-off analyses are documented and provide an optimized solution that is the basis for the production planning effort. 				
3382 3383 3384	 The analyses are based on established modeling tools and factor in the current capabilities and experience of the contractor. Cost optimization is a significant factor. 				

3385 3386		• The production plan provides for scheduled and unscheduled maintenance with little disruption to the production schedule.
3387	0	Subcontractor/Supplier Management including,
3388 3389 3390		 List of proposed major/critical subs and suppliers including products Locations Make/Buy decisions and BOM complete to support FRP.
3391 3392	0	Make/buy decisions are consistent with contractor policy and reflect a rationale that meets the planned schedule and offers the best value to the government.
3393 3394 3395		 Data used to determine supplier capacity and capability to meet program needs Data used to support second sourcing decisions and to define supplier risk Supplier management methodology/process/tracking
3396	0	Manufacturing Methods and Production Flow including:
3397 3398 3399 3400 3401 3402 3403 3404 3405 3406 3407 3408 3409		 Advanced or unique manufacturing technology required to produce components or end items including tools and processes requiring proofing or demonstration to minimize high risk or critical operations Effective production control system in place to support FRP. Production flow utilizing a "goes-into" chart, tree chart, to portray the planned process of fabrication and assembly in terms of key operational points. This includes lead times from procurement of raw material to delivery of end product. The acquisition of production tooling and equipment is based on a schedule that represents reasonable acquisition lead times, installation and setup, training, etc., that is coordinated with the overall schedule and presents contingency plans that address any schedule risks. Identify production, test, or inspection stations which have bottleneck potential and identify corrective action
3410		 Plant flow of major in-plant manufacturing operations including operation,
3411 3412		 equipment, and location Identify expected process yields for each process and indicate statistical or other
3413		method used to maintain control
3414		 During LRIP or Production obtain and evaluate processes using process control
3415		system
3416 3417		• A detailed allocation of production space and equipment is described, along with the factors used in developing the plan
3418 3419 3420		 The status of design and acquisition of production equipment is tracked in the schedule. Equipment cost, efficiency, and availability are reflected in the planning process.
3421	0	Tooling, ST and STE
3422 3423		 The program verifies procedures for ensuring functional compliance and calibration of all tooling and test equipment.

3424	0	Productivity Improvement
3425		 All manufacturing risks mitigated.
3426	0	Industrial Materials Management including:
3427 3428 3429 3430 3431 3432 3433		 Critical forms and parts Strategic and critical materials Diminishing Manufacturing Sources and Materials Shortages Material planning systems proven in LRIP and sufficient for FRP. Requests for Special Priorities Assistance Scrap management and reclamation Material planning systems validated on FRP build.
3434	0	Manufacturing Management Data
3435 3436 3437		 Cost of work scheduled, cost of work performed, and the actual cost of work performed in hours Cause, corrective action, and means of follow-up to attain planned performance
3438 3439 3440 3441	0	Manufacturing Audits including checklists and other criteria used by the prime to conduct audits of the contractor and supplier operations. Include audit summaries and corrective actions. Labor Relations including:
3442 3443 3444 3445 3446 3447		 Location of facilities performing program work Each union representing workers at the facility locations, type and number of workers Expiration date of union's labor management agreement. History of last 3 negotiations Components supplied by each facility location Contingency plan listing possible alternate suppliers
3448	0	The plan should also describe:
3449		 All GFP required and specific need dates.
3450 3451 3452 3453 3454	0	The contractor has established procedures for management of company and government- furnished information assets that support the needs of the program. All contractor management control systems, including those for configuration management and the control of subcontractors and manufacturing performance evaluation.
3455 3456 3457	0	The identification and planned use of existing contractor assets and government-owned resources are supported by the confirmed availability of the resources. Resource sharing between programs is on a non-competing basis.
3458 3459 3460 3461		 The plan should also include industrial preparedness planning, including surge capability during the production phase and the post production phase requirements for support to employment of the system in combat situations. Have you updated the Manufacturing Plan for FRP?

3462 3463	0	Have you ensured that all of the information necessary to plan the detailed manufacturing operations for the system is available to the contractor?
3464	0	Have you ensured this information is described in a contractor's manufacturing plan
3465		covering:
3466		 Manufacturing organization including who is responsible, organization charts, points of contact, etc.²
3407		• Manufacturing Management System including how materials and parts are ordered
3408		- Manufacturing Management System including now inaterials and parts are ordered, structure order for parts and components, and track a project to produce the end item?
3470		 How all manufacturing risks are being tracked and mitigated?
3471	0	Have you verified the Manufacturing Management Program describes manufacturing
3472		strategy including:
3473		 Program manufacturing time-phased schedule?
3474		Manpower Plan?
3475		 Industrial facilities capacity assessment?
3476		Surge and Mobilization capacity assessment?
3477		Manufacturing risk assessment?
3478		• Capital investment commitment?
3479	0	Have you verified the Manufacturing Program Planning includes:
3480		 A Producibility Program Plan?
3481		 Make-or-Buy Criteria including these types of considerations used in making
3482		decisions:
3483	0	Conservation of critical/strategic materials?
3484	0	Reduction of critical forms and parts (reducing foreign dependency)?
3485	0	Capacity to support normal production needs, surge, mobilization?
3486	0	Risk reduction?
3487	0	Second-sourcing of critical components including critical safety items?
3488	0	Standardization of components and parts?
3489	0	Have you verified that Trade-off analyses are documented and provide an optimized
3490		solution that is the basis for the production planning effort?
3491		 That analyses are based on established modeling tools and factor in the current
3492		capabilities and experience of the contractor?
3493		That cost optimization is a significant factor?
3494		• That the production plan provides for scheduled and unscheduled maintenance with
3495		little disruption to the production schedule?
3496	0	Have you verified Subcontractor/Supplier Management includes,
3497		 List of proposed major/critical subs and suppliers including products?
3498		Locations?
3499		 Make/Buy decisions and BOM complete to support FRP?
5. Production and Deployment (P&D) Phase

3500 3501 3502 3503 3504		 Make/buy decisions are consistent with contractor policy and reflect a rationale that meets the planned schedule and offers the best value to the government? Data used to determine supplier capacity and capability to meet program needs? Data used to support second sourcing decisions and to define supplier risk? Supplier management methodology/process/tracking?
3505	0	Have you validated Manufacturing Methods and Production Flow to include:
3506 3507 3508 3509 3510 3511 3512 3513 3514 3515 3516 3517 3518 3519 3520 3521 3522 3523 3524 3525 3526 3527 3528 3529		 Advanced or unique manufacturing technology required to produce components or end items including tools and processes requiring proofing or demonstration to minimize high risk or critical operations? Effective production control system in place to support FRP? Production flow utilizing a "goes-into" chart, tree chart, to portray the planned process of fabrication and assembly in terms of key operational points? This includes lead times from procurement of raw material to delivery of end product. Is the acquisition of production tooling and equipment based on a schedule that represents reasonable acquisition lead times, installation and setup, training, etc., that is coordinated with the overall schedule and presents contingency plans that address any schedule risks? Identify production, test, or inspection stations which have bottleneck potential and identify corrective action? Plant flow of major in-plant manufacturing operations including operation, equipment, and location? Identify expected process yields for each process and indicate statistical or other method used to maintain control? During LRIP or Production obtain and evaluate processes using process control system? A detailed allocation of production space and equipment is described, along with the factors used in developing the plan?
2520		However well-deted Tealing, ST and STE2
5550	0	Have you vandated rooming, ST and STE?
3531 3532		 Did you verify program procedures for ensuring functional compliance and calibration of all tooling and test equipment?
3533	0	Have you validated Productivity Improvement efforts?
3534		 Have all manufacturing risks been mitigated?
3535	0	Have you validated Industrial Materials Management including:
3536 3537 3538		 Critical forms and parts? Strategic and critical materials? Diminishing Manufacturing Sources and Materials Shortages?

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5. Production and Deployment (P&D) Phase

3539 3540 3541 3542		 Material planning systems proven in LRIP and sufficient for FRP? Requests for Special Priorities Assistance? Scrap management and reclamation? Material planning systems validated on FRP build?
3543		• Have you validated Manufacturing Management Data including;
3544 3545 3546		 Cost of work scheduled, cost of work performed, and the actual cost of work performed in hours? Cause, corrective action, and means of follow-up to attain planned performance?
3547 3548 3549 3550 3551		 Have you validated that Manufacturing Audits including checklists and other criteria used by the prime to conduct audits of the contractor and supplier operations include audit summaries and corrective actions? Have you reviewed Labor Relations activity to ensure a smooth transition in to LRIP and FRP to include:
3552 3553 3554 3555 3556 3557 3558		 Location of facilities performing program work? Each union representing workers at the facility locations, and type and number of workers? Expiration date of union's labor management agreement? History of last 3 negotiations? Components supplied by each facility location? Contingency plan listing possible alternate suppliers?
3559		• Have you evaluated the Manufacturing Plan for FRP to ensure it also describes:
3560 3561 3562		 All GFP required and specific need dates? The contractor has established procedures for management of company and GFI assets that support the needs of the program?
3563 3564 3565 3566 3567 3568		 All contractor management control systems, including those for configuration management and the control of subcontractors and manufacturing performance evaluation? The identification and planned use of existing contractor assets and government-owned resources are supported by the confirmed availability of the resources. Resource sharing between programs is on a non-competing basis?
3569 3570 3571 3572		 Does your evaluation of the Manufacturing Plan for FRP also include industrial preparedness planning, including surge capability during the production phase and the post production phase requirements for support to employment of the system in combat situations?
3573	Tools	
3574	•	Acquisition Strategy Template
3575	•	Manufacturing Readiness Level (MRL) assessment questionnaire using Manufacturing
3576		Management/Control thread

5. Production and Deployment (P&D) Phase

3577 AS6500 assessment •

2570	Decourses
33/8	Resources

3579	•	Acquisition Plan Preparation Guide, Jan 2009
3580	•	DSMC Acquisition Strategy Guide, Dec 1999
3581	•	MRL Deskbook Version 2016
3582	•	AS6500, Manufacturing Management System, Sep 2016
3583	•	MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016
3584	•	DoDI 5000.02
3585	•	Service specific policies and regulations (i.e., AFI 63-145)
3586	٠	DoDI 5000.02, Enclosure 14 Cybersecurity
3587	•	DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident
3588		Reporting
3589	•	IEEE 15288, Systems and Software Engineering, 2015
3590	•	NIST 800-82 Guide to Industrial Control Systems Security
3591	•	NIST 800-171, Protecting Controlled Unclassified Information in Nonfederal Information
3592		Systems and Organizations
3593	L.2. C	Conduct LRIP/FRP Manufacturing Strategy using Pilot-Line actuals
3594	Manu	ifacturing and Quality Tasks
3595	•	Manufacturing Planning accomplished during EMD supports LRIP/FRP Manufacturing
3596		Strategy and Risk Reduction efforts.
3597	•	All manufacturing risks tracked and mitigated for LRIP.
3598	•	LRIP/FRP Manufacturing Plan developed incorporates Pilot-Line results.
3599	•	Manufacturing planning included in Initial Manufacturing Planning Strategy.
3600	٠	Manufacturing risks integrated into risk mitigation plans.
3601	•	Develop LRIP/FRP work instructions and validate with pilot-line experience.
3602	•	Effective production control system in place to support LRIP.
3603	٠	Make/Buy decisions and BOM complete for production build.
3604	•	Material planning systems in place for production build.
3605	•	FRP Manufacturing plan updated with LRIP actuals.
3606	•	Key manufacturing risks are identified and assessed with approved mitigation plans in place.
3607	•	Production work instructions finalized.
3608		• Labor standards are considered a key aspect of production planning and important in
3609		workforce projection. These standards also are considered when planning facilities and
3610		equipment to ensure efficient utilization rates and overall productivity of the workforce.
3611	•	Effective production control system in place to support FRP.
3612	•	All manufacturing risks mitigated for FRP.

5. Production and Deployment (P&D) Phase

3613 Make/Buy decisions and BOM complete to support FRP. • 3614 • Material planning systems proven on LRIP for FRP build. 3615 Strategy should address production and rate issues such as process capabilities and proofing, • 3616 factory layout, availability of tooling, lead-times, etc. 3617 Metrics 3618 Have you evaluated the Manufacturing Planning accomplished during EMD to ensure it • 3619 supports LRIP/FRP Manufacturing Strategy and Risk Reduction efforts? 3620 Have tracked and mitigated all manufacturing risks for LRIP? • Have you ensured the LRIP/FRP Manufacturing Plan developed uses Pilot-Line results? 3621 • 3622 Did you include manufacturing planning in your Initial Manufacturing Planning Strategy? • 3623 Did you integrate all manufacturing risks into risk mitigation plans? • 3624 Did vou ensure LRIP/FRP work instructions were developed and validated with pilot-line • 3625 experience? 3626 • Did you ensure effective production control systems are in place to support LRIP. 3627 • Did you validate that Make/Buy decisions and the BOM were complete for the production 3628 build? 3629 • Did you validate that Material Planning systems are in place for the production build? Did you ensure the FRP Manufacturing plan was updated with LRIP actuals? 3630 • 3631 • Did you validate that all key LRIP/FRP manufacturing risks are identified and assessed with 3632 approved mitigation plans in place? 3633 Did you validate that all Production work instructions have been finalized? • o Did you consider labor standards a key aspect of production planning and their 3634 importance in workforce projection? Did you also consider these standards when 3635 3636 planning facilities and equipment to ensure efficient utilization rates and overall productivity of the workforce? 3637 3638 Did you ensure effective production control system are in place to support FRP? • 3639 Did you ensure all manufacturing risks are mitigated for FRP? • 3640 Have you made sure all Make/Buy decisions and the BOM are complete to support FRP? • 3641 Have you ensured the Material Planning Systems were proven on LRIP for the FRP build? • 3642 • Have you ensured the Manufacturing Strategy addresses production and rate issues such as 3643 process capabilities and proofing, factory layout, availability of tooling, lead-times, etc.? 3644 Tools 3645 • Manufacturing Readiness Assessment, Material Management and Control thread 3646 AS6500 Manufacturing Management Program Assessment • Material Management and Accounting System Audit 3647 • 3648 Resources 3649 AS6500 Manufacturing Management Program •

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5. Production and Deployment (P&D) Phase

- MIL-HDBK-896A, Manufacturing Management Program Guide
- 3651 DoDI 5000.02
- MRL Deskbook Version 2016
- DFAR 242.72 Contractor Material Management and Accounting System

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5. Production and Deployment (P&D) Phase

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6. Operations and Support (O&S) Phase

2 Introduction

- 3 As stated in DoD Instruction (DoDI) 5000.02, "The purpose of the O&S phase is to execute the
- 4 product support strategy, satisfy materiel readiness and operational support performance
- 5 requirements, and sustain the system over its life cycle (to include disposal)." The Defense
- 6 Acquisition Guidebook (DAG) Chapter 4, provides guidance on the development and execution of
- 7 activities that support the sustainment of weapon systems.
- 8 The O&S phase has two major efforts, Sustainment and Disposal. The Life Cycle Sustainment Plan
- 9 (LCSP), prepared by the Program Manager (PM) and approved by the Milestone Decision Authority
- 10 (MDA), is the basis for the activities conducted during this phase.



11 12 13

Figure 6.1. O&S Phase Manufacturing and Quality Activities

6. Operations and Support (O&S) Phase

- Sustainment: During this phase, the Program Manager will deploy the product support package and monitor its performance according to the LCSP. The LCSP may include timephased transitions between commercial, organic, and partnered product support providers. The Program Manager will ensure resources are programmed and necessary IP deliverables and associated license rights, tools, equipment, and facilities are acquired to support each of the levels of maintenance that will provide product support; and will establish necessary organic depot maintenance capability in compliance with statute and the LCSP.
- 21 A successful program meets the sustainment performance requirements, remains 0 22 affordable, and continues to seek cost reductions by applying Should Cost management 23 and other techniques throughout the O&S phase. Doing so requires close coordination with the war-fighting sponsor (i.e., user), resource sponsors, and materiel enterprise stake 24 25 holders, along with effective management of support arrangements and contracts. During 26 O&S, the Program Manager will measure, assess, and report system readiness using 27 sustainment metrics and implement corrective actions for trends diverging from the 28 required performance outcomes defined in the Acquisition Program Baseline (APB) and 29 LCSP.
- Over the system life cycle, operational needs, technology advances, evolving threats,
 process improvements, fiscal constraints, plans for follow-on systems, or a combination
 of these influences and others may warrant revisions to the LCSP. When revising the
 LCSP, the Program Manager will revalidate the supportability analyses and review the
 most current product support requirements, senior leader guidance, and fiscal
 assumptions to evaluate product support changes or alternatives and determine best value.
- Disposal: The O&S phase ends when the program is at the end of its useful life, the system
 will be demilitarized and disposed of in accordance with all legal and regulatory
 requirements and policy relating to safety (including explosives safety), security, and the
 environment.

40 Key Program Phase Reviews, Documentation and Activities

- 41 The O&S phase begins after the production or deployment decision and is based on an MDA-
- 42 approved Life Cycle Sustainment Plan (LCSP). The life cycle sustainment planning begins as early
- 43 as the Materiel Solution Analysis (MSA) phase and is updated in every phase all the way through the
- 44 O&S phase. The LCSP helps the PM to develop a complete and detailed product support package,
- 45 resulting in product support arrangements. The package consists of product support elements needed
- to achieve sustainment requirements and the set of arrangements that programs establish with organic
- 47 and commercial sustainment providers. The backbone of the product support package is the
- 48 Integrated Product Support (IPS) Elements as detailed in the IPS Element Guidebook. These 12
- 49 elements can be grouped into three buckets that cover the full range of life cycle functions:
- 50 Life cycle management
- 51 o Product Support Management
- 52 o Supply Support

6. Operations and Support (O&S) Phase

- 53 o Packing, Handling, Storage, and Transportation (PHST)
- 54 o Maintenance Planning and Management
- 55 Technical management
- 56 o Design Interface
- 57 o Sustaining Engineering
- 58 o Technical Data
- 59 o Computer Resources
- 60 Infrastructure management
- 61 o Support Equipment

63

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80

- 62 o Training and Training Support
 - Manpower and Personnel
- 64 o Facilities and Infrastructure.

65 A major focus during the sustainment effort of the Operations and Support (O&S) phase is 66 identifying root causes and resolutions for safety and critical readiness degrading issues. These 67 efforts include participating in Trade Studies and decision making relative to changes to the 68 product support package, process improvements, modifications, upgrades, and future increments 69 of the system. All these changes need to consider the operational needs and the remaining 70 expected service life, Interoperability or technology improvements, parts or manufacturing 71 obsolescence, aging aircraft (or system) issues, premature failures, changes in fuel or lubricants, 72 and Joint or service commonality.

- 73• Program Documentation
- o Capability Development Document (CDD)
- 75 o System Safety Analysis
- 76
 o
 Programmatic Environmental, Safety and Occupational Health Evaluation (PESHE)
 - o National Environmental Policy Act (NEPA) and NEPA Compliance Schedule
- 78oSystems Engineering Plan (SEP)
- 79oLife Cycle Sustainment Plan (LCSP)
 - Reliability Centered Maintenance Analysis
- 81 Independent Logistics Assessment
- Requests for Proposals (RFPs)
- Source Selection Plans (SSPs)

84 Manufacturing and Quality O&S Objectives

85 During the Production and Deployment phase and into the Operations and Support phase, program

- 86 offices collect service use data, user feedback, failure reports and discrepancy reports in order to
- assess sustainment performance. Based on user feedback, there is often a series of product
- improvements which are defined and executed. This could happen as a result of a Pre-Planned
- 89 Product Improvement, Value Engineering proposal, or modifications/upgrades to meet warfighter

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- 90 needs. When the product is competitive with similar products, these improvements are often driven
- by the action of competitors. The challenge in this phase of the cycle is to integrate these changes
- 92 into the production system with minimum disruption and cost. The changes introduced reflect both
- improvements in the ability of the product to meet the original design objective and extensions of
- 94 capability to meet increased or broadened performance objectives.
- 95 Manufacturing considerations during the O&S phase should include the following:
- 96 Continued production of units being fielded
- 97 Updates/Product Improvements often tied to block upgrades
- Changes to the supply chain
- 99 Items maturing (Diminishing Manufacturing and Diminishing Suppliers
 100 (DMSMS)/Obsolescence/Counterfeit Parts)
- Changes to rate and quantity of items being produced, need to ensure a source of supply
- Items manufactured for spare parts (different configurations)
- Improvements to a contractor's Manufacturing Management System or Quality Management
 System
- Impacts of Continuous Process Improvement (CPI) due to Lean/Six Sigma/TOC or other
 improvement activities
- Environmental considerations (ESOH/OSHA/NEPA and PESHE), requirements and risks
- Need to be able to maintain fielded items (Data/Technical information availability)
- Manage Total Life Cycle costs/Affordability (Manufacturing/QA elements)
- End of life management (Demil and Disposal)
- 111 The O&S phase often overlaps with the Production and Deployment phase for many years, since
- 112 O&S activities begin when the first system is fielded and production can run for many years after
- 113 IOC. O&S ends when a system is demilitarized and disposed of. Manufacturing and QA activities
- 114 often change as production sometimes moves from a prime contractor to government owned and
- 115 operated facilities, such as depots and Maintenance, Repair and Overhaul (MROs) facilities. Key
- 116 activities during this phase include:
- 117 Continuation of Full Rate Production
- 118 PBL implementation continues
- Updates to the Sustainment contract
- Updates to Intel/Counter Intelligence products
- Disposal and Demil at the end of its useful life

122 A. DD ACQUISITION SYSTEM

123 Sustainment planning, including the requirements in 10 U.S.C. 2337 must be an integral element of

- 124 the capability requirements and acquisition process from inception. The Program Manager, with the
- 125 support of the Product Support Manager (PSM), will:

6. Operations and Support (O&S) Phase

- Develop and implement an affordable and effective performance-based product support
 strategy. The product support strategy will be the basis for all sustainment efforts and lead to
 a product support package to achieve and sustain warfighter requirements.
- Initiate system modifications, as necessary, to improve performance and reduce ownership
 costs, consistent with the limitations prescribed in 10 U.S.C. 2244a.
- Begin demilitarization and disposal planning, including demilitarization and controlled
- 132 inventory item coding of system, subsystems, or components, as required by DoD Manual
- 133 4160.28-M, with sufficient lead time before the disposal or retirement of the first asset to
- reduce costs and risks and to ensure compliance with statutory and regulatory requirements.



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136 The LCSP will be updated at each milestone and specified decision points to reflect the increased

137 maturity of the product support strategy, any changes in the corresponding product support package,

138 current risks, and any cost reduction activities.

139 The Program Manager will integrate the product support design into the overall design process, and

140 assess enablers that improve supportability, such as diagnostics and prognostics, for inclusion in the

141 system performance specification. As the design matures, the Program Manager will ensure that life-

142 cycle affordability is a factor in engineering and sustainment trades.

143 The following information sources provide important inputs to the O&S phase systems engineering144 process and should contain manufacturing considerations:

- Systems Engineering Plan (SEP)
- 146 PESHE
- 147 LCSP

148 Manufacturing/Quality tasks during the O&S phase are generally focus on producing spare parts/

subsystems/ systems to keep the production articles operating and initiating system modifications, to

- 150 improve performance and reduce ownership costs.
- 151 Manufacturing should help develop and implement an affordable and effective performance-based
- 152 product support strategy. The product support strategy will be the basis for all sustainment efforts
- and leads to a product support package that will achieve and sustain warfighter requirements.

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154 155 156 157 158 159 160 161 162 163 164	 Manufacturing should begin demilitarization and disposal planning, including demilitarization and controlled inventory item coding of system, subsystems, or components with sufficient lead time before the disposal or retirement of the first asset to reduce costs and risks and to ensure compliance with statutory and regulatory requirements. Manufacturing should initiate/support system modifications, as necessary, to improve performance and reduce ownership costs. Manufacturing will also be concerned about several related issues to include: Diminishing Manufacturing Sources and Material Shortages Obsolescence Counterfeit Parts Corrosion Prevention and Control
165 166 167	• Manufacturing should provide updates that reflect the increased maturity of the product support strategy, any changes in the corresponding product support package, current risks, and any cost reduction activities.
168	A.1 Provide Manufacturing Updates to the Acquisition Strategy
169	Manufacturing and Quality Tasks
170 171	• Manufacturing inputs for the O&S phase should evolve from the P&D phase. Sustainment requirements will be finalized to support sustainment contracts and LCSP.
172	• Support the development of the Product Support Package.
173	• Tasks associated with the 12 product support elements in the Product Support Package are:
174	 Product Support Management
175	• Design Interface
176	 Sustaining Engineering
177	 Maintenance Planning and Management
178	• Supply Support
179	• Support Equipment
180	o Technical Data
181	• Training and Training Support
102	• Manpower and Personnel
18/	• Packaging Handling Storage and Transportation (PHS&T)
185	 Computer Resources
186	• Support the development of the Plan
187	• Support the development of the Product Support Strategy
188	Support the development of the Product Support Requirements
189	Manufacturing inputs include:
190	• Manufacturing support to system and product support package design trades.

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191	• Manufacturing support to test and evaluation (T&E) planning.
192	• Manufacturing support in defining performance metrics for product support contracts and
193	organic support requirements.
194	• Manufacturing support to logistics requirements, workload estimates, and logistics risk
195	assessment.
196	• Manufacturing support to integrate the product support design into the overall design
197	process, and assess enablers that improve supportability, such as diagnostics and
198	prognostics, for inclusion in the system performance specification.
199	• Manufacturing support helps ensure that life-cycle affordability is a factor in engineering
200	and sustainment trades.
201	• Manufacturing tasks during the O&S phase include producing spare
202	parts/subsystems/systems to keep the production articles operating and initiating system
203	modifications, to improve performance and reduce ownership costs.
204	• Manufacturing should help develop and implement an affordable and effective
205	performance-based product support strategy. The product support strategy will be the
206	basis for all sustainment efforts and leads to a product support package that will achieve
207	and sustain warfighter requirements.
208	 Manufacturing should help to assess field R&M data to evaluate the impact of
209	manufacturing/QA activities on field failures. Assess using Failure Modes and Effects
210	Analysis (FMEA) and Process Failure Modes and Effects Analysis (PFMEA).
211	 Manufacturing should begin demilitarization and disposal planning, including
212	demilitarization and controlled inventory item coding of system, subsystems, or
213	components with sufficient lead time before the disposal or retirement of the first asset to
214	reduce costs and risks and to ensure compliance with statutory and regulatory
215	requirements.
216	 Manufacturing should initiate/support system modifications, as necessary, to improve
217	performance and reduce ownership costs.
218	 Manufacturing should support cost estimating associated with system modifications.
219	• Manufacturing will also be concerned about several related issues to include:
220	Diminishing Manufacturing Sources and Material Shortages
221	Obsolescence
222	Counterfeit Parts
223	Corrosion Prevention and Control
224	• Manufacturing should provide updates that reflect the increased maturity of the product
225	support strategy, any changes in the corresponding product support package, current risks,
226	and any cost reduction activities.
227	Metrics
228	• Manufacturing and quality inputs to Program Management's Risk. Issue. and Opportunity
229	(RIO) processes have been provided and documents industrial base, manufacturing

230 technology, quality, software, and engineering related risks/issues, etc.

231 232	• Manufacturing and quality Program workforce requirements have been documented and provided to Program Management.
233	• Manufacturing and quality management requirements have been documented and provided to
234	Program Management for use in assessing contractor plans to meet sustainment objectives.
235	o Data management and software (including collection, analysis, testing, and methods of
236	analysis, storage, retrieval of manufacturing and quality data)
237	o Environmental parameters (e.g., shock, vibration, thermal, humidity, electromagnetic
238	interference/impact, electrostatic discharge, transport, etc.)
239	• Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC)
240	requirements
241	• Human safety and health
242	 Hazardous materials management and pollution prevention
243	 Interoperability requirements
244	• Key Performance Parameters (KPPs) (i.e., Key Product and Process Characteristics)
245	• Parts, materials, and processes (PM&P)
246	• Security parameters (physical and cyber) for both hardware and software
247	 Supportability and sustainment
248	• Use of commercial off-the-shelf (COTS), government off-the-shelf (GOTS), and
249	government-furnished equipment (GFE) (including diminishing manufacturing sources)
250	Analyses have been accomplished and document the completeness and adequacy of
251	manufacturing and quality aspects and requirements included in contractor's:
252	• Plans for processes and metrics included in System Engineering Management Plan (SEMP)
253	• Plans for budget and schedule including identification of cost and schedule drivers (with
254	impacts on the critical path)
255	• Software development strategy and plans (to include functionality, adequacy, testing, etc.)
256	Technology maturation plans
257	 Follow-on Test and Evaluation (FOT&E) approaches
258	• Development, qualification, and acceptance testing approaches including consideration for
259	Non-Developmental Items (NDI), COTS, and reuse items
260	• Modeling and Simulation plans to include design, production, processes, costing, etc.
261	Tools
262	AS6500 Manufacturing Management System Checklist
263	AS9100 Quality Management System Checklist
264	ISO 9001 Quality Management System Checklist
265	• Technology Readiness Level (TRL) Assessment Checklist
266	• Industrial Base Assessment Survey Form Defense Contract Management Agency (DCMA)
267	Industrial Analysis Center
268	• Product Support Strategy Development Tool, Defense Acquisition University (DAU)
269	• Life Cycle Sustainment Plan Outline

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271 DoDI 5000.02, Operation of the Defense Acquisition System, Jan 2017 • 272 CJS JCIDS 3170.01, JCIDS System • 273 10 USC, title 10, Section 2337, Life-cycle Management and Product Support • 274 AS6500 Manufacturing Management Program • 275 • AS9100 Quality Systems - Aerospace 276 DFARS 252.204-7012 Safeguarding Covered Defense Information and Cyber Incident 277 Reporting 278 • ISO/IEC/IEEE 15288, Systems and Software Engineering–System Life Cycle Processes, 279 2015 280 • ISO 9001, Quality Management System 281 • NIST 800-171, June 2015, Controls for Controlled Unclassified information 282 MIL-STD-1472, DoD Design Criteria Standard: Human Engineering • 283 DoD HCI Style Guide, 1994, Human Computer Interaction (HCI) • 284 • DoD 5000.60-H DoD Handbook: Assessing Defense Industrial Capabilities, Apr 1996 285 Technology Readiness Assessment Guidance, Apr 2011 • 286 Defense Manufacturing Management Guide for Program Managers, Chapter 12.5.14 In-287 Service Review 288 • Guide to Environment, Safety, and Occupational Health (ESOH) in the Systems Engineering 289 Plan (SEP), no date 290 • Product Support Manager Guidebook, 2016 Performance Based Logistics (PBL) Guidance, Nov 2011 291 •

292 A.2 Support Program Management Reviews

270

Resources

293 The only review planned for the O&S phase is a series of Integrated Logistics Assessment (ILA).

294 The ILA is a multi-disciplined product and process assessment to ensure that the fielded system is

295 operationally employed with well-understood and managed risk. This review is intended to

296 characterize in-service technical and operational health of the fielded system by providing an

assessment of risk, readiness, technical status, and trends in a measurable form that will substantiate

298 in-service support budget priorities. Normally ISRs occur at numerous points in the O&S phase. It is

299 typically initiated prior to, and in support of, the initiation of the following fiscal year(s) operations

300 and support budget requirements determination process.

301 During the sustainment effort of the Operations and Support phase, systems engineering processes

302 support in-service reviews including identifying root causes and resolutions for safety and critical

303 readiness degrading issues. This effort includes participating in trade studies and decision making

relative to the best resolution (e.g., changes to the product support package, manufacturing process

305 improvements, modifications, upgrades, and future increments of the system), considering the

306 operational needs and the remaining expected service life.

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307 308 309	Interoperability or technology improvements, parts or manufacturing obsolescence, aging aircraft (or system) issues, premature failures, changes in fuel or lubricants, joint or service commonality, etc. may all indicate the need for a system upgrade(s) or process improvements.
310	• Measure, assess, and report manufacturing readiness.
 311 312 313 314 315 316 	 The major review during the O&S phase is the In-Service Review. During O&S reviews, manufacturing should measure, assess, and report manufacturing readiness using metrics and implement corrective actions for trends diverging from the required performance outcomes. Provide input of quality, manufacturing/production, engineering and software related issues, deficiencies and/or risks.
317 318 319	• Manufacturing analysis supports the depot source of repair decision and must include detailed requirements for core depot-level maintenance and repair capabilities, and associated sustaining workloads required to support such requirements.
320 321 322	During O&S, the Program Manager will measure, assess, and report system readiness using sustainment metrics and implement corrective actions for trends diverging from the required performance outcomes defined in the Acquisition Program Baseline and LCSP.
323 324 325	Ensure that sustainment factors are fully considered at all key life-cycle management decision points, and that appropriate measures are taken to reduce O&S costs by influencing system design early in development, developing sound product support strategies, and addressing key drivers of cost.
 326 327 328 329 330 331 	The program manager should be aware of changing production capability as the transition from production to spare parts provisioning will severely reduce opportunities for future spares procurement if production facilities are changed to accommodate a new product line, material needs change or new tooling for special purpose machines is installed. If extended production runs did not provide a spare parts inventory, the cost of parts produced at a later date can be significantly higher than the original procurement. Conditions which drive up spare parts prices include:
 332 333 334 335 336 337 338 	 Smaller order quantity requirements; Orders for earlier configuration units which require special documentation; Parts requiring special purpose tooling; Unique or scarce material requirements; Lack of production capability due to a number of factors: Out of business, discontinued facilities, lack of available production capacity, etc.; and Special handling, packaging and shipping requirements
339	Manufacturing & Quality Tasks
340	• Provide manufacturing and quality assessments in support of the ILA:
341 342	 Assess system hazard Operational readiness impacts from Manufacturing/Quality Assurance (QA) risks

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343		 Impacts to cost and schedule from Manufacturing/QA risks
344		 Budget estimates in support of future Manufacturing/QA activities
345		• Assessment of the impact of Manufacturing/QA on reliability, maintainability and
346		operational readiness
347	Metrio	CS
348	•	Integrated Logistics Assessment Tool, Mar 2017
349	Tools	
350	•	Life Cycle Sustainment Plan Outline
351	Resou	rces
352	٠	Logistics Assessment Guidebook, Jul 2011
353	٠	Logistics Assessment Guidebook Tool, Mar 2017
354	•	AS6500, Manufacturing Management System, 2015
355	•	AS9100, Quality Management System, Sep 2016
356	٠	ISO 9001, Quality Management System, Sep 2016

357 **B. DEFENSE CONTRACTING SYSTEM**

358 The RFP is the primary opportunity to make inputs to the Engineering and Manufacturing 359 Development (EMD) contract and should be based on manufacturing and quality risks, issues, and 360 opportunities discovered during Technology Maturation and Risk Reduction (TMRR). Typical areas 361 to be included in the proposal include industry best practices for manufacturing management, quality management, and systems engineering. Other areas such as design and producibility, trade studies, 362 363 manufacturing and quality technology investments, competition, materials (availability, counterfeit, 364 and/or long-lead), data management, quality processes (capability studies), manufacturing and quality reporting and control, etc. should be addressed by manufacturing and quality. This list and 365 other details should be addressed in the Statement of Work (SOW) and/or the Statement of 366 Objectives (SOO). 367



369 B.1 Provide Input to Sustainment Request for Proposal (RFP)

370 Manufacturing and Quality Tasks

- A well-written RFP is absolutely critical to the success of the source selection. There shall be
- 372 consistency between the requirements documents, Source Selection Plan (SSP), and Request for
- 373 Proposal (RFP). The acquisition team must ensure a clear linkage between the requirements and
- 374 evaluation factors to maximize the accuracy and clarity of the RFP.
- 375
 During O&S, manufacturing should support the Program Manager to revalidate the supportability
- analyses and review the most current product support requirements, senior leader guidance, and fiscalassumptions to evaluate product support changes or alternatives and determine best value.
- Ensure that manufacturing and quality personnel are included in the Sustainment Request for Proposals (RFPs) writing and review teams. Typical RFPs shall contain the following item:
 Content for SOW, SOO
- 381 o Contract sections C, L, M, and H
- 382
 o
 System Performance Specification
- 383 o Top-level Schedule
- 384oPreliminary Work Breakdown Structure (PWBS)
- 385oContract Data Requirements List (CDRLs) (Manufacturing/QA)
- 386oContract Line Items (CLINs)
- Insert the following into Sustainment RFPs and Contracts (if appropriate).
- 388 o Higher-Level Contract Quality Requirement per Federal Acquisition Regulation (FAR)
 389 Part 52
- ISO 9001, AS9100, etc.
- 391 o Manufacturing Management Program
- Not a biAS6500, Manufacturing Management Systems
- 393 Failure Modes, Effects, and Criticality Analysis (FMECA)
- 394oFailure Reporting, Analysis, and Corrective Action System (FRACAS)
- 395 o System Safety Military Standard (MIL-STD-882)
- 396 Material Management and Accounting System (MMAS)
- 397oSoftware QA Plan
- 398oOther (Parts Management Program, Counterfeit Management Program, Configuration399Management Program, Integrated Product Support Plan, etc.)
- As a basis for RFP Sustainment requirements and inputs, analyze manufacturing and quality outputs from:
- 402oRisk, Issue, and Opportunity Management System and processes
- 0 Design producibility, feasibility, and manufacturability studies and analyses

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404	 Tooling, facility, and workforce analyses
405	 Prototype demonstrations and development tests
406	• Materials analyses
407	 Make/buy processes and analyses
408	 Costs and budget analyses
409	• Market research and analyses
410	 Modeling and simulations analyses
411	 Process Capability Studies
412	 Environmental studies and risks (PESHE)
413	 Manufacturing and quality processes and data
414	 Work measurement/learning curve analyses
415	 Industrial Base studies
416	• Specify contractual manufacturing and quality requirements for:
417 418	 Content for Statement of Work, Statement of Objectives, and contract sections C, L, M, and H
410	
419 420	• DPAS can be a valuable tool for critical programs in obtaining priority support from contractors and subcontractors.
421	• The role of manufacturing/quality assurance is to assure the proper Defense Priorities and
422	Allocation System (DPAS) rating is imposed on their program (if a change is required
423	this will require a major effort to document and support) and then to assure the contractor
424	is effectively using it and flowing it down to suppliers.
425	• In cases where military programs are competing for limited resources, or where
426	commercial items are competing with military products, it may be necessary to get the
427	DPAS office to mediate.
428	When revising the LCSP, the Program Manager will revalidate the supportability analyses and
429	review the most current product support requirements, senior leader guidance, and fiscal assumptions
430	to evaluate product support changes or alternatives and determine best value.
431	After the Full Rate Production decision, the LCSP will focus on finalizing the sustainment metrics,
432	integrating sustainment considerations with design and risk management activities, and refining the
433	execution plan for the design, acquisition, fielding, and competition of sustainment activities
434	Metrics
435	• Most are Go/No-Go, the items are either on contract or not
436	Manufacturing Readiness Risk Assessment
437	• Technology Readiness Assessment (if required)
438	Industrial Base Capability Assessment

439	Tools
440	AS6500, Manufacturing Management System Checklist
441	AS9100, Quality Management System Checklist
442	ISO 9001, Quality Management System Checklist
443	• ISO/IEC/IEEE 15288, Systems and Software Engineering–System Life Cycle Processes,
444	2015
445	• IG5315.204-5(b) Section L Guide and Template
446	• IG5315.204-5(c) Section M Guide and Template
447	Technology Readiness Level (TRL) Assessment Checklist
448	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
449	Resources
450	• AS6500. Manufacturing Management System
451	AS9100. Quality Management System
452	• ISO 9000. Quality Management System
453	• ISO/IEC/IEEE 15288. System and Software Engineering IG5315.204-5(b) Section L Guide
454	• IG5315.204-5(c) Section M Guide
455	• DoD 5000.60-H DoD Handbook: Assessing Defense Industrial Capabilities, Apr 1996
456	Technology Readiness Assessment Guidance, Apr 2011
457	D.2. Drevide Invite to Sustainment Course Colection Dian (SSD)
457	B.2 Provide inputs to Sustainment Source Selection Plan (SSP)
458	Manufacturing and Quality Tasks
459	A Source Selection Plan (SSP) is required for all best-value, negotiated, competitive acquisitions
460	under FAR Part 15. The Source Selection Authority shall approve the SSP before the final
461	solicitation is issued. The SSP shall include the following (as a minimum):
167	Packground and Objectives
402	Acquisition Strategy
405	 Acquisition Strategy Source Selection Team (should include Manufacturing/OA)
-0- 165	 Communications
-05 166	 Evaluation Eactors and Sub-factors (should include some Manufacturing/OA)
467	 Evaluation 1 actors and Sub-factors (should metude some Wandracturing QA) Documentation
468	Schedule of Events
469	Non-governmental personnel
470	 Source Selection materials management
471	Manufacturing and OA should provide inputs to the SSP
.,1	
472	 Manufacturing inputs to the Sustainment SSP include:

473 474 475	 Manufacturing/QA evaluation criteria, Technical Data Rights and Manufacturing Process Data Rights, Intellectual property (IP) deliverables and associated license rights.
476 477 478 479 480 481	Specify how the program will provide for rights, access, or delivery of technical data the government requires for the systems total life cycle sustainment. Include analysis of data needs to implement the product support life cycle strategy including such areas as materiel management, training, Information Assurance protection, cataloging, open architecture, configuration management, engineering, technology refreshment, maintenance/repair within the Technical Order (TO) limits and specifically engineered outside of TO limits, and reliability management.
482	The Program Manager should describe:
483 484 485	 The overall management approach to managing data acquired with other than unlimited rights. The management approach for management data (i.e. data that is not software or technical data). It should include here contracted data meeting mutation will be identified, meeting data acquired with other than unlimited data.
486 487	data). It should include how contractor data needing protection will be identified, marked, and managed.
488 489 490	• How the data deliverables will be reviewed for unjustified or non-conforming markings. It should include the process the program will follow to question or challenge contractor assertions or markings
491 492	 The data deliverables specified in the RFP or contract, including the technical data, computer software documentation, and management data items.
493 494 495	• The approach for maintaining the software and its documentation once software maintenance is transferred from the Original Equipment Manufacturer (OEM. It should include the contract provisions being put into place that will allow for a cost-effective migration.
496 497 498	• The degree to which data will be acquired to support future competitions. It should include the logic by which these elements were selected; the alternative solutions considered; and the criteria by which the decision to procure technical data was made.
499 500	• The extent to which priced options and associated source selection criteria will be used to acquire additional licenses
501 502	 The intended use of other mechanisms such as deferred ordering, deferred delivery, and the use of withholding or incentives specific to performance in the area of data management.
503 504	• How the use of an integrated digital environment and the repository system factors into the data strategy.
505 506	• Any required interfaces to government data systems or repositories, and how those requirements will be satisfied.
507 508 509	• The digital format standards to be used and why they were selected. The process (i.e., business case analysis, adherence to DoD Component policy, etc.) used to determine the deliverable form/format for all deliverables should be included.

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- 510 At the end of its useful life, a system will be demilitarized and disposed of in accordance with all
- 511 legal and regulatory requirements and policy relating to safety (including explosives safety), security,
- 512 and the environment.
- 513 Life-cycle sustainment for information systems may be provided via multiple approaches, including
- 514 service level agreements, support agreements, performance work statements, and enterprise services.
- 515 Where feasible and as approved by the MDA, programs may employ portfolio-level documents to
- 516 satisfy their LCSP requirements. COTS and GOTS products used as intended will normally be
- 517 supported via standard warranties and support agreements. Effective life-cycle sustainment requires
- 518 continuous monitoring to ensure investments are maintained at the right size, cost, and condition, to
- 519 include vulnerability management, to support warfighter and business missions and objectives.
- 520 The necessary intellectual property (IP) deliverables and associated license rights, consistent with 521 and integrated with the program IP Strategy.
- 522 COTS and GOTS products used as intended will normally be supported via standard warranties and
- 523 support agreements. Effective life-cycle sustainment requires continuous monitoring to ensure
- 524 investments are maintained at the right size, cost, and condition, to include vulnerability
- 525 management, to support warfighter and business missions and objectives.
- 526 Reduced oversight: Generally, contractors prefer less oversight/insight by the government. We can
- 527 use this desire to trade off personal involvement from Program Management Office (PMO)
- 528 manufacturing/quality assurance if contractor performance is improved/acceptable. We may also
- 529 have some influence over the amount of DCMC oversight if contractor performance is acceptable.
- 530 Relationship between government and contractor: This may be one of the most critical areas an
- 531 individual may influence in their day-to-day job. Although senior management creates the overall
- 532 program environment, personal, professional, and constructive relationships at the working levels can
- 533 still be cultivated. The PMOmanufacturing/quality assurance manager should strive to create and
- 534 maintain close teaming arrangements with their counterparts. This will enable better communications
- and enhanced respect among both parties.

536 Metrics

- Most are Go/No-Go, the items are either on contract or not
 Manufacturing Readiness Risk Assessment
 Technology Readiness Assessment (if required)
 Industrial Base Capability Assessment
- 541 **Tools**
- AS6500, Manufacturing Management System Checklist
- AS9100, Quality Management System Checklist

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- ISO 9001, Quality Management System Checklist
- ISO/IEC/IEEE 15288, Systems and Software Engineering–System Life Cycle Processes,
 2015
- Source Selection Plan Template, USMC
- Technology Readiness Level (TRL) Assessment Checklist
- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center

550 **Resources**

- AS6500, Manufacturing Management System
- AS9100, Quality Management System
- ISO 9000, Quality Management System
- IG5315.303 Source Selection Plan Guide, Dec 2008
- DoD 5000.60-H DoD Handbook: Assessing Defense Industrial Capabilities, Apr 1996
- Technology Readiness Assessment Guidance, Apr 2011

557 B.3 Provide Award Fee/Incentive Fee Criteria Performance Tracking

- 558 Performance Tracking within the SOO/SOW and RFP should focus on technical and business
- 559 measures that will help to assure program success (cost, schedule and performance). Cost
- 560 performance measures should focus on affordability and total life cycle costs, schedule performance
- 561 measures should focus on the Integrated Master Plan/Schedule. Adherence to both may be found in
- an Earned Value Management (EVM) if required. Technical performance should be assessed using
- technical measures that are derived from the Measures of Effectiveness (MOEs), Key Performance
- 564 Parameters (KPPs), Measures of Performance, and Technical Performance Measures (TPMs).
- 565 Manufacturing and QA related TPMs should support the achievement of Sustainment Supportability
- 566 Measures.

567 Manufacturing and Quality Tasks

568 Manufacturing and Quality personnel should support an integrated product support capability

- 569 implementing the program's mix of government and industry providers supported by appropriate 570 analyses as included in 10 U.S.C. 2337 – Life-cycle management and product support that focuses
- analyses as included in 10 U.S.C. 2337 Life-cycle management and product support that focuses
 on:
- Maximize competition and make the best possible use of available Department of Defense
 and industry resources at the system, subsystem, and component levels; and
- Maximize value to the DoD by providing the best possible product support outcomes at the
 lowest operations and support cost.
- 576 Manufacturing and QA personnel should be working to identify cost, schedule and technical
- 577 performance measures. Technical Performance Measures are often derived from mission needs or
- 578 Measures of Effectiveness, Key Performance Parameters, and Measures of Performance. These

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- 579 measures can then be related to and tracked by an Earned Value Management system (if applicable),
- 580 and the Integrated Master Plan/Schedule.

581 Award Fee/Incentive Fee: An award fee or incentive fee is intended to motivate the contractor's

582 performance in those areas critical to program success. While the overall Award Fee process and

583 final rating is not controlled by manufacturing/quality assurance, we may own specific sections and

usually have a great deal of control over what items we want to include as criteria. We also control

the evaluations for those sections and can use this authority as a basis for communicating our

- 586 concerns to our contractor counterparts as well as rewarding them for doing well.
- 587 Potential Manufacturing/QA Award Fee Criteria could include:
- Customer Responsiveness
- 589 Customer Fulfillment Rate (on time/schedule)
- 590 o Throughput Time
- 591 o Manufacturing Cycle Time
- 592 Quality
- 593 First Pass Yield/Scrap/Rework and Repair Rates
- 594oSupplier Quality Yield Rates
- 595 o Field Data (Warranty/Mean Time Between Failure) (Technical performance)
- 596oCost of Quality (affordability)
- 597 In-Plant
- 598oOSHA Compliance
- 599oInventory Reduction
- 600 o Overall Equipment Effectiveness

601 Metrics

- Technical Performance Measures
- Schedule Performance Measures
- Cost Performance Measures

605 **Tools**

- Award Fee Template, Annex B of the Air Force Award Fee Guide
- Quality Function Deployment excel template
- Requirements Roadmap worksheet

609 **Resources**

- AS6500, Manufacturing Management System
- AS9100, Quality Management System
- ISO 9000, Quality Management System

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- Award Fee Guide, various Army, Navy and Air Force
- Quality Function Deployment, Dr. Akao
- Guidebook for the Acquisition of Services, Jun 2012 (Chapter 4.3.1 Automated
- 616 Requirements Roadmap Tool)

617 **B.4** Provide Manufacturing Incentives Criteria Tracking

618 Manufacturing and Quality Tasks

- 619 Manufacturing should provide appropriate analyses support in developing an integrated product
- 620 support capability implementing the program's mix of government and industry providers by
- 621 focusing on the twelve Integrated Support Elements listed below:
- Product Support Management
- Supply Support
- Packaging, Handling, Storage and Transportation
- Maintenance Planning and Management
- 626 Design Interface
- 627 Sustaining Engineering
- Technical Data
- 629 Computer Resources
- Facilities and Infrastructure
- Manpower and Personnel
- 632 Support Equipment
- Training and Training Support
- 634 Manufacturing and Quality personnel should support an integrated product support capability
- 635 implementing the program's mix of government and industry providers supported by appropriate 636 analyses as included in 10 U.S.C. 2337.
- 637 Competition, or the option of competition, at the prime and subcontract levels for large and small638 businesses, and system and sub-system levels.
- 639 Plan for Corrosion Prevention and ontrol (CPC) in systems engineering and life cycle sustainment as
- 640 required by DoDI 5000.67. Product support planning, especially maintenance planning and
- 641 sustaining engineering, will incorporate appropriate mitigation of CPC risks inherent in the design to
- 642 meet sustainment requirements.
- 643 The LCSP will focus on ensuring operational supportability and verifying performance.
- 644 Mean Down Time. The average total downtime required to restore an asset to its operational
- 645 capability, measures the effectiveness of the supply chain and support infrastructure (e.g., customer
- 646 wait time, logistics response time, retrograde time). It is an important element in assessing a system's

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- 647 affordability across its life cycle and identifies constraints and opportunities of a system's product
- 648 support strategy and product support arrangements.
- 649 The Acquisition Strategy should promote sufficient program stability to encourage industry to invest,
- 650 plan, and bear their share of the risk. However, the strategy should not compel the contractor to use
- 651 independent research and development contracts, except in unusual situations where there is a
- reasonable expectation of a potential commercial application.
- All of the great quality improvement tools and producibility initiatives will make no difference if the
- 654 contractor is not properly motivated to employ those tools or make producibility changes. For many
- 655 years it has been suspected that a contractor can make more profit in the short term by producing
- defective products that we pay him to fix, than he would if he fixed the system and prevented the
- 657 defects. In that light, some suggestions for specific incentives an individual Manufacturing or Quality
- Assurance Manager may have include award fee, reduced oversite, lab resources, bully pulpit,
- 659 increased review of critical suppliers/processes, government/contractor relationships.

660 Metrics

- Life Cycle Sustainment Plan
- Competition
- Corrosion Prevention
- Mean Down Time
- Industry Investments
- Producibility

667 **Tools**

• Life Cycle Sustainment Plan Outline

669 Resources

• Life Cycle Sustainment Plan Content Guide, June 2010

671 B.5 Validate and Track Proposed Sustainment Learning Curves

672 Manufacturing and Quality Tasks

- 673 A successful program meets the sustainment performance requirements, remains affordable, and
- 674 continues to seek cost reductions by applying should-cost management and other techniques
- 675 throughout the O&S phase. Doing so requires close coordination with the warfighting sponsor (i.e.,
- 676 user), resource sponsors, and materiel enterprise stake holders, along with effective management of
- 677 support arrangements and contracts.

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- 678 Manufacturing should help the program meet the sustainment performance requirements, remain
- affordable, and continues to seek cost reductions by applying should-cost management and other
- techniques throughout the O&S phase. At the Full-Rate Production Decision or Full Deployment
- 681 Decision, the LCSP will focus on how sustainment performance is measured, managed, assessed, and
- reported; and the actions to adjust the product support package to ensure continued competition and
- 683 cost control while meeting warfighter mission requirements.
- 684 During Full-Rate Production, manufacturing should focus on how sustainment performance will be
- measured, managed, assessed, and reported; and the necessary actions to adjust the product support
- 686 package to ensure continued competition and cost control while meeting warfighter mission
- requirements. After Initial Operational Capability (IOC), the LCSP is the principle document
- 688 governing the system's sustainment. Programs will update the plan whenever there are changes to the
- 689 product support strategy, or every 5 years, whichever occurs first, supported by appropriate analyses,
- 690 sustainment metrics, sustainment costs, system components or configuration (hardware and
- 691 software), environmental requirements, and disposal plans or costs.
- Manufacturing should support programs to update the plan whenever there are changes to the product
- 693 support strategy, or every 5 years, whichever occurs first, supported by appropriate analyses,
- 694 sustainment metrics, sustainment costs, system components or configuration (hardware and
- software), environmental requirements, and disposal plans or costs. Use performance-based payment
- 696 events as effective Manufacturing /quality measures. This activity involves the assessment of how
- 697 efficiently the contractor is producing products, primarily through the evaluation of work
- 698 measurement data. It also includes the analysis of causes of variances, their root causes, and
- 699 championing and motivating contractor improvements.
- During production and into sustainment, manufacturing should support performance-based
 payment events such as award fees, manufacturing/production incentives, and learning curve
 analysis.
- Manufacturing/quality activity sometimes involves the use of the "bully pulpit" of the PMO and the role we have in encouraging the contractors to continually improve their processes and products. The manufacturing/quality assurance managers have numerous opportunities to do this, such as during teleconferences, Program Management Reviews, Fact Findings, etc. Also note this is not confined to contractors - we can encourage internal improvements at depots and within the PMOs.

708 Metrics

709 • [TBD]

710 **Tools**

- DoD Progress-Based Payments Tool, Version 4.2
- Cash Flow Tool for Evaluating Alternative Finance Arrangement
- 713• Learning Curve Tool

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- Work Measurement Time Study Worksheet
- Resources

726

- 716• Performance Based Payments Guide
- DFAR Subpart 232.10 Performance-Based Payments
- Application of Learning Curve Theory, DAU Teaching Note, Feb 2011
- Chapter 8 Work Measurement

720 C. SURVEILLANCE SYSTEM

- 721 The Program Manager and Program Office should utilize to the maximum extent possible available
- 722 Contract Administration Services (CAS) and functions in accordance with FAR 42.302(a) Contract
- 723 Administration Functions. Typical CAS functions involving engineering, manufacturing and quality
- assurance can provide program offices with timely, value-added analysis, acquisition insight, and
- early confirmation of progress and risk reporting.



727 Note: Many manufacturing/QA functions may have moved from prime contractor facilities to

government owned and operated facilities such as depots and MROs where CAS surveillance may not be available.

730 C.1 Conduct Manufacturing/QA Performance Meetings

731 Manufacturing and Quality Tasks

- Manufacturing should support the contractor's government/contractor status meetings. At the prime contractor facility as well as at key/critical subcontractors and suppliers.
 Manufacturing should provide inputs to the government accountable property system that documents all government owned property whether it is held and managed by the government, contractor, or third party. Production tooling, testing equipment, spares, and
- materials left from production are all important assets that must be maintained and may be
 held for use during the Sustainment phase.
- The government accountable property system that documents all government owned property
 whether it is held and managed by the government, contractor, or third party, in accordance
 with 40 USC 524.

After IOC, the DoD Components will continue to conduct Independent Logistics Assessments (ILAs)
 at a minimum interval of every 5 years. Assessments will focus on the weapon system-level product

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- support performance in satisfying warfighter needs, meeting sustainment metrics, and providing best-
- value outcomes. They must specifically assess O&S costs to identify and address factors resulting in
- 746 growth in O&S costs and adapt strategies to reduce such costs. Results will inform LCSP and
- 747 analyses updates.
- 748 The contractor shall conduct regular (weekly/monthly) government/contractor status meetings.

749	Metrio	CS CS	
750	•	Meetings held with Manufacturing/QA discussions	
751	•	Independent Logistics Assessments	
752	Tools		
753	•	Material Management and Accounting System checklist	
754	•	DAU Logistics Assessment Guidebook, Appendix A: Integrated Product Support Element	
755		Assessment Criteria (checklist), Mar 2017	
756	Resources		
757	•	DCMA-INST-205 Major Program Support	
758	•	AS6500	
759	•	DCMA-INST-204 Manufacturing and Production	
760	•	AS9100	
761	•	DCMA-INST-309 Government QA Surveillance Planning	
762	•	Army, AT&L Memo, Independent Logistics Assessments (ILA), Aug 2013	
763	•	SECNAVINST4105.1C, Independent Logistics Assessment and Certification Requirements,	
764	•	Integrated Logistics Assessment Handbook (Navy), Sep 2012	
765	•	DoD Logistics Assessment Guidebook, 2011	
766	•	Material Management and Accounting System udit Program, Apr 2017	
767	•	FAR Part 46 Government Property	
768	•	DFARS 245 Government-Furnished Property	
769	•	DoDI 4161.02 Accountability and Management of Government Contract Property	
770	٠	ISO 9000	

771 C.2 Participate in Sustainment Program Reviews

772 Manufacturing and Quality Task

- The In-Service Review (ISR) is a multi-disciplined product and process assessment to ensure that the
- fielded system is operationally employed with well-understood and managed risk. This review is
- intended to characterize in-service technical and operational health of the fielded system by
- providing an assessment of risk, readiness, technical status, and trends in a measurable form that will
- substantiate in-service support budget priorities.

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778 779	• Provide input of quality, manufacturing, engineering and software related issues, deficiencies and/or risks during program reviews	
780	Current levels of System Operational Pick and System Deadiness have been quantified and	
780	• Current levels of System Operational Kisk and System Readiness have been quantified and related to current O&M and procurement budgets.	
782	• Future levels of System Operational Risk and System Readiness have been quantified and	
783	related to future Operations and Maintenance (O&M) and procurement budgets.	
784	• Risk assessment checklist are use to assess risk during the review process.	
785	• Sustainment Reviews may include time-phased transitions between commercial, organic, and	
786	partnered product support providers. Manufacturing should help ensure resources are	
787	programmed and necessary IP deliverables and associated license rights, tools, equipment,	
788	and facilities are acquired to support each of the levels of maintenance that will provide	
789	product support; and will help establish necessary organic depot maintenance capability.	
790	• Manufacturing should help identify features that are likely to drive future operating and	
791	support costs, changes to system design that could reduce costs, and effective strategies for	
792	managing such costs. The reviews will focus on sustainment planning and execution, to	
793	include the core logistics analyses and establishment of organic capabilities.	
794	• Manufacturing should support Performance-Based Logistics (PBL) planning, development,	
795	implementation, and management during Sustainment. PBL is performance-based product	
796	support, where outcomes are acquired through performance-based arrangements that deliver	
797	warfighter requirements and incentivize product support providers to reduce costs through	
798	innovation.	
799	• Production Planning and Systems Engineering must account for product obsolescence and	
800	the likelihood of future redesign in order to upgrade system capability. It is unlikely that the	
801	impacts of Diminishing Manufacturing Sources (DMS) and obsolescence can be eliminated	
802	entirely. Manufacturing should support by addressing likely risk areas, particularly in	
803	avionics and electronics, during design and production before the part supply evaporates.	
804	This can make the system more affordable and supportable.	
805	• Production surveillance performed by manufacturing is a function of contract administration	
806	used to determine contractor progress and to identify any factors that may delay performance.	
807	DCMA provides production surveillance of the contractor's performance based on the	
808	Surveillance Criticality Designator (SCD).	
809	• Manufacturing should be working with the depots to determine what tooling and data	
810	must be kept after production ends.	
812	operation it performs and for which configuration	
813	 Manufacturing should support program office shutdown activities as needed. 	
814	• Manufacturing should be a member of the shutdown Integrated Product Team (IPT).	
815	The LCSP may include time-phased transitions between commercial, organic, and partnered product	
816	support providers. The Program Manager will ensure resources are programmed and necessary IP	

deliverables and associated license rights, tools, equipment, and facilities are acquired to support 817

6. Operations and Support (O&S) Phase

- 818 each of the levels of maintenance that will provide product support; and will establish necessary
- 819 organic depot maintenance capability in compliance with statute and the LCSP.
- 820 The DoD Components will conduct independent logistics assessments to assess the adequacy of the
- product support strategy, and to identify features that are likely to drive future operating and support
- 822 costs, changes to system design that could reduce costs, and effective strategies for managing such
- 823 costs. The reviews will focus on sustainment planning and execution, to include the core logistics
- analyses and establishment of organic capabilities.
- B25 DCMA supports program office shutdown activities as needed and should be a member of theshutdown IPT.

827 Metrics

• Manufacturing and quality support the performance of the In-Service Review

829 **Tools**

• Independent Logistics Assessment

831 Resources

- Independent Logistics Assessment Handbook, Sep 2013
- AS6500, Manufacturing Management System
- AS9100, Quality Management System
- ISO 9000, Quality Management System
- 836 C.3 Conduct Sustainment Pre-Award Survey
- 837 Manufacturing and Quality Tasks
- Evaluate Technical Capability; Production Capability; Quality Assurance; Packaging; Flight
 Operations/Safety; Technical documentation; Configuration Management; and Software
 Capability.
- Manufacturing must be aware that over the system life cycle, operational needs, technology advances, evolving threats, process improvements, fiscal constraints, plans for follow-on systems, or a combination of these influences and others may warrant revisions and system modifications.
- Manufacturing should help ensure that appropriate measures are taken to reduce operating
 and support costs by influencing system design early in development, developing sound
 product support strategies, and addressing key drivers of cost.

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 Manufacturing should support independent logistics assessments prior to Milestones B and C and the Full-Rate Production Decision to assess the adequacy of the product support strategy, and to identify features that are likely to drive future operating and support costs, changes to system design that could reduce costs, and effective strategies for managing such costs. The reviews will focus on sustainment planning and execution, to include the core logistics analyses and establishment of organic capabilities.

Over the system life cycle, operational needs, technology advances, evolving threats, process
improvements, fiscal constraints, plans for follow-on systems, or a combination of these influences
and others may warrant revisions to the LCSP.

Each DoD Component will establish its criteria for independence, and will provide (1) guidance to

- ensure consistency within the respective Component and (2) the scope of the assessment for key
- acquisition decision points. At a minimum, these reviews will be chartered by the Component
- 860 Acquisition Executive (CAE) and conducted by logistics, program management, and business experts
- from outside the program office. Each DoD Component will establish its criteria for independence,
- and will provide guidance to ensure consistency within the respective Component and the scope of
- the assessment for key acquisition decision points. At a minimum, these reviews will be chartered by

the CAE and conducted by logistics, program management, and business experts from outside the

865 program office (manufacturing/quality experts should participate in this activity.

866 Ensure that sustainment factors are fully considered at all key life-cycle management decision points,

and that appropriate measures are taken to reduce operating and support costs by influencing system
design early in development, developing sound product support strategies, and addressing key drivers

of cost.

870 The DoD Components will conduct independent logistics assessments (ILAs) for all weapon system

- 871 Major Defense Acquisition Programs (MDAPs) prior to Milestones B and C and the Full-Rate
- 872 Production Decision to assess the adequacy of the product support strategy, and to identify features
- that are likely to drive future operating and support costs, changes to system design that could reduce
- costs, and effective strategies for managing such costs. The reviews will focus on sustainment
- planning and execution, to include the core logistics analyses and establishment of organic
- 876 capabilities.

877 Metrics

• Pre-Award Survey

879 **Tools**

- SF 1404 Pre-award Survey Technical
- SF 1405 Pre-award Survey Production
- SF 1406 Pre-award Survey Quality Assurance
- SF 1407 Pre-award Survey Financial Capability

884	Resources				
885	DCMA Pre-award Survey Guide				
886	• AS9100				
887	• ISO 9000				
888	C.4 Participate in Other CAS On-Site Activities				
889	39 Manufacturing and Quality Tasks				
890	DCMA-INST-205, Major Program Support and FAR 42.302(a) Contract Administration				
891	Functions outlines how DCMA personnel can be used to support Program Office functions.				
892	Manufacturing and Quality Task				
893 894	• Manufacturing and Quality Assurance personnel may be called out to perform some or all of the following functions:				
895	• Input into the development of a Memorandum Of Agreement (MOA) between with program				
896	office and the government contract administration activity.				
897	Attend/participate in Post Award Orientation Conference (PAOC).				
898	• Provide independent program status of cost, schedule and technical performance.				
899 900	• FLIGHT OPERATIONS, if applicable. Request unrestricted government ability to select and access to test and inspect Safety of Flight (SOF) characteristics.				
901	• Accept/reject minor Requests for Variation (RFVs) Material Review Board (MRB) proposals				
902	for Use-As-Is (UAI) and repair non-conformances.				
903	• Verify supplier complies with contractual Special Packaging Instructions (SPIs) for end item				
904	systems and spares, as defined in the contract.				
905 906	• Perform Government Contract Quality Assurance (GCQA), to include Inspection and Acceptance, of production quantities.				
907	• Verify Surveillance Critical Designator (SCD) (FAR 42.11) applied to the contract is the				
908	correct designator.				
909	• Perform government surveillance of the supplier's compliance to DFARS 252.242-7004,				
910	Material Management and Accounting System (MMAS), when invoked in the contract.				
911	• Verify Beyond Economical Repair (BER) requests.				
912	• Perform evaluation of Over and Above (O&A) requests.				
913	 Perform Physical Progress Reviews (PPRs) to support Progress Payments. 				
914	• Perform Estimates to Completion (EAC) when requested.				
915	• Provide delivery delay notices to the customer.				
916	Validate/verify Performance Base Payment requests.				
917	• Provide support to customer priority delivery requests.				
918	Support Material Review Board activities				
919	 Support of Failure Reporting, Analysis and Corrective Action (FRACAS) 				
920	Support assessment of field failures				

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92	1 Metri	Metrics		
92	•2	Various activities supported or not		
92	3 Tools			
92	4 •	DMCA Program Support Plan		
92	5•	DCMA Manufacturing and Production Surveillance Plan		
92	• •	DMCA Engineering Surveillance Plan		
92	•7 •	DMCA QA Surveillance Plan		
92	8 Resou	irces		
92	.9 •	DMCA-INST-205 Program Support		
93	• 0	DCMA-INST-204 Manufacturing and Production		
93	1 •	DMCA-INST-207 Engineering Surveillance		
93	2 •	DMCA-INST-309 Government Contract QA Surveillance Planning		
93	3•	AS9100		
93	4 •	ISO 9001		

935 D. TECHNOLOGY AND INDUSTRIAL BASE

- 936 The O&S phase is characterized by on-going production and sustainment operations. The Program
- Manager should evaluate the industrial base to ensure that there will be a source of material for future
- 938 development, production and sustainment.



- During the O&S phase the industrial base will include depots, MROs and other organic activities.
- 941 There are several concerns for the PM during this phase to include:
- Diminishing Manufacturing Sources and Material Shortages (DMSMS)
- Obsolescence
- Counterfeit Parts
- Insertion of New Technology
- Smart Shutdown
- Demil and Disposal

948 D.1 Conduct Industrial Capabilities (IC) Assessment

- 949 Industrial Base Assessments are required by law:
- 10 USC 2440: Technology and Industrial Base
- 10 USC 2503: Analysis of the Technology and Industrial Base
- 10 USC 2504: Annual Report to Congress
- 10 USC 2505: Periodic Defense Capability Assessments

954 Manufacturing and Quality Tasks

- 955 Industrial base assessments are about understanding the "capability of the industrial base of the
- 956 United States to support the development, production and sustainment of weapon systems used by 957 our defense forces." There are several concerns during the sustainment phase.
- 958 Prior to completing or terminating production, manufacturing should ensure an adequate industrial

959 capability and capacity to meet post-production operational needs. The risk of industry being unable

960 to provide program design or manufacturing capabilities at planned cost and schedule is the major

- 961 program risk during the O&S phase.
- 962 The analysis should also address product technology obsolescence, diminishing manufacturing
- 963 sources and material shortages, counterfeit parts, replacement of limited-life items, regeneration
- 964 options for unique manufacturing processes, and conversion to performance specifications at the
- subsystems, component, and spares levels as these will drive a program's cost and risk.

966 Metrics

- Program Industrial Base Assessment Conducted
- DCMA inputs to the following documents, go/no-go (either is or is not included)
- Manufacturing Readiness Assessment
- Technology Readiness Assessment
- Industrial Base Assessment
- Systems Engineering Plan
- Test and Evaluation Master Plan
- Integrated Master Plan/Schedule

975 **Tools**

- Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
- Technology Readiness Assessment (TRA)
- Manufacturing Readiness Level (MRL) Assessment Checklist, Technology and Industrial
 Base thread
- Integrated Master Plan/Schedule (IMP/IMS)
- Test and Evaluation Master Plan (TEMP)

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• Systems Engineering Plan (SEP)

983 **Resources**

- DoDI 5000.02, Jan 2017
- DODI 5000.60H Defense Industrial Capabilities Assessments
- 10 USC 2440, Technology and Industrial Base
- 987
 10 USC 2501, National Security Objectives Concerning National Technology and Industrial 988
 Base
- 10 USC 2503, Analysis of the Technology and Industrial Base
- TRA Deskbook, Apr 2012
- 991 MRL Deskbook Version 2016
- Systems Engineering Plan (SEP) Outline, Jun 2015
- Test and Evaluation Management Guide, Dec 2012
- 994 DoD Integrated Master Plan and Integrated Master Schedule Preparation and Use Guide, Oct
 2005

996 D.2 Assess Manufacturing Technology Voids

- 997 Typically, the program is very mature, but may still require research and development of new998 technologies to keep weapon systems current with new threats.
- 999 Update assessments and analysis of emerging technologies needed to upgrade existing
 1000 weapon systems.
- Perform manufacturing trade studies on potential technologies to solve the requirements gap
- Identify costs and risks associated with these new technologies
- Update current ManTech and other technology development plans and roadmaps.
- Manufacturing Technology programs should specifically target the risk of industry being
 unable to provide program design or manufacturing capabilities at planned cost and schedule
 following production.
- Manufacturing analysis should address product technology obsolescence, replacement of
 limited-life items, regeneration options for unique manufacturing processes, and conversion
 to performance specifications at the subsystems, component, and spares levels.
- Lab resources: We may be able to provide expert assistance or financial resources from the
 labs to help contractors solve some of the most difficult technical problems.
- 1012 Manufacturing and Quality Tasks
- 1013 ManTech analysis conducted
- 1014 Metrics
- 1015 ManTech Assessment
6. Operations and Support (O&S) Phase

1016	Tools			
1017	Producibility Assessment Worksheet			
1018	Pugh Matrix			
1019	Technology Readiness Assessment			
1020	ManTech Roadmap			
1021	• Manufacturing Readiness Level (MRL) Assessment Checklist, Technology and Industrial			
1022	Base thread			
1023	Resources			
1024	NAVSO P-3687Producibility Systems Guidelines, Dec 1999			
1025	Technology Transition Managers Guide, June 2005			
1026	• TRA Deskbook, Apr 2012			
1027	MRL Deskbook Version 2016			
1028	D.3 Assess CTE Product and Process Limitations			
1020				
1029	The risk of industry being unable to provide program design or manufacturing capabilities at planned			
1030	cost and schedule is the major program risk during the O&S phase.			
1031	Manufacturing and Quality Tasks			
1032	• Manufacturing should watch for critical processes that may be difficult to provide on a			
1033	limited production basis. Some processes operate much more efficiently at a high production			
1034	rate than would be possible during spare part manufacturing.			
1035	 Assess Critical Technology Element (CTE) Process Limitations Assess CTE for imports to foosibility offendability and supportability. 			
1030	 Assess CTE for impacts to reasibility, anordability, producibility, and supportability. Assess maturity of the technology. 			
1037	 Manufacturing and OA feed into product and process assessments. 			
1000	manufacturing and Qriffeed into product and process assessments.			
1039	Metrics			
1040	CTEs identified			
1041	Product limitations identified			
1042	Tools			
1043	Producibility Assessment Worksheet			
1044	Technology Readiness Assessment			
1045	TRL Calculator			
1046	• Manufacturing Readiness Level (MRL) Assessment Checklist, Technology and Industrial			
1047	Base thread			

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1048 **Resources**

- DoDI 5000.02, 5d(4)(b)3. And 5d(4)(c)
 Defense Acquisition Program Support Methodology, Ver. 3.0
 NAVSO P-3687Producibility Systems Guidelines, Dec 1999Technology Readiness Assessment Deskbook, Jul 2009
- 1053 MRL Deskbook Version 2016

1054 **D.4 Perform Industrial Capability Analysis**

Identify DoD investments needed to create and maintain access to competitive suppliers for critical areas at the system, subsystem and component level. When the analysis indicates that industrial capabilities needed by DoD are in danger of being lost, the components should determine whether government action is required to preserve the industrial capability. Address product technology obsolescence, replacement of limited-life items, regeneration options for unique manufacturing processes and conversion to performance specifications at the subsystem, component and spares levels.

1062	Manufacturing and Quality Tasks
1002	
1063	• Identify where industrial capabilities are endangered, an additional analysis is required as the
1064	basis for determining what if any DOD action is required to preserve an industrial capability.
1065	 Perform Industrial Capabilities Analysis (ICA) per DoD Handbook 5000.60H
1066	Identify potential Industrial Base Investments
1067	Identify ManTech projects
1068	Initiate ManTech projects
1069	Metrics
1070	Industrial Base Capability assessment conducted
1071	Industrial Base investments identified
1072	ManTech projects identified and initiated
1073	Tools
1074	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
1075	Army ManTech Proposal Rating spreadsheet
1076	ManTech Phase I project questionnaire
1077	TRL Assessment Checklist
1078	• Manufacturing Readiness Level Assessment Checklist, Technology and Industrial Base
1079	thread
1080	Resources

• DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities, Apr 1996

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6. Operations and Support (O&S) Phase

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1083 D.5 Conduct IB Risk Mitigation

1084 When there is an indication that industrial capabilities needed by DOD are endangered, an additional 1085 analysis is required as the basis for determining what if any DOD action is required to preserve an 1086 industrial capability (see DODD 5000.60 and DOD 5000.60H).

1087 The risk of industry being unable to provide program design or manufacturing capabilities at planned 1088 cost and schedule is a major risk during this phase.

- 1089 Manufacturing should consider industrial surge requirements and capability for • 1090 operationally-expendable items such as munitions, spares, and troop support items. These are 1091 likely surge candidates and should receive close attention and specific planning, to include 1092 use of contract options.
- 1093 • Manufacturing should identify production bottlenecks at both the prime and sub-tier supplier 1094 levels for high use/high volume programs in an asymmetric warfare construct. Consider 1095 surge capability in evaluation criteria for contract award.
- 1096 • If manufacturing analysis indicates that industrial capabilities are in danger of being lost to 1097 include DMSMS and Obsolescence, the DOD Components should determine whether 1098 government action is required to preserve the industrial capability.
- 1099 • Conduct Industrial Base (IB) Risk Handling

1100 Where feasible, Acquisition Strategies should consider industrial surge requirements and capability 1101 for operationally-expendable items such as munitions, spares, and troop support items. These are 1102 likely surge candidates and should receive close attention and specific planning, to include use of contract options. The program office should identify production bottlenecks at both the prime and 1103 1104 sub-tier supplier levels for high use/high volume programs in an asymmetric warfare construct. Surge 1105 capability can be included in evaluation criteria for contract award.

- 1106 **Manufacturing and Quality Tasks**
- 1107 • Initiate mitigation plans that address current and future manufacturing and quality Industrial Base risks. Plans should: 1108 1109 • Address all manufacturing and quality capabilities required that should be maintained
- 1110
- throughout the life of the program 1111 Mitigate product or technology obsolescence, lifetime replacement, or regeneration of items 1112 projected to go out of production
- 1113 • Address the approach to making production rate and quantity changes that support a response 1114 to contingency and support requirements including surges
- Mitigate the vulnerability of the supply chain (to include sole, single, fragile, foreign sources, 1115 • 1116 cyber exploitation, and foreign acquisition of domestic sources)

6. Operations and Support (O&S) Phase

1117 1118 1119 1120 1121	•	Address the 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 National Technology Industrial Base (NTIB) Address the risks introduced by new and unique capabilities and processes
1122	Metric	S
1123	•	Mitigation plans developed
1124	Tools	
1125	٠	Industrial Base Assessment Survey Form DCMA Industrial Analysis Center
1126	•	Manufacturing/QA Risk Mitigation Plan (no Template available)
1127	•	Manufacturing Readiness Level Assessment Checklist, Technology and Industrial Base
1128		thread
1129	Resou	rces
1130	•	DoD Handbook 5000.60H, Assessing Defense Industrial Capabilities, Part II, Chapter 5
1131		Identify and evaluate Alternative Actions, Apr 1996
1132	•	MRL Deskbook Version 2016, Chapter 5.2 Development of a Manufacturing Maturation
1133		Plan

1134 **E. DESIGN**

Manufacturing and quality personnel participation in and support to Program Systems Engineering 1135 IPTs is critical to success in producing a manufacturable and affordable systems with acceptable 1136 risks. Manufacturing and quality industry best practices are integral to design and development 1137 efforts in both Manufacturing Management System (MMS) and Ouality Management System (OMS) 1138 1139 requirements (e.g., AS6500, ISO 9001, AS9100, etc.). The Program should integrate manufacturing 1140 and quality into the product design and development process and engage manufacturing and quality 1141 expertise as early as possible and throughout the entire life cycle of a system to include the O&S phase. Analyses of design alternatives through trade studies, producibility analyses, and 1142 1143 manufacturing feasibility based on Program requirements need to be conducted with results 1144 incorporated into the design. To accomplish Program objectives, producibility planning and analysis 1145 along with manufacturing/QA planning and analysis need to be performed throughout the supply 1146 chain (e.g., failure mode analyses, Key Characteristics, quality capabilities, test processes, etc.), 1147 enabling appropriate visibility and accountability through collection, recording, and communication

1148 of technical and programmatic data to all levels.

6. Operations and Support (O&S) Phase



1150

1151 During the O&S phase, manufacturing and quality should be assessed to support all sustainment

1152 activities and concerns. This includes continued production and design activities associated with

value engineering activities, pre-planned product improvements and capability enhancements. It 1153 1154 should be noted that during the O&S phase design, manufacturing and OA activities can be taking

1155 place at contractor facilities or at government depots, maintenance, repair and overhaul facilities, or

1156 other forms of government facilities.

Update Producibility Plan for Sustainment 1157 E.1

1158 The purpose of Producibility Engineering and Planning (PEP) is to ensure that product designs

1159 reflect good producibility considerations prior to release for manufacturing. Although there is no

commonly accepted starting point for PEP, it is prudent to anticipate production system requirements 1160

1161 as early in the program as in the material solution analysis phase, when only a small percentage of

1162 the total expected program life cycle costs has been incurred.

1163 PEP involves the engineering tasks necessary to ensure timely, efficient and economic production of

essential material. It includes efforts related to development of the Technical Data Package (TDP), 1164

Quality Assurance (QA) procedures, and evaluation of special production processes through trade 1165

1166 studies. Also included are development of unique processes essential to the design and manufacture

1167 of the material and details of performance ratings; dimension and tolerance data; manufacturing

1168 methods; sequences; assembly; schematics; physical characteristics including form, fit and function;

1169 inspection test and evaluation requirements; calibration information and quality control procedures.

1170 PEP is, in effect, a qualification process that will confirm the adequacy of the production planning,

1171 tool design, manufacturing process, and procedures before rate production begins.

1172 It is DoD policy that factors affecting producibility and supportability shall be fully integrated during

EMD. The design and test cycle shall be structured to provide a continuum in development for 1173

1174 production, as opposed to discrete phases that cause iterative and redundant activities. The PEP

1175 program should be defined contractually and contain specific tasks and measurable performance that

will support an orderly transition. PEP progress should be tracked by means of production readiness 1176

reviews required before initial or full production decisions. The objective of a transition plan is to 1177

1178 provide visibility of how well each activity is being executed. Progress should be regularly compared

1179 against the transition plan.

6. Operations and Support (O&S) Phase

- 1180 Employ a "Should-Cost" management and analysis approach to identify and implement system and
- 1181 enterprise sustainment cost reduction initiatives. Should-cost targets will be established and reviewed
- 1182 periodically based on analysis of acquisition sustainment costs and operations and support (O&S)
- 1183 cost element drivers. Program managers will capture product support metrics and cost data in DoD
- 1184 Component- and DoD-level information systems, and track performance against should-cost targets.
- 1185 Continually monitor product support performance and correct trends that could negatively impact 1186 availability and cost.
- 1187 Manufacturing and Quality Tasks
- Manufacturing and QA should provide input into the LCSP.
- Manufacturing should provide input into producibility/design reviews, systems engineering, and trade studies for Sustainment planning.
- 1191 Review contractor/governments plans for producibility planning
- Ensure the plan describes how the design engineers will apply producibility principles
- Identify specific producibility engineering techniques (Design For Manufacturing and Assembly (DFMA), Design for Reliability and Maintainability, Design for Six Sigma DFSS), DfX, etc.)
- Identify producibility risks and issues
- 1197 Metrics
- 1198 Producibility Plan Updated

1199 **Tools**

- Producibility Engineering and Planning Data Item Description
- Manufacturing Readiness Level Assessment Checklist, Design thread

1202 **Resources**

- IEEE15288.2, System and Software Engineering, Standard for Technical Reviews and Audits
 on Defense Programs, 2015
- 1205 NAVSO P-3687 Producibility System Guidelines, Dec 1999
- Producibility System Guidelines, Missile Defense Agency, Apr 2009
- Defense Manufacturing Management Guide for Program Managers, Chapter 7.6
 Producibility Engineering and Planning
- MRL Deskbook Version 2016

6. Operations and Support (O&S) Phase

1210 E.2 Complete Producibility Assessments

- 1211 Manufacturing/quality personnel should provide input into producibility/design reviews, systems 1212 engineering, and trade studies.
- 1213 Manufacturing/quality assurance managers should look at producibility assessments as a vehicle for
- 1214 encouraging the contractors to continually improve their processes and products. Also note this is not
- 1215 confined to contractors - encourage internal improvements at depots and within the support facilities.
- 1216 According to DODD 5000.01, Knowledge-Based Acquisition, program managers (PMs) "shall
- 1217 reduce manufacturing risk and demonstrate producibility prior to full-rate production."
- 1218 DOD policy on major system acquisitions makes producibility considerations a requirement prior to
- 1219 the start of Technology Development. The Alternative Systems Review should have included
- 1220 producibility assessments of the design concepts. Producibility assessments and engineering should
- 1221 be a part of the on-going systems engineering process. DoDI 5000.02 states that "design for
- 1222 producibility" shall be a part of the Engineering and Manufacturing Development phase. DoDD
- 1223 5000.01 states that the PM shall "reduce manufacturing risk and demonstrate producibility" prior to
- 1224 full-rate production.
- 1225 History has demonstrated that as the complexity of systems increases, so does the acquisition cost
- 1226 (including life-cycle cost). Therefore, producibility programs are necessary as a management means
- 1227 for assuring that practicality is addressed and that the cost increases associated with the growing
- 1228 complexity of systems are minimized. It should be recognized that the producibility analysis
- 1229 accomplished by the program management office (must be performed by a team of specialists
- 1230 assembled from the program office: and supporting organizations. One functional organization
- 1231 cannot possibly accomplish the total producibility effort without assistance from other functional
- 1232 organizations. Consequently, the PMO approach to organizing for producibility is of prime
- 1233 importance to a successful defense system.
- 1234 Congress passed the following laws that impact the U.S. industrial base. U.S. Code; Title 10, Chapter
- 1235 148, Section 2501 sets the national security objectives that the U.S. industrial base must be 1236 capable of:
- 1237 Supplying, equipping, and supporting the force structure of the armed forces;
- 1238
- Sustaining production, maintenance, repair, logistics, and other activities in support of
- 1239 military operations of various durations and intensity;
- 1240 • Maintaining advanced research and development activities to provide the armed forces with 1241 systems capable of ensuring technological superiority over potential adversaries;
- 1242 • Reconstituting within a reasonable period the capability to develop, produce, and support 1243 supplies and equipment, including technologically advanced systems, in sufficient quantities 1244 to prepare fully for a war, national emergency, or mobilization of the armed forces before the 1245 commencement of that war, national emergency, or mobilization;

6. Operations and Support (O&S) Phase

1246 1247 1248 1249 1250 1251 1252 1253	 Providing for the development, manufacture, and supply of items and technologies critical to the production and sustainment of advanced military weapon systems within the NTIB; Providing for the generation of services capabilities that are not core functions of the armed forces and that are critical to military operations within the NTIB; Providing for the development, production, and integration of information technology within the NTIB; and Maintaining critical design skills to ensure that the armed forces are provided with systems capable of ensuring technological superiority over potential adversaries.
1254	Manufacturing and Quality Tasks
1255 1256 1257 1258 1259	Producibility assessments are required in order to develop and manufacture products that will satisfy the warfighter. NAVSO P-3687, Producibility Systems Guidelines, outlines a five-step process for ensuring that producibility planning and execution is integrated into the systems engineering process and into the Life Cycle Sustainment Plan. One of the major steps in that process is to "determine the process capability" and that means to assess the producibility of the item.
1260	Metrics
1261	Producibility Assessment Rating
1262 1263 1264	 Fools Producibility Assessment Worksheet Manufacturing Readiness Level Assessment Checklist, Design thread
1265	Resources
1266 1267	 NAVSO P-3687 Producibility System Guidelines, Dec 1999 MRL Deskbook Version 2016
1268	E.3 Participate in Design IPT
1269 1270 1271 1272	The producibility engineering review is conducted in addition to normal and necessary design reviews. These reviews during the O&S phase are conducted by the engineering IPT and should be used to assess progress against specific goals and metrics for the product. Producibility Engineering should naturally support any requirements for "design for supportability."
1273 1274 1275 1276 1277 1278	Metrics should be derived from the mission requirements and first expressed as Measures of Effectiveness (MOEs), and then as Key Performance Parameters (KPPs). The KPPs then get expresses as Measures of Performance and the as Technical Performance Measures. Manufacturing and quality personnel need to understand their role in achieving the MOEs/KPPs and develop systems and processes that will help the program to achieve these measures. A good example to illustrate this concept is you have a requirement to fly two sorties a day and in order to do that you

6. Operations and Support (O&S) Phase

- need an operational availability rate Operational Availability (Ao) of .98. In order to achieve that
- 1280 availability rate, the entire system, to include subsystems and components, must be highly reliable
- 1281 and have a long Mean Time Between Failure (MTBF). That means that the design must be
- 1282 producible and that there is very little variation on Key Characteristics.
- 1283 Since it is imperative that the IPT maintain a focus on producibility, the regular design reviews
- 1284 address many producibility issues. However, they are typically focused on individual processes and
- 1285 components and normally include tool, production, and facilities planning for those processes.
- 1286 In contrast, the focus of the producibility engineering review expands to an evaluation of whether the
- 1287 entire product can be manufactured in the intended facility within the given schedule and budget.
- 1288 Internal experts who are not part of the product IPT nor involved in the product development are
- 1289 normally brought in to conduct this review.
- 1290 Manufacturing and Quality Tasks
- Manufacturing and QA personnel participate in the Systems Engineering process.
- Manufacturing and QA personnel ensure adherence to appropriate manufacturing and QA requirements and best practices
- Manufacturing and QA personnel provide inputs to any trade studies
- Manufacturing and QA personnel provide inputs to any engineering trouble analysis on factory floor problems or on field failures (FRACAS, etc.)
- 1297 Metrics
- Manufacturing and QA personnel participate in the Systems Engineering process

1299 **Tools**

- 1300 Systems Engineering Plan (SEP) Outline
- 1301 Life Cycle Sustainment Plan outline
- Manufacturing Readiness Level Assessment Checklist, Design thread

1303 Resources

- Defense Acquisition Guide, Chapter 3 Systems Engineering
- 1305 Systems Engineering Plan (SEP) Outline, Jun 2015
- LCSP memo, Sep, 2011 and DAG Chapter 4-3.1
- Defense Acquisition Guide, Chapter 4 Life Cycle Sustainment
- 1308 MRL Deskbook Version 2016

1309 E.4 Develop Detailed Product Design

- 1310 One of the roles of Manufacturing/QA personnel is to "influence the design." It must be noted that
- 1311 Manufacturing/QA personnel are not design engineers and thus their role is a supporting role. They

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1312	need to assess the design to ensure that the design is manufacturable and inspectable/testable. The		
1313	existing factory floor is a "capability," and a design that cannot be produced on the existing factory		
1314	floor either requires a design change to match the existing condition or the development of		
1315	manufacturing and QA processes that will ensure that the design can be build that results in uniform,		
1316	defect-free products that are affordable. A good example was when the Air Force first started putting		
1317	composite materials on the skin of aircraft to make them less visible. Manufacturing processes had to		
1318	be developed that would ensure wing skins were put down uniformly and that the process was		
1319	affordable. Quality assurance personnel had to think about new inspection methods and the		
1320	development of acceptance criteria for these new materials.		
1321	• Manufacturing must assess the detailed production designs, processes, WBS, and schedules		
1322	must be transitioned from full rate production to a schedule and rate that can be used to		
1323	produce spares during sustainment.		
1324	• Manufacturing must assess new analytical methods, tools, and processes for analyzing		
1325	production schedules against spare parts manufacturing.		
1326	Manufacturing and Quality Tasks		
1327	• Assess proposed design changes for manufacturability.		
1328	• Assess proposed design changes for inspectability and high levels of quality (yields).		
1329	Metrics		
1330	• Manufacturing/QA personnel influencing the design process		
1331	Tools		
1332	Design for Performance		
1333	• Design for Manufacturing and Assembly (DFMA)		
1334	Design for Six Sigma		
1335	Design for Producibility		
1336	Design for Affordability		
1337	Manufacturing Readiness Level Assessment Checklist, Design thread		
1338	Resources		
1339	• Defense Acquisition Guide, Chapter 3 – Systems Engineering		
1340	• IEEE15288.2, System and Software Engineering, Standard for Technical Reviews and Audits		
1341	on Defense Programs, 2015		
1342	AS6500, Manufacturing Management Program		
1343	MRL Deskbook Version 2016		

6. Operations and Support (O&S) Phase

1344 E.5 Develop Production Work Breakdown Structure (WBS)

Manufacturing should support developing an overarching WBS framework to identify "smart
shutdown" tasks. This would stop full rate production efforts and change over to a limited spares
production capability.

The planning, execution and control of the production phase activities require that the work be divided into manageable tasks that are compatible with the existing manufacturing and performance measurement systems. Often, the WBS used during the development phases will not be appropriate for the production phase or for sustainment. Consequently, the contractor should, as a basis for production planning, identify and develop the WBS which is to be used. While this was may differ from the EMD structure, the two should be such that production phase costs can be related to the development WBS and the sustainment costs can be related to the production costs. This is critical

1355 for those programs which have utilized a design-to-unit production cost management approach

1356 during development.

1357 The objective of the O&S phase is the execution of a support program that meets operational support

1358 performance requirements and sustains the system in the most cost-effective manner over its total life

1359 cycle. When the system reaches the end of its useful life, the department should dispose of it.

1360 During the sustainment effort of the operations and support phase, systems engineering processes

1361 support in-service reviews including identifying root causes and resolutions for safety and critical

readiness degrading issues. This effort includes participating in trade studies and decision making

1363 relative to the best resolution (e.g., changes to the product support package, manufacturing process

1364 improvements, modifications, upgrades, and future increments of the system), considering the

1365 operational needs and the remaining expected service life. Interoperability or technology

1366 improvements, parts or manufacturing obsolescence, aging aircraft (or system) issues, premature

1367 failures, changes in fuel or lubricants, joint or service commonality, etc. may all indicate the need for

- a system upgrade(s) or process improvements.
- 1369 The last activity associated with the operations and support acquisition phase is disposal. Early
- 1370 systems engineering processes should include and inject disposal requirements and considerations
- 1371 into the design processes that ultimately facilitate disposal.

1372 Manufacturing and Quality Tasks

- Develop a production WBS
- 1374 Metrics
- Development of a Production WBS

6. Operations and Support (O&S) Phase

1376	Tools	
1377	٠	WBS Template
1378	•	Manufacturing Readiness Level Assessment Checklist, Design thread

1379 **Resources**

- MIL-STD-881 Work Breakdown Structure for Defense Materiel Items, Oct 2011
- MRL Deskbook Version 2016

1382 E.6 Design Stability

- 1383 Designs should be stable and mature prior to going into production, with design changes limited to
- 1384 those required for continuous improvement. All Key Characteristics should be stable and under
- 1385 control per appropriate quality standards. Any significant design changes should be assessed for
- 1386 maturity prior to release to production.
- 1387 Contractors and production organizations during the O&S phase may be experiencing the following:
- On-going production (no design impact)
- Ramp up or ramp down in production (no design impact)
- Production of Spares (no design impact)
- Design changes to meet changing requirements or for continuous improvement
- Changing requirement could indicate a significant design change
- Continuous improvement may involve "tweaking" of the design or manufacturing processes

Manufacturing/QA personnel should advocate Continuous Improvement. This activity involves the
use of the "bully pulpit" of the SPO and the role we have in encouraging the contractors to
continually improve their processes and products. The manufacturing/quality assurance managers
have numerous opportunities to do this, such as during teleconferences, Program Management
Reviews, Fact Findings, etc. Also note this is not confined to contractors - we can encourage internal
improvements at depots and within the SPOs.

- 1400 Manufacturing and Quality Tasks
- Manufacturing/QA personnel should be encouraging the contractors to continually improve their processes and products and change from rate production to limited production of spares.
- Manufacturing/QA personnel monitor field failures and the potential for design changes due to a variety of problems (Field Failure Reports, etc.).
- 1405 Metrics
- Manufacturing/QA personnel participation in design reviews

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1407	Tools
1408	Design for Performance
1409	Design for Six Sigma
1410	Design for Producibility
1411	Design for Affordability
1412	Manufacturing Readiness Level Assessment Checklist, Design thread
1413	Resources
1414	• Defense Acquisition Guide, Chapter 3 – Systems Engineering
1415	MRL Deskbook Version 2016

1416 **F. COST AND FUNDING**

1417 Cost and Funding is mainly concerned about having cost models to initially estimate costs, then

1418 validating the cost models by collecting and analyzing actual cost against cost targets or budget

1419 goals, and finally, establishing a budget to support future Manufacturing/QA efforts. Mainly,

1420 improvement efforts.

- 1421 Manufacturing/QA cost estimates for the O&S phase are normally often based on actual costs that
- 1422 were experienced during the Production and Operations phase, the costs associated with Full Rate
- 1423 Production. Cost associated with FRP should be well known, however, during the O&S phase you
- 1424 may not be producing product or spares at the same rate and the contractor may not be in full rate
- 1425 production, so the cost may be higher. Or the O&S cost are now associated to depot level work, and
- 1426 because the throughput is lower and thus the cost per unit to remanufacture may be higher.



1427

1428 Additionally, DoD's Sustainability Analysis Guidance: Integrating Sustainability into Acquisition

- 1429 Using Life Cycle Assessment, Dec 2016, provides weapon system and product support managers
- 1430 with guidance for conducting sustainability cost estimates. Sustainability Analysis combines Life
- 1431 Cycle Cost (LCC) estimating and Life Cycle Assessments (LCA). The LCA quantifies resource
- requirements, environmental releases, and waste through each life cycle stage of a system, and
- 1433 estimates the associated impacts on the following:
- Resource Availability: Includes natural resource use (e.g., land, water, mineral, and fossil
 resources), potential impacts on resource quality and availability, and the associated marginal
 cost increases.

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- Climate Change: Includes greenhouse gas emissions, their contribution to global warming,
 and the associated impacts, including changes in net agricultural productivity, human health,
 property damages from increased flood risk, and ecosystem services.
- Human Health: Includes environmental releases, water use, and noise emissions, and the associated impacts on human health and productivity.
- Ecosystem Quality: Includes environmental releases, land use, and water use, and the associated impacts on biodiversity and ecosystem services.
- 1444 Together LCC estimating and LCA are employed to reveal and estimate three types of sustainability1445 related costs:
- 1446 Internal Cost
- External Cost
- 1448 Contingent Cost
- 1449 F.1 Update Manufacturing Cost Estimate

1450 Manufacturing and Quality Tasks

Detailed cost estimates need to be established and/or updated. Costs could be related to contractor or
depot/MRO activities and products. Historical costs estimates based on Full Rate Production
quantities may not be appropriate for the O&S phase.

- Manufacturing/QA may want to establish cost models for the O&S phase based on the planned rates and quantities.
- Manufacturing/QA estimates need to take into consideration that the work may be done by a contractor or the government, and at a production facility or at a depot or MRO.
- Manufacturing/QA should assess if DOD investments are going to be needed to create or enhance certain critical industrial capabilities.
- Manufacturing/QA should be able to track expenditures and the estimate to complete using
 approved techniques such as Earned Value Management System (EVMS) analysis, or its
 predecessor Cost/Schedule Control System (C/SCS) during sustainment operations.
- Manufacturing cost estimates for the production phase are normally based on the assumption that thedesign is complete, that the manufacturing processes are known, stable and in control, and
- 1465 manufacturing operations will be accomplished as planned. The same hold true for the O&S phase.
- 1466 However, the O&S phase may see several changes to the P&D model.
- Full Rate Production may not continue, and if it stops and the contractor is only producing
 spares, then the unit cost may go up.
- Work may be done at a public or private

6. Operations and Support (O&S) Phase

- 1470 Any deviation from these assumptions could cause a growth in cost. As such, time and conformance
- 1471 measures can give some indication of potential or real cost aberrations since there is normally a
- 1472 direct correlation between late delivery or conformance problems and cost.
- 1473 Support Earned Value Management System (EVMS) analysis, or its predecessor Cost/Schedule
- 1474 Control System (C/SCS). This will help in updating manufacturing costs using production phase
- 1475 actuals when developing cost estimates for the O&S phase to ensure that the government receives the
- 1476 full benefit of the contractor's production learning curve.

1477 Metrics

- Should Cost or Could Cost Models
- Design to Cost Goals
- Manufacturing/QA Cost Estimates
- Estimate to Complete

1482 **Tools**

- Cost Analysis Requirements Description (CARD) template
- Cost and Lead Time Estimating Worksheet
- Cost/Schedule Control System Criteria (see EVM)
- Design to Cost Estimates
- Manufacturing Cost Estimating Spreadsheet
- Cost, Schedule Control Systems Criteria (CSCSC)
- Manufacturing Readiness Level (MRL) Assessment Checklist, Cost and Funding thread
- See CAPE website for tools

1491 **Resources**

- Sustainability Analysis Guidance: Integrating Sustainability into Acquisition Life Cycle
 Assessment, Dec 2016
- Earned Value Management Guide, Oct 2006
- CSCSC Reference Guide, Sep 1992
- Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
 Program Managers, Chapter 9
- MIL-HDBK-766 Design to Cost
- Should-cost and Affordability Memo, Aug 2011
- DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
- Defense Acquisition Guidebook, Section 3.4.4 Cost Assessment Reporting Requirements
- MRL Deskbook Version 2016
- CARD Website and process

1504 **F.2** Update Manufacturing Cost Drivers with Actuals

1505 Manufacturing and Quality Tasks

1506 Typically, in any industry, materials and labor are the two biggest manufacturing cost drives. 1507 Another major factor is rate and quantity. During the O&S phase there are several changes that often 1508 take place that impact costs. Changes to rate and quantity as the contractor's original rate from full 1509 rate production goes down, and the majority of their production is in support of spares. There may 1510 also be changes to the supply chain as contractors either move in and out of a business or contractors 1511 look for lower prices and higher quality. Then there is the problem of Diminishing Manufacturing 1512 Sources and Material Shortages (DMSMS), obsolescence and counterfeit parts. 1513 During the Production phase manufacturing used Should Cost management and other •

- During the Production phase manufacturing used Should Cost management and other
 techniques to identify manufacturing cost and cost drivers, and then continuously control and
 reduce cost. The actuals generated should be used to update Sustainment costs to determine
 new cost drivers and to validate funding estimates.
- Assess manufacturing/QA risks and the costs associated with those risks.
- Manufacturing should employ a "Should-Cost" management and analysis approach to
 identify and implement system and enterprise sustainment cost reduction initiatives.
- Manufacturing should periodically establish and review should-cost targets based on analysis of acquisition sustainment costs and operations and support (O&S) cost element drivers.
 Support the program manager to capture product support metrics and cost data and track performance against should-cost targets.
- Manufacturing should conduct cost analysis on the vendors as nearly 80% of the life cycle
 cost of any system is locked in during prior to sustainment. Typically, the supplier network
 represents an enormous opportunity of distributed technological knowledge and an excellent
 source of cost savings.
- 1528 During this phase Should Cost management and other techniques will be used continuously to1529 control and reduce cost.
- 1530 Employ a "Should-Cost" management and analysis approach to identify and implement system and
- 1531 enterprise sustainment cost reduction initiatives. Should-cost targets will be established and reviewed
- 1532 periodically based on analysis of acquisition sustainment costs and operations and support (O&S)
- 1533 cost element drivers. Program managers will capture product support metrics and cost data in DoD
- 1534 Component- and DoD-level information systems, and track performance against should-cost targets.

1535 Metrics

- Should Cost Estimate
- 1537 Design to Cost Estimate
- 1538 Manufacturing/QA Actuals

6. Operations and Support (O&S) Phase

1539	Tools
1540	Cost Analysis Requirements Description template
1541	Cost and Lead Time Estimating Worksheet
1542	• Cost/Schedule Control System Criteria (see EVM)
1543	• Design to Cost Estimates
1544	Manufacturing Cost Estimating Spreadsheet
1545	Cost, Schedule Control Systems Criteria (CSCSC)
1546	Manufacturing Readiness Level Assessment Checklist, Cost and Funding thread
1547	• See CAPE website for tools
1548	Resources
1549	• Manufacturing Cost Estimating, see the Defense Manufacturing Management Guide for
1550	Program Managers, Chapter 9
1551	• MIL-HDBK-766 Design to Cost
1552	Should-cost and Affordability Memo, Aug 2011
1553	• DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
1554	MRL Deskbook Version 2016
1555	E.3 Develop Manufacturing Cost Mitigation/Maturation Plan
1333	
1556	Manufacturing and Quality Tasks
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6. Operations and Support (O&S) Phase

1574 1575 1576	 Manufacturing should ensure reliability and maintainability data from operational and developmental testing and evaluation and fielding informs estimates of O&S costs for major weapon systems.
1577	Metrics
1578	Manufacturing/QA cost estimates
1579	Manufacturing/QA risk assessment
1580	Tools
1581	Manufacturing Readiness Assessment Cost and Funding thread
1582	• EVM and CSCSC software tools or in excel
1583	Cost and Lead Time Estimating worksheet
1584	Manufacturing Readiness Level Assessment Checklist, Cost and Funding thread
1585	• Resources
1586	MRL Deskbook Version 2016
1587	• 10 USC Sec. 2334 Independent Cost Estimation and Cost Analysis
1588	 DoDI 5000.73 Cost Analysis Guidance and Procedures, Jun 2015
1589	• Public Law 114-328, §807, Cost, Schedule and performance of major defense acquisition
1590	programs
1591	CARD - Cost Analysis Requirements Description Template (See CAPE website for
1592	guidance)
1593	Cost/Schedule Control Systems Criteria Reference Guide, Sep 1992
1594	 DODI 5000.73 Cost Analysis Guidance and Procedures
1595	MRL Deskbook Version 2016
1596	Risk, Opportunities and Issues Guide, Jun 2015

1597 MATERIALS MANAGEMENT G.

1598 During the sustainment phase, programs face unique challenges as they attempt to manage their

1599 military supply chains, especially during wartime. Thus, they should have a general understanding of

- 1600 the Supply Chain Operations Reference (SCOR) Model. DOD 4140.1R, DoD Supply Chain Material
- 1601 Management Regulation, directs DoD Components to use the supply chain operational reference
- 1602 processes of Plan, Source, Maintain/Make, Deliver, and Return as a framework for developing,
- 1603 improving, and conducting material management activities. Most of the DoD supply chain focus is 1604 on operations and logistics. However, there is growing concern within the acquisition communities
- 1605 for improving the way supply chains are managed on large weapon system programs.

6. Operations and Support (O&S) Phase



1606

1607 At the strategic level, military and private organizations are driven by many material management

1608 opportunities and constraints. They must address the logistics issues of acquisition, distribution,

- 1609 sustainment, and disposition and disposal. In addition, as the program matures and moves from
- 1610 production to spares production, and on-going maintenance and sustainment activities, the nature of
- 1611 the business arrangement often changes as DoD contractors get out of the business and DoD MRO
- 1612 activities take on increasingly more responsibilities. No doubt, adopting blanket business solutions

and practices and applying them with little thought to the DoD supply chain would be problematic.

- 1614 However, many of the problems faced in today's DoD supply chain are the same ones that the
- 1615 commercial sector has dealt with or is currently facing.

As the program matures and transitions from the Production and Deployment phase to the Operationsand Support phase, Sustainment managers should be concerned about:

- 1618 Material availability and in particularly DMSMS, Obsolescence and Counterfeit parts
- 1619 Material maturity
- 1620 Supply Chain Management
- 1621 Special Handling

1622 Many of these material considerations should have been matured by this time, but because of

1623 changes in where (facilities) the production or remanufacturing is taking place, these considerations1624 may have changed or regressed.

1625 G.1 Manage Materials Risk

1626 The objective of this phase is the execution of a support program that meets operational support 1627 performance requirements and sustains the system in the most cost-effective manner over its total life 1628 cycle. When the system reaches the end of its useful life, the department should dispose of it.

1629 During the sustainment effort of the operations and support phase, systems engineering processes

- 1630 support in-service reviews including identifying root causes and resolutions for safety and critical
- 1631 readiness degrading issues. This effort includes participating in trade studies and decision making
- 1632 relative to the best resolution (e.g., changes to the product support package, manufacturing process
- 1633 improvements, modifications, upgrades, and future increments of the system), considering the
- 1634 operational needs and the remaining expected service life. Interoperability or technology
- 1635 improvements, parts or manufacturing obsolescence, aging aircraft (or system) issues, premature

6. Operations and Support (O&S) Phase

1636 failures, changes in fuel or lubricants, joint or service commonality, etc. may all indicate the need for1637 a system upgrade(s) or process improvements.

1638 Many DOD systems require maintenance long beyond the useful life initially anticipated. Extending 1639 the service life of military systems increases the costs of ownership. For the purposes of Commercial

- 1640 Operations and Support Savings Initiative (COSSI), O&S costs are the costs of owning and operating
- 1641 a military system, including the costs of personnel, consumables, goods and services, and sustaining
- 1642 the support and investment associated with the peacetime operation of a weapon system. One way to
- 1643 reduce O&S costs is to take advantage of the commercial sector's technological innovations by
- 1644 inserting commercial technology into fielded weapon systems. The COSSI was initiated under 10
- 1645 U.S. Code 2511 to develop and test methods for reducing DOD operations and support cost by
- 1646 inserting commercial items into fielded military systems.
- 1647 One of the major challenges facing DOD is modernizing legacy systems using state-of-the-art
- technology. Therefore, from the start of an acquisition program, DOD must consider not only how to

1649 get a useful military capability to the field quickly, but also how it can upgrade a system later.

1650 Considerations include the latest technology, increasing mission performance, reducing O&S costs,

- and enhancing supportability.
- 1652 Although basic and applied research are the foundations for meeting future technology needs, other
- 1653 programs such as Advanced Technology Demonstration , Advanced Concept Technology

1654 Demonstrations, warfighter experiments, and other approaches - are key to accelerating the

- 1655 transition from Science and Technology (S&T) to military weapons systems. Managers of S&T,
- 1656 Research and Development (R&D), and acquisitions must collaborate on their efforts if a technology
- 1657 is to be transitioned into weapons systems.
- 1658 Identifying and selecting technologies are important early steps in developing or upgrading weapon
- 1659 systems. Numerous technology "clearinghouses" exist for identifying technologies.
- 1660 Often PMs rely on prime contractors to identify and select technologies to insert into systems,
- 1661 believing the contractor will always use the best source for technology, and use it to develop the
- 1662 system. However, this is not always the case and may not be the best way to find leading
- 1663 technologies that are applicable to weapons systems. Working together, the communities for
- 1664 capability needs, S&T, R&D, T&E, acquisition, and sustainment, must work hard to communicate
- 1665 program requirements and identify the technologies, regardless of their source, that most benefit the
- 1666 warfighters.
- 1667 S&T leaders (government and industry) must maintain close and continuous ties with the warfighters
- 1668 or other users of systems, as well as with acquisition and sustainment PMs. Maintaining these ties
- 1669 can help ensure that S&T leaders understand the needs, develop technologies that will be useful for
- 1670 satisfying those needs, have a sense for the timing needed for integration, and anticipate future
- 1671 warfighting needs. The ties can be maintained through formal forums or, even more effectively,

6. Operations and Support (O&S) Phase

1672	through frequent interactions	between technologists and	d acquisition	or sustainment PMs.	The
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- 1673 interaction will help keep S&T projects focused on increasing the effectiveness of a mission
- 1674 capability while decreasing cost, increasing operational life, and incrementally improving products
- 1675 through planned product upgrades.

1676 Manufacturing and Quality Tasks

- Manufacturing should identify obsolete parts in specifications and develop plans for suitable
 replacements.
- Periodically assess product support performance and assist program managers, users,
 resource sponsors, and materiel enterprise stake holders to take corrective action to prevent
 degraded materiel readiness or O&S cost growth.
- Materiel Reliability is the design metric that has the most significant impact on the program's operational availability and O&S cost. Higher materiel reliability will result in higher
 Operational Availability and Materiel Availability since both A_o and A_m are a function of R_m.
 The inherent reliability of a system is, by far, the biggest contributor to high Operational
- 1686 Availability.

1687 Metrics

1688 • Material Reliability

1689 **Tools**

- Manufacturing Readiness Level Assessment Checklist, Materials Management thread
- DMSMS Product Life Cycle Assessment
- 1692 Market Research
- 1693 Supply Chain Management Risk Assessment Checklist

1694 **Resources**

- MRL Deskbook Version 2016
- DOD 4140.1R, DoD Supply Chain Material Management Regulation, May 2003
- DMSMS Acquisition Guidelines, 2001
- 1698 DoD Market Research Guide, May 2012

1699 G.2 Identify Alternate Sources

- 1700 Diminishing Manufacturing Sources and Material Shortages (DMSMS), the loss of sources of items
- 1701 or material, surfaces when a source announces the actual or impending discontinuation of a product,
- 1702 or when procurements fail because of product unavailability. DMSMS may endanger the life-cycle
- 1703 support and viability of the weapon system or equipment.

6. Operations and Support (O&S) Phase

- 1704 Although electronics are the most likely parts to be discontinued, obsolescence of non-electronic and
- 1705 COTS items also poses a significant problem to weapon systems. In short, DMSMS is a threat to
- 1706 system supportability.
- 1707 Solving DMSMS is complex, data intensive, and expensive. There are two approaches to solving
- 1708 DMSMS in a system: reactive (you address DMSMS problems after they surface) and proactive (you
- 1709 identify and take steps to mitigate impending DMSMS problems). DoD policy prescribes the
- 1710 proactive approach.
- 1711 Materiel Reliability. As required by the Manual for the Operation of the Joint Capabilities Integration
- and Development System (JCIDS), materiel reliability is the design metric that has the most
- 1713 significant impact on the program's operational availability and O&S cost.
- 1714 Counterfeiting of parts and materials, especially in the electronic business segment, is growing at an
- 1715 alarming rate. According to the General Accountability Office (GAO), the increase in counterfeit
- 1716 parts is one of several potential barriers the DoD faces in addressing part quality problems. As we
- 1717 draw from a large network of suppliers in an increasingly global supply chain, there can be limited
- 1718 visibility into these sources and greater risk of procuring counterfeit parts. Additionally, there are
- 1719 unique conditions that make aerospace and defense products susceptible to counterfeiting, including
- a long life-cycle and Diminishing Manufacturing Sources and Material Shortages issues. Therefore,
- supporting aerospace and defense products throughout their lifecycle sometimes requires the use of
- 1722 parts that may no longer be available from the Original Equipment Manufacturer , authorized
- aftermarket manufacturer or through franchised or authorized distributors or resellers.
- 1724

4 Manufacturing and Quality Tasks

- Manufacturing should work with product support integrators and product support providers
 to investigate alternate source options. These may be organic, commercial, or a combination.
- Verify prime supplier has validated alternate sources are capability of meeting quality,
 manufacturing, engineering and software requirements.
- Periodically assess product support performance and assist program managers, users,
 resource sponsors, and materiel enterprise stake holders to take corrective action to prevent
 degraded materiel readiness or O&S cost growth.

1732 **Metrics**

- 1733 SCM Functional Performance Measures
- Customer Satisfaction, Cost, Readiness and Sustainability
- MOE's KPPs TPMs

1736 **Tools**

- 1737 Manufacturing Readiness Level Assessment Checklist, Materials Management thread
- 1738 DMSMS Product Life Cycle Assessment

Manufacturing and Quality Management Body of Knowledge

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6. Operations and Support (O&S) Phase

1739 •	Market Research
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• Supply Chain Management Risk Assessment Checklist

1741 **Resources**

1762

- MRL Deskbook Version 2016
- DOD 4140.1R, DoD Supply Chain Material Management Regulation, May 2003
- SCM: A Recommended Performance Measurement Scorecard, Jun 1999
- DMSMS Acquisition Guidelines, 2001
- DoD Market Research Guide, May 2012
- Developing Alternative Sources Thesis, Mar 1987

1748 G.3 Review Critical Sources

1749 DMSMS and obsolescence are often used interchangeably within the DoD, however there is one

1750 minor difference between the two terms. Obsolescence is a DMSMS problem that was created by a

regulatory or statutory requirement. For example, the banning of lead in electronics by the European

1752 Union has led to a drop in the number of suppliers for these products. But whether it's called

1753 DMSMS or obsolescence, the outcome is the same; the customer has a product or weapon system

1754 that may no longer be supportable.

1755 In simple terms DMSMS occurs because the market for an item, and therefore availability, shrinks to

the point where it becomes unprofitable for a company to continue to manufacture the item. When

this occurs, any customer (*e.g.*, DoD) that still has a requirement for that item will find it

increasingly difficult to obtain the item and the cost will be markedly higher due to scarcity.

- 1759 Obsolescence occurs within DoD when:
- Weapon system capability becomes degraded due to reduced availability of parts and sources.
 - New technology displaces old.
- Costs become unaffordable for production, support, and sustainment.

Where and how you get sources of material can be a vital concern for PMs. Having just one sole source, single source or foreign source in supply chain could be a show stopper, especially if that item is a critical item that significantly impacts the capability of the system to perform its mission.

1767 A sole source is one in which there is only one source for that item. There are no other alternatives.

1768 What happens if that sole source goes bankrupt or goes out of business for any reason? What happens

1769 if this situation happens overnight, like the plant burns down? What are you going to do to keep your

- 1770 program from being stopped in its tracks?
- 1771 A single source is one in which there is only one "qualified" source. This condition is slightly better 1772 than the sole source situation as there are other companies capable of making your item, they just

6. Operations and Support (O&S) Phase

- 1773 have not been "qualified" as a source. Qualification can be an expensive and time-consuming
- 1774 process. If you find yourself in a sole or single source situation you may want to consider an
- 1775 investment strategy to get a second source qualified, now do you not only have a backup source, you
- 1776 have competition.

1777 A foreign source is one that is outside of the U.S. industrial base. Remember that Canada is by law a

- 1778 part of the U.S. industrial base. Foreign sources carry with them many problems. The transfer of
- some intellectual information to companies outside of the U.S. can be restricted by International
- 1780 Traffic in Arms Regulations (ITAR) making it difficult to do business outside of the U.S. In addition,
- some countries restrict the types of items that their companies can sell to the U.S., for example items
- 1782 that go into nuclear programs are often restricted by countries with strong nuclear concerns.
- 1783 Sometimes politics can play a role and an item that is available this week may not be available next
- 1784 week due to political pressures. If you have a foreign sources item that is critical to your program,
- 1785 you might want to consider funding a second source, a U.S. source.

1786 Manufacturing and Quality Tasks

- 1787 Identifying and assessing materials risks, especially critical materials and sources, should include the1788 assessment of:
- Material Availability: Concerned primarily about sole source and foreign source, but could also include limited sourcing and long lead sourcing. In the O&S phase there will be growing concerns about DMSMS and Obsolescence. Along with that will be concerns about counterfeit parts.
- Material Maturity: Concerned about the introduction on new parts, especially electronic parts
 that are replacing parts that are old and no longer being produced. This is usually concerned
 with having complete material knowledge at the time of production.
- Material Supply Chain Management (SCM): Concerned about SCM since 60-80% of the fabricated and assembled items come from subcontractors and vendors and this is often where we have problems. Often the design occurs at the supplier level. The supply chain for the)&S phase often shifts from the prime and subcontractors to Maintenance Activities, Inventory Control Points, Depots, Maintenance, Repair and Overhaul facilities, and Installation Support Activities.
- Material Special Handling: Concerned about the movement of material to and within the
 plant and any ESOH concerns.
- 1804 The review of critical sources should include a review of the contractor's technical capabilities to1805 include engineering, configuration management, and quality assurance.
- Manufacturing should analyze and encourage sources to continually improve their processes
 and products. Also encourage internal improvements at depots and within the support
 facilities.

6. Operations and Support (O&S) Phase

1809	•	Manufacturing should be looking at counterfeiting of parts and materials in the electronic
1810		business segment are a growing problem especially during the Sustainment phase when many
1811		of the OEMs have moved on to other programs.
1812	•	As we draw from a large network of suppliers in an increasingly global supply chain, there
1813		can be limited visibility into these sources and greater risk of procuring counterfeit parts.
1814	•	Additionally, there are unique conditions that make aerospace and defense products
1815		susceptible to counterfeiting, including a long life cycle and DMSMS issues.
1816	•	Therefore, supporting aerospace and defense products throughout their lifecycle sometimes
1817		requires the use of parts that may no longer be available from the OEM, authorized
1818		aftermarket manufacturer or through franchised or authorized distributors or resellers.
1819	•	Prime contractors need to ensure a flow-down of technical requirements to include quality
1820		requirements. The DCMA organization at the prime contractor level needs to ensure the
1821		flow-down of oversight to their counterparts at subcontractor and vendor organizations.
1822	Metri	CS
1823	•	1 st Pass Yields
1824	•	Quality Deficiency Reports
1825	Tools	
1826	•	ISO 9001 Quality Audit Checklist
1827	•	AS9134 Supply Chain Risk Management Guidelines
1828	•	AS9100 Quality Audit Checklist
1829	Resou	rces
1830	•	AS9100, Quality Management System – Aerospace, Sep 2016
1831	•	ISO 9001, Quality Management System, Sep 2016
1832	Н. Р	ROCESS CAPABILITY AND CONTROL
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1833 During the sustainment phase, Process Capability and Control should be well understood, based on

1834 knowledge and experience during the Production and Deployment phase. However, production

1835 operations may shift from the prime contractor to government owned and operated facilities such as

1836 Depots, MROs and other industrial operations. Moving from one facility to another, with a different 1837 workforce, machines and other factory floor considerations may cause the process capability and

1838 control to slip, and slip below levels that are required to satisfy the warfighter.

6. Operations and Support (O&S) Phase



1840 H.1. Identify Required Process Capability

1841 Product quality, and effective operations and sustainment results, are a product of the feedback of 1842 quality and other data during production and after the item has been fielded and is in use. The results 1843 of the design and manufacturing efforts receive their real test when the item or system is actually 1844 placed in use under rigorous field conditions. If all of the prior efforts have been adequately 1845 performed, the resulting product should meet the user's needs. The goal is to strive for no failures and 1846 full user satisfaction. If this is not achieved, then corrective action must be taken, and taken quickly 1847 to remove the cause of failure and of the user discontent. Of course, this is more difficult at this late stage of the acquisition cycle then if action were taken to identify and correct the root cause of the 1848 1849 problem early in design or production. If the root cause of the problem requires a design change then 1850 engineering changes after this point cost more to implement than those discovered during initial 1851 design; therefore, it is important that all quality actions take place during design, development, and 1852 manufacture of the product. It is essential that manufacturing/QA personnel are involved in all 1853 aspects of any program, and are involved early in the process. If the problem is in the production or 1854 MRO/Depot facility then root cause corrective action must be taken on the industrial facilities that 1855 caused the defect or problem. 1856 Manufacturing and Quality Tasks 1857 Review supplier's key/critical characteristics/features list to identify possible government • 1858 surveillance.

- Review supplier's process control plan to identify possible government surveillance.
- Review supplier process capability information of key/critical product characteristics/
 features in the form of CP and CPK to identify possible government surveillance and flow down requirements, and to determine process stability.
- Review supplier process yields and Process Failure Modes and Effects Analysis (PFMEA)
 conducted on key/critical manufacturing processes to identify possible government
 surveillance.
- Manufacturing should use Sustainment metrics mapped to the sustainment key performance
 parameter and key system attributes to manage sustainment performance.
- Manufacturing should conduct a series of either PRRs or MRAs to monitor progress in standing up a new spare parts or repair facility.

6. Operations and Support (O&S) Phase

1870	Metrics	
1871	Key/Critical Characteristics identified	
1872	Process Capability Gap analysis	
1873	Quality Defects	
1874	Tools	
1875	MRL Assessment Checklist for the Process Capability and Control Thread	
1876	Process Capability Studies (Cp and Cpk assessment)	
1877	Producibility Assessment Worksheet (PAWs)	
1878	Six Sigma Worksheet	
1879	• FMEA Template	
1880	Resources	
1881	MRL Deskbook Version 2016	
1882	• DoD-Wide Continuous Process Improvement (CPI)/Lean and Six Sigma) Program, May	
1883	2008	
1884	 DoD Continuous Process Improvement Transformation Guide, May 2006 	
1885	• Capability-Based Assessment (CBA) Handbook, Mar 2014	
1886	H.2. Mature Critical Manufacturing Processes	

1887 If AS6500, Manufacturing Management Program is invoked on contract, verify supplier has
conducted a PFMEA of critical manufacturing processes. This may also be required to be
accomplished by the supplier when required by contract requirements language.

Review supplier process yields and PFMEA conducted on critical manufacturing processes to identify possible government surveillance.

1892 Studies have shown that by the time a Preliminary Design Review (PDR) is held around 80% of a 1893 program's life cycle cost are locked in even though only a small percentage of the programs

1894 cumulative costs have been expended. It is also the time when a program or contractor has the most

1895 opportunity to impact life cycle cost savings. By the time the Critical Design Review (CDR) is held

1896 the LCC commitment is around 90%. Manufacturing, logistics and other considerations must be

- 1897 taken seriously early or the program is doomed to becoming unaffordable. All manufacturing
- 1898 processes should have been demonstrated and those processes, especially the key processes should be
- 1899 stable and in-control. However, there may have been changes to manufacturing due to engineering
- 1900 changes (Value Engineering Change Proposals, etc.), or to changes in manufacturing facilities as
- 1901 production of items and spares moves from the prime contractor to subcontractors, vendors or at

1902 government facilities.

6. Operations and Support (O&S) Phase

1903	Manufacturing and Quality Tasks	
1904 1905	Sustainment Process uses an integrated product support capability implementing the program's mix of government and industry providers supported by appropriate analyses.	
1906 1907 1908 1909 1910 1911 1912 1913	 Manufacturing should support performance-based logistics planning, development, implementation, and management in developing a system's product support arrangements. PBL is performance-based product support, where outcomes are acquired through performance-based arrangements that deliver warfighter requirements and incentivize product support providers to reduce costs through innovation. Manufacturing should continually assess and refine the product support strategy based on projected and actual performance. Assess key/critical manufacturing processes to ensure that they are stable and in control. 	
1914 1915 1916 1917 1918	The Program Manager has the responsibility for and authority to accomplish program objectives for development, production, and sustainment to meet the user's operational needs. These activities rely heavily on the capabilities and capacity of the defense industrial base. PMs need to specifically assess the capabilities of that industrial base in order to understand if the base can support their program.	
1919	Metrics	
1920 1921	Statistical Process Control (Cp and Cpk)Yield Rates	
1922	Tools	
1923 1924 1925	 MRL Assessment Checklist for the Process Capability and Control Thread AS6500, Manufacturing Management Program, Nov 2014 Process Capability Study (Cp and Cpk assessments) 	
1926	Resources	
1927 1928 1929	 MRL Deskbook Version 2016 DoD-Wide Continuous Process Improvement (CPI/Lean and Six Sigma) Program, May 2008 DoDI 5000.02, Jan 2017 	
1930	H.3. Focus on Manufacturing Risk Reduction	
1931	Employ effective performance-based logistics (PBL) planning, development, implementation, and	

management in developing a system's product support arrangements. PBL is performance-based
 product support, where outcomes are acquired through performance-based arrangements that deliver

1934 warfighter requirements and incentivize product support providers to reduce costs through innovation

6. Operations and Support (O&S) Phase

1935 During the P&D phase the contractor will produce and deliver requirements compliant products to

- receiving military organizations. During the O&S phase they will have to supply compliant
- 1937 sustainment products, parts, limited-life supplies to maintain the systems they have produced.
- 1938 Continually assess and refine the product support strategy based on projected and actual1939 performance.
- 1940 The sustainment KPP (Availability) is as critical to a program's success as cost, schedule, and
- 1941 performance. Acquisition Category (ACAT) I and II program managers will use availability and
- 1942 sustainment cost metrics as triggers to conduct further investigation and analysis into drivers of those
- 1943 metrics, to develop Should Cost targets, and to develop strategies for improving reliability,
- 1944 availability, and maintainability of such systems at a reduced cost. The materiel availability portion
- 1945 of the KPP will be based on the entire system inventory and supported by the following sustainment
- 1946 metrics.

1947 The EMD Acquisition Strategy should have highlighted the strategy for assessing the manufacturing

1948 processes to ensure they have been effectively demonstrated in an appropriate environment, such as a

- 1949 pilot line environment, prior to Milestone C.
- 1950 To the maximum extent practical, the environment should utilize rate production processes using
- 1951 production processes forecasted to be used in LRIP. The Acquisition Strategy should strategically
- 1952 describe the planning to assess and demonstrate that the manufacturing processes/capabilities,
- 1953 required for production will have been matured to a level of high confidence for building production
- 1954 configuration products in the P&D phase and spares during sustainment.

1955 Manufacturing and Quality Tasks

- 1956 During the Sustainment phase the contractor will support and maintain requirements compliant1957 products for receiving military organizations.
- Assess manufacturing risks and develop a manufacturing maturity program.
- Manufacturing should use the sustainment KPP (Availability) is as critical to a program's success as cost, schedule, and performance.
- Use availability and sustainment cost metrics as triggers to conduct further investigation and analysis into drivers of those metrics, to develop Should Cost targets, and to develop strategies for improving reliability, availability, and maintainability of such systems at a reduced cost.
- The materiel availability portion of the KPP will be based on the entire system inventory.

1966 Metrics

- 1967 KPPs TPMs
- 1968 Availability (Reliability and Maintainability)

6. Operations and Support (O&S) Phase

1969	Tools	
1970	•	MRL Assessment Checklist for the Process Capability and Control Thread
1971	•	Manufacturing Maturation Plan
1972	Resou	rces

- 1972Resources
- MRL Deskbook Version 2016

1974 I. QUALITY MANAGEMENT

1975 An effective quality management strategy (QMS) and quality controls are required if the Program is

1976 to deliver, operate and sustain operationally safe, suitable and effective weapon systems. The initial

1977 quality strategy should have been developed during the MSA phase and updated in every phase in

1978 support of the Systems Engineering Plan (SEP). The QMS assures the as-delivered configuration is

1979 the same as the as-designed and as-tested configuration. The strategy requires monitoring and

1980 measuring of processes and products (including embedded software and firmware) to ensure they

1981 conform to requirements. Quality strategy development must begin during the earliest stages of

1982 system development and must continue throughout the program life-cycle.



1983

During the sustainment phase, a contractor or a government owned or operated remanufacturing
facility (Depot/MRO, etc.) should have implemented an effective QMS in accordance with FAR
46.202-4 Higher-level Contract Quality Requirements.

1987 I.1 Update Quality Strategy

The Quality Strategy should be updated based on performance results, sustainment metrics mapped
to the sustainment key performance parameter and key system attributes, to manage sustainment
performance.

- Continually monitor product support performance and correct trends that could negatively
 impact availability and cost.
- Outcome metrics to support sustainment elements included in capability requirements documentation or required by the DoD Component to manage the system development, product support package, and supply chain to develop and maintain the system.
- Department by department status (schedule, work measurement, Scrap, Rework, and Repair, yields, etc.)

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6. Operations and Support (O&S) Phase

1998 1999 2000	 Provide focus on improving manufacturing/quality assurance processes to reinforce the need for process improvement efforts. Update the Quality Strategy
2001 2002 2003	Address problem/failure reports through the use of a comprehensive data collection approach such as a Failure Reporting, Analysis and Corrective Action System. Determine root cause of problems, identify corrective actions, and manage to completion.
2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017	 Process and analyze mission data Manage Preplanned Product Improvements (P3I) Develop and implement technology refresh schedules Conduct technology insertion efforts as needed to maintain or improve system performance Update system safety assessments Perform engineering analysis to investigate the impact of DMSMS issues Work with vendors and the general technical community to determine opportunities for technology incursion to increase reliability and affordability The disposal activities in which the Systems Engineer should participate include: Support demilitarizing and disposing of the system; in accordance with all legal and regulatory requirements and policy relating to safety (including explosives safety), security, and the environment Document lessons learned Archive data
2018	Metrics
2019	Quality Strategy updated
2020	Tools
2021 2022 2023 2024 2025	 Acquisition Strategy Template ISO 9001 QMS Audit Checklist AS9100 Audit Checklist Manufacturing Readiness Level Assessment (MRL) Questionnaire for the Quality thread Requirements Analysis Roadmap
2026	Resources
2027 2028 2029 2030 2031 2032 2033	 DSMC Acquisition Strategy Guide, Dec 1999 AFMC Instruction 63-145 Manufacturing and Quality AS9100, Quality Management System – Aerospace, Sep 2016 ISO 9001, Quality Management System, Sep 2016 FAR 46.202 Types of Contract Quality Requirements FAR 52.246-11, Quality MRL Deskbook Version 2016

6. Operations and Support (O&S) Phase

2034 I.2 Verify Subcontractor Quality Management Plan

Subcontractors make up 60-80% of the material content on many programs, thus prime control of
sub-contractors Quality Management System and Plan are essential to the success of any program.
This includes during the O&S phase when the government may be acting as the prime contractor or
during government management of Depot/MRO activities.

- Assess how efficiently the subcontractor o vendor is producing products, primarily through
 on-site quality assessments and the evaluation of work measurement data. It also includes the
 analysis of causes of variances, their root causes, and championing and motivating contractor
 improvements.
- Verify the supplier is conducting a Corrective Action Board (CAB) and/or Material Review
 Board (MRB), or similar meetings, to discuss quality, manufacturing/production, supply
 chain, engineering and software deficiencies/issues and proposed/status corrective actions, at
 a minimum.
- Draw attention to troubled suppliers or critical processes needing corrective action by on-site visits/reviews.
- Perform government surveillance of supplier's compliance to Software Quality Assurance,
 Configuration Management, and Testing contract requirements
- Review how primes and suppliers conduct training in Counterfeit Parts Avoidance for
 Inspectors, Operators, Auditors and lower tier suppliers. Training should discuss how to
 inspect parts and identify possible counterfeits (e.g., non-conforming part markings).
- The intent of verifying supplier quality programs is to draw attention to troubled suppliers or critical processes needing corrective action by on-site visits/reviews. The contractor will usually respond by sending his own representative to the site when you explain your reasoning. Consider inviting the program chief engineer or even the program director if the situation warrants their attention. The contractor will usually respond with equal high-level attention.
- Primes and suppliers conduct training in Counterfeit Parts Avoidance for Inspectors, Operators,
 Auditors and lower tier suppliers to include awareness of AS5553. Training should discuss how to
- 2061 inspect parts and identify possible counterfeits (e.g., non-conforming part markings).
- As our major defense acquisition programs become more complex and supply chains become longer, more obscure, and prone to unforeseen quality breakdowns, program risk associated with supplier processes has increased exponentially. Since the issues surrounding the supply chain typically impact program quality, cost, and schedule, the manufacturing and quality assurance personnel at DCMC can be key contributors in addressing this type of risk and providing visibility into potential future suppliers' problems/ issues.
- 2068 Metrics
- Supplier Quality Audit Rating

6. Operations and Support (O&S) Phase

2070	Tools		
2071	Supplier QA Questionnaire		
2072	ISO 9001 QMS Audit Checklist		
2073	AS9100 Audit Checklist		
2074	AS9134 Supply Chain Risk Management Guidelines		
2075	Manufacturing Readiness Level Assessment Questionnaire for the Quality thread		
2076	Resources		
2077	• AS9100. Quality Management System – Aerospace, Sep 2016		
2078	• ISO 9001. Ouality Management System. Sep 2016		
2079	• MRL Deskbook Version 2016		
2080	• DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs.		
2081	Jan 2017		
2082	• DAG Chapter 14.3.1.3.6 Quality Plans		
2083	I.3. Evaluate Contractor Quality Management System		
2084	A Quality Management System (QMS) is a formal system that documents policies, processes and		
2085	procedures that may be required in order to achieve specific quality goals and objectives. The intent		
2086	is to use the QMS to meet or exceed customer expectations and improve overall efficiency and		
2087	effectiveness. The two dominant QMS programs that are currently available are ISO 9001 and		
2088	AS9100. A QMS should be in place at all contractor facilities with a higher level quality requirement		
2089	per FAR/DFAR or at any government owned and operated facility doing production type work.		
2090	• Primes and suppliers should institute strong incoming quality assurance on all parts, and visually inspect for defacts		
2091	 Prime contractors require certificates of conformance, testing certification, and procedures 		
2092	for handling any counterfeit parts that might slip through the system		
2093	 Perform/delegate government surveillance of First Article (FA)/Qualification unit(s) 		
2095	(OUAL), if conducted.		
2096	• Determine the need for delegated government surveillance on critical products.		
2097	configuration items, critical product characteristics and critical manufacturing processes		
2098	that are produced at a sub-tier supplier, especially those that have been designated high or		
2099	moderate risk and those that impact KSA/KPP compliance.		
2100	• Review implementation of a reliability improvement program based on Failure Modes		
2101	and Effects Criticality Analysis (FMECA) (or defect tracking for software), other		
2102	engineering data developed during the systems engineering process, system health		
2103	information generated by applicable on-board and off-board technologies, and data		
2104	sources.		
2105	• Continually assess and refine the product support strategy based on projected and actual		
2106	performance.		

6. Operations and Support (O&S) Phase

2107		• Conduct Benchmarking to survey outside organizations that perform similar processes.
2108		Ideally, benchmarking should be performed in conjunction with the contractor, who
2109		should be investigating better ways to do business.
2110		• At the end of the Production phase the Prime has a large responsibility in effecting line
2111		shutdowns. In addition to assessing and controlling in-house shutdown activities, the
2112		Prime is responsible for working with the suppliers to ensure their involvement as early
2113		as possible as well as ensuring ongoing support is available.
2114	Metric	CS
2115	•	Quality Audit results/ratings
2116		Tools
2117	•	ISO 9001 QMS Audit Checklist
2118	•	AS9100 Audit Checklist
2119	•	Manufacturing Readiness Level Assessment Questionnaire for the Quality thread
2120		Resources
2121	•	AS9100, Quality Management System – Aerospace, Sep 2016
2122	•	ISO 9001, Quality Management System, Sep 2016
2123	•	MRL Deskbook Version2016

2124 J. MANUFACTURING WORKFORCE

2125 During the sustainment phase, workforce management is concerned about the availability of workers

and skill levels required to perform the production and quality operations. Problems may occur when

2127 the prime contractor cuts back from Full Rate Production to supporting production for spares and

2128 sustainment operations. This lower level of production may cause the contractor to lose sight of

2129 important functions while they put their resources into higher rate production programs. Or, the work

2130 may now be delegated to government owned and operated facilities such as Depots, MROs and other

2131 organic activities.

2132



2133 J.1. Identify Potential Critical Skills

2134 During the sustainment phase,

6. Operations and Support (O&S) Phase

2135 2136	•	Review and assess the contractors Manufacturing Plans to identify workforce requirements for skills, capabilities, training and certification requirements:
2137		 Contractor's make/buy processes for factors that determine the outsourcing of workforce
2138		skills
2139		• Scale-up or scale down of materials, subsystems, items, and components for TMRR
2140		• Contractor's labor market (availability, stability, capabilities, training, etc.)
2141		• Potential ManTech changes, additions, and new manufacturing methods (e.g.,
2142		automation, upgrades, additive manufacturing, etc.)
2143		• Potential facilities changes (e.g., location, improvements and expansion, lay-out changes,
2144		etc.)
2145		• Materials handling (e.g., safety processes, storage and disposal processes, environmental
2146		processes, etc.)
2147		• Environmental, safety, and health
2148		• Manufacturing machinery and equipment (e.g., programming and operation,
2149		Excilities and tooling (e.g. operation and maintenance, safety, security, cleanliness
2150		acoustics Heating Ventilation Air Conditioning (HVAC) and environmental controls
2151		etc.)
2152		• Ouality (e.g., inspections, equipment operation, maintenance, calibration, etc.)
2100		
2154	•	Manufacturing and factory floor environment (union contract status, earthquakes, power
2155		outages, etc.) to determine potential impacts to program performance and sustainability goals.
2156	•	Assess Factory Efficiency. This activity involves the assessment of how efficiently the
2137		data. It also includes the analysis of causes of variances, their root causes, and championing
2150		and motivating contractor improvements
2159		and motivating contractor improvements.
2160	Metric	S
2161	•	Manufacturing Plans (Throughput, Cycle Time, Takt time, etc.)
2162	Tools	
2163	•	Assembly Chart Analysis
2164	•	Bottleneck Analysis (Theory of Constraints)
2165	•	Capacity Planning Worksheet
2166	•	Critical Chain Project Management
2167	•	Forecasting and Regression Analysis
2168	٠	Learning Curve Estimator
2169	٠	Line of Balance Template
2170	•	Manufacturing Resource Planning (MRPII)
2171	•	MRL assessment using Manufacturing Management thread
2172	•	Route Sheet Analysis

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6. Operations and Support (O&S) Phase

2173	٠	Shop Floor Manufacturing Plan Analysis
2174	•	SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)
2175	•	Work Measurement Analysis
2176	٠	Workforce Planning Tools (SAP/Oracle/MRPII)
2177	Resou	irces
2178	•	AS6500, Manufacturing Management System, Sep 2016
2179		• MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
2180		 MRL Deskbook Version 2016
2181		 Manufacturing Resource Planning (MRP II) software

2182 K. FACILITIES

2187

2183 During the sustainment phase, manufacturing and quality personnel should update the facility and

tooling strategies and plans developed and used during production and operations. Additionally, they

2185 should conduct assessments of proposed production facilities, and update and finalize the tooling

2186 plan for the O&S phases and then plan for smart shutdown.



2188 During the sustainment phase, a contractor or a government owned or operated remanufacturing

facility (Depot/MRO, etc.) should have implemented an effective facilities management plan alongwith a tooling plan.

2191 K.1. Update Tooling Strategy

2192 Manufacturing tooling, to include Special Tooling (ST), Special Test Equipment (STE) and Special 2193 Inspection Equipment (SIE), should be assessed for its ability to support sustainment production and 2194 operations. Current special tooling strategies favor Condition-Based Maintenance or Total Productive 2195 Maintenance. Often special tools, test and inspection equipment has been in use in the production environment for a long time and may face the need for refurbishment or purchasing of new tools and 2196 2197 test equipment. But as production rates and quantities go down, the budget for special tools and test 2198 equipment may also go down. In addition, the manufacturing environment may have moved from a 2199 prime contractor facility to government owned and operated facilities, such as Depots, MROs, etc.


6. Operations and Support (O&S) Phase

•	Identify special tooling, test and inspection replacement or refurbishment costs and schedule and update the manufacturing plan (tooling section). Identify smart shutdown conditions and operations with respect to special tooling, test and inspection equipment. Preservation and Storage of Unique Tooling Plan once shutdown has been accompliabed
•	and update the manufacturing plan (tooling section). Identify smart shutdown conditions and operations with respect to special tooling, test and inspection equipment. Preservation and Storage of Unique Tooling Plan once shutdown has
•	Identify smart shutdown conditions and operations with respect to special tooling, test and inspection equipment. Preservation and Storage of Unique Tooling Plan once shutdown has
•	inspection equipment. Preservation and Storage of Unique Tooling Plan once shutdown has
•	heen accomplished
•	occh accomptistica.
	Identify ST, STE and SIE risk areas.
•	Identify ST, STE and SIE requirements to maintain equipment for the life of the program.
•	Manufacturing review the use of existing government owned inventory prior to use of
	product support arrangements.
	• The government accountable property system that documents all government owned
	property whether it is held and managed by the government, contractor, or third party.
	• The government accountable property system that documents all government owned
	property whether it is held and managed by the government, contractor, or third party, in
	accordance with 40 U.S.C. 524.
Metri	CS
•	ST STE and SIE plans and risks assessments
•	51, 51E and 51E plans and fisks assessments
Tools	
•	Acquisition Strategy Template
•	Manufacturing Strategy (no template available)
•	Manufacturing Readiness Level Assessment Questionnaire, Facilities thread
Resou	rces
•	P.L. 110-417, Section 815, program documentation must include the review cycle for
	assessing tool retention across the life of the system.
•	FAR / DFAR 52.245.17 Special Tooling
•	FAR / DFAR 52.245.18 Special Test Equipment
•	DoDI 4151.22, Condition Based Maintenance Plus for Material Management, Oct 2012
•	Condition Based Maintenance Plus DoD Guidebook, May 2008
•	MRL Deskbook Version 2016
•	Acquisition Plan Preparation Guide, Jan 2009
•	Defense Manufacturing Management Guide for Program Managers, Chapter 4.5, Elements of
	a Manufacturing Strategy
К.2	Conduct Production Facilities Assessment
	Metric Tools Resou

- 2234 Manufacturing facilities should be assessed for its ability to support sustainment production and
- 2235 operations. Often the prime and subcontractor facilities have been in use in for production for a long

6. Operations and Support (O&S) Phase

time and may face the need for refurbishment or capital investment. But as production rates and

- 2237 quantities go down, the budget for facility improvement may also go down. In addition, the
- 2238 manufacturing environment may have moved from a prime contractor facility to government owned
- and operated facilities, such as Depots, MROs, etc.
- 2240 Manufacturing/QA managers should ensure that:
- Facilities assessments should consider the impact of a program winding down production and producing only to support spares.
- Facilities should plan for a smart shut down at the end of the program.
- The contractor's manufacturing plan has been updated to include facilities management.
- That the current usage and utilization rates are cost effective and affordable.
- Product support integrators and product support providers identify future production or
 remanufacturing as organic, commercial, or a combination.
- 2248 Manufacturing should prepare information on the facility capacity. Information such as:
- General knowledge of factory and environment (union contract status, earthquakes, power outages, etc.)
- Identify schedule, key milestones, decision points, risks, and long lead items.
- Delineate between shutdown tasks to be charged directly to the shutdown effort, tasks
 covered by existing contracts including post production planning, and tasks to be otherwise
 allocated to overhead/indirect expenses.
- Assess any impact to the last production contract due to Ramp-Down. There may be a loss of
 efficiency due in part to employee morale, unless the workforce moves to another program
 immediately.
- Process to include government personnel in the preliminary planning phases to identify items
 to be retained, disposed and/or stored for sustainment or production restart.
- Union termination agreements.
- Shutdown of subcontractor activities and contract close-out.
- Cessation of production, disposal, and other related activities unless initially negotiated for the government to pay certain costs.
- Sustainment Planning must be an integral element of the capability requirements and acquisitionprocess from inception. This includes:
- Product support integrators and product support providers may be organic, commercial, or a combination.
- 2268 During the O&S phase the Program Manager will:
- Develop and implement an affordable and effective performance-based product support strategy. The product support strategy will be the basis for all sustainment efforts and lead to a product support package to achieve and sustain warfighter requirements.
 The product support strategy will address, at a minimum:

6. Operations and Support (O&S) Phase

2273		i.	An integrated product support capability implementing the program's mix of
2274			government and industry providers supported by appropriate analyses included in
2275			10 U.S.C. 2337.
2276		ii.	Sustainment metrics mapped to the sustainment key performance parameter and
2277			key system attributes to manage sustainment performance.
2278		iii.	Implementation of a reliability improvement program based on FMECA (or
2279			defect tracking for software), other engineering data developed during the
2280			systems engineering process, system health information generated by applicable
2281			on-board and off-board technologies, and data sources in accordance with DoD
2282			Instruction 4151 22
2283		iv	Competition or the option of competition at the prime and subcontract levels for
2285		1	large and small husinesses and system and sub-system levels
2285		V	The necessary intellectual property deliverables and associated license rights
2285		v.	consistent with and integrated with the program IP Strategy
2280		vi	How and when computer software and computer software documentation (as
2207		v1.	defined in Defense Federal Acquisition Perculation Supplement section 252 227
2288			7014) and other material and activities required to maintain and sustain the
2209			(014) and other inaterial and activities required to maintain and sustain the
2290			for systems that require core logistics support or when denot level software
2291			maintenance is required
2292		::	The use of existing accomment owned inventory prior to use of graduat surgest
2295		vii.	arrangements as required in 10 U.S.C. 2227
2294			The government ecountable property system that decuments all government
2293		viii.	owned property whether it is held and managed by the government, contractor, or
2290			owned property whether it is held and managed by the government, contractor, or third warts in accordance with $40 \text{ LLS} = 524$
2297		ե Ե	unito party, in accordance with 40 U.S.C. 524.
2298		D. P	roduct support integrators and product support providers may be organic,
2299	2	C	ommercial, or a combination.
2300	2.	Ensu	re identification of obsolete parts in specifications and develop plans for suitable
2301	2	repla	cements in accordance with P.L. 113-00, section 803.
2302	3.	Empi	oy effective performance-based logistics planning, development, implementation,
2303		and n	nanagement in developing a system's product support arrangements. PBL is
2304		perio	rmance-based product support, where outcomes are acquired through performance-
2305		basec	arrangements that deliver warrighter requirements and incentivize product support
2306	4	provi	ders to reduce costs through innovation.
2307	4.	Conti	nually assess and refine the product support strategy based on projected and actual
2308	~	perfo	rmance.
2309	э.	Empl	oy a "Should-Cost" management and analysis approach to identify and implement
2310		syste	m and enterprise sustainment cost reduction initiatives. Should-cost targets will be
2311		estab	lished and reviewed periodically based on analysis of acquisition sustainment costs
2312		and C	D&S cost element drivers. Program managers will capture product support metrics
2313		and c	ost data in DoD Component- and DoD-level information systems, and track
2314	_	perfo	rmance against should-cost targets.
2315	6.	Conti	nually monitor product support performance and correct trends that could
2316	_	negat	ively impact availability and cost.
2317	7.	Minii	mize unique Automatic Test Equipment (ATE) by utilizing designated DoD
2318		autor	natic test system families for all ATE hardware and software in DoD field and depot
2319	c	opera	tions.
2320	8.	Begin	1 demilitarization and disposal planning, including demilitarization and controlled
2321		inven	tory item coding of system, subsystems, or components, as required by DoD

6. Operations and Support (O&S) Phase

2322 2323 2324	Manual 4160.28-M with sufficient lead time before the disposal or retirement of the first asset to reduce costs and risks and to ensure compliance with statutory and regulatory requirements.
2325	Metrics
2326	• Facilities Plans
2327	Facilities Risk Assessment
2328	Tools
2329	Manufacturing Readiness Level Assessment Questionnaire, Facilities thread
2330	DCMA Production Planning and Control Risk Assessment Checklist
2331	DCMA Manufacturing Systems Risk Assessment (MSRA) Checklist
2332	Resources
2333	• DoDI 5000.02, Jan 2017
2334	AS6500, Manufacturing Management Systems
2335	• MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
2336	MRL Deskbook Version 2016DCMA-INST-204 Manufacturing and Production
2337	• DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs,
2338	Jan 2017
2339	K.3. Identify Special Tooling, Test, and Inspection Equipment
2340	Manufacturing tooling, to include special tooling (ST), special test equipment (STE) and special
2341	inspection equipment (SIE), should be assessed for its ability to support sustainment production and
2342	operations. Often ST/STE/SIE has been in use in the production environment for a long time and
2343	may face the need for refurbishment or purchasing of new tools and test equipment. But as
2344	production rates and quantities go down, the budget for special tools and test equipment may also go
2345	down. In addition, the manufacturing environment may have moved from a prime contractor facility
2346	to government owned and operated facilities, such as Depots, MROs, etc.
2347	Manufacturing/QA managers may want to:
2348	• Review the contractors or governments tooling plan and inventory.
2349	• Review the use of existing government owned inventory prior to use of product support
2350	arrangements.
2351	• Minimize unique automatic test equipment (ATE) by utilizing designated DoD automatic test
2352	system families for all ATE hardware in DoD field and depot operations.

- Review the Preservation and Storage of Unique Tooling Plan. It must include the review
 cycle for assessing tool retention across the life of the system.
- Review STE whether single or multipurpose integrated test units engineered, designed,
 fabricated, or modified to accomplish special purpose testing in performing a contract.

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6. Operations and Support (O&S) Phase

2357	The manufacturing/quality assurance role is to:
2358 2359 2360	 Identify unique tooling associated with the production of hardware in order to facilitate its protection and storage through the end of the program's service life. Review movement of special tooling and special test equipment
2361 2362 2363 2364	Government Activities: As part of a shutdown numerous activities will be the responsibility of the government. Along with these activities come additional costs the government will endure. Some shutdown activities the government will be responsible for include: Movement of special tooling and special test equipment.
2365	Metrics
2366	• ST, STE and SIE plans and risks assessments
2367	Tools
2368	Life Cycle Sustainment Plan Outline, Tooling Plan
2369	Tooling Inventory
2370	• Manufacturing Readiness Level Assessment Questionnaire, Facilities thread
2371	Resources
2372	• FAR 45 Government Property
2373	• FAR 52.245-1(J)
2374	• DUSD Memo, Preservation and Storage of Tooling for MDAPs, Aug 2009
2375	Guidebook for Contract Property Administration, Apr 2012
2376	DCMA Instruction 124, Contract Property Administration
2377	MRL Deskbook Version 2016
2378	• Defense Manufacturing Management Guide for Program Managers, Chapter 4.5, Elements of
2379	a Manufacturing Strategy

2380 L. MANUFACTURING MANAGEMENT AND CONTROL

2381 During the sustainment phase, Manufacturing Management/Control includes Materials Planning

2382 (MRP) and Manufacturing Planning (MRP II).



6. Operations and Support (O&S) Phase

Materials Requirements Planning (MRP) is a production control system that integrates production requirements (rates and quantities) with the Bill of Material and inventories in order to calculate purchasing and shipping schedules for parts and components. The primary functions of an MRP system is to ensure that the right materials are at the right place and at the right time in order to support production operations. A secondary function is to reduce waste by maintaining only the lowest possible levels of materials and stock (inventory) while still meeting customer demand.

2390 Manufacturing Resource Planning (MRPII) is a planning control system that addresses factory floor 2391 planning from rough cut capacity planning, to capacity requirements planning, and down to the daily 2392 execution of shop floor activities to meet daily demand.

2393 Manufacturing Plans should have been developed in support of the O&S phase and sustainment

2394 operations. The manufacturing environment may have moved from a prime contractor facility to

2395 government owned and operated facilities, such as Depots, MROs, etc.

2396 Manufacturing resources consist of facilities, materials, machines, manpower, methods, measurement

2397 systems, and capital that are used to convert or transform raw materials and component parts into end

products. Contractors must have an effective combination of people and systems in order to plan for,
 monitor, and control these manufacturing resources. Effective implementation of a manufacturing

2400 management system is required to manage these resources. A well-structured manufacturing

2401 management system is required to manage these resources. A wen-subctured manufacturing 2401 management system generally employs the use of industry best practices. Assessment of the

2402 contractor's manufacturing management and quality systems should be performed against the

recognized industry best practices such as AS6500, ISO 9000, AS9100, etc.

2404 L.1. Update Manufacturing Strategy

A Manufacturing Strategy should have been developed in support of the O&S phase and sustainment operations as a part of a SEP and/or the LCSP. Included in the plan would be Make/Buy decisions and the decision to have either organic or contractor sustainment support. Thus, the manufacturing environment may have moved from a prime contractor facility to government owned and operated facilities, such as Depots, MROs, etc.

2410 Manufacturing should support the program managers in developing and maintaining an LCSP

consistent with the product support strategy. The plan describes sustainment influences on system

2412 design and the technical, business, and management activities to develop, implement, and deliver a

2413 product support package that maintains affordable system operational effectiveness over the system

2414 life cycle and seeks to reduce cost without sacrificing necessary levels of program support.

- Specify Manufacturing Management System requirements (e.g., AS6500), if applicable to be 2416 met by the prime contractor and flowed down to suppliers, as appropriate.
- 2417 Manufacturing should review sources of industrial and manufacturing readiness data to include:

6. Operations and Support (O&S) Phase

2418 Program Status Reviews, • 2419 pre-award surveys, • 2420 Production Readiness Reviews. • 2421 Industrial Capabilities Assessments, • 2422 trade-off studies, tooling plans, • 2423 make-or-buy plans, • 2424 manufacturing plans, • 2425 and bills of material. • 2426 An important output includes the identification of risks and actions to reduce or address any 2427 remaining risks. 2428 Manufacturing should review foreign sources and international cooperative development • 2429 should be used where advantageous. 2430 Manufacturing should provide inputs to support production surge capability and what-if 2431 exercises. 2432 • Manufacturing should provide inputs to program cuts and smart shutdown once a program 2433 has concluded. 2434 • Manufacturing should review priorities of competing programs (commercial and military). 2435 • Manufacturing should review production shutdown planning efforts. 2436 Manufacturing should start this planning process early and benefit from their advanced planning and 2437 preparation in dealing with all potential risks embedded in this process. 2438 There will be some drivers which will indicate that the line should be idled with the potential 2439 to "flip the switch" and restart production in the future and other indicators which indicate the line should be shut down, dismantled and never be restarted. 2440 2441 Even if the decision is made to dismantle the production line, arrangement for storage and • 2442 protection of unique program tooling until the end of service life may still be required. 2443 • Identify any current work contained in the production contract, which will need to be 2444 transitioned to other contract vehicles post production, e.g., drawing release. 2445 Manufacturing should conduct a series of either PRRs or MRAs to monitor progress in • 2446 standing up new facility. 2447 Modifications of production parts should be treated the same as any new start. Use the MRL guide to determine the manufacturing maturity of the item before proceeding. 2448 2449 During the system Sustainment, the Program Manager will deploy the product support package and 2450 monitor its performance according to the LCSP. 2451 Program managers for all programs are responsible for developing and maintaining an LCSP 2452 consistent with the product support strategy, beginning at Milestone A. The plan describes 2453 sustainment influences on system design and the technical, business, and management activities to

6. Operations and Support (O&S) Phase

2454 develop, implement, and deliver a product support package that maintains affordable system

- 2455 operational effectiveness over the system life cycle and seeks to reduce cost without sacrificing
- 2456 necessary levels of program support. The Acquisition Strategy will also include an overview of the
- 2457 product support strategy and sustainment-related contracts.

2458 Counterfeiting of parts and materials in the electronic business segment is growing at an alarming

- rate. As we draw from a large network of suppliers in an increasingly global supply chain, there can
- be limited visibility into these sources and greater risk of procuring counterfeit parts. Additionally,
- there are unique conditions that make aerospace and defense products susceptible to counterfeiting,
- 2462 including a long-life cycle and DMSMS issues. Therefore, supporting aerospace and defense
- 2463 products throughout their lifecycle sometimes requires the use of parts that may no longer be
- available from the OEM, authorized aftermarket manufacturer or through franchised or authorizeddistributors or resellers.
- 2466 Conduct Environmental, Safety and Occupational Health risk assessments and maintain oversight of 2467 critical safety item supply chain management.
- Conduct analysis to identify and mitigate potential obsolescence impacts (i.e., DiminishingManufacturing Sources and Material Shortages).
- 2470 Support implementation of follow-on development efforts in response to formal decisions to extend
- the weapon system's service life extension program (SLEP), or to initiate a major modification (may
- 2472 be treated as a stand-alone acquisition program).

2473 Metrics

- Manufacturing Strategy updated
- Systems Engineering Plan updated
- Life Cycle Sustainment Plan updated

2477 **Tools**

- Acquisition Strategy Template
- Manufacturing Readiness Level assessment questionnaire using Manufacturing
 Management/Control thread

2481 **Resources**

- Acquisition Plan Preparation Guide, Jan 2009
- DSMC Acquisition Strategy Guide, Dec 1999
- Systems Engineering Plan (SEP) Outline, Jun 2015
- Life memo, Sep, 2011 and DAG Chapter 4-3.1
- MRL Deskbook Version 2016
- DoDI 5000.02, Jan 2017

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2488 2489 2490	•	ISO/IEC/IEEE 15288, Systems and Software Engineering–System Life Cycle Processes, 2015 AS6500, Manufacturing Management System, Sep 2016
2491	•	MIL-HDBK-896A, Manufacturing Management Program Guide, Aug 2016
2492	L.2.	Review Sustainment Manufacturing Plan
2493	Manu	facturing Plans should have been developed in support of the O&S phase and sustainment
2494 2495	govern	iment owned and operated facilities, such as Depots, MROs, etc.
2496 2497	•	Review the Manufacturing Plan to ensure it will provide the resources needed for sustainment operations as outlined in the LCSP.
2498	•	Assess the Manufacturing Plan for impact to the 'five Ms' (Manpower, Material, Methods,
2499		Measurement and Machinery).
2500	٠	Assess the Manufacturing Plan for Risks, Issues and Opportunities.
2501	•	Defense acquisition programs should minimize the need for new defense-unique industrial
2502	•	Manufacturing should identify any assumptions made in developing the shutdown plan
2504	•	Defense acquisition programs should attempt to minimize the need for new defense-unique
2505		industrial capabilities.
2506	٠	Identify any assumptions made in developing the shutdown plan. This may include potential
2507		DoD, commercial and/or foreign military sale production requirements that may impact
2508		shutdown planning.
2509 2510	•	Ensure the contractor is conducting First Article Inspections on the hardware being produced from the new facility.
2511	Metri	CS
2512	٠	Manufacturing Plan updated
2513	•	Systems Engineering Plan updated
2514	•	Life Cycle Sustainment Plan updated
2515	Tools	
2516	•	Assembly Chart Analysis
2517	٠	Bottleneck Analysis (Theory of Constraints)
2518	•	Capacity Planning Worksheet
2519	•	Critical Chain Project Management
2520	•	Manufacturing Resource Planning (MRPII)
2521	•	Naterial Management and Accounting System (MMAS) audit
2522 2523	•	Nulle Sheet Allalysis Shon Eloor Manufacturing Plan Analysis
2525	-	Shop i toor manufacturing i fan Anarysis

6. Operations and Support (O&S) Phase

- 2524 Manufacturing Readiness Level (MRL) assessment questionnaire using Manufacturing 2525 Management/Control thread 2526 Risk, Issues and Opportunities assessment • 2527 **Resources** 2528 AS6500, Manufacturing Management Program, Nov 2014 2529 MRL Deskbook Version 2016 • 2530 MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016 2531 • Systems Engineering Preparation Guide, Apr 2008 2532 DAG, Chapter 3-4 3.18, Producibility, Quality and Manufacturing Readiness, 2017 2533 • ISO/IEC/IEEE 15288, Systems and Software Engineering–System Life Cycle Processes, 2534 2015 2535 • DoDI 5000.02, Enclosure 14 2536 DFARS 252.72 Contractor Material Management and Accounting System 2537 • DoD Risk, Issue, and Opportunity Management Guide for Defense Acquisition Programs, 2538 Jan 2017 2539 L.3. Evaluate Materials and Inventory Control Systems 2540 Manufacturing should periodically assess product support performance and assist program managers, 2541 users, resource sponsors, and materiel enterprise stake holders to take corrective action to prevent 2542 degraded materiel readiness or O&S cost growth. 2543 Periodically assess product support performance and assist program managers, users, resource 2544 sponsors, and materiel enterprise stake holders to take corrective action to prevent degraded materiel 2545 readiness or O&S cost growth. 2546 Inventory control is aimed at minimizing the total cost of inventory. It is often concerned with 2547 minimizing the amount of inventory on-hand and with the loss of inventory. Manufacturing 2548 management is concerned with the integration of manpower, materials, measurement, machines, and 2549 manufacturing methods in the production of the end item. This requires determination of material 2550 requirements and components to support the manufacturing rate and determination of manufacturing 2551 lot quantities. 2552 Manufacturing management is generally concerned with three types of material inventories: 2553 • Raw Materials: Raw materials are the basic building blocks for the company. Often this is in 2554 the form of raw materials and components. 2555 • Work-in-Progress (WIP): WIP is made up of materials, components, sub-assemblies and 2556 assemblies that are in the process of being produced. That is they have been released from 2557 material stores and have not yet been through final inspection and acceptance.
- Finished Goods: Finished goods have been inspected and accepted and are awaiting delivery to the customer.

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6. Operations and Support (O&S) Phase

2560 Two other types of inventory are a sub set of WIP, these are buffer inventories and de-coupler

- 2561 (supermarket) inventories. These inventories insulate a manufacturing process from the inherent
- 2562 variability of the processing stages in the manufacturing cycle. These inventories also provide
- 2563 protection against potential line stoppages. Buffer inventories are inventories that are carried as a
- 2564 safety valve or cushion against possible quality or vendor delivery problems. A decoupling inventory
- 2565 is inventory that exists due to the fact that all machines do not process parts and assemblies at the
- same speed and thus an inventory may build up in front of a slower machine. This may be a
- 2567 bottleneck in the production process.
- 2568 Many companies use inventories to decouple successive stages of production. They view it as
- uneconomical to schedule parts through some systems due to the unbalanced nature of operation
- times in processes performed at the various machine stations and the tool changes required for each
- 2571 operation. The use of inventories to disengage successive stages allows each stage to operate more
- efficiently; the operation of a particular stage is not compromised by the demands of preceding and
- 2573 succeeding stages.
- 2574 Although inventories provide production benefits, they represent an investment that involves capital
- 2575 costs that needs to be balanced against the benefits obtained. Batch processing is a term often used to
- 2576 describe this type of manufacturing system. Batch size should reflect the most economical order
- 2577 quantity for the process, thus minimizing total cost of setup and processing.
- The DCMA MSRA Production Planning and Control (PPC), Material Requirement PlanningChecklist can be used to assess Material Requirements Planning.

2580	Metric	S S
2581	•	MMAS Audit results
2582	Tools	
2583	٠	Manufacturing Readiness Level Assessment Questionnaire for the Manufacturing
2584		Management and Control thread
2585	•	AS6500 Assessment
2586	•	ISO 9001 Assessment

- AS9100 Assessment
- Material Management and Accounting System Audit
- MSRA Production Planning and Control (PPC), Material Requirement Planning Checklist

2590 **Resources**

- AS6500, Manufacturing Management System, Sep 2016
- AS9100, Quality Management System Aerospace, Sep 2016
- ISO 9001, Quality Management System, Sep 2016
- MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016

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- MRL Deskbook Version 2016
 Material Management and Accounting System Audit Program, Apr 2017
- DFAR Subpart 242.72 Contractor Material Management and Accounting System
- DCMA, Audit Policies, Procedures and Internal Controls Relative to Accounting and Management Systems, Jan 2016
- AS5553, Counterfeit Electronic Parts, 2013
- AS6174, Counterfeit Material, 2012

2602 L.4. Initial Make/Buy Decisions

Organizations making product may be required to submit a "Make/Buy" plan identifying those major
items to be produced or work efforts to be performed at the prime contractor's facility and those
items that will be subcontracted.

2606 Contractors are often given wide-latitude in determining whether during performance of a contract it

should "make" an item or "buy" any items required. For acquisitions >\$12.5 million (or at lower

dollar values if circumstances justify their use) as described in FAR 15.407-2(c), a "Make or Buy"

2609 plan may be required of a contractor. The decision to require or not require a "Make or Buy" plan

- should be detailed.
- 2611 Make or Buy decisions are often made based on factors such as lowest overall cost or technical risk.
- 2612 In general, a prime contractor may choose to make an item if they:
- Have the capability to produce
- Have the capacity to produce
- Can do so at a lower cost than a subcontractor
- Manufacturing should conduct a Product Support Business Case Analyses that includes relevant
 assumptions, constraints, and analyses used to develop the product support strategy for the LCSP that
 details criteria for their Make/Buy decisions, which could include:
- Industrial base viability,
- Design stability,
- Process maturity,
- Supply chain management,
- Quality management,
- Facilities, and
- Manufacturing skills availability.

The program's Product Support Strategy will be included in the LCSP and updated appropriatelyduring the O&S phase.

6. Operations and Support (O&S) Phase

2628 Program management must establish and maintain a Product Support Strategy (PSS) to identify and 2629 manage the full spectrum of IP and related issues (e.g., technical data and computer software 2630 deliverables, patented technologies, and appropriate license rights) from the inception of a program 2631 and throughout the life cycle. The IP Strategy will describe, at a minimum, how program 2632 management will assess program needs for, and acquire competitively whenever possible, the PSS deliverables and associated license rights necessary for competitive and affordable acquisition and 2633 2634 sustainment over the entire product life cycle, including by integrating, for all systems, the PSS 2635 planning elements required by subpart 207.106 (S-70) of the Defense Federal Acquisition Regulation 2636 Supplement for major weapon systems and subsystems thereof. The PSS Strategy will be updated throughout the entire product life cycle, initially as part of the Acquisition Strategy, and during the 2637 operations and support phase as part of the Life-Cycle Sustainment Plan. Program management is 2638 2639 also responsible for evaluating and implementing open systems architectures, where cost effective, and implementing a consistent PSS Strategy. This approach integrates technical requirements with 2640 2641 contracting mechanisms and legal considerations to support continuous availability of multiple

2642 competitive alternatives throughout the product life cycle.

2643 Manufacturing plans should have been developed in support of the O&S phase and sustainment

2644 operations. However, the manufacturing environment may have moved from a prime contractor

- 2645 facility to government owned and operated facilities, such as Depots, MROs, etc. In this case the
- 2646 Make/Buy decision will assess organic and contractor capabilities and decide which will best serve
- the needs of the LCSP.

2648 Metrics 2649 • Product Support Business Case 2650 • Vife G and G and Case

• Life Cycle Sustainment Plan (LCSP)

2651 **Tools**

- Product Support Business Case Analysis Guidebook Appendix A BCA Checklist
- Weapon System Acquisition Reform Product Assessment report requirements tool
- Manufacturing Readiness Level (MRL) Assessment Questionnaire for the Manufacturing Management and Control thread

2656 **Resources**

- Product Support Business Case Analysis Guidebook
- MRL Deskbook Version 2016

2659 L.5 Evaluate Manufacturing Planning and Control Systems

2660 Manufacturing Planning and Control systems are concerned with planning and controlling all aspects 2661 of manufacturing, including managing materials, scheduling machines and people, and coordinating

6. Operations and Support (O&S) Phase

2662 suppliers and key customers should ensure the program's IP Strategy is included in the LCSP and 2663 updated appropriately during the O&S phase. 2664 Manufacturing Planning and Control systems are divided into three different time horizons: 2665 Long-term planning • 2666 Medium-term planning • Short-term planning 2667 • 2668 Long-term planning is the "front-end" of the Manufacturing Resource Planning (MRP II) system and 2669 includes: 2670 • Demand Management (Customer requirements, how many and when) 2671 Sales and Operations Planning • 2672 • Resource/Production Planning (Rough Cut Capacity Planning) 2673 Master Production Scheduling • 2674 • Medium-term planning is the "engine" of an MRP II system and includes: 2675 • **Detailed Material Planning** 2676 Demand Capacity Planning (Capacity Requirements Planning) • 2677 Material and Capacity Plans • 2678 Short-term planning is the "back-end" of an MRP II system and includes: 2679 Supplier Systems (Purchase Order Release) 2680 Shop-Floor Systems (Work Order Release) • 2681 **Shop Floor Activities** • 2682 Manufacturing/QA should: 2683 • Periodically assess manufacturing plans along with the LCSP to identify risks and develop 2684 risk mitigation measures. 2685 • Review the Manufacturing Plan to ensure it will provide the resources needed for sustainment operations as outlined in the LCSP. 2686 2687 Assess the Manufacturing Plan for impact to the 'five Ms' (Manpower, Material, Methods, • Measurement and Machinery). 2688 2689 • Assess the Manufacturing Plan for Risks, Issues and Opportunities. Manufacturing should identify any assumptions made in developing the shutdown plan. 2690 • 2691 Identify any assumptions made in developing the shutdown plan. This may include potential • 2692 DoD, commercial and/or foreign military sale production requirements that may impact 2693 shutdown planning. 2694 • Ensure the contractor is conducting First Article Inspections on the hardware being produced 2695 from the new facility. 2696 The DCMA MSRA Production Planning and Control, Material Requirement Planning Checklist can

be used to assess:

6. Operations and Support (O&S) Phase

2698	٠	Resource Requirements Planning
2699	•	Aggregate Planning
2700	•	Master Production Schedule
2701	•	Rough Cut Capacity Planning
2702	•	Capacity Requirements Planning
2703	•	Shop Floor Controls
2704	Metrie	CS
2705	•	MMAS Audit results
2706	Tools	
2707	•	DCMA Production Planning and Control Checklist
2708	•	Manufacturing Readiness Level Assessment Questionnaire for the Manufacturing
2709		Management and Control thread
2710	•	AS6500 Assessment
2711	•	Material Management and Accounting System Audit
2712	Resou	rces
2713	•	AS6500, Manufacturing Management System, Sep 2016
2714	•	MIL-HDBK-896A, Manufacturing and Quality Program, Aug 2016
2715	•	MRL Deskbook Version 2016
2716		
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2718		
2719		
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2721		

6. Operations and Support (O&S) Phase

2722

Acronyms

Am	Materiel Availability
Ao	Operational Availability
AoA	Analysis of Alternatives
APA	Additional Performance Attributes
APB	Acquisition Program Baseline
AS	Acquisition Strategy
ASR	Alternative Systems Review
AT	Anti-Tamper
ATE	Automatic Test Equipment
AUPC	Average Unit Procurement Cost
BER	Beyond Economical Repair
BOM	Bill of Materials
C/SCSC	Cost/Schedule Control Systems Criteria
C4I	Command, Control, Communication, Computer, and Intelligence
CAB	Corrective Action Board
CAE	Component Acquisition Executive
CAI	Critical Application Item
CAIV	Cost as an Independent Variable
САРЕ	Cost Analysis and Program Assessment
CARD	Cost Analysis Requirements Description
CAS	Contract Administration Services
СВА	Capabilities-Based Assessment
ССВ	Change Configuration Boards
CDD	Capability Development Document
CDRL	Contract Data Requirements List
CLIN	Contract Line Item
СМ	Configuration Management
СМО	Contract Management Office
СМР	Configuration Management Plan
СМР	Critical Manufacturing Processes
СРІ	Continuous Process Improvement

Acronyms

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
CPD	Capability Production Document
CPFF/CPIF	Cost Plus Fixed Fee/Cost Plus Incentive Fee
СРІ	Continuous Process Improvement
CpK/ CP Cpks	Process Capabilities
CRI	Cost Reduction Initiative
CSCSC	Cost, Schedule Control Systems Criteria
CSI	Critical Safety Item
СТЕ	Critical Technology Element
CUI	Controlled Unclassified Information
DAE	Defense Acquisition Executive
DAG	Defense Acquisition Guidebook
DAPS	Defense Acquisition Program Support
DAU	Defense Acquisition University
DCMA	Defense Contract Management Agency
DFA	Design for Assembly
DFARS	Defense Federal Acquisition Regulations
DFM	Design for Manufacturing
DFMA	Design for Manufacture/Assembly
DFMEA	Design Failure Modes and Effects Analysis
DFSS	Design For Six Sigma
DID	Data Item Description
DLA	Defense Logistics Agency
DMS	Diminishing Manufacturing Sources
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DOE	Design of Experiments
DPAS	Defense Priorities and Allocation System
DPAS	Defense Priority Allocation System
DSS	Design for Six Sigma

Acronyms

DT&F	Developmental Test & Evaluation
DTC	Design to Cost
	Estimates to Completion
EAC	
ECP	Engineering Change Proposal
EMC	Electromagnetic Compatibility
EMD	Engineering and Manufacturing Development
EMI	Electromagnetic Interference
EOQ	Economic Order Quantity
ERP	Enterprise Resource Plan
ESOH	Environment, Safety, and Occupational Health
ESS	Environmental Stress Screening
EVMS	Earned Value Management System
FA	First Article
FAI	First Article Inspections
FAR	Federal Acquisition Regulation
FCA	Functional Configuration Audit
FDD	Full Deployment Decision.
FFP	Firm Fixed Price
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes, Effects, and Criticality Analysis
FOT&E	Follow-on Test and Evaluation
FPIF	Fixed Price Incentive Fee
FRACAS	Failure Reporting, Analysis, and Corrective Action System
GAO	Government Accountability Office
GCQA	Government Contract Quality Assurance
GFE	Government-Furnished Equipment
GFI	Government-Furnished Information
GIDEP	Government and Industry Data Exchange Program
GOTS	Government Off-the-Shelf
HALT	Highly Accelerated Life Testing
HASS	Highly Accelerated Stress Screen
HSI	Human Systems Integration
HVAC	Heating, Ventilation, Air Conditioning

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Acronyms

IB	Industrial Base
ICA	Industrial Capabilities Analysis
ICD	Initial Capabilities Document
IIPT	Integrating 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
ISO	International Organization for Standardization
ISR	In-Service Review
ITAR	International Trafficking in Arms Regulation
ITR	Initial Technical Review
JCIDS	Joint Capabilities Integration and Development System
КС	Key Characteristics
KLP	Key Leadership Position
КРР	Key Performance Parameters
KSA	Key System Attribute
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LCSP	Life Cycle Sustainment Plan
LFT&E	Live Fire Test and Evaluation
LRIP	Low Rate Initial Production
M&S	Modeling and Simulation
ManTech	Manufacturing Technology
MATE	Multi-Attribute Tradespace Exploration
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MIL-STD	Military Standard
MMAS	Material Management and Accounting System
MMS	Manufacturing Management System

Acronyms

MMS	Manufacturing Management System
MOE	Measure of Effectiveness
MRO	Maintenance, Repair and Overhaul
MOSA	Modular Open Systems Approach
MP	Mission Profile
MRB	Material Review Board
MRL	Manufacturing Readiness Level
MRP	Materials Requirements Planning
MRPII	Manufacturing Resource Planning
MS A	Milestone A
MS B	Milestone B
MS C	Milestone C
MSA	Materiel Solution Analysis
MSRA	Manufacturing Systems Risk Assessment
MTBF	Mean Time Between Failure
NDI	Non-Developmental Items
NEPA	National Environmental Policy Act
NSPAR	Non-Standard Parts Approval Requests
NTIB	National Technology and Industrial Base
O&M	Operations and Maintenance
O&S	Operating and Support
OEM	Original Equipment Manufacturer
OIPT	Over-arching Integrated Product Team
OMS	Operational Mode Summary
OSD	Office of the Secretary of Defense
OTRR	Operational Test Readiness Review
P&D	Production and Deployment
P3I/P ³ I	Pre-planned Product Improvement
PBL	Performance-Based Logistics
PCA	Physical Configuration Audit
PCO	Procurement Contracting Officer
PCO	Procuring Contracting Officer
PDR	Preliminary Design Review

Acronyms

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
РМ	Program Manager
PM&P	Parts, Materials, and Processes
РМО	Program Management Office
PPP	Program Protection Plan
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
PWBS	Preliminary Work Breakdown Structure
QA	Quality Assurance
QFD	Quality Function Deployment
QMS	Quality Management System
R&D	Research and Development
RFI	Requests for Information
RFP	Request for Proposal
RFP RDP	Request for Proposal Release Decision Point
RFV	Requests for Variation
S&T	Science and Technology
SAE	Society of Automotive Engineers
SAT	Software Acceptance Test
SCD	Surveillance Criticality Designator
SCM	Supply Chain Management
SCMP	Software Configuration Management Plan
SDP	Software Development Plan
SE	Systems Engineering
SEMP	Systems Engineering Management Plan

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Acronyms

SEP	Systems Engineering Plan
SFMEA	System Failure Modes and Effects Analysis
SFQT	Software Formal Qualification Testing
SFR	System Functional Review
SIE	Special Inspection Equipment
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
SSP	Source Selection Plan
ST	Special Tooling
STE	Special Test Equipment
STEM	Science, Technology, Engineering and Math
SVR	System Verification Review
SWOT	Strengths, Weaknesses, Opportunities and Threats
T&E	Test & Evaluation
TBD	To Be Determined
TDP	Technical Data Package
ТЕМР	Test and Evaluation Master Plan
TMRR	Technology Maturation and Risk Reduction
ТО	Technical Order
ТРМ	Technical Performance Measures
TRA	Technology Readiness Assessment
TRIZ	Theory of Innovative Problem Solving
TRL	Technology Readiness Level
TRR	Test Readiness Review
U.S.C.	United States Code
V&V	Validation and Verification
VCRM	Verification Cross-Reference Matrix
VOLT	Validated On-line Life-cycle Threat

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Acronyms

VR	Variability Reduction
VSM	Value Stream Mapping
WBS	Work Breakdown Structure
WIP	Work-in-Progress

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