ANALYSIS OF ALTERNATIVES COST ESTIMATING HANDBOOK

OFFICE OF THE SECRETARY OF DEFENSE

COST ASSESSMENT AND PROGRAM EVALUATION, JULY 2021

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Contents

1. Introduction

A. Purpose

This handbook was prepared by the Office of the Secretary of Defense (OSD) Director of Cost Assessment and Program Evaluation (DCAPE) for use by OSD, the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the DoD (referred to collectively in this handbook as the "DoD Components") in developing life-cycle cost estimates in support of analysis of alternatives (AoA). The information contained herein is intended to guide DoD cost estimators in planning, execution, presentation, and documentation of analysis required to support multiple aspects of an AoA. While this handbook contains original material not available in other DoD issuances, it frequently refers to a wide range of existing DoD issuances on related topics, primarily to promote consistency in regard to codified cost analysis requirements and best practices.

B. Applicability

This handbook is focused on best practices, analytic methods, and data collection for cost analysis prepared in support of AoAs within the DoD. While the focus of this guide is primarily AoAs conducted in support of Major Defense Acquisition Programs (MDAPs), the information captured herein may be useful for conducting AoAs in support of any Adaptive Acquisition Framework (AAF) pathway. The DoD may use this cost analysis to support multiple requirements in close proximity to the AoA, including but not limited to:

- Establishing an initial estimate of the total cost to DoD and the Federal Government of developing, procuring, testing, fielding, operating, sustaining, and disposing each alternative over its expected life-cycle;
- Offering initial assessments of uncertainty and risk in both program cost and schedule, which the DoD cost and acquisition communities can use to inform follow-on research and data collection efforts;
- Identifying cost contributors and/or drivers, which lead to significant differences in life-cycle costs between alternatives or, alternatively, have a significant effect on the overall cost of the resulting program, in general;
- Providing a time-phased itemization of costs for each alternative by funding category and appropriation, which can inform the DoD's Planning, Programming, Budgeting, and Execution (PPBE) process;

- Conducting Cost as an Independent Variable (CAIV)-type analyses to identify solutions that, given a fixed cost, provide greatest capability or effectiveness;
- Assessing the affordability of the resulting acquisition program;
- Documenting compliance with the requirements of 10 U.S. Code 2366a and 2366b;
- And informing the Major Defense Acquisition Program Goal Development Procedures, as required by 10 U.S. Code 2448a and DoDI 5000.85.

Cost analysis conducted in accordance with the guidance in this handbook should be well suited to support or inform the AoA and any of the associated requirements discussed above.

C. Overview

The remainder of this handbook is organized as follows:

- Section 2 introduces the critical terminology used throughout this handbook.
- Section 3 provides a brief overview of the OSD CAPE process for issuing AoA Study Guidance, and discusses the standard elements of the "Cost Guidance" section.
- Section 4 is a discussion of life-cycle cost estimates produced in support of an AoA, with a specific focus on comparative cost analysis and cost elements (e.g., Fully Burdened Cost of Fuel), which are unique to the AoA process in DoD cost estimating.
- Section 5 presents and describes a list of AoA Cost Analysis Best Practices.
- Section 6 provides guidance and recommendations for preparation of affordability analysis in support of an AoA.
- Section 7 provides a list of references used in preparation of this manual.
- Appendix A provides a computational framework for calculating the Fully Burdened Cost of Fuel, which is a required complementary analysis to the life-cycle cost estimate.

2. Terminology

This chapter will introduce analysts to the terminology used throughout the Handbook. Analysts will be expected to use the terminology as defined in this handbook when preparing, presenting, and documenting cost estimates in support of analysis of alternatives. The authoritative source of the definition is listed in parentheses at the end of each entry.

AFFORDABILITY. A determination that the Life-Cycle Cost (LCC) of an acquisition program is in consonance with the long-range investment and force structure plans of the DoD or individual DoD components. Conducting a program at a cost constrained by the maximum resources that the DoD or DoD component can allocate to that capability. (DAU Glossary, as cited in DoDI 5000.85)

ANALYSIS OF ALTERNATIVES (AOA). Assessment of potential materiel solutions to satisfy the capability need documented in the approved Initial Capabilities Document (ICD). The AoA focuses on identification and assessment of potential materiel solutions, key trades between cost and capability, total life-cycle cost, including sustainment, schedule, concepts of operations, and overall risk. The AoA will inform and be informed by affordability analysis, cost analysis, sustainment considerations, early systems engineering analyses, threat projections, and market research. It identifies the most cost-effective solution that has a reasonable likelihood of providing the validated capability requirement(s). The AoA is normally conducted during the Materiel Solution Analysis phase for MDAPs, is a key input to the Capability Development Document (CDD), and supports the materiel solution decision at Milestone A; AoAs may be conducted at comparable points for other AAF pathways as appropriate. The AoA may be updated for subsequent decision points and milestone reviews if design changes result in changes to AoA assumptions. (DAU Glossary, as cited in DoDI 5000.85)

AVERAGE PROCUREMENT UNIT COST (APUC): Calculated by dividing total program procurement cost by the number of items to be procured. The APUC procurement quantity includes any Engineering and Manufacturing Development (EMD) quantities that have been refurbished using procurement dollars. APUC is displayed in constant year dollars of a base year fixed for each program. Total procurement cost includes flyaway, rollaway, sailaway cost (that is, recurring and nonrecurring costs associated with production of an item such as hardware/software, systems engineering (SE), engineering changes and warranties), plus the costs of procuring technical data (TD), training, support equipment, and initial spares. (DAU Glossary, as cited in DoDI 5000.85)

AVERAGE UNIT MANUFACTURING COST (AUMC): Includes the costs of all materials, labor, and other direct costs incurred in the fabrication, checkout, paint, preparation for shipment to its acceptance destination, processing and installation of parts, sub-assemblies, major assemblies, and subsystems needed for the final system, and associated burdens (i.e., overhead, general and administrative, cost of money, and profit/fee) necessary to build complete production end item(s) by the prime contractor and all subcontractors. AUMC includes the labor and other direct costs to integrate Government-Furnished Equipment (GFE) into the final end item(s) if completed prior to final acceptance. To calculate AUMC, total costs in the above categories are divided by the total number of fully-configured end items to be procured. (AoA Cost Handbook)

Constant-Year (CY) Dollar: A cost that has been normalized relative to a selected base year via an inflation index. Constant-year dollars exclude the effect of inflation relative to the base year, and include real price change. Also known as "real dollars" outside the DoD community. (Inflation and Escalation Best Practices for Cost Analysis)

Cost Contributor: The element(s) of the estimate structure (generally at a level lower than acquisition or Operating and Support (O&S)) that contribute(s) the greatest cost to the program. Finding data to support elements of the cost estimate structure that contribute only a small fraction to the total cost is not as important as finding those that contribute significantly more to the total cost of interest. (DoD Cost Estimating Guide)

Cost Driver: The inputs (hours, labor rates, quantities, weight, power, source lines of code, etc.) to cost-estimating methods that have the most influence on the total cost of interest. (DoD Cost Estimating Guide)

Economic Life: The period of time during which the benefits from an alternative are expected to accrue. The economic life is set by the shortest of its physical life, mission life, or technological life. (DoDI 7041.03)

Fully Burdened Cost of Fuel (FBCF): Commodity price of fuel, plus the total cost of all personnel and assets required to move and, when necessary, protect the fuel from the point at which the fuel is received from the commercial supplier to the point of use. (Pub. L. 110-417, NDAA 2009)

Fully Configured End Item: A final combination of component parts and/or materials which is ready for its intended use. (CFR Sec. 252.212–7002)

Life-Cycle Cost Estimate (LCCE): The estimated cost of developing, producing, deploying, maintaining, operating, and disposing of a system over its entire lifespan. (DoD Cost Estimating Guide)

Period of Analysis: The economic life of the program or project plus the lead time. (DoDI 7041.03)

Program Acquisition Cost: The estimated cost of research, development, test, and evaluation (RDT&E), procurement, and system-specific military construction necessary to acquire the defense system. RDT&E costs are accumulated from the point in time when the DoD acquisition program is designated by title as a program element (PE) or major project within a PE. Military construction costs include only those projects that directly support and uniquely identify with the system. (DAU Glossary, as cited by DoDI 5000.85)

PROGRAM ACQUISITION UNIT COST (PAUC): Computed by dividing the Program Acquisition Cost by the Program Acquisition Quantity. (DAU Glossary as cited by DoDI 5000.85)

PROGRAM ACQUISITION QUANTITY: The total number of fully configured end items (to include research and development (R&D) units) a DoD component intends to buy through the life of the program, as approved by the Service Acquisition Executive (SAE) or Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)). This quantity may extend beyond the Future Years Defense Program (FYDP) years but shall be consistent with the current approved program. (DAU Glossary, as cited by DoDI 5000.85)

THEN-YEAR (TY) DOLLAR: Costs that reflect the value of money at the time of a transaction. The type of transaction defines the two types of TY$: obligations (which include outlay profiles) and expenditures (which do not include outlay profiles). Also known as "nominal dollars" outside the DoD environment. (Inflation and Escalation Best Practices for Cost Analysis)

3. AoA Cost Guidance

A. AoA Study Guidance

Per DoDI 5000.84, the Director, Cost Assessment and Program Evaluation (DCAPE) issues approved AoA study guidance to the DoD Component no later than 40 days prior to a scheduled Materiel Development Decision (MDD) for potential ACAT I programs. OSD CAPE, Cost Assessment assists in preparation of this study guidance in order to ensure that the AoA includes robust analysis of standard and unique issues related to the costs of the capability in question. Components are required to adhere to all study guidance, including elements related to cost, in order for DCAPE to deem the final AoA report sufficient.

Cost guidance may vary with each AoA due to specific design, operational, affordability, or other concerns related to the capability under consideration. In addition to soliciting cost-related input from OSD stakeholders, CAPE action officers preparing study guidance should consult previous AoA study guidance and results within that capability area or weapon system commodity group to identify special cost considerations.

B. Standard Elements of AoA Cost Guidance

In addition to any unique cost guidance, CAPE action officers and AoA study directors should ensure that the AoA cost guidance covers the following minimum set of cost-related factors.

- **Provide life-cycle cost estimates for each alternative, including estimates of research and development, investment, operating and support (O&S), and disposal.** This element ensures that the cost analysis for each alternative covers all phases of the acquisition life-cycle. While alternatives may have common costs for particular cost elements or acquisition life-cycle phases, the AoA will explicitly consider the unique costs of each system, and the use of common costs must be substantiated with data and analysis.
- **Produce estimates of "sufficient quality" to support investment and acquisition decisions.** The degree of uncertainty associated with AoA cost estimates will undoubtedly reflect any uncertainty related to design, acquisition strategy, schedule, and potential vendors. However, AoA cost estimates should be prepared in accordance with DoD cost policy, guidance, and best practices in order to support early acquisition and investment decisions. Particularly given the DoD's constant efforts to accelerate acquisition, an AoA cost estimate may be the only or best cost estimate available to inform early program budget and contracting decisions. As a result, the estimate must be produced using sound cost estimating methodologies and actual cost data to the maximum possible extent.

- **Consider how prototyping may affect development and production costs.** The number and configuration (e.g., fully configured end item versus a ballistic test asset) of prototypes manufactured during development will undoubtedly serve as a cost driver for each program and may represent a key cost difference between alternatives (e.g., an alternative based on an existing platform in production may require fewer prototypes for testing than a new start program). In theory, however, the contractor's efforts to manufacture prototypes should result in information and organizational learning that may serve to reduce initial production costs. The net effect of prototyping must be assessed for each alternative, substantiated by data and analysis, and presented as a standalone result of the cost analysis in order to address the statutory language (10 U.S. Code 2446b) related to this standard element.

  - **Ensure estimates cover an identical period of analysis for each alternative.** Alternatives under consideration may have different economic lives, based on differences in physical, mission, or technological lives across the alternatives. In order to ensure an economically equivalent comparison of costs over time, the AoA must use an equivalent period of analysis for each alternative. When economic lives are unequal, this condition may require truncation and/or extension of the economic lives of alternatives. If truncation occurs, the study should credit the alternative with any residual value. Meanwhile, if the study extends an alternative beyond its economic life, the life-cycle cost of the alternative should include any resulting requirement for service life extension programs (SLEP). See DoDI 7041.03, Enclosure 2 for a discussion of procedures to calculate residual values. Additionally, under the scenario where the various alternatives under consideration need to be replenished at different time intervals because of factors such as design life, the time period of the analysis should capture any partial replenishment costs within the time period. For example, if one option has satellites with a seven-year design life (DL) and one option has a 12 year DL, it may be unfair to end the analysis after 13 years as the seven-year DL constellation would need to be fully replenished if 15 years had been chosen whereas the 12 year option wouldn't need to be fully replenished. The estimate should account for system sustainment/replenishment costs within the chosen time period.

- **Account for the requirements and vulnerability of fuel logistics for each alternative by including costs representative of fuel delivered to the point of use (i.e., the fully burdened cost of fuel).** Public Law 110-417, Title III, Section 332, paragraph C states, "The Secretary of Defense shall require that the life-cycle cost analysis for new capabilities include the fully burdened cost of fuel during analysis of alternatives and evaluation of alternatives and acquisition program design trades."

Existing guidance and approaches for consideration of the fully burdened cost of fuel are listed in Appendix A of this handbook.

- **Include estimates for Average Procurement Unit Cost (APUC), Program Acquisition Unit Cost (PAUC), and any additional metrics commonly used to assess cost differences for the commodity group in question (e.g., Average Unit Manufacturing Cost (AUMC), unit recurring flyaway cost, cost per flying hour, etc.).** In addition to serving as useful metrics for comparison across alternatives with the AoA, the DoD uses these types of metrics to establish Acquisition Program Baselines, affordability targets, and even Key System Attributes (KSAs) for programs. Consistent calculation and presentation of these types of metrics for each alternative provides decision makers with familiar, well-defined measurements of associated program costs. Although these cost metrics are acceptable for comparing alternatives, the program selected should formalize the acquisition assumptions and program cost estimate to accurately develop an APB.
- **Use present value discounting in comparing the alternatives in accordance with OSD and Office of Management and Budget guidelines.** In accordance with DoDI 7041.03, economic analyses of investment alternatives within the DoD must use a discount rate based on the U.S. Treasury Department's cost of borrowing funds. The Office of Management and Budget (OMB) publishes an annual update to these discount rates, differentiated by the period of analysis, in OMB Circular A-94, Appendix C, which is available from: https://www.whitehouse.gov/omb/information-for-agencies/circulars/. Additionally, both DoDI 7041.03 and OMB Circular A-94 provide guidance on selection and use (i.e., discounting formulas) of discount rates.

4. Life-Cycle Cost Estimates for AoAs

A. Overview

Cost estimates prepared in support of AoAs are unique in several ways when compared to other required DoD cost analyses. These unique characteristics are, perhaps unsurprisingly, primarily due to the requirement to compare costs across multiple, mutually exclusive alternatives covering an identical period of analysis. The following sections provide a discussion of these unique characteristics and suggestions for addressing them.

B. Types of Costs in a Comparative Assessment

When comparing life-cycle costs across alternatives in an AoA, certain cost elements may be common to all alternatives or unique to individual alternatives. In order to ensure sound analytical consideration of all life-cycle costs across alternatives, it may be helpful to identify and explicitly list decisions related to certain types of costs in the study's ground rules and assumptions. At a minimum, the AoA's ground rules and assumptions should address how the study handles the following types of costs:

- **Sunk Costs:** Per DoDI 7041.03, a sunk cost is a "cost that has already been incurred and cannot be recovered" and "[is] not relevant to prospective investment decisions that are made after the sunk costs have been incurred." As a result, sunk costs associated with any of the alternatives should be identified and discussed in the study's ground rules and assumptions, but should never be included in a cost estimate of an alternative or any derivative analysis used to distinguish alternatives.
- **Common or "Wash" Costs:** According to DoDI 7041.03, a common or "wash" cost is identical in BOTH timing and magnitude for all alternatives. A cost that is truly common will not add any unique value to the comparative cost assessment. The AoA cost team should exercise caution in identifying common costs to ensure that the cost is truly identical across alternatives. Once identified, any common cost should be listed in the study's ground rules and assumptions, and the study team must decide whether to include or omit the common costs from various aspects of the comparative analysis. For the purposes of establishing the life-cycle cost of each alternative, affordability analysis, and calculation of standard acquisition metrics (e.g., APUC), the study team must include common costs in all alternatives.
- **Indirect Support Costs:** Per the CAPE 2020 Operating and Support (O&S) Cost Estimating Guide, "Indirect support costs are those installation and personnel support costs that cannot be identified directly (in the budget or Future Years Defense Program) to the units and personnel that operate and support the system being analyzed, but nevertheless can be logically attributed to the system and its associated manpower." Indirect support costs are typically not used in cost estimates supporting the defense acquisition process. Moreover, these indirect support costs are likely to be common

costs and may be treated in accordance with the common cost guidance discussed above. However, in the case of alternatives with differences in manpower requirements, the associated indirect support costs will magnify cost differences due to variation in required crew members, maintainers, or other support personnel. As a result, study teams may elect to include indirect support costs in comparing life-cycle costs of different alternatives when manpower costs are an affordability concern.

- **Non-financial Costs:** Certain alternatives may have intangible or social costs (e.g., negative public perception due to environmental impact) associated with the effect of the alternative on society at large. When quantification of a cost is impossible, the AoA must document and discuss the cost in narrative format for consideration by decision-makers. These non-financial cost considerations may be particularly relevant to discussions of effectiveness and/or risks associated with each alternative.

C. Special Cost Considerations by Cost Category

Variation in cost between alternatives can result from a multitude of factors, ranging from design characteristics to availability of industry partners to concept of operation. The following section provides a list of considerations by life-cycle cost category that may be useful in identifying cost contributors.

- **Research & Development:** Differences in research and development costs across alternatives will largely depend on the degree to which technological maturity differs for each potential solution. The study team should consider the following areas when working to identify potential cost differences:
  - *Scope of developmental tasks:* If an alternative is based on creating a variant of an existing platform currently in production, the scope of the related development effort is likely to be much smaller than development required for a new start program. For example, it is possible that the new alternative could be achieved via a simple Engineering Change Proposal to the existing platform, whereas a new start might require an entire development and prototyping contract to achieve a similar technological maturity level. AoA cost analysts must identify these differences and adjust cost and schedule accordingly.
  - *Number and type of prototype units:* The number and type of prototype units for an alternative will depend on the degree to which the underlying design or technology has been previously tested and accepted by the DoD. The number of prototypes associated with each alternative will be positively correlated with the number of required test events. A new-start ground vehicle program with zero developmental or operational test history will require a full suite of tests, to include ballistic test assets. Meanwhile, an alternative derived from an existing platform may need testing on the aspects of the system changed to meet new requirements, but is unlikely to repeat all tests performed on the existing platform to date.

- *Number of vendors / acquisition strategy:* In order to promote innovation and share the risk of maturing new technology with industry partners, the DoD often awards contracts to multiple vendors during the research and development phase of a program. The AoA cost team should consult with Service acquisition officials to understand potential acquisition strategies for new-start programs resulting from the AoA versus alternatives achieved through modification of an existing platform. The life-cycle cost estimate for each alternative should reflect a probable acquisition strategy, to include a specified number of vendors in each phase and presumed contracting approach, aligned with the scope of required system development.

- **Investment:** Variation in investment costs between alternatives can arise from differences in required quantities, direct production costs (e.g., labor, materials, and other direct costs), maturity of the production process, availability of production capacity, fielding plans, system-specific support equipment, and many other factors. The study team should consider the following areas when creating investment models and collecting data to estimate investment costs in an AoA.

  - *Learning*: With a new-start alternative, learning at the system level will begin with the first prototype unit. Depending on the commodity group, the study team may be able to substantiate an assumption that learning continues from prototype manufacturing into the first production lot, perhaps scaled by a "step-up" or "step-down" factor. In other commodity groups, the transition from prototype to production unit may coincide with a lapse in production, shift in location, wholesale change in labor force, or other impediments to continued learning, leading to a model that "re-starts" learning in production. For alternatives derived from a program currently in production, the study team should attempt to account for learning experienced to date on the common aspects of the existing platform and the planned alternative. For instance, if an alternative that essentially represents a variant of an existing program is "cut into" the production line for the program at unit 1,500, the alternative should account for learning achieved to date on the previous 1,499 units. In addition to system-level learning, the study team should also attempt to account for any plan to share subsystems between alternatives and existing programs. For example, if the alternative would share a common drive train with existing programs, the cost of the alternative should reflect and continue learning achieved, rather than assuming learning starts with the alternative's production.

  - *Effects of exchange vehicles and other GFE on Production Costs:* If an alternative is based on an Engineering Change Proposal to an existing platform, the DoD may receive benefits from the re-use of existing hulls, turrets, gun systems, engines, transmissions, or other high cost system components in manufacturing of the alternative. The study team should attempt to account for the potential cost savings derived from exchange vehicles in an alternative where this type of material re-use is a major aspect of the design.

  - *Specific support or training equipment:* If an alternative introduces a new capability to a military unit or represents a significant departure in design from an antecedent system, it will likely require the creation and/or fielding of new support or training equipment. For example, introducing a 40-ton, tracked direct fire vehicle to an infantry brigade combat team (IBCT) will likely require the fielding of a new recovery capability to the IBCT, more organic fuel trucks, hands-on maintenance trainers, and gunnery training assets. The study team must consider these impacts to support equipment requirements in order to ensure an accurate representation and comparison of alternatives' life-cycle costs.
  - *Military construction (MILCON):* Alternatives may generate requirements for military construction for multiple reasons. It is possible that an alternative's physical dimensions will necessitate additional maintenance, hangar, or parking facility space in comparison to existing facilities. On the other hand, an alternative may also generate requirements for facilities (e.g., gunnery range for higher caliber weapon systems) or equipment (e.g., overhead cranes or higher capacity launch and recovery equipment) that do not currently exist at the physical locations that would receive the new equipment. While a comprehensive, budget quality MILCON estimate may be unachievable within the time constraints of the AoA, the study team must consider and document potential MILCON costs for each alternative, particularly when MILCON costs are anticipated to differ significantly across alternatives.

- **Operating and Support (O&S) Costs**: Differences in O&S costs across alternatives will typically be tied to variation in design and operational employment. Design tradeoffs between mobility, armament, survivability, and other characteristics will lead to variation in propulsion systems, suspension, size, weight, and power. As a result, the underlying system components required to provide significantly different "ilities" (e.g., reliability, survivability, mobility) will exhibit important variation in estimated maintenance and sustainment costs. The study team should consider the following areas when preparing O&S cost estimates for alternatives:
  - *Operations manpower requirements*: If an alternative requires a change to force structure by adding operator, maintainer, or other system support manpower requirements, the AoA estimate must account for the cost of these changes. For example, a ground vehicle design that reduces crew size by one person could result in billions of dollars in reduced personnel costs over the life of a program, potentially offsetting the added repair costs associated with the technology that enabled the crew reduction. The study team should, however, exercise caution in

communicating manpower cost differences across alternatives to decision makers. The force structure impacts of an acquisition program are typically unclear at the time of an AoA, so the study team should appropriately communicate any assumptions used in manpower estimates to capture uncertainty around the point estimate. For additional information on manpower costs to include in an AoA O&S cost estimate, see the current *Operating and Support Cost Estimating Guide*, as listed in the References section of this guide.

- *Organic versus contract maintenance:* The AoA cost team should consult with logistics experts familiar with the commodity group in question to determine whether a Service would typically use organic or contract support for each level of maintenance (Organizational, Intermediate, or Depot). This discussion should separately consider the sources of parts and labor (e.g., a Component may assume that a contractor provides repair parts for organizational maintenance, while the actual labor is performed by organic maintainers). In the case of a new start program, the resulting input from logistics experts should serve as the basis for the maintenance plan represented in the cost estimate. However, if an alternative is intended to be a variant of a platform currently in operation, the cost estimate for that alternative should deviate from the existing maintenance plan only by documented, justified exception. No matter the source of the maintenance plan, the cost team should use representative actual cost data, whether organic or contractor, to estimate all levels of maintenance.

- *Effect of depot maintenance on operating inventory:* Depending on the commodity group and associated depot maintenance capacity in question, depot-level maintenance events may require an asset to be removed from the operating inventory anywhere from six months to four years. The operating inventory and assumed economic useful life of the system should reflect this effect of depot maintenance. For example, if a Service does not intend to field "repair cycle floats" or similar additional assets to maintain a uniform operating inventory during depot maintenance, the operating inventory should decrease one-for-one by the number of assets in depot maintenance. In addition, if the physical life of the asset is the limiting factor in its economic life, the time spent in depot maintenance should be added to its baseline economic life for any event when the asset is "reset to zero." As an example, if a vehicle has a 20-year assumed economic life with a year-long system overhaul at mid-life, the vehicle will appear in the inventory for 21 total years. These assumptions will likely have a significant impact on the O&S cost estimate for each alternative, as they drive changes to operating inventory over time and the economic life of each alternative. As a result, the cost team should ensure these effects on operating inventory are explicitly listed in its Ground Rules and Assumptions (GRA). For analysts estimating Navy ships, these GRAs are standardized in OPNAV Letter 4700 - Representative Intervals, Durations, And Repair Man-Days for Depot Level Maintenance Availabilities Of U.S. Navy Ships.

- *Inflation and escalation:* The effects of inflation and escalation are based on year-over-year changes in the overall price level in the economy and prices for a specific item, respectively. While it is important to correctly apply inflation and escalation in all cost categories, accurately capturing the cost of an alternative over time in inflation-adjusted terms is especially critical for O&S costs, which are typically spread over decades. Notably, OUSD (Comptroller) publishes several escalation indices (military pay, civilian pay, and fuel) used extensively in O&S cost estimates. When converting from Then-Year dollars estimated using these escalation indices to Constant-Year dollars, the cost team must use an inflation index in order to preserve the real price changes inherent to the Comptroller escalation indices. Failure to do so will cause an understatement of the life-cycle cost of an alternative in Constant-Year terms when Comptroller's escalation indices forecast positive real price change. For additional guidance on inflation and escalation calculations, to include conversion between different types of Then-Year and Constant-Year dollars, see the current version of *Inflation and Escalation Best Practices for Cost Analysis*, as listed in the References section of this guide.
- *Fully Burdened Cost of Fuel (FBCF):* AoAs are required to consider FBCF as a complement to standard O&S cost analysis. Appendix A provides a detailed discussion of FBCF and an analytical framework.

5. Best Practices for AoA Cost Analysis

The best practices listed below are based on observations from successful AoA cost analyses conducted in the DoD over the past five years. These approaches and behaviors are recommended to ensure a favorable sufficiency rating on the cost analysis portion of the AoA.

Start cost analysis early. Begin cost data collection in parallel with development of the list of possible alternatives. Preliminary cost data collection may help to shape the list of possible alternatives. Additionally, cost data collection requirements may be unique to each alternative, whereas other aspects of the cost analysis (e.g., an underlying cost model) may be similar across alternatives. Prioritizing the cost data collection effort will allow the study team to streamline other aspects of the cost analysis to account for differences in cost data availability across alternatives. Finally, cost data collection for certain alternatives (e.g., foreign-made systems) may require significant coordination and should be pursued as soon as the study team identifies a requirement for the data.

Build a robust team. AoA cost analysis is challenging and resource intensive due to the innate uncertainty and ambiguity surrounding the alternatives in question. Organizing a team with the required cost estimating skills, availability for dedication to the effort, understanding of the requirements studied in the AoA, and ability to collect and interpret actual cost data in a short amount of time is critical to conducting AoA cost analysis. The cost analysis team should include one or more certified cost analysts, who are familiar with the commodity group in question; representatives from operating and implementing organizations; and a representative from the respective Service Cost Agency(ies). Though an OSD CAPE Cost Assessment analyst is not an official member of the team, it is imperative to involve OSD CAPE early to ensure AoA sufficiency.

Coordinate with functional SMEs to understand design, fielding, maintenance, and support challenges for each alternative, then document the resulting technical baseline. A general lack of representative cost data will undoubtedly complicate the preparation of life-cycle estimates for multiple, brand new alternatives. To establish a sound technical baseline and incorporate sound GRAs, the cost team should interact early and often with functional SMEs from other disciplines who are familiar with the AoA and/or commodity group in question. Input from these SMEs, such as technical data describing each alternative and areas of risk, can enable the cost team's use of cost data from historical programs in models that adjust for differences in the AoA alternatives' designs, fielding plans, and maintenance concepts. For example, an engineer may be able to provide SME input to complexity factors that allow the cost team to "scale up" research and development costs from a previous program to account for new design challenges. A robust AoA cost study will identify unique and common challenges and incorporate them into the estimates for each alternative. After validating and agreeing upon the technical baseline for each alternative as early as possible in the AoA, the study team should document the resulting information in a CARD-like document.

Select appropriate cost estimating methodology. Referencing the DoD Cost Estimating Guide the cost team should choose the appropriate cost estimating methodology for the available data and the maturity of the alternatives. This methology should be agreed to in the AoA ground rules.

Use actual cost data. Use actual, historical costs from analogous DoD acquisition programs as the basis of the estimate for each alternative, and provide justification for the selected cost data analogies. OSD CAPE's Cost Assessment Data Enterprise (CADE) is the DoD's official repository of contractor cost data and should be employed to derive acquisition costs for analogous weapon systems. Service Visibility and Management of Operating and Support Cost (VAMOSC) databases or CAPE's Enterprise VAMOSC (EVAMOSC) database should be used to collect historical O&S costs for analogous systems.

Use a common Work Breakdown Structure (WBS) for all alternatives. Use the current version of MIL-STD 881 and the appropriate appendix to identify the appropriate work breakdown structure for the commodity group considered in the AoA. The common structure will assist with comparison of costs across alternatives, identification of any prevalent cost contributors in the AoA, and consistency in assignment of common costs to multiple platforms. Furthermore, use of a common, MIL-STD WBS will facilitate conversion of AoA cost estimates to initial models for subsequent cost analysis in support of milestone or contracting decisions. In the event that additional WBS element(s) are incorporated into an existing MIL-STD WBS, the cost team should document these differences and underlying justification in the cost section of the final AoA report.

Assess interaction of cost and schedule. Align the cost estimate for each alternative with a schedule consistent with historical experience for the technical complexity of that alternative, or use historical schedule data from programs with similar technical characteristics to assess the risk inherent in the proposed acquisition timeline for each alternative.

Conduct sensitivity analysis and highlight inflection points. Given that AoA cost estimates are intended to identify differences in life-cycle cost and metrics among alternatives, conducting sensitivity analysis and communicating the results are particularly important tasks for the AoA cost team. Assumptions regarding cost drivers and contributors that lead to large differences among alternatives must be thoroughly investigated, documented, and shared with decision makers. Regardless of whether an element is a cost driver, the cost team should consider the effect of variance in each element, as even a minor cost element can have a significant impact on the AoA if it carries a large variance. See the DoD Cost Estimating Guide for additional guidance regarding treatment of risks/opportunities, uncertainty, and sensitivity analyses.

Provide time-phased results. Provide annual costs (i.e., a time-phased cost estimate in both CY$ and TY$) at the major appropriation level for the base case and each alternative. This time-phased data is critical for assessing affordability risks across the weapon system's lifetime and for identifying the effects of programmatic decisions (e.g., annual production and fielding profiles) over time.

Present results in appropriate dollar types. Provide required and recommended cost estimate output in both Then-Year and desired Constant-Year dollars. Then-Year dollars are useful for comparing effects of different alternatives on the DoD budget, whereas Constant-Year dollars are useful for comparison of total program costs and/or affordability metrics across alternatives (e.g., total life-cycle cost, PAUC, APUC, AUMC, and sustainment Key Performance Parameter). See the latest version of the OSD CAPE Inflation and Escalation Best Practices For Cost Analysis: Analyst Handbook for additional guidance on the appropriate calculation and use of Then-Year versus Constant-Year dollars.

Identify cost contributors within and across alternatives to assist with tradeoff discussions involving cost and capability. Illumination of the available tradespace for decision-makers is a primary objective of an AoA. Although other analyses conducted as part of the AoA are likely to identify performance tradeoffs among key system attributes, cost analysis will separately identify affordability tradeoffs (or a lack thereof) between these same characteristics. Moreover, cost analyses are key to detecting alternatives with uniquely expensive designs and/or requirements that will be cost contributors, no matter the technical solution. Making leadership aware of these cost issues during the AoA can enable proactive refinement of requirements to ensure an achievable, affordable acquisition program.

Follow DoD cost policy and guidance for preparing DoD cost estimates. Organizations conducting AoA cost analyses are often not the same organizations responsible for preparing cost estimates in support of the defense acquisition process. As a result, cost estimators in these organizations may not be as familiar with DoD cost policy, guidance, and best practices. Cost analysts supporting an AoA are encouraged to separately read and use the cost estimating resources listed throughout this guide, regardless of whether those references specifically discuss cost estimating for an AoA.

Engage early and provide regular updates to Service Headquarters and OSD. Meet as early as possible in the AoA timeline with OSD CAPE analysts to discuss the cost guidance and rectify any issues with the cost requirements in the study guidance. Rather than waiting until the conclusion of the study to correct discrepancies, provide regular cost updates or in-progress reviews (IPRs) throughout the AoA study period to OSD CAPE analysts to facilitate continuous improvement of the cost estimates.

Document the life-cycle cost estimate for each alternative and ensure reproducibility. As with any cost estimate, the cost analysis in support of an AoA should be conducted and documented such that a trained cost analyst could produce the same result, given the final cost report and identical data. At a minimum, the cost analysis team should document and/or archive all ground rules and assumptions; data sources, files, and source system points of contact; a discussion of methodologies used, to include any differences in methodology by variant; inflation and escalation indices; and any cost model (e.g., .aces or .xlsx file used to compute and/or aggregate results).

Write the cost section and/or appendix of the final AoA report. The cost team supporting an AoA is likely to be a subset of a much larger group of analysts with various functional backgrounds and expertise. Of note, the primary study director and core team are unlikely to be cost analysts. To ensure the final AoA report accurately reflects any major cost conclusions and correctly represents the underlying analysis, the cost team should serve as primary authors of the cost section and/or appendices.

6. Affordability Analysis

Note: Portions of this section are adapted from a former enclosure to DoDI 5000.02 (Enclosure 8: Affordability Analysis and Investment Constraints). At the time of publication of this handbook, this information is no longer contained in an existing DoD Issuance.

A. Requirement for Affordability Analysis

Per DoDI 5000.84, AoAs must consider the affordability of proposed solutions, to include any Milestone Decision Authority (MDA)-established affordability goals. The purpose of affordability analysis in the AoA is to avoid starting a program that cannot be produced or supported, given reasonable expectations for future funding levels. As an outcome of the AoA, affordability constraints can inform prioritization of program requirements and potential cost tradeoffs. This affordability analysis must occur within the context of the relevant commodity group, portfolio, and/or appropriation. The supporting analysis must use the life-cycle cost estimates, prepared in accordance with Section 4 of this guide, to examine the estimated effect of each alternative on all relevant appropriations for the duration of the system's acquisition life-cycle.

Affordability analysis and life-cycle cost estimates are complementary analyses, not substitutes for one another. Affordability constraints are produced via a "top-down" accounting of the resources the DoD Component can allocate for the program under consideration in the AoA, and will be largely determined by objectives of other program and fiscal demands on the Component. Life-cycle cost estimates, on the other hand, are produced via granular, "bottom-up" analyses of the costs required to develop, produce, or sustain each alternative. It is ultimately the combination of these two analyses, measured by the difference between the affordability constraints and the required resources from the life-cycle cost estimate, that provide decision makers with the opportunity to make impactful decisions that will ultimately shape the program's affordability over time.

B. Organizations Involved in Affordability Analysis

Due to the requirement to combine budget constraint information with cost estimate results, affordability analysis requires participation from additional study team members from outside of the cost team. In fact, affordability analysis should be led and conducted by the Component organization responsible for program analysis and evaluation, rather than the organization leading the AoA study, program management, or the acquisition community. These program analysis organizations possess the comprehensive knowledge of the Component's budget, plans, and programs required to establish the affordability constraints for the commodity group or mission area in question. The Component's resource planning, requirements, intelligence, and acquisition communities should provide support and inputs to the program analysis organization during execution of the affordability analysis.

C. Affordability Constraints and Comparison Groups

Affordability analysis conducted in support of an AoA must address the total life-cycle of each alternative, excluding sunk costs. In establishing the corresponding budget constraints, analysts should use the respective Service's most recent Program Objective Memorandum (POM) or budget submission as their reference point for appropriation totals within the Future Year Defense Program (FYDP). For fiscal years beyond the FYDP, analysts should reference the latest CAPE guidance on budget growth assumptions, to include discussion of topline growth assumptions in paragraph E (below). CAPE routinely publishes guidance for select long-term escalation rates, including the topline budget. The addition or subtraction of budget requirements associated with each alternative should then be compared to the total available budget for each appropriation in order to determine whether an alternative is affordable.

The program under consideration for the affordability analysis should be considered against the portfolio, commodity group, and any other comparison group funded with the same appropriations within the PPBE process. For example, if an affordability analysis is conducted in support of an AoA for a new Army tracked combat vehicle, and the Army plans to fund the new vehicle by divesting existing tracked combat vehicles, then the relevant comparison group used to establish affordability within the procurement portfolio should be the Army's Weapon and Tracked Combat Vehicle appropriation portfolio. If, however, the Army planned to grow the size of the Weapon and Tracked Combat Vehicle portfolio, and while reducing aviation investment, then the AoA should include, and depict the corresponding aviation divestment used to offset growth in the tracked vehicle portfolio. During affordability analysis the cost team must ensure GFE items or elements funded from separate appropriations are removed from the comparison.

D. Affordability Analysis Construct

Each Component organization responsible for leading the affordability analysis portion of an AoA determines the processes and analytic techniques it will use during the AoA. However, the selected approach should adhere to the following basic affordability guidelines:

Future Budget. A future total budget projection for each DoD Component for affordability analysis provides the first-order estimate for allocation of future resources to each portfolio. This projection covers all fiscal demands on resources in the Component, including those outside acquisition and sustainment. The appropriations and/or portfolios under consideration in the AoA should be constrained by the Component's overarching total budget estimate.

Time Horizon. In an AoA, affordability analysis should cover the study's entire period of analysis. Affordability analysis should extend for enough years to reveal the life-cycle cost and inventory implications of the alternatives under consideration.

Fiscal Guidance. Absent specific guidance from the Director of Cost Assessment and Program Evaluation or the Service Acquisition Executive for the program in question, each Component may project its topline budget. See paragraph E below for an example.

Inflators. Affordability analysis assumes constant purchasing power. Each Component uses the OSD inflator provided by USD(C) in the Component's future total budget projection to inflate their cost estimates for comparison against affordability constraints, assuming budgets will be adjusted later for any differential inflator issues.

Portfolios. Components should subdivide their accounts into defined portfolios to facilitate trade-off analysis. For the purposes of the AoA, the Component will employ the relevant, defined portfolio to facilitate a detailed discussion of the resource impacts of the alternative in question.

Other Portfolio Plans. The Component's affordability analyses should be consistent with any relevant existing portfolio plans and strategies such as those required by statute (i.e., the 30-year plans required by 10 U.S. Code 231 (for ships) and 10 U.S. Code 231a (for aircraft)).

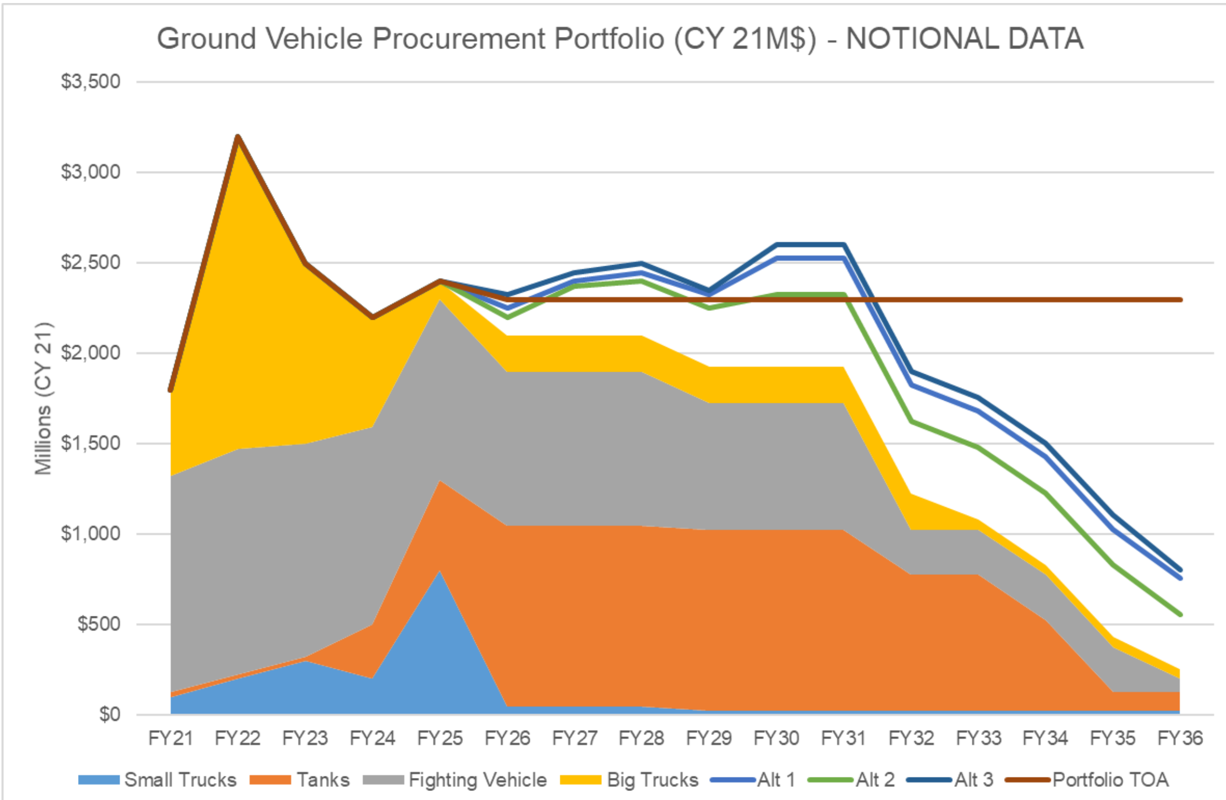
E. Example Affordability Analysis Output

Figure 6-1 provides a notional example of potential output from an affordability analysis prepared in support of an AoA. In the example, the Component has used a standard, defined "Ground Vehicle Procurement Portfolio" to establish the relevant resource constraint for the program under consideration in the AoA. The analysis projects the budget for this portfolio beyond the FYDP using the last two years of the current FYDP (Fiscal Years 2024 and 2025 in the example) and assumes no real growth beyond Fiscal Year 2025. The output is presented in Constant-Year 2021 dollars, which when combined with the no real growth assumption, leads to a flat line Total Obligation Authority (TOA) forecast beyond Fiscal Year 2025. If any of the alternatives are replacing a program of record already included in the TOA, the TOA should be reduced by the costs that would have been incurred by the program being replaced.

For the notional portfolio in the example, the procurement cost estimates for the three alternatives under consideration present an affordability challenge in Fiscal Years 2027-2031. Note that the estimate for each alternative is displayed separately on the chart, instead of using only an average or "representative" cost estimate from the group. This type of result might lead the Component's decision makers to carefully consider the return on investment of any additional capabilities offered by Alternatives 1 and 3, versus Alternative 2. All of the alternatives would require resource adjustments within the portfolio or from another portfolio into this "Ground Vehicle Procurement" area to address the forecasted resource shortage. However, the adjustments required for Alternative 2 are relatively smaller in magnitude.

Note that this example only covers a single appropriation and/or phase of the system's life-cycle. In order to be deemed sufficient, the AoA's affordability analysis should consider *all* phases and *all* relevant appropriations. CAPE recommends providing three separate charts when presenting and documenting affordability analysis in the AoA: RDT&E Portfolio, Procurement Portfolio, and O&S (multiple appropriations) Portfolio affordability analysis Charts.

Figure 6-1: Notional Procurement Portfolio Affordability Analysis Chart



7. References

Defense Acquisition University Glossary. Available from: https://www.dau.edu/tools/t/DAU-Glossary.

DoD Instruction 5000.02, "Operation of the Adaptive Acquisition Framework," January 23, 2020.

DoD Instruction 5000.73, "Cost Analysis Guidance and Procedures," March 13, 2020.

DoD Instruction 5000.84, "Analysis of Alternatives," August 4, 2020.

DoD Instruction 5000.85, "Major Capability Acquisition," August 6, 2020.

DoD Instruction 7041.03, "Economic Analysis for Decision-making," September 9, 2015.

DoD Cost Estimating Guide, December 2020. Available from: https://www.cape.osd.mil/files/Reports/DoD_CostEstimatingGuidev1.0_Dec2020.pdf.

Inflation and Escalation Best Practices for Cost Analysis: Analyst Handbook, Available from https://www.cape.osd.mil/

MIL-STD 881E, "Department of Defense Standard Practice: Work Breakdown Structures for Defense Materiel Items," October 6, 2020. Available from: https://cade.osd.mil/Content/cade/files/coplan/MIL-STD-881E%20Final.pdf.

Operating and Support Cost Estimating Guide, September 2020. Available from: https://www.cape.osd.mil/files/OS_Guide_Sept_2020.pdf.

Public Law 110-417, Title III, Section 332, paragraph C, "Duncan Hunter National Defense Authorization Act of 2009."

United States Code, Title 10.

Appendix A: Fully Burdened Cost of Fuel

Note: This section is adapted from a since removed chapter of the Defense Acquisition Guidebook. At the time of publication, this information is no longer in the Defense Acquisition Guidebook or the Joint Capability Integration and Development System (JCIDS) Manual.

Summary

In accordance with Title III, Section 332, paragraph C of the National Defense Authorization Act of 2009, life-cycle cost analysis in support of an AoA must consider the Fully Burdened Cost of Fuel (FBCF). FBCF, per the definition offered in the aforementioned statute, estimates the fuel-related costs to sustain specific pieces of equipment, including procurement of fuel, the logistics needed to deliver it where and when needed, related infrastructure, and force protection for those logistics forces directly involved in energy delivery. FBCF does not identify savings for programmatic purposes. It is an input to the AoA designed to identify the difference in total fuel-related costs among the alternatives. The cost team shall estimate FBCF for any system in an AoA that will demand fuel in operations. FBCF is not additive to the life-cycle cost estimate, but rather is reported beside it. While life-cycle cost estimates are based on the total peacetime life of a system, FBCF estimates are based on short combat scenarios. FBCF estimates provide different but complementary insights.

Introduction

FBCF is used to inform the acquisition tradespace by quantifying the per gallon (or barrel) price of fuel (or per kilowatt price of electricity) used per day for two or more competing materiel solutions. Calculating the FBCF gives DoD decision makers a way to more accurately consider the cost of a system's energy logistics footprint when making trades among cost, schedule, and performance.

FBCF includes the cost of the fuel itself and the apportioned cost of all of the fuel logistics and related force protection required beyond the Defense Logistics Agency-Energy (DLA Energy) point of sale. While most planning scenarios generally employ military forces for fuel delivery and protection, contractor logistics and protection may be presumed in certain scenarios. Regardless of whether military or contractor resources are used, the cost estimation method is the same, though the data sources required may vary.

FBCF estimates shall be prepared for each materiel solution being considered. The AoA should develop those estimates to a sufficient level of fidelity to determine whether the differences in energy demand and resupply costs are significant enough to meaningfully influence the final choice of alternatives. Even if FBCF does not significantly differ between alternatives, but shows sensitivity to change between sub-component or design choices within all alternatives, the Service sponsoring the program should continue FBCF efforts after completion of the AoA to inform trades in the subsequent acquisition phases. This includes technology development, systems engineering, and design decisions, or even incentivizing bidders to offer more efficient systems. In all cases, FBCF shall be developed for all alternatives remaining in the tradespace at the end of the AoA and not just for the alternative favored or chosen by the Service sponsor.

Fully Burdened Cost of Fuel Computational Framework

This section outlines a basic framework to calculate the FBCF. This framework is oriented towards liquid fuels but could be extended to other forms of energy demands (e.g., fuel cells, hybrid-electric engines, and nuclear and solar energy sources). Moreover, this framework is intended to give DoD Components flexibility in developing methodologies tailored to their various domains and force planning methods. Alternative methods may be allowed, but the AoA study team should request approval of any alternative method from OSD CAPE prior to proceeding with analysis.

Calculation of the FBCF differs from the estimation of element 2.1 Energy in the CAPE O&S Cost Estimating Structure in two main ways. First, FBCF is scenario-based, rather than life-cycle based. The FBCF analysis should be based upon a range of operational scenarios or use conditions from those specified in the program's AoA guidance to ensure comparability within program tradespace discussions. Second, whereas the 2.1 Energy element includes only the fuel consumed due to operation of the platform in question, FBCF also includes burdens associated with logistics and security assets required to deliver additional fuel to a specific location during execution of the scenario.

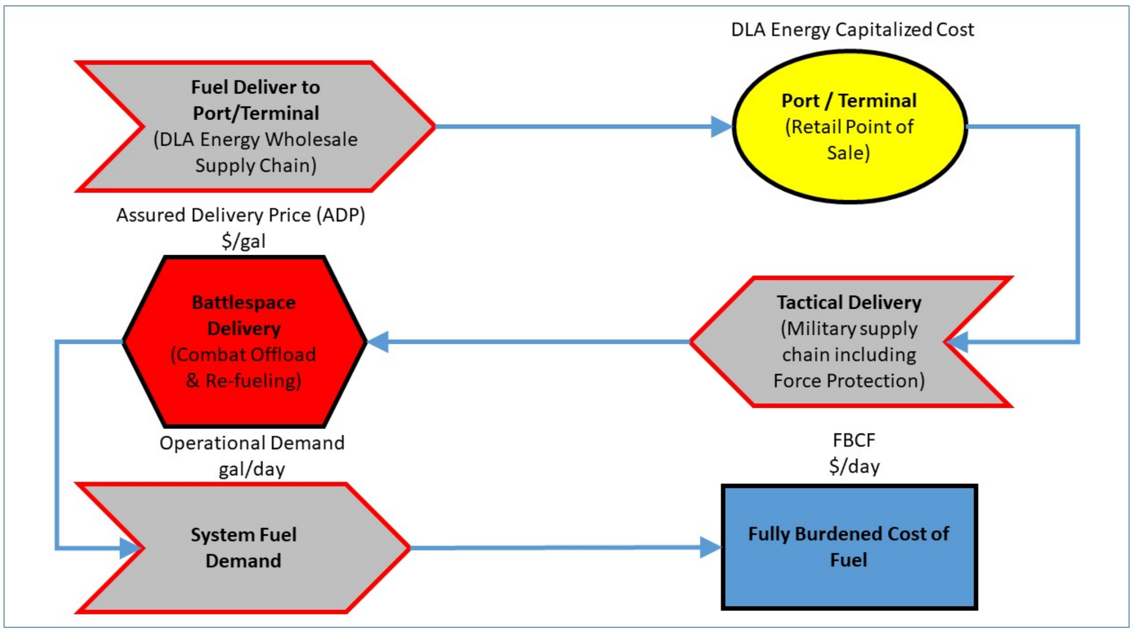
There are two key analytical components essential to developing a FBCF value:

1. Scenarios. Services decide upon a representative set of future operational scenarios or vignettes. To ensure the results of the FBCF calculations are comparable to other analytic measures, the same scenarios used elsewhere in the program's AoA shall be used in calculating the FBCF. For purposes of computing the FBCF, scenarios must be of sufficient duration to require logistical re-supply of energy. Figure 5-1 (below) presents an example FBCF scenario with fuel delivery process. Once the FBCF is calculated for the chosen scenarios, a simple mean average of the results will be computed to represent each alternative studied in the AoA.

2. Apportionment. Services determine what proportion of the fuel logistics footprint identified in the selected scenarios is attributable to the platform or system in question. For example, is it drawing 5% of the fuel from the fuel logistics units in the scenario? 20%? 50%? This percentage should inform how the study team establishes the logistics footprint for the single system under consideration. Because no single system in any operation takes 100% of the fuel, it is inappropriate to attribute 100% of the logistics tail cost to one system when calculating FBCF.

As with any estimate, there is no definitive, "correct" answer for a given system's FBCF. However, the AoA study team should present a realistic and analytically defensible scenario for use in estimating FBCF. The scenario assumptions for fuel logistics must be consistent with Service future force plans and Concepts of Operation. This consistency enables DoD decision makers to evaluate their assumptions relative to strategy and doctrine and make better informed risk decisions. Furthermore, the study team should use approved analytic tools, authoritative data, and costing methodologies where possible to develop FBCF values, as they should with all cost estimates.

FIGURE 5-1: FBCF Scenario Fuel Delivery Process Diagram



Assured Delivery Cost Computation

The first item needed to compute the FBCF is the Assured Delivery Cost (ADC). The cost elements described in Figure 5-2 (below), when summed together, determine the ADC of fuel within a given scenario. It is a measure of the burdened cost of the fuel in $/gallon or $/barrel and all the tactical delivery assets and force protection needed to assure the fuel is safely delivered to a given location. The ADC is the same for all users of fuel in that location using a given source of fuel and delivery method.

Figure 5-2: Summary of Elements to Apply within Each Scenario to Determine the Assured Delivery Cost

Element #	Element Name	Element Description
1	Fuel	Most recent DLA Energy "standard price," converted to the Then-Year price per gallon of the fiscal year in the scenario using the appropriate OUSD Comptroller-published fuel escalation rate.
2	Tactical Delivery Assets	Includes all of the following:
	Fuel Delivery O&S Cost	Per gallon cost of operating Service-owned fuel delivery assets, including the cost of military and civilian personnel dedicated to the fuel mission.
	Depreciation Cost of Fuel Delivery Assets	Captures the per gallon cost of the decline in value of fuel delivery assets, using straight-line depreciation over total service life. Combat losses due to attack or other loss (terrain, accident, etc.) should be captured as a fully depreciated vehicle.
	Infrastructure, environmental, and other miscellaneous costs. [Does not include DLA Energy capitalized cost of fuel]	Per gallon cost of non-DLA fuel infrastructure, regulatory compliance, tactical terminal operations, and other expenses as appropriate.
3	Security	Per gallon cost of delivering fuel, e.g., convoy escort and force protection. Includes the manpower, O&S, asset depreciation costs, and losses associated with force protection.

Although Figure 5-2 provides a framework for calculating ADC, the elements must be tailored to a selected supply chain, system or platform type, and larger force structure context. In all cases, the results are scenario or unit-type-specific, and are not applicable for all situations. Each of the elements is discussed in greater detail in the following sections.

Elements of Assured Delivery Cost

Fuel

The first cost element for consideration is the fuel itself. DLA Energy serves as DoD's single supply center for petroleum products worldwide and for coal, natural gas, and electricity services within the continental United States. DLA Energy not only procures the energy products but serves as DoDs Integrated Materiel Manager for all petroleum products. DLA Energy charges the Services for the fuel delivered through a reimbursable arrangement known as the Defense Working Capital Fund.

The Standard Price established by DLA Energy is the rate that is charged to military customers at the retail point of sale worldwide. To simplify cost planning and accounting, the Standard Price for a given fuel is the same globally and does not represent the full capitalized costs DLA Energy incurs to deliver the fuel out to the point of sale. For purposes of calculating ADC, the Standard Price shall be used, referencing the most recent price update from DLA Energy, which is available from https://www.dla.mil/Energy/Business/StandardPrices/. The Standard Price should then be escalated, using the most recent OUSD Comptroller escalation factor for fuel prices, to the year in which the AoA scenarios in the analysis are set. OUSD Comptroller's escalation factors are available in several formats, including the Joint Inflation Calculator and the public DoD Budget Request website: https://comptroller.defense.gov/Budget-Materials/.

In certain circumstances, particularly for current-day, site-specific calculations, DoD Components may use the actual contracted delivery price if it is available instead of the Standard Price. DLA Energy maintains a database of capitalized costs to purchase and deliver fuel at various supply points around the world. Site-specific fuel prices may only be used to inform rapid fielding and related procurement choices, as they represent market pricing in a specific operational situation. It is DLA Energy's responsibility to provide this data to DoD Components if required for these analyses.

Tactical Delivery Assets

The second cost element captures the burdens associated with the tactical delivery assets used by the Service to deliver fuel from the point of sale to the system that will consume it. It includes the Operating and Support (O&S) costs of the delivery assets, the cost of depreciation of the actual delivery assets, and any significant infrastructure costs needed to operate these assets.

Once a Service takes over possession of fuel from DLA Energy at the point of sale, they must employ Service-owned delivery assets. For the purposes of ADC estimates, a "fuel delivery asset" is a major item of fuel delivery equipment, such as Navy oilers (T-AO), aerial refueling aircraft (KC aircraft), or tanker trucks and trailers. A C-130 airdropping palletized fuel or rotary-wing aircraft carrying fuel by sling load for delivery might also constitute a "fuel delivery asset" in a given scenario.

The *Fuel Delivery O&S cost* is measured in $/gallon and consists of the O&S costs of the fuel delivery assets, divided by the gallons of fuel delivered. The cost team should use data available in the respective Service Visibility and Management of Operating and Support Cost (VAMOSC) databases to calculate O&S costs for the fuel delivery assets. If the planning scenarios/missions used in the FBCF estimate require another Service's assets to deliver fuel in the battlespace, calculation of the fuel delivery O&S cost may require collaboration with another Service to gain access to the required data.

The *Depreciation Cost of Fuel Delivery Assets* is also part of the second cost element. Depreciation provides a measure of the decline in capital value of the fuel delivery assets over time. For example, for an ADC calculation for an aerial system that requires air-to-air refueling as part of its mission profile, this step would require inclusion of a depreciation value for the system's air refueling tanker. The standard method is to use straight line depreciation over the anticipated service life of the primary fuel delivery asset. The annual straight line depreciation rate is calculated by dividing the asset's useful life into 1 (e.g., a system with a useful life of 20 years has a straight line depreciation rate of 1/20 = 0.05).

An additional part of the cost of depreciation is the potential loss of delivery assets due to hostile attack or other attrition. Based on the scenario chosen, there is a definable probability that the associated logistics platforms will be interdicted and destroyed. If destroyed, the entire remaining value of the platform is immediately amortized and this cost is added to this cost element. Depending on the quantity of fuel being carried by the delivery asset, an adjustment to the amount of fuel obtained from the point of sale may be required to account for this potential loss.

Finally, *Infrastructure, Environmental, and Other Miscellaneous Costs* may be added if they significantly add to the cost of supporting the delivery assets and if the scenarios in the AoA involve energy infrastructure. These items may include O&S costs for the facilities (such as fueling facilities and fuel storage sites) and related ground system equipment (such as pumps, fuel storage bladders, hose lines, and other refueling equipment). The costs to deploy the delivery assets may also be included, if the assets need to be transported to the theater of interest. Note: this category only includes infrastructure or equipment that is operated by the military Services in the theaters of interest, and does not apply to infrastructure that is operated by DLA Energy and incorporated into the DLA Energy capitalized cost of fuel.

Security

The third and final cost element includes the costs of escort protection of the fuel supply chain in hostile environments. In the case of DoD force protection assets allocated to the fuel delivery forces, the O&S costs, direct fuel costs, and the depreciation cost of those forces will also be included in the overall calculation. In essence, all of the costs considered in the second cost element (*Tactical Delivery Assets*) should also be considered for security assets. This includes the possibility that some security assets will be destroyed due to hostile activity while protecting the fuel supply chain. In certain high-risk scenarios, force protection costs may be the largest factor in the FBCF estimate.

Fully Burdened Cost of Fuel Computation

To arrive at the FBCF, the ADC ($/gallon) is multiplied by the apportioned amount of fuel (gallons) demanded by the system of interest. The FBCF is computed for each scenario being considered. The study team will report the FBCF for each of the scenarios they've assessed separately. To arrive at a single FBCF for an alternative, create a weighted average FBCF, based on the relative amount of time that the system is expected to operate in each of the modeled scenarios.