



DEFENSE BUSINESS BOARD

Report to the Secretary of Defense

**Best Business Practices for
Fixed-Price Contracting**

Report FY10-03

- **Recommendations on when and how fixed-price contracting might reduce acquisition costs and program risks.**

January 2010

Best Business Practices for Fixed-Price Contracting

TASK

The Under Secretary of Defense, Acquisition, Technology, and Logistics (USD (AT&L)) who, in an effort to reduce acquisition program costs, requested the Defense Business Board (DBB) form a Task Group to provide recommendations on how the Department of Defense (DoD) might better utilize fixed-price contracts. He asked the Board to consider the use of fixed-priced contracting across the full spectrum of the acquisition life cycle and provide recommendations, based on best business practices, on when and how fixed-price contracting might provide savings and reduce risk. He also requested the Task Group develop a rule set for using fixed-price contracts rather than other contract types, and particularly, consider the use of an appeals review and/or process within the rule set to help the DoD assure optimum contract type selections. A copy of the official Terms of Reference (TOR) may be found at **Appendix A**.

Mr. Mark Ronald chaired the Task Group, supported by Mel Immergut; DBB Senior Fellow, Neil Albert; and DBB Consultant, Pierre Chao. The Task Group Sponsor was Dr. Ashton Carter, (USD (AT&L)). The Task Group Executive Secretary was Kelly S. Van Niman, DBB Deputy Director.

PROCESS

In addition to relying on their own professional expertise with the defense acquisition system, the Task Group researched, as well as interviewed, current and past government leaders who have dealt with the Federal Acquisition Regulations (FAR), the Defense Federal Acquisition Regulations (DFAR), and DoD rules and processes contained in DoD Instruction 5000.02 (Operation of the Defense Acquisition System, December 8, 2008). Specifically, the Task Group met with leaders in the office of the USD AT&L, the Defense Contract Management Agency, and the Office of Management and Budget (OMB). To develop a balanced perspective on the challenges with using fixed-price contracts, the Task Group met with industry leaders from the defense industrial base, both

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primary and secondary suppliers, defense industry trade associations, and the Australian Defense Material Organization.

The Task Group presented their findings and recommendations to the full Board during the January 21, 2010 quarterly meeting. A copy of the brief containing the final recommendations as approved by the Board may be found at **Appendix B**.

BACKGROUND

DoD's acquisition programs often experience large cost overruns. From 2000 to 2007, the total acquisition budget for all Major Defense Acquisition Programs more than doubled – from \$783 billion to \$1,702 billion (see DBB Report FY09-4, "Focusing a Transition"). This rate of cost growth is unsustainable and must be brought under control. Furthermore, these excessive costs consume money that otherwise might be used to sustain force structure. Starting in the 1950s, DoD had a long history of contract administration policies which vacillated between the use of cost-plus and fixed-price contracts as a means of controlling this growth. Unfortunately, history has shown that the extreme use of either contract type has proved incapable of controlling ballooning acquisition cost growth. (See **Appendix B** for an historical overview.)

The FAR represents over 40 years of historical wisdom and states a clear preference for the use of fixed-price contracts when program risks are low, and cost-type contracts when program risks are high. The Department clarifies the implementation of this regulation in the DFAR, which states that cost-reimbursement contracts are preferred for development efforts, particularly major weapons systems, because DoD assesses program risks as being too great.

The DFAR also guides program managers to use fixed-price contracts when program risks have been reduced to the extent that realistic pricing can occur (e.g., when a program has reached the final stages of development and technical risks are minimal). The DFAR also directs a firm fixed-price contract be considered when the requirement recurs or as quantity production begins.

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The DFAR strongly discourages Time and Material (T&M) contracts and only allows T&M contracts to be used when it is not possible at the time of placing the contract to estimate accurately the extent or duration of the work or to anticipate costs with any reasonable degree of confidence. The FAR allows the use of T&M contracts for commercial services but strongly encourages program managers to maximize the use of fixed-price contracts for future acquisitions of the same or similar requirements.

On March 4, 2009, President Barak Obama reiterated the FAR's preference for fixed-price contracts, and directed the OMB to issue government-wide guidance for using and overseeing all contract types.¹ In July 2009, OMB issued guidance focused on how agencies should obtain savings by improving their contract review process, analyzing risk, assessing performance, and strengthening the acquisition workforce and practices.² In October 2009, OMB again issued a non-regulatory report that provided further management guidance regarding contract type with a goal toward greater use of fixed-price contracts where practical.³

In reaction to the President's March 2009 direction, DoD's acquisition policy leaders, specifically, the office of Program Acquisition and Strategic Sourcing (PASS), located within the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, Defense Procurement and Acquisition Policy (DPAP), expressed a preference for cost-plus contracts to switch to fixed-price contracts when development of a major weapons program concludes Preliminary Design Review. At the time of this report, no formal guidance was issued either to incorporate this preference into policy, or to create awareness for contract officers to seek early opportunities to move from cost-plus contracts into fixed-priced contracts.

Industry had a more cautious reaction to the early use of fixed-price contracts. Industry leaders testified before Congress that fixed-price contracting was most suitable for weapon systems with a stable design and based upon verified specifications, (i.e., testing complete Technology Readiness Level 8 – Technology Readiness Level 9 (TRL 8 – TRL 9)). (See **Appendix B**, January 2010 Briefing, Charts 13-14) Industry also

1 Federal Register (vol. 74, no.43) Friday, March 6, 2009/Presidential Documents

2 <http://www.whitehouse.gov/omb/assets/memoranda--fy2009/m-09-25.pdf>

3 http://www.whitehouse.gov/omb/assets/procurement_gov_contracting/increasing_competition_10272009.pdf

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cautioned against assuming that the sum of multiple new technologies, each at TRL 6, for example, equated to an integrated system at TRL 6. In essence, fixed-price contracts were not suitable for contracts with high cost risks such as development of major weapons systems.

OBSERVATIONS

The Board observed that the FAR, DFAR, and DoD Policies lack sufficient specificity with respect to the definition of risk, and therefore, further clarification was needed. Recent studies collectively showed that the biggest problems driving up the cost of weapons systems are: (1) inadequate planning of requirements, (2) poor assessment of risks, (3) cost realism, (4) stability of requirements, and (5) quality of program leadership – not contract type. (See Chart 12 of **Appendix B**).

In regard to services contracts the Board observed that cost growth results from poor task definition and a tendency to defer to T&M type contracts. This practice is inconsistent with FAR 16.6 and DFAR 216.601 guidance.

Additionally, the Board noted that contracting officers frequently fall into the natural “creatures of habit” behavior, and use the contract type they are most familiar with, rather than conducting an objective review of the most appropriate contract for the requirement. Culturally, these behaviors need to be recognized and addressed through focused training on contract type selection.

RECOMMENDATIONS

Based on the findings above, the Board approved three overarching recommendations to help DoD better utilize fixed-price contracting. The Board also recommended guidelines on the use of fixed-price contracting and an approach to clarify the definition of risk. A summary of these recommendations is below. A full listing of the final recommendations is at **Appendix B**.

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1. Add specific guidelines regarding contract selection to DoD Instruction 5000.02 and the Defense Acquisition Guidebook to:
 - a. Clarify the application of the term “risk” by adding TRL as a major determining factor, among others, to selecting contract type
 - b. Delineate a clear hierarchy of contract preference where fixed-price is first, then cost-plus, and then T&M
 - c. Divide service contracts over \$1B into smaller increments with contract type determined on a task-by-task basis
 - d. Integrate these guidelines into the acquisition life-cycle

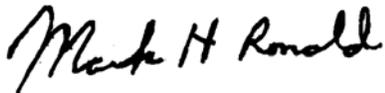
2. Enforce adherence to rules through peer review, management oversight and new training – specifically:
 - a. Clarify and enforce the requirement for a Peer Review for supplies (i.e., weapons systems) contracts, not just services contracts
 - b. Add a review of contract type to the list of Pre-Award Peer Review topics
 - c. Develop a computer-based training module by the Defense Acquisition University to expand the education of contracting officers on the appropriate application of each contract type

3. Do not allow the selection of contract type to become prescriptive – specifically:
 - a. Require the Director of Cost Assessment and Program Evaluation to conduct an independent assessment of TRL, which should be used as a major determining factor in selecting contract type
 - b. Modify DoD Instruction 5000.02 to reflect the FAR’s guidance that: (1) cost-type contracts should strive to be incentive-based, (2) fixed-price contracts should also consider incentives to help manage government and contractor risk, and (3) award-fee contracts should be considered only when contractor performance cannot be measured objectively

CONCLUSION

As the Department looks to better utilize fixed-price contracting, it is critical to look at history, lest they be destined to repeat the mistakes of the past. History clearly shows that extreme policy mandates for one type of contract versus another are not effective cost control management tools. The Board is hopeful that a clear hierarchical delineation of contract types and a clearer definition of “risk” as related to technology development (e.g., TRL) will bring clarity and consistency to contract type selection. However, implementation across the Department will require the Deputy Secretary to direct the Service Acquisition Executives to align their policies and programs with these recommendations, and to implement metrics to measure and track training for contracting officers. Institutionalizing these best practices will be critical to the Department’s success in achieving real cost savings necessary for the recapitalization of our nation’s forces.

Respectfully submitted,



Mark H. Ronald
Task Group Chairman

APPENDIX A
TERMS OF REFERENCE

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DEPUTY SECRETARY OF DEFENSE
1010 DEFENSE PENTAGON
WASHINGTON, DC 20301-1010

JUL 17 2009

MEMORANDUM FOR CHAIRMAN, DEFENSE BUSINESS BOARD

SUBJECT: Terms of Reference – Task Group on “Reducing Acquisition Costs by Applying Best Business Practices to Fixed-Price Contracting”

In an effort to reduce acquisition program costs, I request the Defense Business Board form a Task Group to provide recommendations on how the Department might better utilize fixed-price contracts. The Group should consider the use of fixed-priced contracting across the full spectrum of the acquisition life cycle and provide recommendations, based on best business practices, on when and how fixed-price contracting might provide savings and reduce risk. Also, request the Task Group develop a rule set for using fixed-price contracts over other contract types. The Task Group should consider the use of an appeals review and/or process within the rule set to help the Department assure optimum contract type selections.

Mr. Mark Ronald will serve as Task Group chair and present his findings and draft recommendations to the full Board at the October 2009 quarterly meeting. The Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics will provide the group with technical support. Ms. Kelly Van Niman from the DBB staff will serve as the Secretariat Representative.

As a subcommittee of the Board, and pursuant to the Federal Advisory Committee Act of 1972, the Government in the Sunshine Act of 1976, and other appropriate federal regulations, this Task Group shall not work independently of the Board’s charter, and shall report its recommendations and advice to the Board for full public deliberation and discussion. The Task Group does not have the authority to make decisions on behalf of the chartered Board, nor can they report directly to the Agency or any federal officer or employee who is not also a Board member. This Task Group will avoid discussing “particular matters” within the meaning of Section 208 of Title 18, U.S. Code, and will not cause any member to be placed in the position of acting as a procurement official.



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APPENDIX B

BRIEF CONTAINING THE FINAL RECOMMENDATIONS
PRESENTED TO THE FULL BOARD ON JANUARY 21, 2010

DEFENSE BUSINESS BOARD



Best Business Practices for Fixed-Price Contracting

January 21, 2010

Task Group Overview

TASK: In an effort to reduce acquisition program costs, the Group will provide recommendations on how the Department might better utilize fixed-price contracts. The Group will consider the use of fixed-priced contracting across the spectrum of the acquisition life cycle and provide recommendations, based on best business practices, on when and how fixed-price contracting might provide savings and reduce risk. The Group also will provide a rule set for using fixed-price contracts over other contract types.

TASK GROUP:

Mark Ronald (Chair)
Mel Immergut

Neil Albert
Pierre Chao

Executive Secretary

Kelly S. Van Niman, DBB Deputy Director

Methodology

■ INTERVIEWS

- Acquisition Technology & Logistics
- Director, Defense Contract Management Agency
- Office of Management and Budget (OMB)
- Tier one and tier two defense suppliers
- Industry Associations
- Australian Defense Material Organization

■ RESEARCH

- Weapons Systems Acquisition Reform Act of 2009
- DoD Instruction 5000.02 (December 8, 2008), Operation of the Defense Acquisition System
- Federal Acquisition Regulations (FAR) and Defense Federal Acquisition Regulations (DFAR)
- Defense Acquisition Guidebook
- Historical program performance (cost growth)

Government Assumptions

- DoD relies on state-of-the-art technology as a strategic advantage on the battlefield, therefore, many programs have inherent risks
- Fixed-price contracting is not used as frequently as it could/should be used
- More frequent use of fixed-price contracting would help control acquisition cost growth
 - Fixed-price development contracts improve cost credibility with gov't.
- Increasing contractor's share of risk in development contracting will sharpen competition and result in more economical and efficient methods of development and production, but the initial price will be higher
- Service contracts are poorly defined which results in cost growth mainly due to use of Time and Material (T&M) contract structure

Historical Perspective

- Long history of pendulum swings between use of cost-plus and fixed-price contracts after a period of cost growth
- 1960's experiment in fixed priced development contracts – Total Package Procurement (TPP)
 - Heavy use of cost-plus contracts in the 1950s in efforts to push technology forward resulted in large cost growth (average aircraft program 220% above baseline).
 - Reaction in 1960s was TPP – single fixed price contract for Research and Development (R&D) through Low-Rate Initial Production (LRIP) – initial production batches. First used by USAF in 1964.
 - C-5A, F-14, SRAM missile, Cheyenne helicopter, LHA ship, F-111
 - Significant cost growth as a result of inaccurate cost estimates, technological unknowns, inflexible contract modification mechanisms and inflation
 - Two major contractors went to brink of bankruptcy and needed financial rescue because of large cost overruns
 - Practice abandoned in 1971, DoD 5000.1 prohibits TPP and establishes policy favoring use of cost-based contracts for development efforts

Historical Perspective

- 1980's use of fixed price development
 - A return to cost growth in 1970s and early 1980s, prompted Navy and others to reintroduce fixed-price contracts in mid-1980s.
 - Hold “contractors feet to the fire”
 - A-12, V-22, F-14D, T-45, T-46, C-17, AMRAAM, DIVAD
 - Inaccurate cost estimates, technological unknowns, changing requirements plagued the programs
 - Programs required major restructuring, one major contractor needed financial rescue because of cost growth, one contract (A-12) is still in litigation
 - 1988 Congress inserted language requiring reporting when DoD intended to use fixed price contracts for development programs
- In 1990's and early 2000's – another return to use of cost-plus contracting for R&D
- 2009 study by the Institute for Defense Analysis analyzing budgeted cost/actual cost (Cost Performance Index) found no significant relationship between contract type and cost growth.

Current Policy and Regulation on Contract Type Selection

▪ **DoD Instruction 5000.02 (December 8, 2008)**

- Requires the Milestone Decision Authority (USD AT&L) to select contract type for a *development* program of a Major Defense Acquisition Program (MDAP) at Milestone B (section 818 of P.L.109-364 (Reference (o)))
 - Must provide written justification for NOT selecting fixed-price
- Service Acquisition Executive for each Military Service and USD AT&L (or designee) select contract type for services contracts as per FAR guidance (Part 12 and Part 16)

▪ **Defense Federal Acquisition Regulation (Part 216.104-70) (Part 216.601)**

- Cost-reimbursement contracts preferred for development efforts, particularly major weapons systems
- Should use fixed-price contracts when risk has been reduced to the extent that realistic pricing can occur, e.g., when program has reached final stages of development and technical risks are minimal
- Time and Material contracts strongly discouraged.

Current Policy and Regulation on Contract Type Selection

▪ Federal Acquisition Regulation (Part 16)

- A firm fixed-price contract shall be used when the risk involved is minimal or can be predicted with an acceptable degree of certainty (Part 16.103(b))
- As the requirement recurs or as quantity production begins...a fixed-price contract should be considered (Part 16.104 (d))
- A time-and-materials contract may be used only when it is not possible at time of placing the contract to estimate accurately the extent or duration of the work or to anticipate costs with any reasonable degree of confidence (Part 16.601)
 - T&M contract provides no positive profit incentive to the contractor for cost control
 - Subcontracts for supplies and *incidental* services

▪ Federal Acquisition Regulation (Part 12)

- Requires use of fixed price contracts for the acquisition of commercial items, but allows for T&M contracts for commercial services and maximize use of fixed-price contracts for future acquisitions of the same or similar requirements

Current policy relies heavily on determination of risk. Uneven application of regulations across DoD procurement agencies.

Recent Government Initiatives

- **Office of Management and Budget** – March 4, 2009, President reiterated Federal Acquisition Regulations' preference for fixed-price contracts, and asked OMB to issue government-wide guidance for using and overseeing all contract types for the purpose of reducing program cost
 - Draft July guidance focused on how agencies should obtain savings by improving their contract review process, analyzing risk, assessing performance, and strengthening the acquisition workforce and practices
 - Final October memorandum re-enforced the July memo, and provided further guidance for better management and understanding of the appropriate contract type to be used – no requirements to use one type vs. another
 - To support this guidance, FAR changes are in process to better define the purpose and use of cost-reimbursable contracts

Recent Government Initiatives

- **Acquisition, Technology & Logistics (AT&L)**
 - Office of Defense Procurement, Acquisition Policy and Strategic Sourcing conducting Independent Management Reviews (“Peer Reviews”) of weapons systems and services contracts over \$1 billion, however, DoD Instruction 5000.02 only requires for services contracts
 - Government does not analyze/review contract type as element of Peer Review process
 - Review Metric – If costs to complete the program and associated risks cannot be identified and monetized at Preliminary Design Review (PDR), then program is not ready to advance
 - U.S.C. 2366 (b) is the statutory authority requiring all technologies in an Acquisition Category (ACAT) program be certified at Technology Readiness Level (TRL) 6 (having been demonstrated in a relevant environment) prior to Milestone B (see Appendix B for TRL definitions)
 - Expressed a preference to switch to fixed-price contracting when development of a program concludes (PDR) but no policy change has been implemented
 - Feels that there is too wide a use of T&M-contracts on services programs (prefers fixed-price or cost-plus contracts – but no policy change has been implemented)

Industry Perspective

- Fixed-price contracting is most suitable for weapon systems contracts with stable design and based on verified specifications, i.e., testing complete (TRL 8 – TRL 9)
 - Not suitable for contracts with high cost risks such as development of major weapons systems because risk-reward ratio is unacceptable to shareholders
 - Sum of multiple new technologies each at Technical Readiness Level (TRL) 6 does not equate to an integrated system at TRL 6
- Fixed-price contracts can equate to more risk for the contractor – edging out small and medium companies that cannot afford the risk because of limited financial resources
- Rigorous government oversight of fixed-price contracts (equal to cost-plus contracts) results in more costs
- Contract type for services varies based on procuring agency's preference for contract type, vice type of service being acquired
- Industry frequently forced to take low profit margins on cost-plus and T&M services contracts – not consistent with private sector margins and drives best talent to private sector

Findings

- Guidance in FAR and DFAR reflects historical perspective, however, leaves too wide of a range for interpretation, and further guidance is needed.
- Biggest problems driving cost overruns are poor planning and task definition (inadequate planning of requirements and poor assessment of risks), cost realism, stability of requirements and quality of program leadership – not contract type
 - Industry and government both play a role (validated by OMB in October 2009 memo).
- Although more money is spent on services, more scrutiny/oversight and congressional attention is directed at major weapon systems.
- Contracting officers frequently use the contract type they prefer or are most familiar with rather than the most appropriate for the contract purpose.
- Fixed-price incentive-fee contracts for both weapon systems development and services contracts pose the challenge of identifying what to incentivize and how to measure success.
- Government does not adequately plan for a transition of contract type across the acquisition life-cycle.
 - Best run private companies adapt contract type as technology matures

RECOMMENDATIONS

1. Add specific guidelines regarding contract selection to DoD Instruction 5000.02 and the Defense Acquisition Guidebook:
 - A. Consistent with existing FAR and DFAR, delineate a clear hierarchy of contract preference in DoD Instruction 5000.02 and rigorously enforce compliance.
 - Hierarchy of use: preferred choice is fixed-price, then cost-plus, then T&M-contracts. As per FAR and DFAR:
 - Fixed-price type contracts should be used when services provide for defined deliverables or requirements to meet specific milestones.
 - Cost-type contracts should be used when the degree of uncertainty about cost, schedule and task precludes the use of fixed-price.
 - T&M-contracts should be used only when it is not possible to accurately estimate the extent or duration of the work or to anticipate costs with any reasonable degree of confidence. Subcontractor labor should be included in the labor categories, not the subcontract .
 - B. Clarify the application of the FAR and DFAR general term “risk” by adding a section to DoD Instruction 5000.02 on Selection of Contract Types to include use of Technology Readiness Levels.
 - Cost-type contracts should be used for complex systems, and particularly major weapon systems, if TRL has not achieved TRL 7 for the system & all its elements.
 - When the achieved TRL is between 7 and 8, a form of cost or cost incentive type contract should be considered.
 - Fixed-price type contracts can be considered for systems that have demonstrated TRL 8 and should be used when TRL 9 is achieved.
 - C. Modify DoD Instruction 5000.02 to require service contracts over \$1B to be broken into tasks of smaller increments with the contract type determined on a task-by-task basis.
 - Based on results of earlier tasks, use fixed-price contracts for future tasks of similar nature under *same* contract
 - D. Modify Defense Acquisition Guidebook to integrate these recommendations into the acquisition life-cycle process.

RECOMMENDATIONS

2. Modify DoD Instruction 5000.02 to add the requirement for an independent assessment of the TRL by the Director of Cost Assessment and Program Evaluation, since TRL should be a major determining factor for selecting contract type, consistent with recommendation #1 (B).
3. Modify DoD Instruction 5000.02 to reflect the FAR:
 - A. Cost-type contracts should strive to be “incentive-based” where practical with clear performance measures for success.
 - B. Fixed-price contracts should also consider incentives to help manage government and contractor risk.
 - C. Award-fee contracts should be considered only when contractor performance cannot be measured objectively.

RECOMMENDATIONS

4. Enforce adherence to rules through peer review, management oversight and new training:
 - A. To clarify the application of Independent Management Review (“Peer Reviews”) for supplies, replicate the details of Pre-Award Peer Reviews at the end of Enclosure 2 (Procedures) (reference Section 6(a) of Enclosure 9 of DoD Instruction 5000.02).
 - B. Modify DoD Instruction 5000.02 to add a review of contract type at Pre-Award Peer Reviews, e.g. prior to issuance of solicitation for competitive contracts and at the pre-business clearance phase for non-competitive contracts.
 - C. Emphasize these new recommendations by expanding education of contracting officers & program managers on appropriate application of each contract type to ensure a broad understanding of the rationale for selection.
 - Direct the Defense Acquisition University to develop a computer-based training module on the application of contract type to teach regulations but also include real-life examples and interactive testing to ensure understanding
 - DAU should collect training metrics to ensure compliance
 - USD(AT&L) and Service Acquisition Executive should review DAU training metrics to enforce compliance

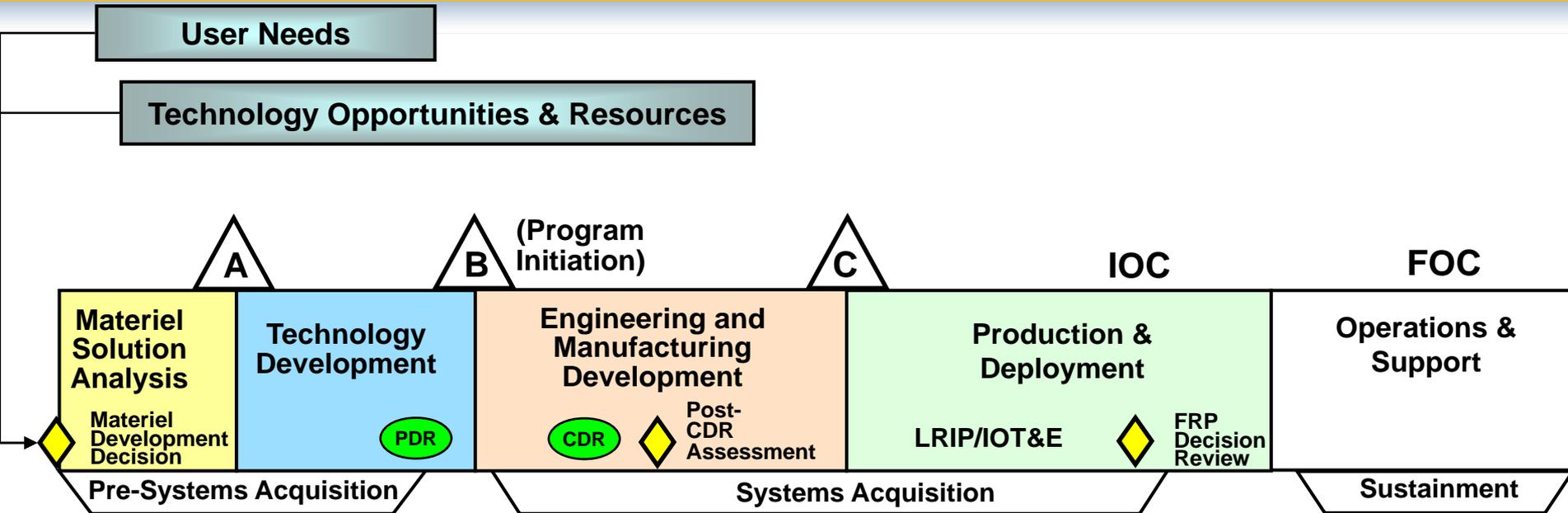
RECOMMENDATIONS

5. Deputy Secretary and USD AT&L should direct the Service Acquisition Executives to align their programs and policies with these guidelines

Outbriefs

- Deputy Secretary of Defense
- Under Secretary of Defense (Acquisition, Technology and Logistics)
- Office of Management and Budget
- Defense Contract Management Agency
- Defense Acquisition University

Acquisition Life Cycle



◆ Decision Point
 △ Milestone Review
 ● PDR Preliminary Design Review*
 ● CDR Critical Design Review

IOC – Initial Operational Capability
 FOC – Full Operational Capability
 LRIP – Low-Rate Initial Production
 FRP – Full-Rate Production
 IOT&E – Initial Operational Test and Evaluation

* The Weapons Systems Acquisition Reform Act of 2009 requires the Milestone Decision Authority (MDA) to certify, prior to Milestone B approval, that (among other things) the MDA “has received a preliminary design review and conducted a formal post-preliminary design review assessment, and . . . on the basis of such assessment that the program demonstrates a high likelihood of accomplishing its intended mission”

Technology Readiness Level	Description
1. Basic principles observed and reported.	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.
2. Technology concept and/or application formulated.	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.
3. Analytical and experimental critical function and/or characteristic proof of concept.	Active research and development is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4. Component and/or breadboard validation in laboratory environment.	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.

Technology Readiness Level	Description
5. Component and/or breadboard validation in relevant environment.	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
6. System/subsystem model or prototype demonstration in a relevant environment.	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.
7. System prototype demonstration in an operational environment.	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.

Technology Readiness Level	Description
8. Actual system completed and qualified through test and demonstration.	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
9. Actual system proven through successful mission operations.	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

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Questions?

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Business Excellence In Defense of the Nation