

INSTITUTE FOR DEFENSE ANALYSES

DMSMS Considerations and Manufacturing Readiness Levels

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> INSTITUTE FOR DEFENSE ANALYSES 730 East Glebe Road Alexandria, Virginia 22301



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About This Publication

This work was conducted by the Institute for Defense Analyses (IDA) under contract HQ0045-14-D-0001, project DE-6-3405, "Fostering Proactive Diminishing Manufacturing Sources and Material Shortages (DMSMS) and Parts Management," for the Defense Standardization Program Office (DSPO) through the Defense Logistics Agency (DLA). The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

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Executive Summary

Diminishing manufacturing sources and material shortages (DMSMS) management is a multidisciplinary process to identify risks resulting from obsolescence, loss of manufacturing sources, or material shortages; to assess the potential for negative impacts on schedule or readiness; to analyze potential mitigations; and then to implement the most cost-effective resolution. Parts management is an engineering discipline for selecting parts for use in a Department of Defense system (or equipment) and take into account considerations that affect the design, production, operation, support, and disposal throughout the life cycle of the system. In March 2022, a Parts and Material Management Conference (PMMC) will cover both topics. The Institute for Defense Analyses (IDA) prepared or substantially helped craft seven briefings for this event.

Three of the briefings will be used for training; they will be presented by DOD practitioners.

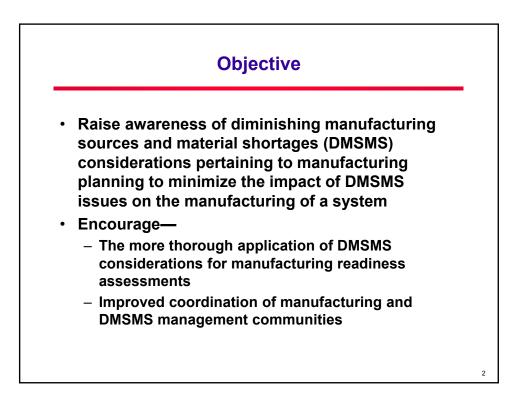
- Standardization-related Document (SD) 22 is DOD's overarching DMSMS guidance. DOD published an updated SD-22 (written by IDA) in January 2021 and IDA is preparing another update. NS D-32993 is a substantially modified three-hour training course on the SD-22 processes.
- Development of a DMSMS Management Plan (DMP) is an important early step in DMSMS management. The January 2021 and forthcoming SD-22s formalized DMP development guidance. NS D-32973 is new DMP preparation training.
- •DOD prime contractors perform many DMSMS procedures and even more parts management procedures. NS D-32996 makes minor revisions to existing training on DMSMS contracting and adds preliminary parts management contracting material.

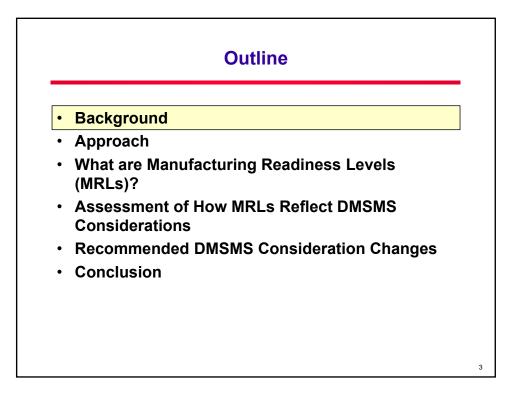
IDA will present the remaining four briefings in technical sessions. These briefings cover the results of specific subtasks from several IDA projects performed in the last two years.

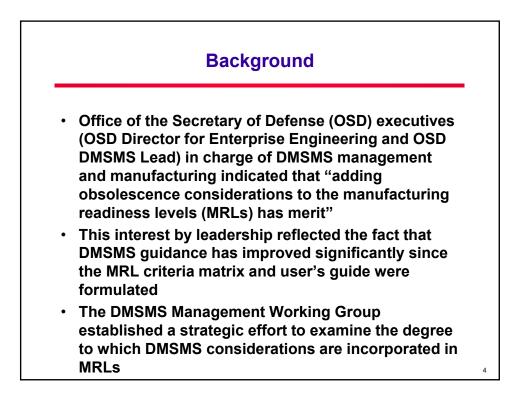
• NS D-32929 provides a detailed explanation of often-misunderstood DMSMS management interfaces with product, product improvement, supportability, and technology roadmaps. This material is a large part of the forthcoming SD-22 revision.

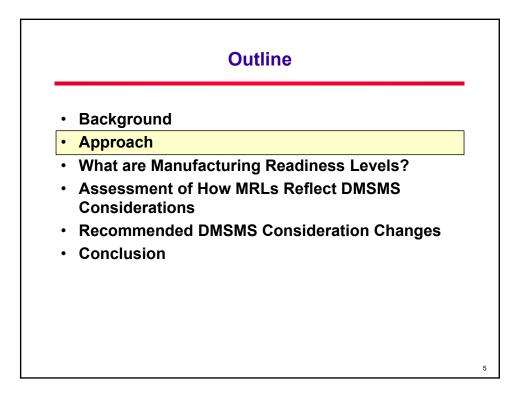
- NS D-32956 describes how to improve the content of manufacturing readiness assessments (MRAs) through a more rigorous consideration of DMSMS management and parts management in the assessment criteria. MRAs are regulatory requirements throughout DOD's acquisition process.
- •NS D-32930 delves into cybersecurity and hardware assurance (HwA) considerations associated with implementing resolutions to DMSMS issues.
 IDA will also moderate a plenary panel on this subject at the PMMC. IDA plans to use these events to help formulate future policy recommendations.
- NS D-32962 defines new DMSMS resolutions and estimates their average cost. These changes contribute to a more accurate estimate of cost avoidance from proactive DMSMS management and also provide program offices with an initial estimate of resolution cost when no other information is readily available.

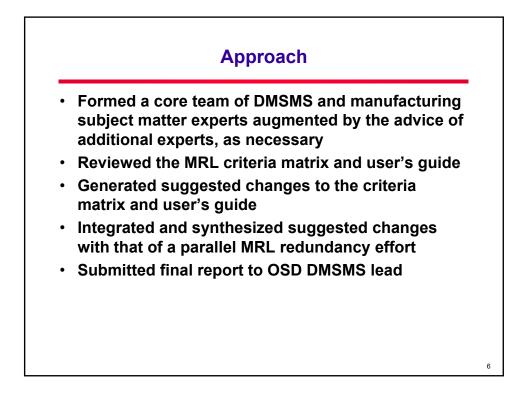


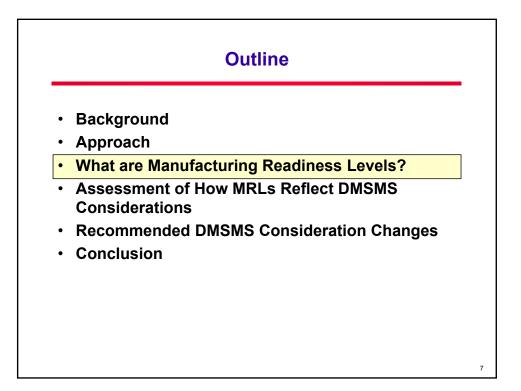






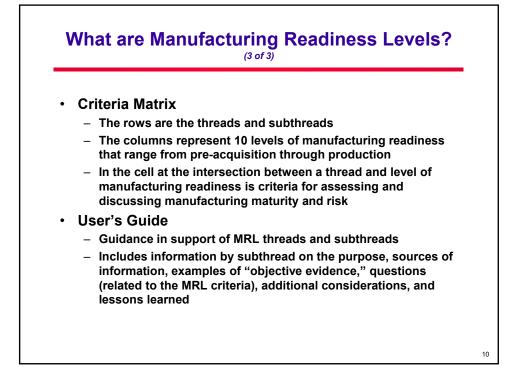


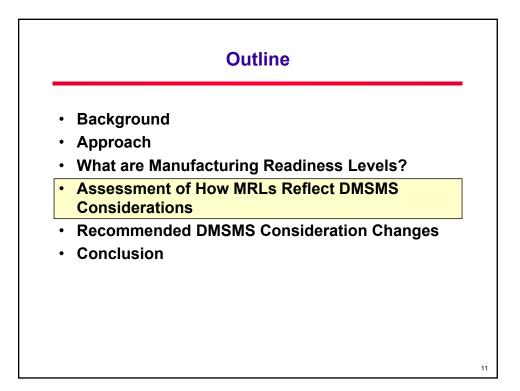


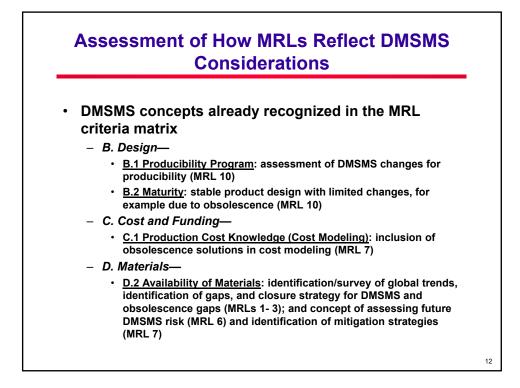


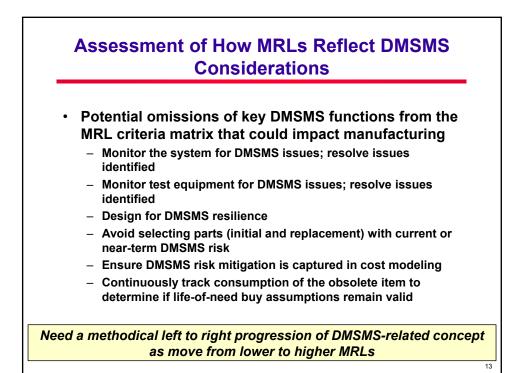


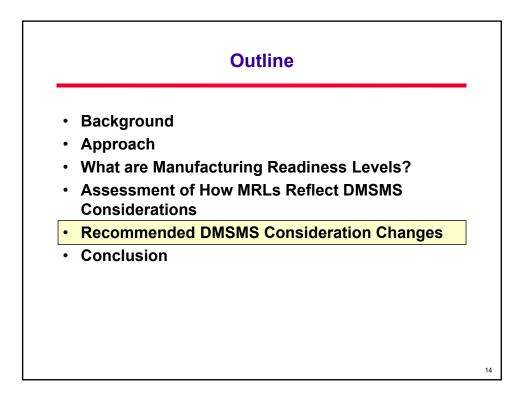
	Vhat are Manufacturi	of 3)	
	MRL Threads a	nd Su	<u>ub-Threads</u>
Α.	Technology and Industrial Base A.1 Industrial Base A.2 Manufacturing Technology Development	E.	Process Capability and Control E.1 Modeling & Simulation E.2 Manufacturing Process Maturity E.3 Process Yields & Rates
B.	Design B.1 Producibiity Program B.2 Design Maturity	F.	F.1 Quality Management F.2 Product Quality
C.	Cost and Funding C.1 Production Cost Knowledge C.2 Cost Analysis C.3 Manufacturing Investment Budget	G. H.	F.3 Supplier Quality/Management Manufacturing Workforce G.1 Manufacturing Workforce Facilities
D.	Materials D.1 Maturity D.2 Availability of Materials D.3 Supply Chain Management D.4 Special Handling	n. I.	H.1 Tooling/STE/SIE* H.2 Facilities Manufacturing Management I.1 Manufacturing Planning & Scheduling I.2 Materials Planning

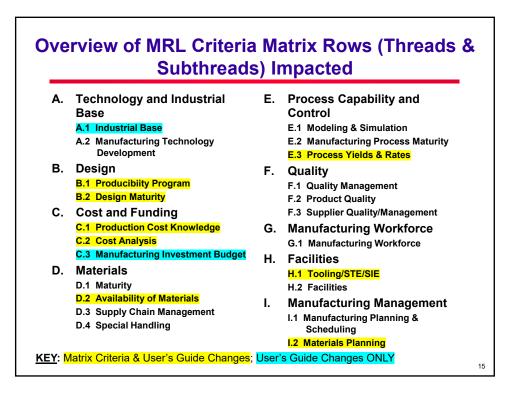


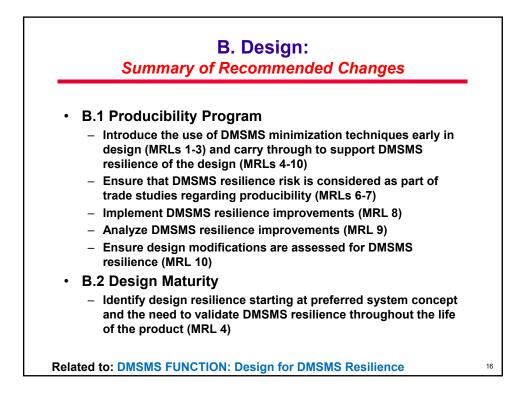


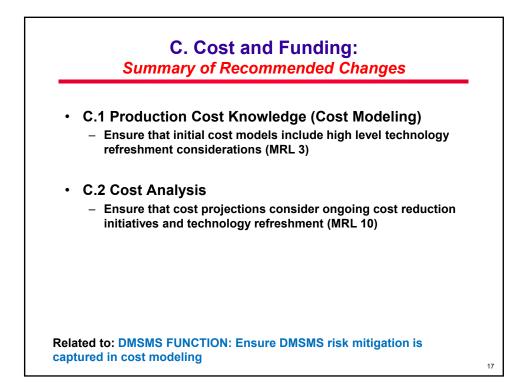


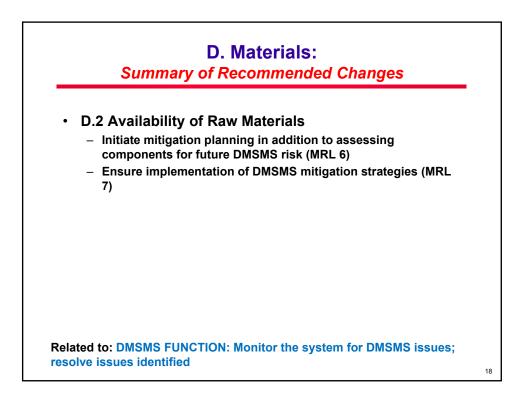


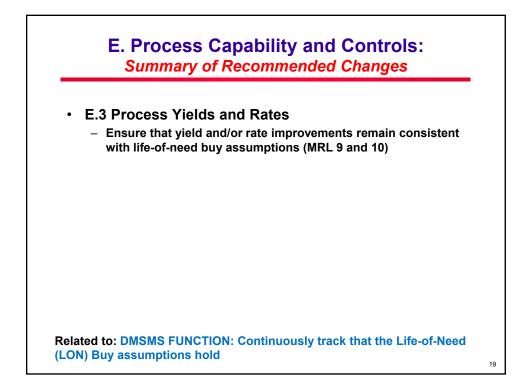


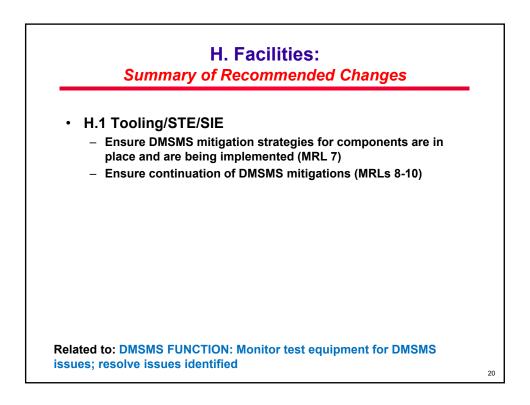


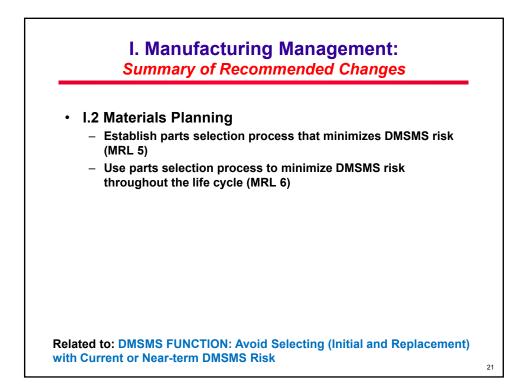


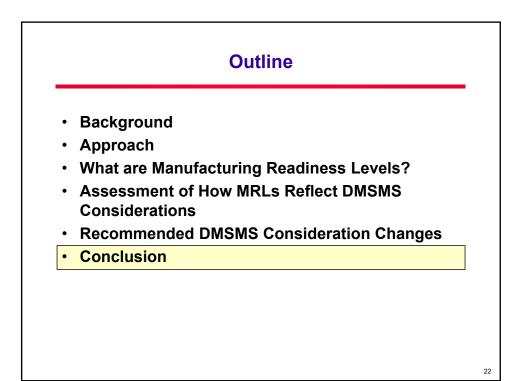


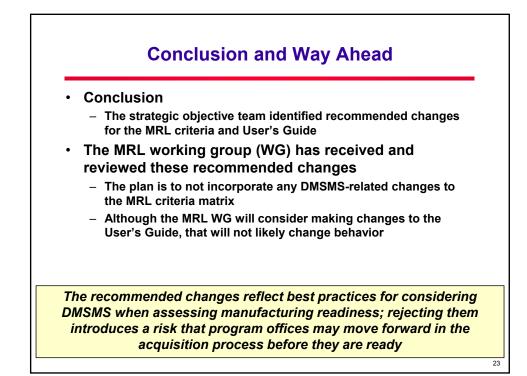


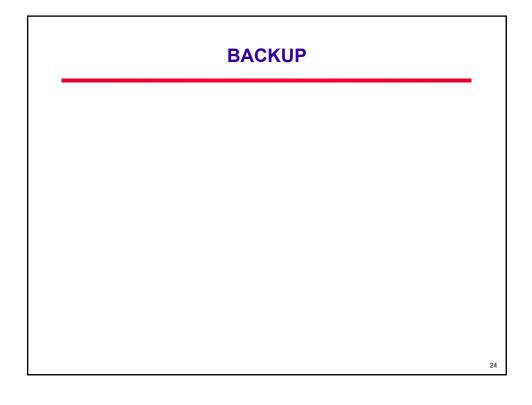












MRL Level	Criteria Statement	Rationale for Changes
	Hypotheses developed	The existing criteria matrix recognizes
	for cause-effect	the fact that DMSMS impacts
1	relationships between technology variables and producibility. Requirement established to use DMSMS minimization techniques in the system's operational design concept.	manufacturing maturity. Therefore, DMSMS resilience (i.e., DMSMS minimization techniques) should be included throughout the producibility program subthread wherever there is a criterion associated with design for producibility. DMSMS resilience at the earliest maturity levels should also incorporate the necessary enabling concept of DMSMS minimization requirements.

2	Studies performed to test hypotheses regarding cause-effect relationships between technology variables and producibility. Elements identified which have a potential impact to producibility (i.e., materials, processes, capabilities, limitations). Requirement established to minimize DMSMS in the design of all	Need to continue the concept that requirement should be in place to minimize DMSMS in potential material solution designs.
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MRL Level	Criteria Statement	Rationale for Changes
	System concept elements evaluated for	As initial performance
3	manufacturability and producibility	attributes are
	using experiments, modeling, and	established they
	simulation. Initial performance attribute	should include
	established to minimize DMSMS.	minimizing DMSMS in
		designs.
	Initial producibility and	Selection of a
	Initial producibility, and	
	manufacturability, and DMSMS	preferred materiel
4	resilience assessments in selection of	solution should also
-	preferred materiel solution completed.	include initial DMSMS
	Results considered in AoA documented	resilience
	in AS key components/technologies.	considerations.

MRL Level	Criteria Statement Producibility, and DMSMS resilience assessments of key technologies and components initiated.	Rationale for Changes An assessment of DMSMS resilience of key technologies and
5	Ongoing design trades consider manufacturing processes and industrial base capability constraints, and DMSMS resilience. Manufacturing processes assessed for capability to be tested and verified in production. Manufacturing processes assessed for influence on Q&S.	components should also be initiated and ongoing design trades should consider DMSMS resilience.

	B. Design: B.1 Producibility Program (5 of 8)			
MRL Level	Criteria Statement	Rationale for Changes		
	Producibility assessments and	DMSMS resilience		
	producibility, and DMSMS resilience	should be a factor of		
	trade studies (performance vs.	trade studies for key		
	producibility <mark>vs DMSMS risk</mark>) of key	technologies and		
	technologies/components completed.	components. DMSMS		
	Results used to shape AS, SEP, LCSP,	resilience should also		
	manufacturing and producibility plans,	be part of planning, to		
6	and DMSMS resilience planning for	include its insertion in		
	EMD or technology insertion programs.	the LCSP, for EMD and		
	Preliminary design choices assessed	technology insertion;		
	against manufacturing processes and	therefore, DMSMS		
	industrial base capability constraints.	resilience activities		
	Producibility enhancement efforts (i.e.,	should be initiated by		
	DFM, DFA, etc.) and DMSMS resilience	this level of maturity.		
	activities (i.e., MOSA) initiated.	,		
Related to	o DMSMS FUNCTION: Design for DMSMS Resilience	1		

MRL Level	Criteria Statement	Rationale for Chans
	Detailed producibility and DMSMS	DMSMS resilience
	resilience trade studies using	should be part of the
	knowledge of key design characteristics	completed trade
	and related manufacturing process	studies and DMSMS
	capability completed. Producibility	resilience activities
	enhancement efforts (i.e., DFM, DFA,	should be ongoing.
7	etc.) and DMSMS resilience activities	eneed are engenig.
	ongoing. Manufacturing processes	
	reassessed as needed for capability to	
	be tested and verified. Manufacturing	
	processes reassessed as needed for	
	potential influence on O&S.	

MRL Level	Criteria Statement Producibility and DMSMS resilience improvements implemented on system. Known producibility risks and issues	Rationale for Chans By this maturity level, DMSMS resilience- related improvements
-	managed for LRIP.	should be implemented.
9	Prior producibility and DMSMS resilience improvements analyzed for effectiveness during LRIP. Producibility and DMSMS resilience risks and issues discovered in LRIP managed for FRP.	Need to ensure that DMSMS resilience impacts on the build- baseline have been identified and addressed.

10	Criteria Statement Design producibility improvements demonstrated in FRP. Process producibility improvements ongoing. All modifications, upgrades, <u>DMSMS</u> - related and other changes assessed for producibility and DMSMS resilience.	Rationale for Chans DMSMS-related changes should be assessed for DMSMS resilience in addition to producibility.
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	B. Design: B.2 Design Maturity		
MRL Level	Criteria Statement	Rationale for Chans	1
	Form, fit, and function constraints,	The existing criteria matrix	1
	and manufacturing capabilities,	discusses form, fit, and	
	and DMSMS resilience identified	function constraints for the	
	for preferred systems concept.	preferred system concept.	
	SEP, LCSP, and T&E Strategy	There are form, fit, and	
	recognize the need for the	function constraints	
	establishment/validation of	associated with DMSMS	
4	manufacturing capability <mark>, DMSMS</mark>	resilience as well. That also	
	resilience, and management of	implies that DMSMS	
	manufacturing risk for the product	resilience should be	
	lifecycle. Initial KPPs identified for	recognized in the LCSP in	
	preferred systems concept. System	addition to the other	
	characteristics and measures to	documents mentioned.	
	support required capabilities		
	identified.		
Related to	o DMSMS FUNCTION: Design for DMSMS Resiliend	;e	

3	Criteria Statement Manufacturing cost estimates for system concepts developed. Initial cost models developed which include high-level process steps, technology refreshment considerations, and materials.	Rationale for Chans Technology refreshment, which is the periodic replacement of early generation or out-of-date technologies, enables continued supportability. Technology refreshment is a common occurrence in DOD systems. Production cost models do not always take this into account. Technology refreshment should be made explicit.
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MRL Level	Criteria Statement	Rationale for Chans
10	FRP cost goals met. Cost	The existing criteria imply
	projections consider	accurate cost projections are
	ongoing cost reduction	based only on planned cost
	initiatives ongoing and	reduction initiatives. The impact of
	technology refreshment.	technology refreshment on cost
		projections could be significant
		and, therefore, technology
		refreshment considerations should
		be included.

MRL Level	Criteria Statement	Rationale for Changes
	Availability risks and issues addressed to	In MRL 7, mitigation
	meet EMD build. Long-lead items	efforts are started, so
6	identified. Components assessed for	planning is necessary
-	future DMSMS risk, mitigation planning	at MRL 6.
	initiated.	
	Availability risks and issues addressed to	At MRL 7, while the
	meet LRIP builds. Long lead	strategies are in
	procurements identified and mitigated.	place, resolutions to
7	DMSMS mitigation strategies for	DMSMS issues have
	components in place and are being	begun to be
	implemented.	implemented.

E. Process Capability and Control: E.3 Process Yields and Rates (1 of 2)					
MRL Level	Criteria Statement	Rationale for Chans			
	LRIP yield and	The criteria matrix already recognizes that			
	rate targets	manufacturing will be impacted if a DMSMS			
	achieved. Yields	issue occurs, but it does not recognize how			
	and rates required	yield can lead to the reoccurrence of			
	to begin FRP	DMSMS issues. Yield at higher levels of			
	refined using	assembly impacts the adequacy of previous			
	LRIP results. Yield	life-of-need buys of components in the			
9	and/or rate	assembly (because faulty assumptions could			
	improvements	have been made in determining the quantity			
	ongoing <mark>,</mark> as	to buy). Faulty assumptions that			
	necessary,	overestimated yield could lead to the			
	consistent with	unnecessary reoccurrence of a DMSMS			
	life-of-need buy	issue that wouldn't have happened if			
	assumptions.	DMSMS assumptions about yield matched			

10	criteria statement FRP yield and rate targets achieved. Yield and/or rate improvements ongoing, as necessary, consistent with	Rationale for Chans Yield impacts the adequacy of life-of-need buys that have been made. The problem is that inadequate yield could lead to the unnecessary reoccurrence of a DMSMS issue that would not have happened if DMSMS assumptions about yield matched actual yield. If a DMSMS issue reoccurs, manufacturing will be impacted.		
	life-of-need buy assumptions			

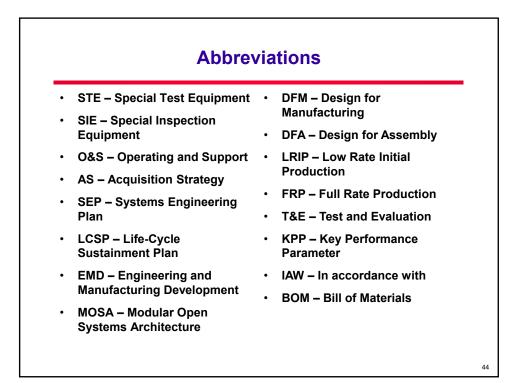
H. Facilities: H.1 Tooling/STE/SIE (1 of 3)					
MRL Level	Criteria Statement	Rationale for Changes			
	Design and development	Tooling, test, and inspection			
	efforts for production	equipment have DMSMS issues just			
	tooling and STE/SIE	like the system itself, in fact, such			
	initiated with STE/SIE	equipment are especially prone to			
	validation plans	serious DMSMS issues. The			
	complete. Manufacturing	processes to identify, assess, and			
-	equipment maintenance	resolve DMSMS issues are therefore			
/	strategy developed.	applicable to tooling, test, and			
	DMSMS mitigation	inspection equipment; once			
	strategies for	established, those processes are			
	components in place	continuously used throughout the			
	and are being	supply chain for the life cycle of the			
	implemented.	system. This parallels the words from			
		MRL 7 in the Availability subthread.			

H.1 Tooling/STE/SIE (2 of 3)				
MRL Level	Criteria Statement Tooling, test, and inspection equipment proven on pilot line and additional requirements identified for LRIP. STE/SIE validated as part of pilot validation IAW validation plan. Manufacturing equipment maintenance demonstrated on pilot line. DMSMS mitigation	Rationale for Changes At this level of maturity a process should have been established that will then continuously identify, assess, and resolve DMSMS issues throughout the supply chain for tooling, test, and inspection equipment for the life cycle. This parallels the words from MRL 8 in the Availability subthread.		
	ongoing.			

MRL Level Criteria Statement Rationale for Changes						
	All tooling, test and inspection	This parallels the				
	equipment proven in LRIP and	words from MRL 9 in				
	additional requirements identified for	the Availability				
9	FRP. Manufacturing equipment	subthread.				
5	maintenance schedule demonstrated.					
	STE/SIE validation maintained as					
	necessary. DMSMS mitigation ongoing.					
	Proven tooling, test and inspection	This parallels the				
	equipment in place to support maximum	words from MRL 10 in				
10	FRP. Planned equipment maintenance	the Availability				
10	schedule achieved. STE/SIE validation.	subthread.				
	DMSMS mitigation ongoing.					

MRL Level	Criteria Statement	Rationale for Chans
	Make/buy evaluations initiated and	Materials planning relies on
	include production considerations	parts selection. That part
	for pilot line, LRIP, and FRP needs.	selection process should
	Lead times and other materials	take DMSMS risk into
	risks and issues identified. Parts	account, otherwise there
	selection process that minimizes	will be manufacturing
5	DMSMS risk established.	maturity risks associated
	Division loc cotabiloned.	with materials availability
		and design that are already
		recognized in the criteria
		matrix and augmented by
		the suggested changes.

MRL Level	Criteria Statement Most material make/buy decisions	Rationale for Chans Materials planning relies on
	complete, material risks and issues	parts selection. The parts
	identified, and mitigation plans	selection process should
	developed. BOM initiated. Part	take into account DMSMS
6	selection process that minimizes	risk and should be
	DMSMS risk in use throughout the	established for MRL 5. That
	l <mark>ife cycle.</mark>	process should be in use
		and continue to be used
		throughout the life cycle.



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