OPERATING AND SUPPORT COST-ESTIMATING GUIDE

OFFICE OF THE SECRETARY OF DEFENSE

COST ASSESSMENT AND PROGRAM EVALUATION

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1. INTRODUCTION

1.1 PURPOSE

This guide was prepared by the Office of the Secretary of Defense (OSD) Director of Cost Assessment and Program Evaluation (CAPE) for use by the Department of Defense (DoD) Components (i.e., military departments and defense agencies) in developing estimates of system operating and support (O&S) costs.

1.2 APPLICABILITY

This guide is focused on O&S cost estimates and analyses for major defense acquisition programs (MDAPs) subject to OSD oversight in the defense acquisition process. However, much of the analytic discussion may be more generally applicable to other types of programs, subject to appropriate tailoring.

This guide is applicable to both Component and CAPE cost estimates and other analyses. Such estimates and analyses include program office estimates, Component cost estimates, Component cost positions, and independent cost estimates. Readers not familiar with these terms should refer to DoD 5000.04-M, *DoD Cost Analysis Guidance and Procedures* (Reference (a)), which explains the character and purpose of each of these estimates and analyses. DoD 5000.04-M also provides the policies, procedures, and timelines for the preparation of the various cost estimates and analyses.

1.3 OVERVIEW

The remainder of this guide is organized as follows:

- Chapter 2 provides an overview of the concept of system life-cycle cost, and introduces basic standard terms and definitions for each life-cycle cost category. It is expected that all O&S cost estimates provided to OSD will use the standard cost terms and definitions.
- Chapter 3 discusses the many uses of O&S cost estimates and analyses in support of the defense acquisition process throughout the program life cycle. The strategic intent of this chapter is to emphasize that O&S cost considerations should be analyzed and presented in order to play a key role in supporting program decisions, rather than preparing O&S cost estimates simply for the sake of having an estimate.
- Chapter 4 provides a summary of the O&S cost data systems that are available to the DoD cost community, and describes an initiative to establish formal

contractor cost data reporting for major contractor logistics support and other sustainment contracts.

- Chapter 5 provides a tutorial on the best practices for preparing, presenting, and documenting O&S cost estimates. This tutorial is intended for less experienced analysts.
- Chapter 6 provides the standard OSD O&S cost element structure. The cost element structure is a well-organized and defined taxonomy of O&S cost elements that follow the basic terms and definitions described in Chapter 2, but with more detail. It is intended that the standard OSD cost element structure be used for both O&S cost data collection and for cost estimates or analyses provided to OSD.
- Appendix A provides the references used for this guide.
- Appendix B provides an example of how O&S costs can be used to influence a system's design during the development process. The example concerns the comparative life-cycle costs of two alternative subsystems, in which one of the subsystems is more reliable but also more expensive.
- Appendix C provides a sketch of an analysis that may be performed to determine if a current aging system experiencing increasing O&S costs should be replaced with a new comparable system, or else upgraded in order to defer the replacement. This type of analysis may be called for as part of the Analysis of Alternatives (AoA) process discussed in Chapter 3.
- Appendix D provides a suggested template for a presentation on an O&S cost estimate.
- Appendix E describes a legislative provision contained in the FY 2012 National Defense Authorization Act that mandates the implementation of several ambitious requirements concerning the tracking, assessing, and management of system O&S costs, and explains how the Department has implemented these requirements in this guide and in other instructions and regulations. Note that suggested approaches and analytic methods for meeting these requirements are provided in earlier portions of this guide (especially Chapter 3, Appendix B, and Appendix C).
- Appendix F contains a list of abbreviations.

2. OVERVIEW OF LIFE-CYCLE COSTS

2.1 LIFE-CYCLE COST CATEGORIES

DoD 5000.04-M provides standardized definitions of cost categories and elements that in total constitute system life-cycle costs. Any changes made to these definitions in future editions of DoD 5000.04-M should be noted and will take precedence over this guide. Estimates of program life-cycle cost are to capture all costs of the program, regardless of funding source or management control; the estimates are not limited to certain budget accounts or to categories controlled by certain lines of authority.

Life-cycle cost is defined as the sum of four major cost categories: (1) research and development costs; (2) investment costs, consisting of procurement, military construction, and acquisition-related operations and maintenance (O&M) associated with the production and deployment activities; (3) O&S costs; and (4) disposal costs. Figure 2-1 depicts a notional profile of annual program expenditures by major cost category over the system life-cycle. The profile for an actual program will vary significantly by system type.

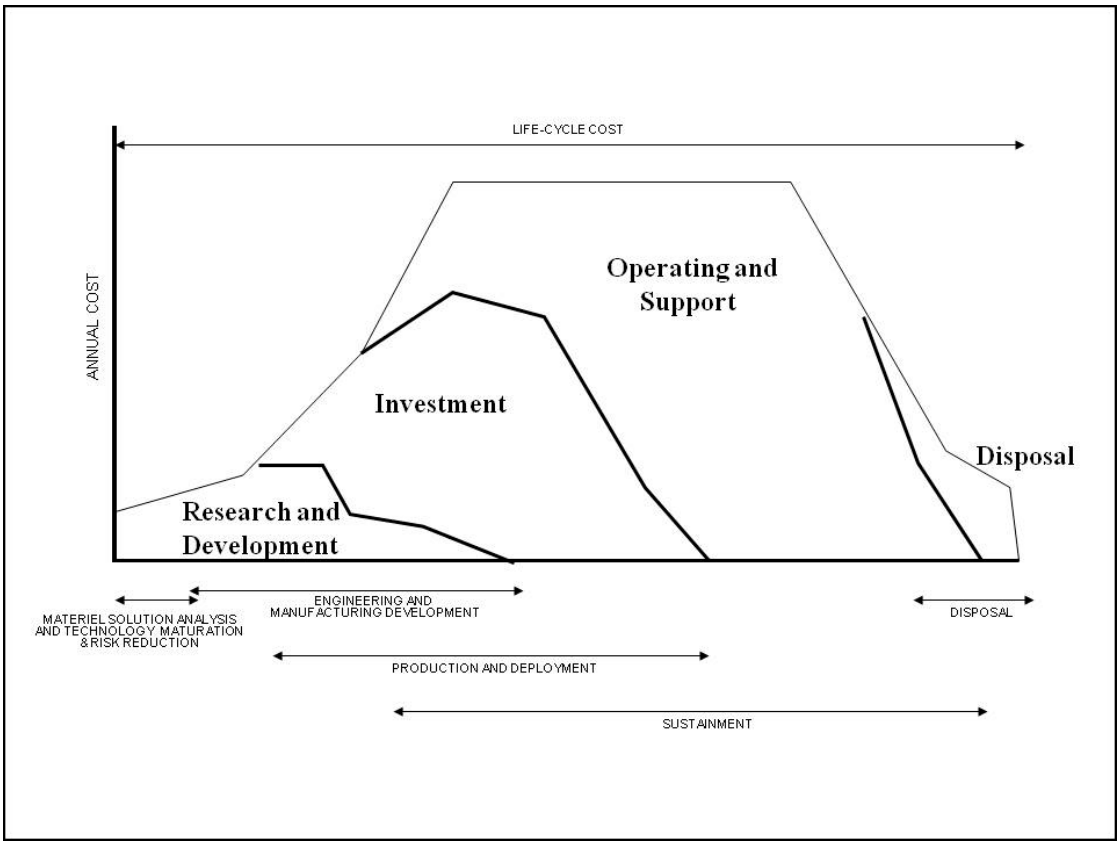

Figure 2-1. Illustrative System Life Cycle

For many programs, the system O&S costs will be the largest of the four cost categories, which is why there is renewed emphasis on O&S affordability and cost management. Based on cost estimates from recent Selected Acquisition Reports (SARs), the percentage of program life-cycle cost associated with O&S costs (for seven system types) calculated in constant base-year dollars is presented in Figure 2-2.

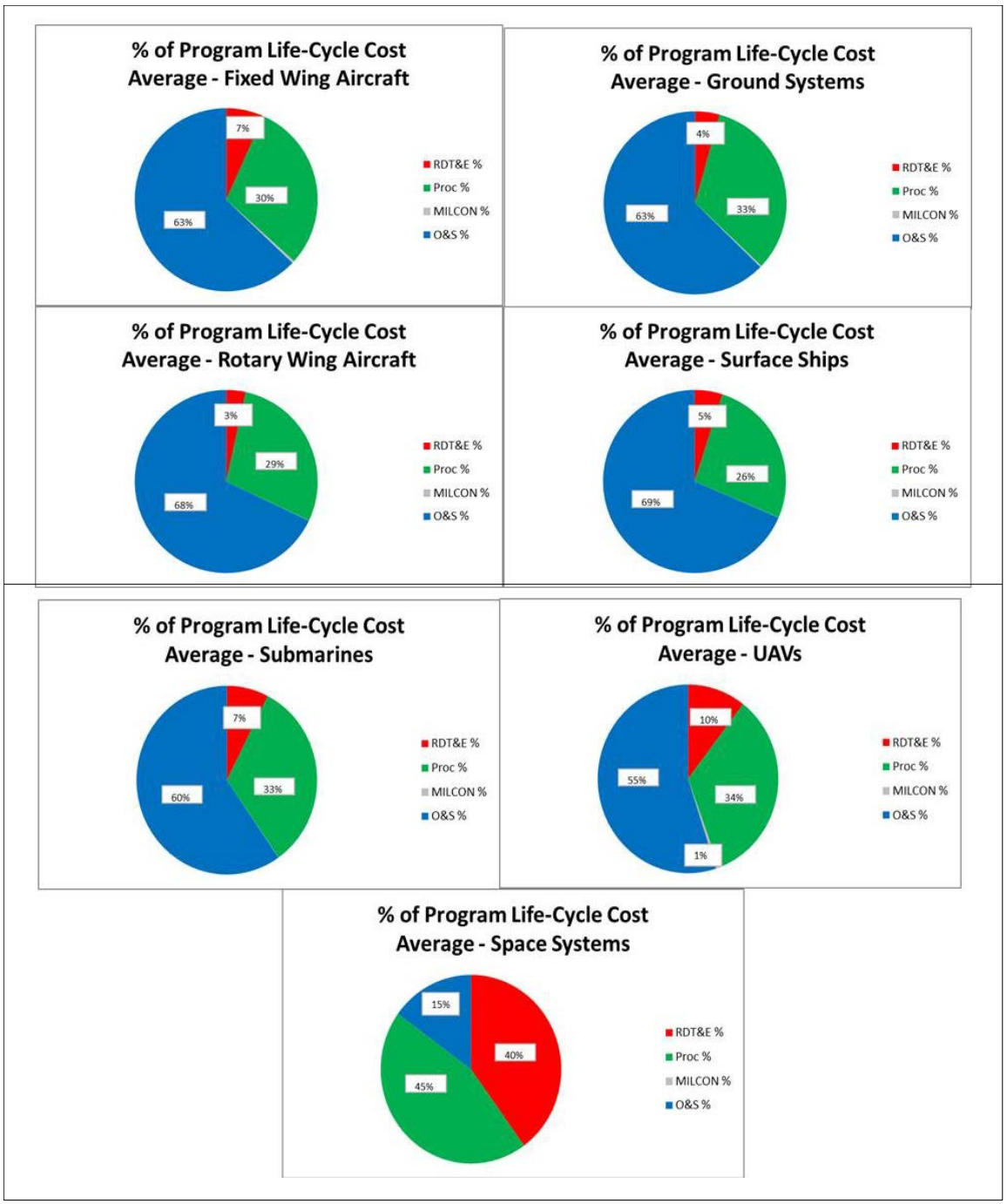

Figure 2-2. O&S Costs as Percentage of Total Life-Cycle Cost for Selected System Types

The actual percentage will vary from program to program. Also, other system types (such as tactical missiles) may have different percentages.

2.2 LIFE-CYCLE COST CATEGORY DEFINITIONS

The following paragraphs summarize the primary cost categories associated with each program life-cycle phase:

- Research and Development. Consists of costs of materiel solution trade studies and advanced technology development; system design and integration; development, fabrication, assembly, and test of hardware and software for prototypes and/or engineering development models; system test and evaluation; systems engineering and program management; and product support elements associated with prototypes and/or engineering development models. For some programs, this may include additional development costs associated with follow-on builds or increments. Further details are provided in DoD 5000.04-M.
- Investment. Consists of procurement and related activities from the beginning of low rate initial production (LRIP) through completion of deployment. Investment typically includes costs associated with producing and deploying the primary hardware; systems engineering and program management; product support elements (i.e., peculiar and common support equipment, peculiar training equipment/initial training, technical publications/data, and initial spares and repair parts) associated with production assets; interim contractor support[1] that is regarded as part of the system procurement and is included in the scope of the Acquisition Program Baseline (APB); and military construction and acquisition-related O&M associated with production and deployment activities (e.g., site activation). Further details are provided in DoD 5000.04-M.
- O&S. Consists of sustainment costs incurred from the initial system deployment through the end of system operations. Includes all costs of operating, maintaining, and supporting a fielded system. Specifically, this consists of the costs (organic and contractor) of personnel, equipment, supplies, software, and services associated with operating, modifying, maintaining, supplying, and otherwise supporting a system in the DoD inventory.

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[1] See DoD 7000.14-R, *Financial Management Regulation* (Reference (b)), Volume 2A, Chapter 1, section 010208, for guidance on funding policies for ICS. Interim Contractor Support (ICS) should be funded in procurement appropriations, and is regarded as a procurement cost, for the period of time up to the target organic support date specified in the program baseline. Any continued funding of ICS beyond that date should be funded in O&M appropriations, and is regarded as an O&S cost.

O&S costs are composed of the following lower-level elements:

- Unit-Level Manpower
  - Operations Manpower
  - Unit-Level Maintenance Manpower
  - Other Unit-Level Manpower
- Unit Operations
  - Operating Materiel
    - Energy (Fuel, Electricity, etc.)
    - Training Munitions and Expendable Stores
    - Other Operational Materiel
  - Support Services
  - Temporary Duty
  - Transportation
- Maintenance
  - Depot Level Reparables
  - Consumable Materials and Repair Parts
  - Intermediate Maintenance (External to Unit-Level)
  - Depot Maintenance
  - Other Maintenance
- Sustaining Support
  - System-Specific Training
  - Support Equipment Replacement and Repair
  - Sustaining/Systems Engineering
  - Program Management
  - Information Systems
  - Data and Technical Publications
  - Simulator Operations and Repair
  - Other Sustaining Support
- Continuing System Improvement

  - Hardware Modifications
  - Software Maintenance
- Indirect Support
  - Installation Support
  - Personnel Support
  - General Training and Education

  Chapter 6 of this guide provides complete definitions and further details for each of these O&S cost elements.

- Disposal. Consists of costs associated with demilitarization and disposal of a military system at the end of its useful life. Costs associated with demilitarization and disposal may include disassembly, materials processing, decontamination, collection/storage/disposal of hazardous materials and/or waste, safety precautions, and transportation of the system to and from the disposal site. Systems may be given credit in the cost estimate for resource recovery and recycling considerations. The disposal cost category is used in a life-cycle cost estimate so that design and other decisions made early in a program consider the effects on the long-term costs that can be attributed logically to the program. Note that demilitarization and disposal costs may also be incurred during the sustainment phase prior to formal entry into a distinct disposal phase. Any disposal expenses anticipated during the sustainment phase (due to combat losses, other destruction of systems beyond economical repair, or unique demilitarization activities) are nevertheless considered part of disposal costs.

2.3 LIFE-CYCLE COST CATEGORIES AND BUDGET APPROPRIATIONS

The life-cycle cost categories correspond not only to phases of the acquisition process, but also to budget appropriation categories. Research and development costs are funded from Research, Development, Test and Evaluation (RDT&E) appropriations; and investment costs are funded from Procurement, Military Construction (MILCON), and, occasionally, acquisition-related O&M appropriations. O&S costs are primarily funded from Military Personnel (MILPERS) and O&M appropriations. Note that for both MILPERS and O&M, there are distinct appropriations for the Active, Reserve, and Guard Components. In addition, the O&S cost elements for continuing system improvements (system hardware modifications and software maintenance) may be funded by RDT&E and/or Procurement appropriations.

Additional information on the alignment of the Integrated Product Support (IPS) elements, O&S cost elements, and funding appropriations is provided in the *AT&L Operating and Support Cost Management Guidebook* (Reference (c)).

3. ROLE OF O&S COST INFORMATION

3.1 INTRODUCTION

Decisions on program requirements, performance, and configuration made early in the acquisition process will generally help to determine a system's O&S costs; the opportunities to reduce O&S costs diminish as a program advances through the phases of the acquisition process. However, as a program matures, it nevertheless remains necessary to continue to track and assess O&S costs and trends to ensure that the program remains sustainable, affordable, and properly funded. For these reasons, beginning with program initiation and continuing at each subsequent acquisition decision point, O&S cost estimates are needed to support various analyses and reviews throughout the program life cycle.

3.2 O&S COST INFORMATION AND PROGRAM DECISION POINTS

The role of O&S cost estimates and cost analyses depends on the acquisition program phase and the specific issues involved. DoD Instruction (DoDI) 5000.02, Operation of the Defense Acquisition System (Reference (d)), describes the phases in the acquisition process and their associated milestone reviews and other acquisition decision points. Any changes made to this terminology in future editions of DoDI 5000.02 should be noted and will take precedence over this guide. The acquisition decision points are listed in Table 3-1.

Table 3-1. Acquisition Decision Points

Acquisition Decision Point	Purpose
Material Development Decision	Formal entry point into the acquisition process initiating the Materiel Solution Analysis
Milestone A	Decision to proceed with Technology Maturation and Risk Reduction
Capability Development Document (CDD) Validation	Decision to review and approve program capability needs (i.e., requirements)
Development Request for Proposal (RFP) Release	Decision to approve acquisition strategy and release of the Development RFP
Milestone B	Decision to proceed with Engineering and Manufacturing Development (EMD)
Milestone C	Decision to proceed with LRIP
Full-Rate Production (FRP) Decision	Decision to proceed with FRP
Post- Initial Operational Capability (IOC) Review	Review of system O&S costs and other sustainment issues(conducted at least every 5 years after IOC

Some of the key roles for O&S cost estimates and analyses associated with these acquisition decision points are shown in Figure 3-1. In most cases, the analytic work being described needs to be started well before the milestone review or other acquisition program decision point being supported by the analysis. For example, for the O&S cost estimates or analyses supporting the Milestone A review, the analytic work will need to be initiated several months earlier, during the Materiel Solution Analysis phase. For the Milestone B review, the analytic work will need to be initiated several months earlier, during the Technology Maturation and Risk Reduction phase.

Role of O&S Cost Estimates and Analyses

EVENT(S)	SUPPORTING ACTIVITIES
MS A	• Obtain enhanced visibility of O&S costs and key cost drivers – Support to trade-off studies – Support to Analysis of Alternatives • Establish initial affordability goal (average annual O&S cost per unit or system)
CDD Val Dev RFP Rel MS B	• Establish balanced requirements for sustainability and reliability, availability, and maintainability (RAM) • Assist the business case analysis supporting the Life-Cycle Sustainment Plan – Organic versus contractor logistics support • Ensure early influence on system design – Adequate attention and investment in logistics engineering efforts, RAM • Update O&S affordability analysis and establish as formal requirement ("cap")
MS C	• Track and assess current O&S estimate relative to prior estimates and affordability cap – Early use of T&E data with reliability/maintainability growth projections – Provide insights into sustainability shortfalls and help identify appropriate mitigation actions • Update product support business case analysis • Provide foundation for budgetary requirements (manpower, major O&M elements)
FRP Dec	• Track and assess current O&S estimate relative to prior estimates and affordability cap – Early use of O&S cost actual experience • Refine product support business case analysis • Update estimates of budgetary requirements
Post-IOC Review	• Assess and manage O&S trends for legacy systems • Assess needs for continuing system improvements/modifications or recapitalization • Assess adequacy of programmed sustainment funding (in context of proper readiness)

Figure 3-1. Role of O&S Cost Estimates by Acquisition Event

At Milestone A, information about the system design, performance, physical characteristics, and O&S concepts are preliminary and tentative. Nevertheless, rough O&S cost estimates are required, primarily to identify key O&S cost drivers in order to support trade-off studies (see Section 3.3) and the AoA (see Section 3.4). The program also establishes its initial O&S affordability goal (see Section 3.5).

At Milestone B, O&S cost estimates are more credible as design and support concepts mature. O&S cost considerations are very important at this formative stage. The long-term affordability of the program is reassessed, and O&S cost goals are refined as formal caps and incorporated into program baselines (see Section 3.5). O&S cost estimates support the systems engineering process, and influence requirements decisions, followed by the system design decisions (see Section 3.6). O&S cost estimates are also used in a program's business case analysis (see Section 3.7), which evaluates the costs and benefits of alternative life-cycle sustainment strategies.

At Milestone C and at the FRP Decision, O&S cost estimates are updated and refined, based on the system's current design characteristics, the latest deployment schedule, and current logistics and training support plans. Actual O&S experience obtained from the system test and evaluation, when available, are factored into the update

to the O&S cost estimate (see Section 3.8), which in turn are used to verify progress in meeting supportability goals or to identify problem areas. The most recent O&S cost estimates are compared to the prior estimates, and reasons for any major variances are identified (see Section 3.9). O&S affordability caps are compared to current cost estimates, the assumptions in business case analyses for the product support strategy are validated, and any funding issues associated with operations and support are resolved (see Section 3.10).

After the program has reached post-IOC status, the focus is to monitor and assess system O&S costs over time, and identify reasons for adverse trends (see Section 3.11). In some cases, systems may experience real growth in O&S costs, possibly due to aging equipment effects. In addition, O&S cost analyses may be used to assist in the assessment of needed system upgrades or replacement.

The remainder of this chapter discusses the various roles of O&S cost estimates and analyses in supporting acquisition decision points in more depth.

3.3 TRADE-OFF STUDIES

DoDI 5000.02 places considerable emphasis on trade-off analyses beginning early in the program life cycle. Analyses of key trades between costs and performance and other capability requirements begin during the Materiel Solution Analysis leading to Milestone A. After Milestone A approval, additional requirements and design trades are conducted to ensure that the program requirements presented in the CDD are affordable on a life-cycle cost basis. Such trade-off studies require cost analyses for all categories of life-cycle costs: Research and Development, Investment, O&S, and Disposal (see Chapter 2 of this guide for descriptions of these categories).

An example of an O&S cost analysis (as an element of a larger life-cycle cost analysis) supporting a trade-off study for a ground combat vehicle is shown in Figure 3-2. System capability is measured in two dimensions: passenger capacity (troop dismounts), and vehicle survivability against ballistic threats. A high-cost element (depot level reparables (DLRs) cost per vehicle mile) is presented as a continuous function of passenger capacity and survivability. Similar figures would be presented for costs of fuel and consumable materials/repair parts.

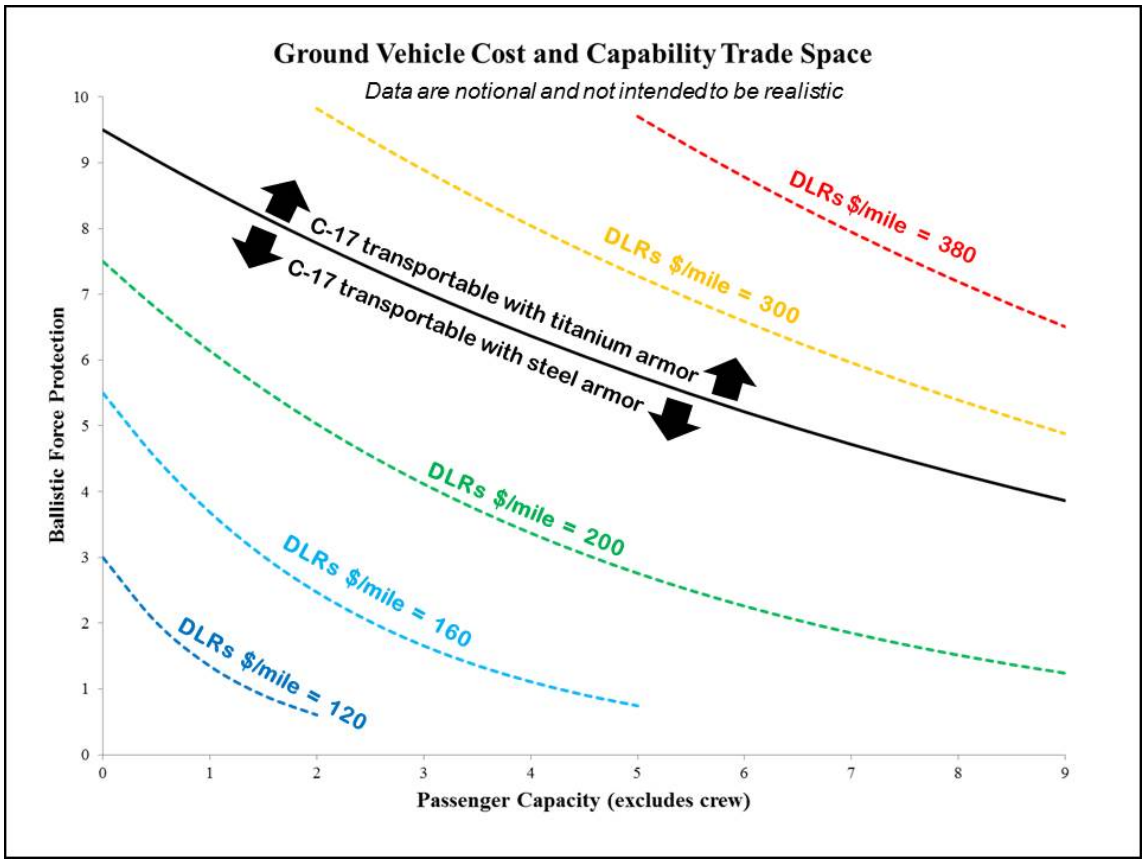

Figure 3-2. Example O&S Cost Analysis Supporting a Trade-Off Study

Such trade-off studies and supporting life-cycle cost analyses are needed to address performance and other capabilities. In addition, all Acquisition Category (ACAT) I programs also are required to establish requirements for sustainment (including availability and reliability). The developers of these sustainment requirements are expected to conduct up-front trade studies and other analyses to determine requirements that are balanced with program acquisition cost and what is achievable based on technology maturity. The process for conducting these trade studies is described in the *DoD Reliability, Availability, Maintainability and Cost (RAM-C) Rationale Report Manual* (Reference (e)). Additional information on this topic is provided in Appendix E of this guide.

Capability requirements proposed in the CDD are expected to be consistent with the program affordability constraints described in Section 3.5.

3.4 ANALYSIS OF ALTERNATIVES

An AoA study is an important element of the defense acquisition process. An AoA is an analytical comparison of the operational effectiveness, suitability, and life-cycle cost of alternative programs that satisfy established capability needs. The AoA submitted

at Milestone A explores numerous conceptual solutions to identify the most promising options for technology development. An update of the AoA may be required by the Milestone Decision Authority (MDA) prior to release of the Development RFP. An AoA normally is not required at Milestone C unless significant changes to threats, costs, or technology have occurred, or the analysis is otherwise deemed necessary by the MDA.

The AoA submitted at Milestone A is informed by the tentative affordability goals (described in Section 3.5) established at the Materiel Development Decision. In this way, the affordability goals will help scope the range of alternatives considered in the AoA to feasible materiel solutions.

System O&S cost estimates are an important part of the AoA. In some cases, the alternative that serves as the analysis baseline is the continuation (or service-life extension) of the existing system that the proposed acquisition program is intended to replace. The alternatives usually have different phasing of resources over time, and appropriate discounting methods should be used to calculate the life-cycle cost of each alternative in net-present-value terms (see DoDI 7041.3, Economic Analysis for Decisionmaking (Reference (f)).

Guidance concerning AoAs is provided in DoDI 5000.02, Enclosure 9, Analysis of Alternatives. Further information on the AoA process may be found in the *Defense Acquisition Guidebook* (Reference (g)), Section 3.3.

3.5 AFFORDABILITY

The description of the DoD policy on program affordability is provided in DoDI 5000.02, Enclosure 8, Affordability Analysis and Investment Constraints. In essence, Enclosure 8 outlines concepts and approaches in which the DoD Components conduct an affordability analysis for each of their programs at the milestone reviews and other acquisition decision points.

For each program under consideration, the affordability analysis is a projection of funding requirements and system inventories by fiscal year—within the Future Years Defense Program (FYDP), and several years beyond. The affordability analysis is made and presented for the relevant portfolio or mission area, so that the DoD Components may conduct trade-off analysis within the portfolio based on life-cycle costs and inventories of related acquisition programs. If necessary, the DoD Components also may make tradeoffs across portfolios to ensure adequate resources for high-priority programs.

The affordability analysis is used to establish affordability constraints for unit procurement cost and annual sustainment cost per system for the program under consideration. The constraints are not based on cost estimates for the program. Rather the constraints are derived from a projection of funding available for the program that can be

accommodated within an investment plan for the relevant portfolio that satisfies fiscal guidance (e.g., zero real growth in funding for the overall portfolio).

The constraints for a program's unit procurement cost and annual sustainment cost per system are first established as tentative cost goals to support the Materiel Development Decision, and to inform the trade space of the AoA and early trade-off studies described earlier. At Milestone A, formal affordability goals for unit procurement cost and annual sustainment cost per system are established to inform early requirements and design trades. The affordability constraints are updated and established as binding caps at the Development RFP Release Decision Point, Milestone B, and subsequent acquisition decision points. The caps are to be considered equivalent to Key Performance Parameters (KPPs)—in essence, treated as firm requirements and incorporated into the program baseline.

The MDA is expected to enforce the approved affordability constraints after they are established as caps. If a program manager concludes that an affordability cap will be exceeded, he or she notifies the Component Acquisition Executive and the MDA to request assistance and resolution. In such a situation, the Component will (1) lower costs by adding cost control efforts or reducing program requirements, (2) raise the cap by lowering constraints on other programs, or (3) terminate the program.

The remainder of this section provides a notional example of how affordability assessments are made for O&S costs. This example demonstrates how an O&S affordability constraint can be derived by a quantitative assessment of the likely resources available for the program's portfolio or mission area. The example also illustrates how O&S cost estimates are compared to affordability constraints at milestone reviews and other acquisition decision points.

This example is for a new amphibious warfare ship program, the LSD(X), which is approaching a Milestone A decision. As a first step, it is necessary to develop a long-range modernization plan for the entire portfolio of amphibious warfare ships. A graphic for this plan is provided in Figure 3-3. Note that the plan includes a projection of the composition of total ship inventories by class for a twenty-year period.

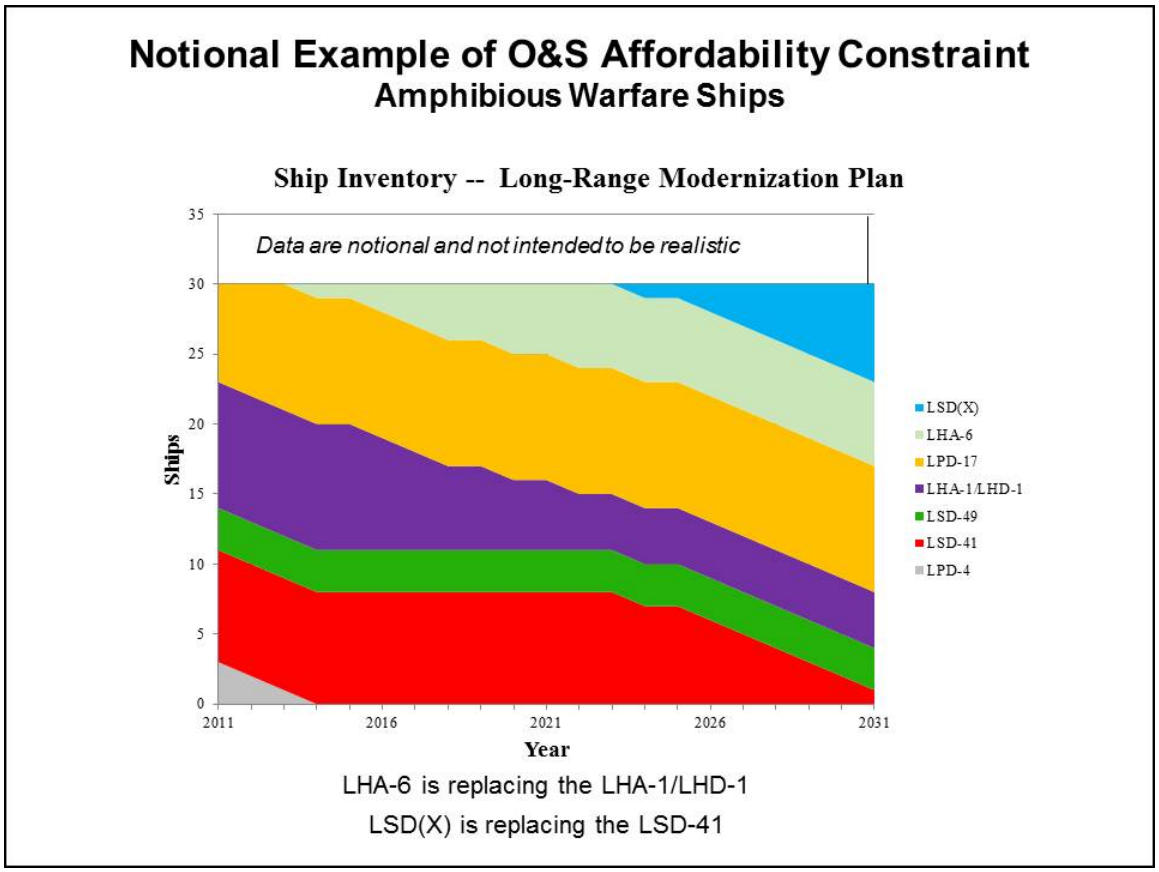

Figure 3-3. Nominal Long-Range Modernization Plan

It is important to ensure that a long-range modernization plan provides for sufficient procurement to recapitalize the portfolio over the long run. In this example, the goal is to maintain a steady-state fleet of thirty amphibious warfare ships. Assuming that the service life of each ship is forty years, the modernization plan must on average procure three ships for every four years in the plan. Otherwise, the fleet would shrink due to insufficient ship replacement.

The second step is to estimate the annual O&S cost for the portfolio, broken out by ship class, over the twenty-year period. This projection is shown in Figure 3-4.

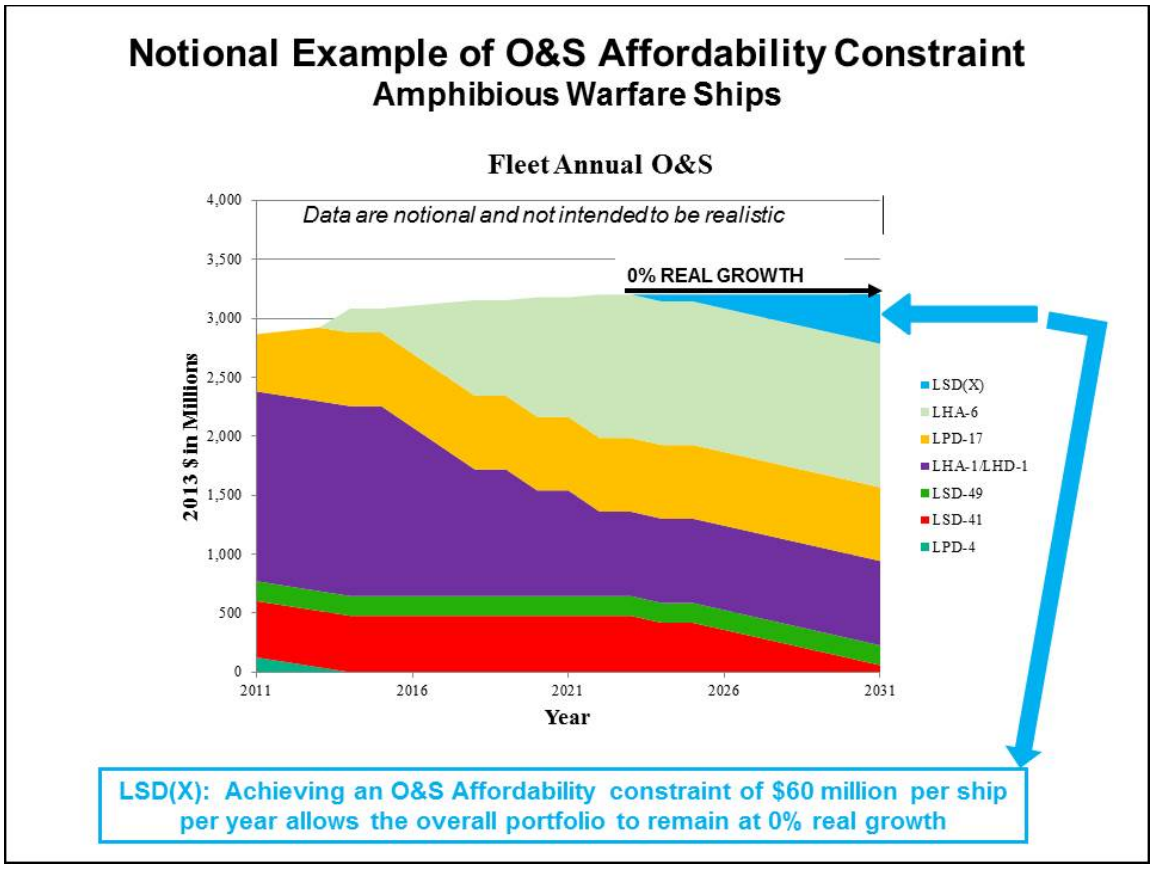

Figure 3-4. Nominal Long-Range O&S Projection

In this example, the fleet O&S projection is derived by multiplying the annual O&S cost per ship times the projected ship inventory for each ship class. The annual O&S cost per ship for the mature programs can be based on actual costs.[2] For the LHA-6, the annual O&S cost per ship will be based on an estimate, such as the program office O&S cost estimates provided in the SARs. For the LSD(X), the affordability constraint is not based on a cost estimate, but rather is derived from an assessment of available funding. In this example, the projection of available funding for the LSD(X) program is made by determining what funding is available if the overall portfolio is constrained at zero percent real growth.[3] Given the available funding and the projected ship inventory for the LSD(X), it is then possible to derive the affordability O&S constraint per ship.

After a program affordability constraint for the LSD(X) is derived, the constraint may be compared to O&S cost estimates for the same program in order to understand the

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2 See Section 4.1, VAMOSC Program, for a discussion about the Services' Visibility and Management of Operating and Support Costs (VAMOSC) data systems.

3 Other projections about available funding for the program's portfolio or mission area are possible, and will depend on the priorities of the program's military department among its various portfolios.

likelihood that the target is realistic and achievable. Such comparisons are made to support the affordability assessment conducted at milestone reviews and other major acquisition decision points. A notional affordability comparison for LSD(X) O&S costs is shown in Figure 3-5.

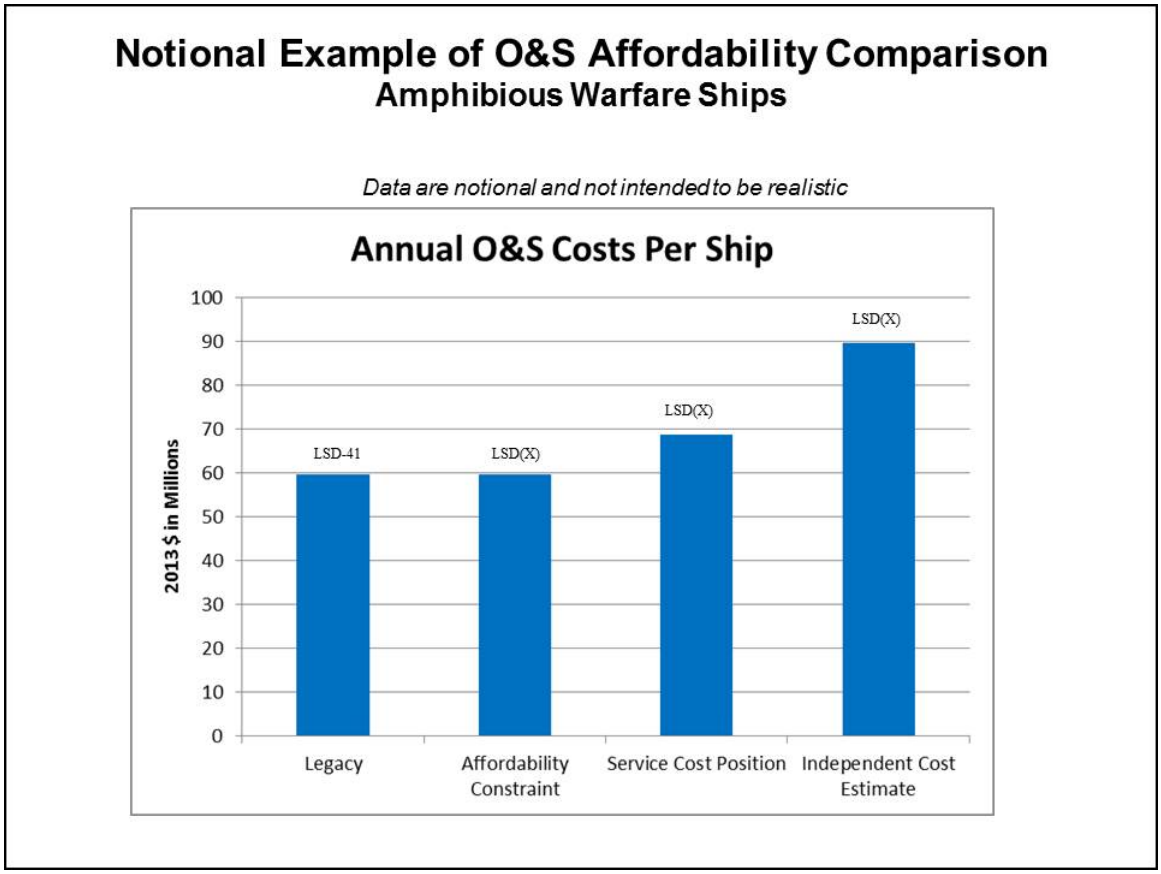


Figure 3-5. Notional O&S Affordability Comparison

In this example, the affordability constraint is compared to both the Service Cost Position and the CAPE independent cost estimate. In addition, the two cost estimates are compared to the annual cost of the legacy system that is being replaced by the new program.[4] If the cost estimates are significantly higher than the affordability constraint, it is likely that the constraint is not realistic. If the cost estimates are significantly higher than the costs of the legacy system, the program as currently envisioned most likely is not affordable in the long run. In either case, the program will need to reassess the

[4] In this example, it is assumed that there is a 1:1 replacement between the new system and the legacy system. If the replacement is to take place at some other ratio, the cost comparison would need to be adjusted accordingly. For example, if each LSD(X) replaced two LSD-41s, the comparison would show the cost of one LSD(X) relative to the costs of two LSD-41s.

fundamental requirements, design, and structure of the program through appropriate trade-off studies in order to make it more affordable.

3.6 EARLY INFLUENCE ON SYSTEM DESIGN

DoDI 5000.02 requires that sustainment factors be fully considered at all milestone reviews and other acquisition decision points, and that appropriate measures be taken to reduce O&S costs by influencing system design early in development, developing sound sustainment strategies, and addressing key drivers of cost. To achieve these goals, the system must be designed for supportability up-front, since the opportunities to reduce O&S costs decline significantly as the system design evolves leading to production and deployment. This early design effort is supported by life-cycle costing integrated with the systems engineering process at increasing levels of design detail to ensure that the system design meets program sustainment requirements within the O&S affordability caps established at Milestone B.

A simple example of how life-cycle costing can support the early design effort is portrayed in Figure 3-6. In this example, there are two alternative designs for a major subsystem. The first subsystem has a lower procurement cost than the second, but it is also less reliable and therefore has a higher annual O&S cost. The life-cycle cost comparison shows that the second subsystem has an overall lower discounted life-cycle cost than the first. The computations associated with this example are provided in Appendix B of this guide.

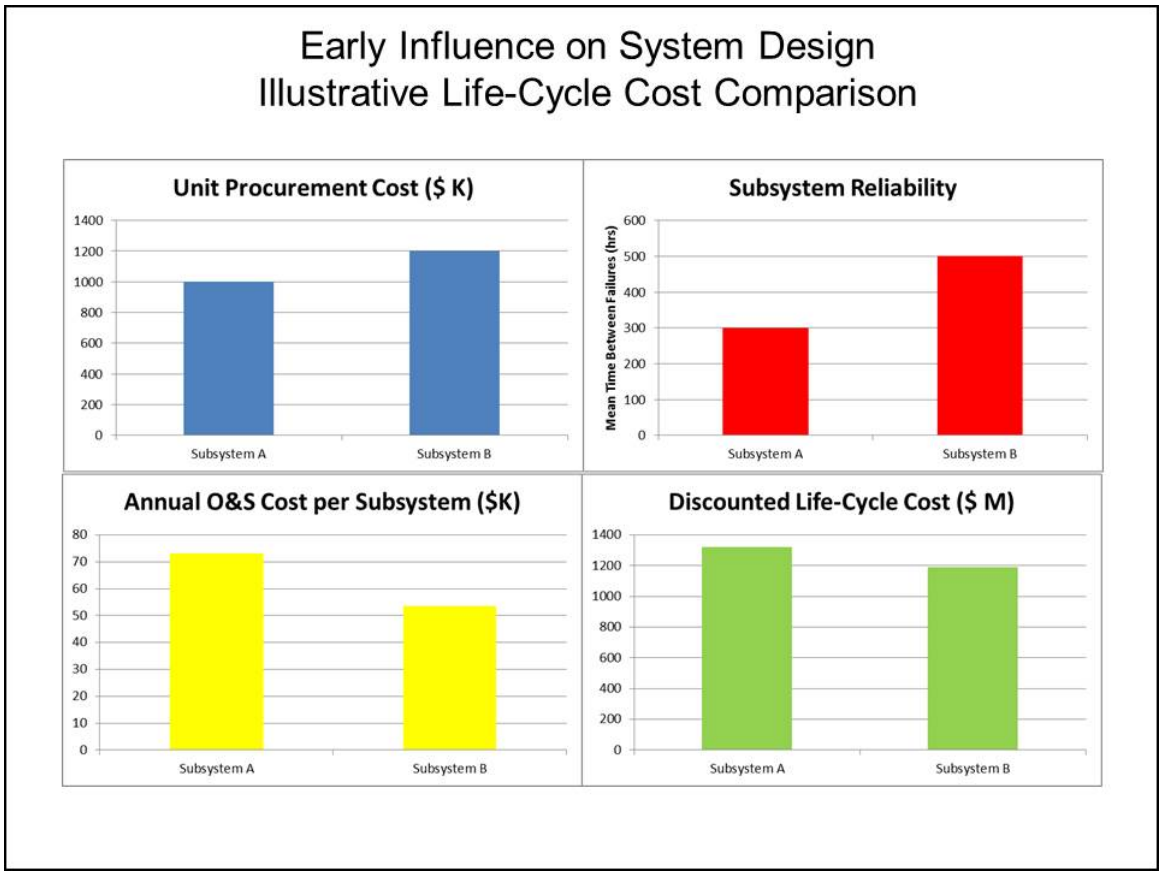


Figure 3-6. Notional Life-Cycle Cost Comparison of Design Alternatives

Beyond reliability and maintainability, there are other technical, design, and other program characteristics that can drive significant impacts to life-cycle cost. For example, choices in energy sources or chemicals and materials can have a significant impact on human health and the environment, leading to unintended consequences for the logistics, installations, and operational communities with associated increases to program life-cycle cost. In addition, other design features can affect costs associated with issues such as program protection or supply chain risk management. These design features should be evaluated for life-cycle cost impacts where it is possible to do so. However, the current tools, methods, and data sources to evaluate the cost effects associated with many of these design features are quite limited and are areas for future research.

3.7 BUSINESS CASE ANALYSIS FOR LIFE-CYCLE SUSTAINMENT PLAN

Every program manager is required to develop and implement an affordable and effective performance-based product support strategy. This strategy is described in the program Life-Cycle Sustainment Plan (LCSP), the primary document used to describe the program plans for sustainment across the life cycle.

A draft of the initial LCSP is provided at the Milestone A review. A draft update is provided at the Development RFP Release, and is finalized and approved at the Milestone B review. The LCSP also is updated at the Milestone C review, at the FRP decision, and at least every five years after system IOC. The LCSP is approved by the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) for ACAT ID programs, and by the Component Acquisition Executive for ACAT IC programs.

The product support strategy should be supported by a business case analysis, which is an annex to the LCSP. A business case analysis is a type of economic analysis that a program manager may use when deciding among any number of product support alternatives. It is a structured approach to identify the cost, benefits, and risks of the alternatives. To ensure accurate results, the business case analysis depends on O&S cost data as well as requirements and supportability analysis results (as explained in Section 3.3 and Appendix E, Section 9).

The business case analysis may consider alternatives of organic, contractor, or some combination for sources of sustainment support. In addition, the business case analysis may evaluate other sustainment alternatives, such as choice of contract type, the use of performance-based logistics, various technical data rights strategies, or whether or not to establish competition—or the option of competition—for the supported system or major subsystems.

Guidance on the business case analysis for the LCSP is provided in DoDI 5000.02, Enclosure 6, Life-Cycle Sustainment Planning. Further information may be found in the *Defense Acquisition Guidebook*, Section 5.2.2, and in the *DoD Product Support Business Case Analysis Guidebook* (Reference (h)).

3.8 RELIABILITY AND MAINTAINABILITY SPECIFICATION AND TRACKING

As explained in Appendix E of this guide, the military departments are required to collect and retain test and evaluation data on the reliability and maintainability of major weapon systems, and to use such data to inform O&S costs for those systems. This section provides illustrative examples of the tracking of actual reliability and maintainability data compared to baseline (i.e., specification) reliability and maintainability growth curves, and shows how such tracking can be used to update estimates of relevant high-cost O&S cost elements such as maintenance manpower.

An example of a track of the reliability of an aircraft is shown in Figure 3-7. In this example, reliability is measured as Mean Time Between Maintenance (MTBM) events, where the events are corrective maintenance actions. The program has two baseline values for reliability that are part of the contract specification. The first reliability value is the minimum requirement (which must be met), and the second is the desired goal that is

slightly better than the requirement. It is assumed that there would be appropriate incentives (such as award fees associated with performance demonstrated in a Reliability, Availability, and Maintainability (RAM) Evaluation) for the contractor to surpass the minimum requirement. The reliability growth curves associated with the specification values assume that the reliability is improved over time due to design changes to correct deficiencies discovered in test and evaluation, or due to improvements in parts quality as the production process matures, up to the point of reliability maturity (which is assumed to occur at 100,000 cumulative flying hours). The track also shows the actual test data for the same points in time as the program baseline (requirement and goal). In this example, the early reliability was deficient relative to the baseline, but over time the contractor was able to address the problem and reach a reliability value at maturity that significantly surpassed the specification values.

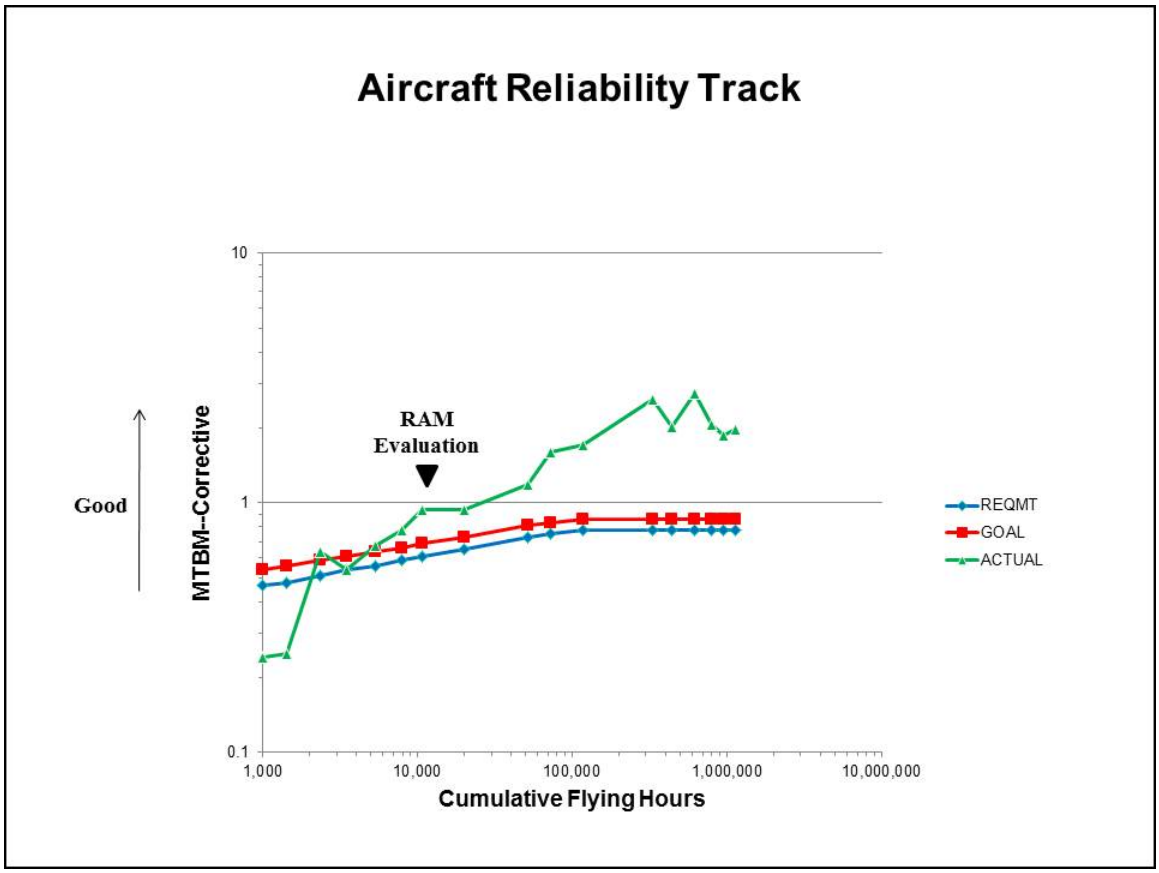


Figure 3-7. Track of Aircraft Reliability Metric

An example of a track of the maintainability for the same aircraft is shown in Figure 3-8. In this example, maintainability is expressed as Maintenance Man-Hours per Flight Hour (MMH/FH).

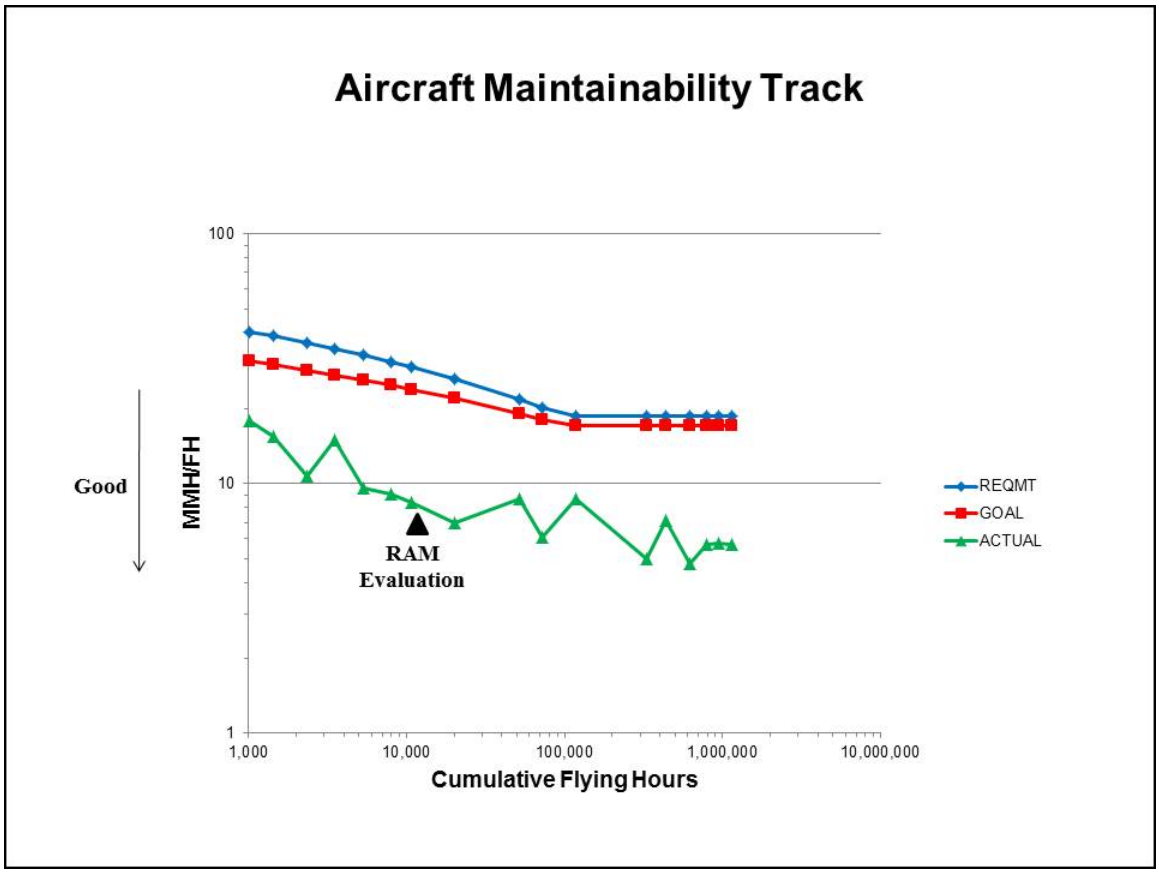


Figure 3-8. Track of Aircraft Maintainability Metric

As the early test and evaluation data is collected and assessed, it is then possible to update the current estimates for system reliability and maintainability. In some cases, the test and evaluation data will come close to the growth curves associated with the current program estimates or specifications, and the current estimates can be validated. In other cases, the test and evaluation data may be significantly different from the program growth curves, and the current estimates may need to be revised.

Once the system reliability and maintainability projections are validated or revised, that information in turn can be used to update the estimates for certain O&S cost elements that are sensitive to reliability and maintainability—typically, unit-level maintenance manpower, depot level reparables, and consumable materials and repair parts.

As an example, maintenance manpower for a unit or squadron can be determined as a function of aircraft reliability and maintainability by use of a model that simulates aircraft maintenance. An example of such a determination is shown in Figure 3-9. In this example, the reliability parameter is MTBM, and the maintainability parameter is Mean Manhours to Repair. These parameters were estimated at the subsystem level.

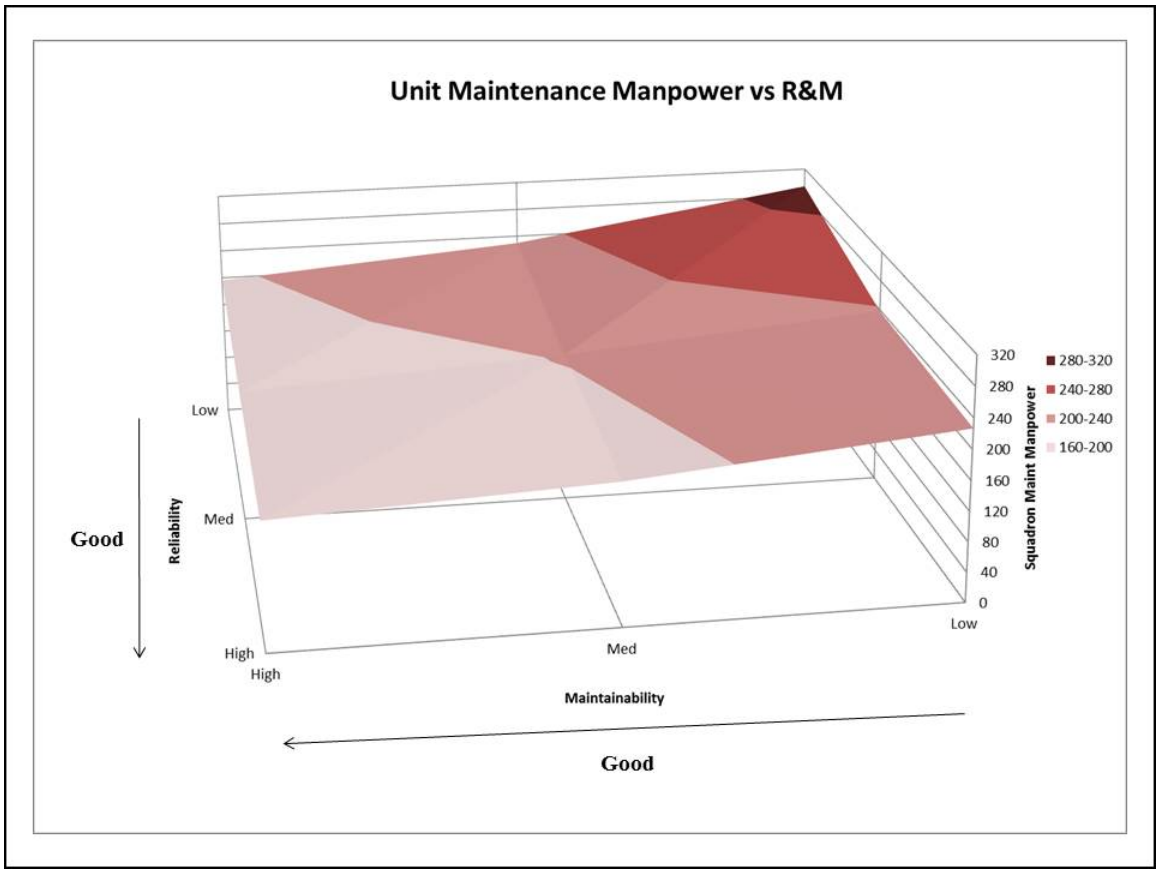
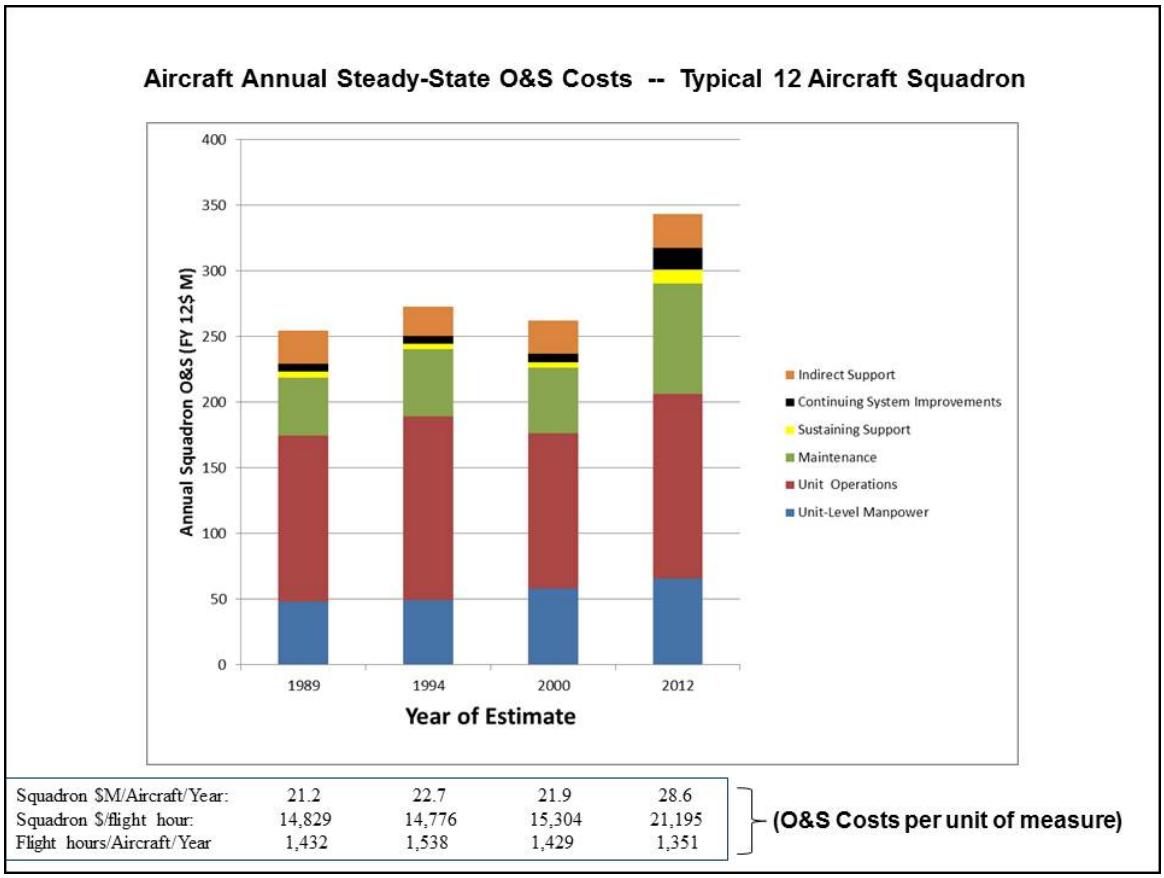


Figure 3-9. Unit Maintenance Manpower as a Function of Reliability and Maintainability

3.9 TRACKING AND ASSESSING O&S COST ESTIMATES

As explained in Appendix E of this guide, the military departments are required to update estimates of system O&S costs periodically throughout the life cycle of each major weapon system, to determine whether preliminary information and assumptions remain relevant and realistic, and identify and record reasons for variances. This section provides an analytic approach and presentation format for such updates.

Figure 3-10 shows an example of a track of various O&S cost estimates that were made for an aircraft program. The chart shows the annual steady-state O&S costs for a typical aircraft squadron, where the costs are broken down into and displayed under the standard six cost elements described in Chapter 6 of this guide. This format is similar to the O&S cost format that is used in the SAR. The chart shows a comparison of four cost estimates made at different points in time. The first estimate supported a Milestone B decision in 1989, the second estimate supported a Milestone C decision in 1994, the third estimate supported an FRP decision in 2000, and the fourth estimate supported a post-IOC review in 2012. The fourth estimate is for a mature program and is regarded as high-confidence (since it is largely based on actual cost experience).



Squadron $M/Aircraft/Year:	21.2	22.7	21.9	28.6
Squadron $/flight hour:	14,829	14,776	15,304	21,195
Flight hours/Aircraft/Year	1,432	1,538	1,429	1,351

(O&S Costs per unit of measure)

Figure 3-10. Track of O&S Cost Estimates

The fourth (current O&S) cost estimate is significantly higher than the earlier estimates. However, in assessing the reasons for the apparent cost growth, we find that the variances can be grouped into three broad categories for this example. The first category consists of accounting and definitional changes that have taken place over time. The second category consists of external or fact-of-life changes that could not reasonably have been predicted at the time of the earlier estimates. These two categories comprise cost variances that are not related to the supportability of the system or that could be regarded as within the control of a program manager. The third category consists of changes inherent to the program that *are* related to the supportability of the weapon system.

In this example, there have accounting and definitional changes that distort the comparisons. The accounting of military member health care costs was affected by the introduction of the Defense Health Program. The accounting of depot maintenance costs also changed with the introduction of the Defense Working Capital Fund (DWCF). Also, the range of indirect costs incorporated into O&S cost estimates, as currently prescribed in Chapter 6 of this guide, is broader in scope then it was in the 1980s and 1990s.

In this example, instances of external factors were changes in active-reserve mix and assumed operating tempos. Another external factor was additional unanticipated modernization costs associated with safety upgrades necessary to meet evolving flight-worthiness standards mandated by the Federal Aviation Administration. Furthermore, manpower costs per military member, even when adjusted for nominal inflation, have grown significantly over the years. This is due to the introduction of the "TRICARE for Life" benefit and real growth in costs for housing, incentive and special pays, and Permanent Change of Station (PCS) moves.

The remaining reasons for the cost growth in this example can be regarded as inherent to the program, and reasonably can be characterized as actual cost growth relative to the cost estimate made at Milestone B. The specific inherent factors were determined to be:

- Higher fuel consumption, due to airframe weight growth during development
- Higher dollars per flight hour for depot level reparables and consumable materials and repair parts, due to cost growth for parts from major suppliers
- Higher costs for engine depot maintenance associated with the contractor logistics support (CLS) strategy (relative to comparable organic support)
- Addition of significant resources for contractor field service representatives, with no offset in organic maintenance manpower
- Higher costs for training support associated with the CLS strategy
- Significant increase in the level of effort for sustaining engineering and program management associated with the CLS strategy

To make a more meaningful comparison, the Milestone B (1989) estimate was normalized to the same accounting and definitional ground rules as the current (2012) estimate. In addition, the reasons for the remaining cost growth were partitioned into external factors and inherent factors, as discussed. The results of this assessment are displayed in Figure 3-11. The Milestone B estimate is shown at the bottom of the stacked bar chart. The variances resulting in the cost growth reflected in the current estimate are displayed individually.

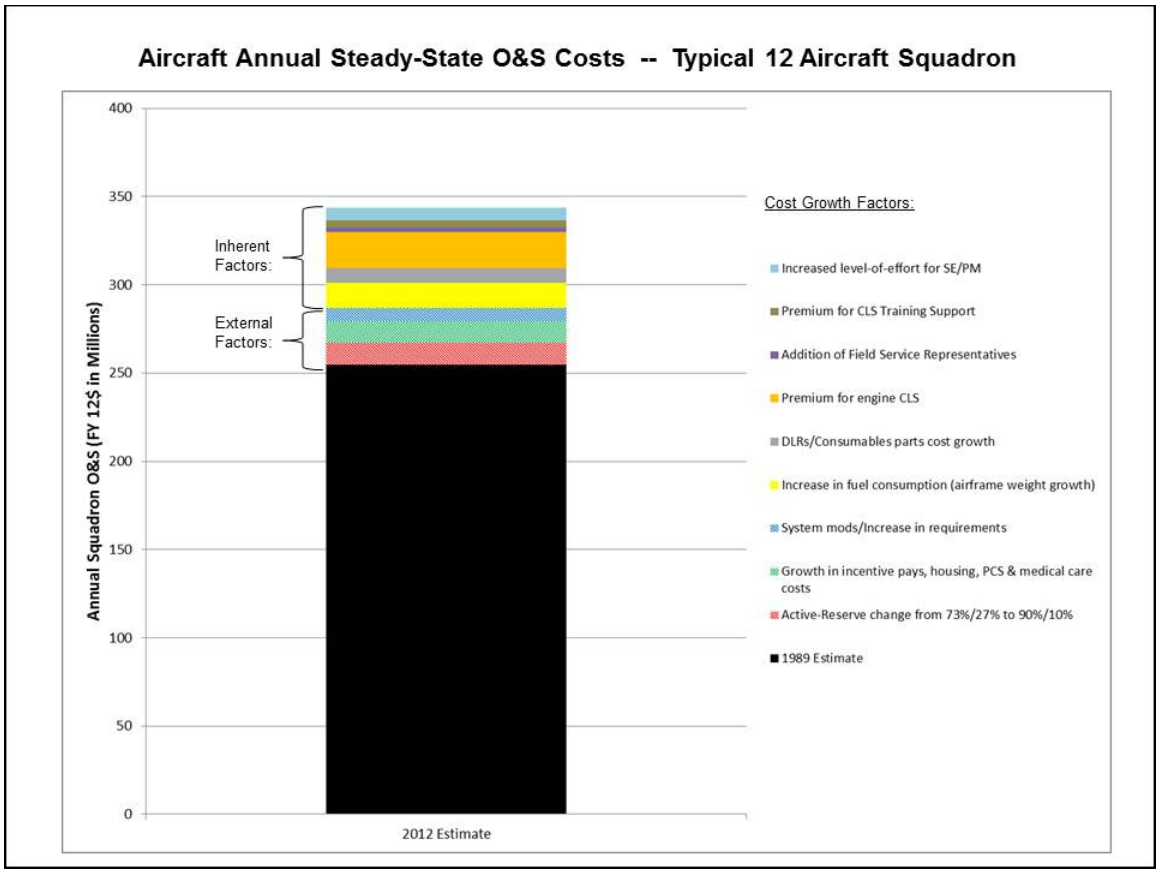


Figure 3-11. Normalized Assessment of O&S Cost Growth

The results of these analyses will be used to inform OSD reviews at the acquisition decision points, including the post-IOC reviews described in Section 3.12 and Appendix E of this guide. In part, these analyses can help identify problem areas or opportunities for reducing program O&S costs. In addition, the results of these analyses will be archived by CAPE (as described in Appendix E) in order to facilitate lessons learned for future programs with regard to O&S cost estimation and analysis.

In addition to tracking and assessing O&S cost estimates at milestone reviews and other acquisition decision points, the AT&L staff also requires the tracking of total O&S costs as part of the Operating and Support Costs data section of the program SAR. In this section, the SAR provides a comparison of the current O&S cost estimate to the value contained in the APB. AT&L guidance on the reporting of O&S costs in the SAR is provided in the Defense Acquisition Management Information Retrieval (DAMIR) SAR Data Entry Instructions (see http://www.acq.osd.mil/damir/guidance.html).

3.10 ASSESSING RESOURCES FOR SUPPORT

Early in a program, assessments and reviews of funding adequacy focus on development and investment costs. However, after the program enters EMD and is

approaching LRIP, there is emerging information about the system support that can provide a foundation for sustainment resource requirements. This information may initially be based on engineering estimates, but can be updated over time with test results and actual cost experience when available to ensure full funding of sustainment resource requirements.

Much of the system or unit O&S cost (such as unit manpower and unit operations) is typically funded in the primary program element associated with the system or unit. Examples of primary program elements are F-16 squadrons, guided missile destroyers, and heavy (armored) brigade combat teams. Straightforward comparisons between most likely cost and funding can be made and presented. Other O&S costs (indirect support and some depot maintenance) are centrally funded (i.e., not funded by individual weapon system accounts). It is more difficult, if not impossible, to compare these costs to available funding.

The analyses presented in Section 3.10 are illustrative examples of the kinds of analyses that can be used to support the FRP Decision and the post-IOC review. While using analyses to support these decision points is important, it is also important to continually refine estimates of sustainment resource requirements and to reassess the adequacy of the actual funding in program reviews and budgets on an annual basis. For the most part, the support to the programming and budget processes is not conducted in terms of the aggregate total system O&S cost, but rather at lower levels of detail—normally, system or unit manpower and individual high-cost O&M elements. These two areas are discussed further in the next two subsections.

3.10.1 Manpower Estimates

Manpower is an important element in system O&S costs, since manpower often accounts for a large fraction of the total program O&S cost. For example, for Navy surface ships, ship manpower accounts for, on average, roughly 40 percent of the ship's total O&S cost.

For MDAPs, manpower estimates are required by law (Title 10, Section 2434) and by regulation (DoDI 5000.02, Enclosure 7, Human Systems Integration). Manpower estimates serve as the authoritative source for a program's projected manpower requirements. A draft of the initial manpower estimate is provided at the Development RFP Release, and is finalized and approved at the Milestone B review. The manpower estimate is also updated at the Milestone C review and at the FRP decision. The manpower estimate is approved by the cognizant DoD Component manpower authority (for the military departments, normally the Assistant Secretary for Manpower and Reserve Affairs), subject to the review of the staff in the office of the Under Secretary of Defense (Personnel and Readiness).

The manpower estimate provides the program manpower needed for system operations, maintenance, support, and system-related training. The manpower is provided separately for active-duty officer and enlisted end-strength, reserve officer and enlisted drill and full-time end-strength, civilian full-time equivalents, and contractor support work-years. Typically, the manpower estimate is incorporated into the program Cost Analysis Requirements Description (CARD), but, normally, additional details are provided to support O&S cost estimates. In the CARD, the manpower is displayed by grade for the military and government civilians. If applicable, it is also necessary to display the manpower requirements by Component (Active, Guard, or Reserve) and by major command.

Further information about manpower estimates is provided in the *Defense Acquisition Guidebook*, Section 3.5. Further information about the CARD is provided in Chapter 5 of this guide and in DoD 5000.04-M.

Each military department has its own process to continually review and update program manpower requirements as the program matures and begins operations. These requirements are typically documented in some form of unit manning document or table of organization and equipment, although the specific format will vary among the military departments. Although the manpower estimate described earlier does not include grade structure or skill level, the unit manning document typically does. For example, in the case of surface ships, the Navy publishes a Ship Manning Document for each class (and configuration) of ship. The Ship Manning Document provides manpower requirements in terms of grade, occupation, and skill level, predicated on the program's required capabilities and operational environment, computed workload, and productivity assumptions (such as standard workweeks, leave policy, etc.). The Navy reviews its Ship Manning Documents each year, and updates them when there are significant changes to the mission, operational concept, or ship configuration.

It is important to verify that the approved manning levels are programmed and funded as the program nears system operations. One way to accomplish this would be to compare the approved manning levels, the programmed manpower authorizations as reflected in the FYDP, and (when available) the actual manning. Such a comparison for a Navy surface ship is shown in Figure 3-12. The actual manning can be provided by the Navy VAMOSC data system, which is described in Chapter 4 of this guide.

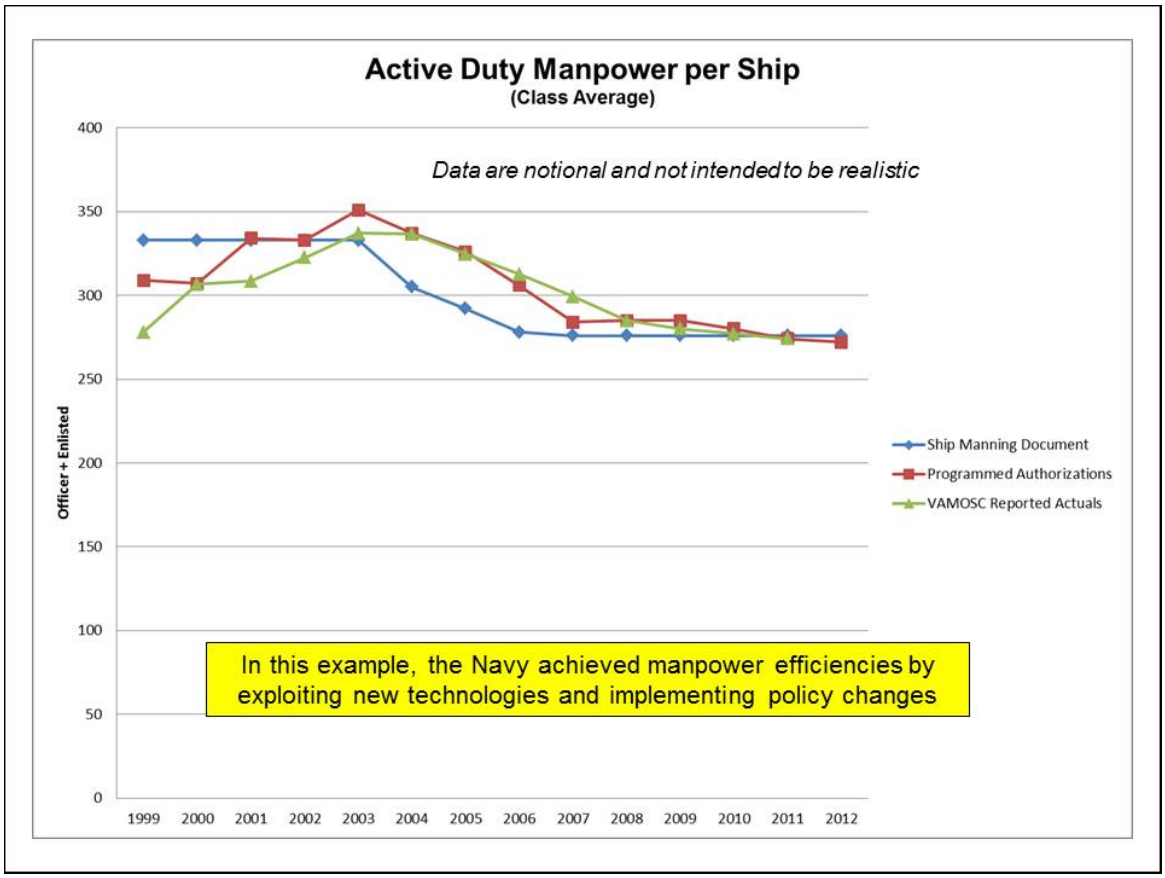


Figure 3-12. Assessment of Approved Ship Manning

In general, the approved manning, programmed manning, and actual manning should be reasonably consistent over a multiple-year period, although there may be variations among the three in any one year due to lags in programming, budgeting, and execution. In this example, the approved manning, programmed manning, and actual manning align quite closely. If that were not the case, it would be appropriate to investigate the reasons for any significant discrepancies.

3.10.2 O&M Budget Reports

Each military department provides an annual budget submission for its O&M accounts. Much of the submission consists of numerous detailed budget justifications. These justifications provide visibility into various O&M activities, and can be used in analyses to help ensure that the O&M accounts are executable, properly priced, and adequately funded for proper readiness.

For the major weapon systems, there are several specific budget reports that provide visibility into system inventories; operating tempos; and funding for reparables, consumables, fuel, depot maintenance, and contractor logistics support. The specific report format is tailored to the type of weapon system involved. The instructions, terms,

and definitions for these reports are provided in the DoD *Financial Management Regulation*, Volume 2A, Chapter 3. The key O&M budget justification documents are summarized in Figure 3-13.

Annual Budget Reports for Weapon System O&M Accounts

Report	Title	Components Reporting	Note
OP-20	Flying Hour Program	All	
• Report Detail……Aircraft Series (e.g. F-16C), O&M Sub-Activity Group (SAG), FYDP Program Element (PE)			
• Type Data……Aircraft Quantity, Flying Hours (Funded and Required), Crews Assigned, Crew Ratio, Hours per Crew per Month • Funding Data……Fuel, Reparables, Consumables , Contract, Maintenance, Other, Indirect			
OP-25	Ground Vehicles Operation	Army/USMC	
• Report Detail……Major Fighting Vehicle (e.g.. M1), O&M SAG, FYDP PE			
• Type Data……Vehicle Quantity, Tank Miles, Barrels of Fuel • Funding Data……Fuel, Reparables, Consumables , Contract/Other, Indirect, Funded and Required			
OP-30	Depot Maintenance Program	All	
• Report Detail……Maintenance Activity (e.g. Acft, Vehicles, Ordnance, etc.), Maint. Type (e.g. Airframe, Software, etc.)			
• Type Data……Units Programmed (Airframe, Engines, Vehicles) • Funding Data……Maintenance Activity and Type, Funded and Required			
OP-41	Ship Operating Cost Data	Navy	
• Report Detail……Ship Type , O&M SAG, FYDP PE			
• Type Data……Steaming Days, Ship Operating Month (Funded/Required) • Funding Data……Repair Parts, Fuel, Consumables, Utilities, Nuclear Fuel, Charter, Other			

Figure 3-13. Key O&M Budget Justification Reports

- The OP-20 report is used for aviation assets by all of the military departments. The OP-20 combines information on flying hours and aircraft inventories with funding for consumables, depot-level reparable (DLR) items, and fuel.
- Similarly, the OP-25 presents data for ground vehicles, including miles driven and funding for consumables, DLRs, and fuel.
- The OP-30 report provides information on the depot maintenance accounts, including planned or completed overhauls and the funding associated with depot maintenance. The report for Navy ships provides information on overhauls, restricted availabilities, and phased maintenance availabilities.
- Specific to ships, the OP-41 report provides information about expenditures for fuel and repair parts, along with operating information, such as steaming hours.

Information extracted from the various O&M budget reports can be compared to actual cost experience in order to assess the funding adequacy for the major O&M cost

elements. An example of such an assessment for the funding for depot maintenance for a Navy surface ship is shown in Figure 3-14. The actual cost data is taken from the Navy VAMOSC system, which is described in Chapter 4 of this guide. Similar charts could be prepared for repair parts, fuel, consumables, and other cost elements.

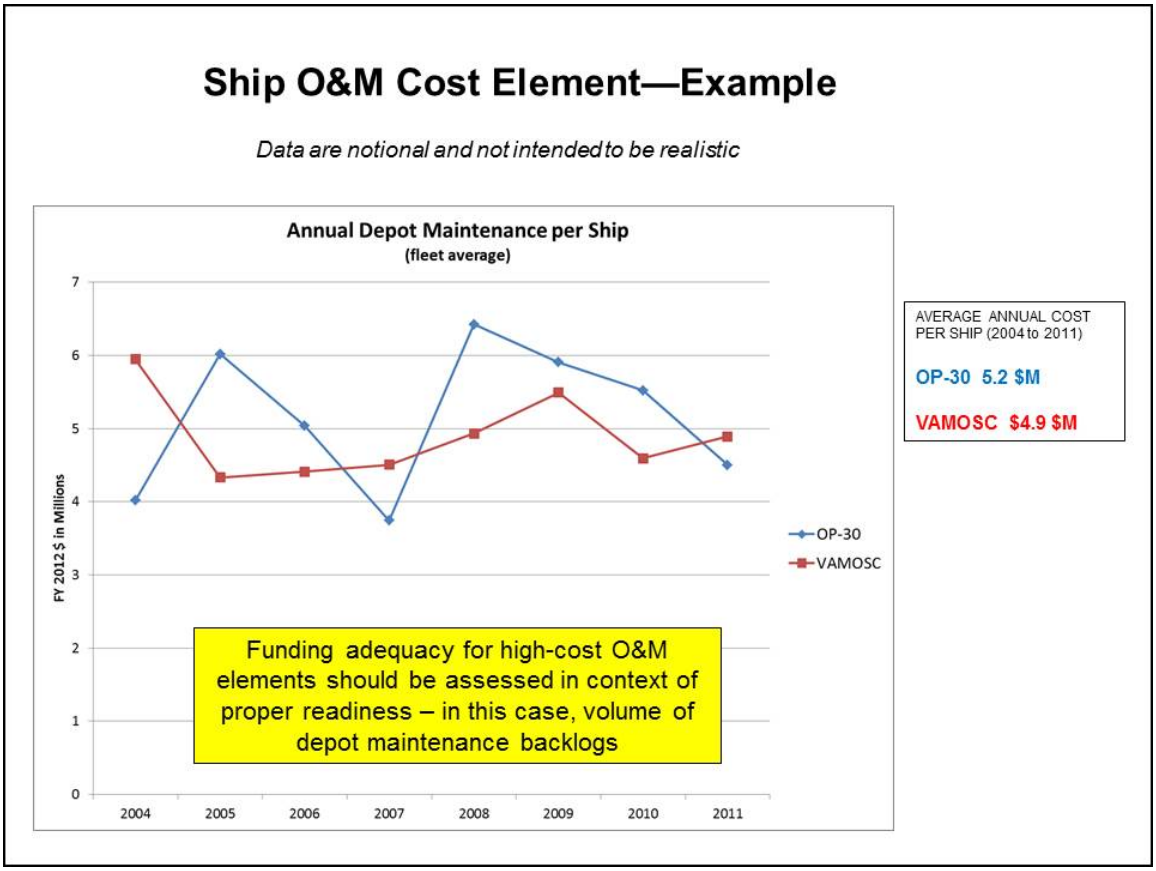


Figure 3-14. Sample Budget Assessment for an O&M Cost Element

In making such assessments, it is important to determine that the funding supports a proper level of readiness. The various budget reports summarized in Figure 3-13 provide the information to make such a determination. For example, in assessing the funding for depot maintenance, it would be important to ensure that the funding was not resulting in growth of maintenance backlogs. Similarly, for O&M cost elements such as fuel, repair parts, and consumables, it would be important to ensure that the current funding supported the required operating tempo for the system.

3.11 ASSESS AND MANAGE TRENDS FOR LEGACY SYSTEMS

DoDI 5000.02, Enclosure 6, Life-Cycle Sustainment Planning, requires periodic reviews of O&S costs of major weapon systems after such systems achieve IOC to identify factors resulting in growth in O&S costs and adapt support strategies to reduce

such costs where possible. Further information about these post-IOC reviews is provided in Appendix E of this guide. The analyses presented in Section 3.11 are illustrative examples of the kinds of analyses that can be used to support the post-IOC review.

As noted earlier, for the older legacy systems, the opportunities to reduce O&S costs are greatly diminished. Nevertheless, it is important to continue to monitor and assess trends in system O&S costs, in order to ensure that the system remains on track and is properly funded to meet materiel readiness requirements.

An example of a trend analysis for a Navy ship is shown in Figure 3-15. This figure provides a comparison of the most recent SAR estimate, the programmed funding reflected in the most recent FYDP, and the actual costs obtained from the Navy VAMOSC data system (described in Chapter 4 of this guide). For many mature programs, SAR reporting will have ceased and a current SAR estimate will not be available. If there were any adverse trend (e.g., rising O&S costs) in the VAMOSC data, that trend would be subject to further investigation.

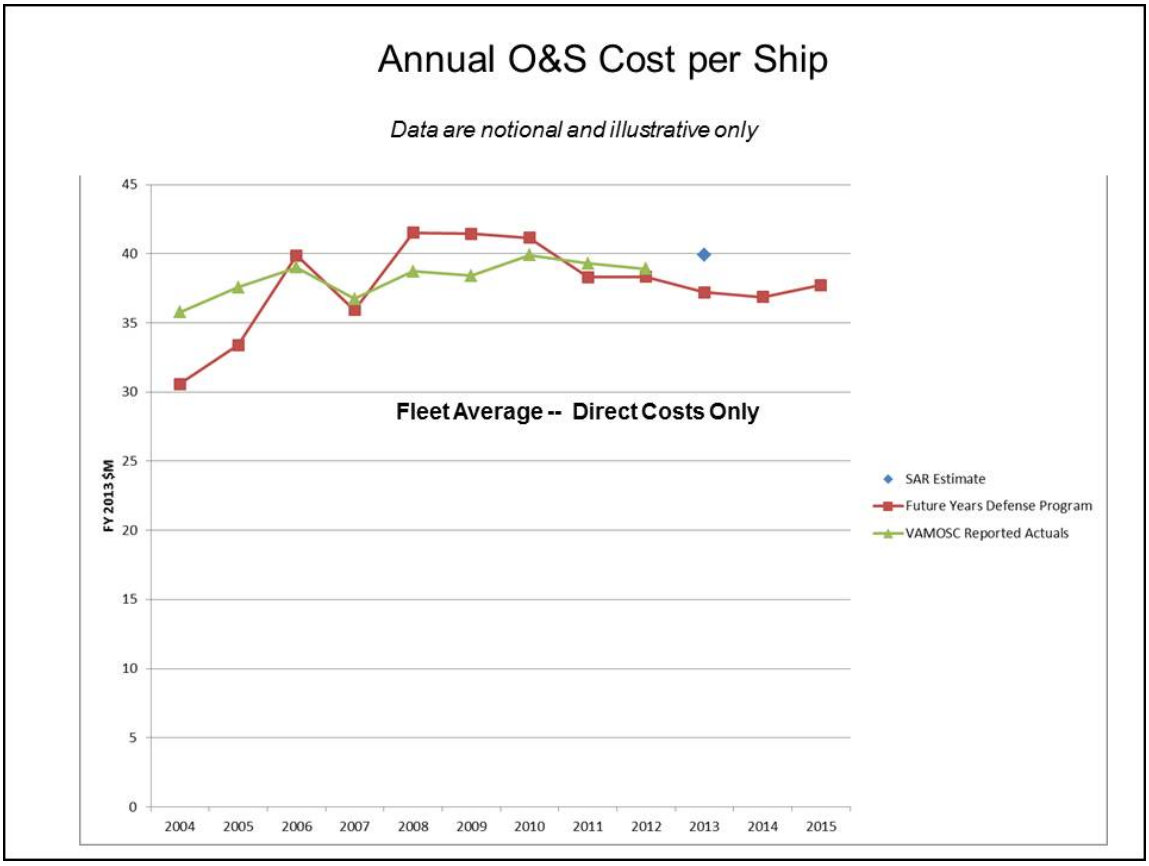


Figure 3-15. Sample System O&S Trend Analysis

The comparison of programmed funding to actual cost experience for individual weapon systems is not always possible. For Army and US Marine Corps (USMC) ground

systems, the unit structure (and associated program element) is not oriented toward individual systems, but rather is associated with a more aggregate unit (e.g., heavy brigade combat team) that is equipped with multiple weapon systems. In other cases, the content in the programmed funding may not exactly align with the content of the available O&S cost data, and the data need to be adjusted to permit a proper comparison.

Additional trend analyses can be conducted at lower levels of details. Figure 3-16 provides a sample of three trend analyses for selected cost elements for the same Navy ship.

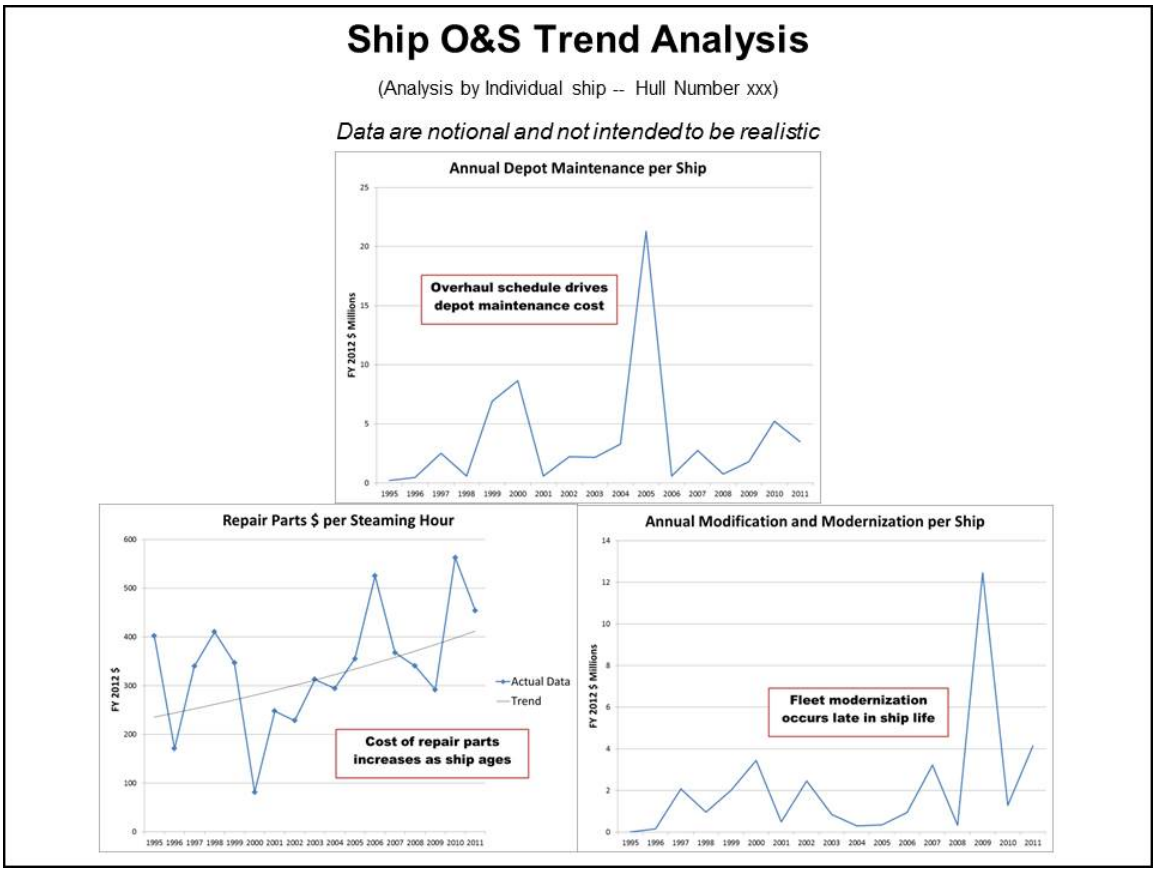


Figure 3-16. Sample System O&S Trend Analysis for Individual Elements

In this case, the data are extracted from the VAMOSC system using a single hull rather than a class average. This is done to isolate the effects of individual ship age and the timing of infrequent overhaul and modernization events in the course of a ship's service life. Specific comments about the individual charts are:

- The upper chart shows the annual cost for the ship's depot maintenance. These costs can vary considerably from one year to the next, since they depend on the schedule for the ship's overhauls and other types of ship availabilities.

- The lower left chart shows a rising trend in the costs for repair parts used in organizational maintenance.
- The lower right chart shows the annual costs associated with ship modernization. It is common for such costs to show a spike after a period of years, due to mid-life upgrades or service-life extension programs.

For legacy systems, it may also be necessary to assess the need for a major upgrade or system replacement. Appendix C of this guide provides a sketch of a life-cycle cost analysis, performed as part of a larger AoA-type analysis, which involves a legacy system experiencing increasing O&S costs due to aging equipment effects. The analysis considers two alternatives: replacement of the legacy system with a new system, or a major upgrade to the legacy system, deferring the acquisition of the new system.

3.12 AT&L DECISION SUPPORT REPORT FORMATS

For post-IOC reviews, and other OSD-level meetings such as Defense Acquisition Executive Summary reviews, the OSD AT&L staff may call for the presentation of various standard charts concerning a program's O&S cost management and affordability initiatives. Four standard charts are (1) the portfolio affordability chart, (2) the program funding and quantities chart, (3) the sustainment quad chart, and (4) the O&M and O&S crosswalk chart. In addition, the AT&L staff may call for a fifth chart, which is program-specific, concerning a program's O&S Should-Cost initiatives. A summary of the content for these charts is as follows:

- The portfolio affordability chart provides the trend in annual sustainment funding requirements for the portfolio of systems associated with the program under review.
- The program funding and quantities chart depicts a program's required funding, compared to its programmed funding, by appropriation, with any funding shortfalls identified.
- The sustainment quad chart displays a summary of the annual O&S cost per system (for the six main cost elements discussed in Chapter 6 of this guide) compared to the system's antecedent. The chart also provides a summary of the current product support strategy, the current sustainment schedule, and a summary of the status of the program sustainment KPPs (described in Appendix E of this guide).
- The O&M and O&S crosswalk chart provides a means for comparing the O&M elements of sustainment to the total program O&S cost.
- The O&S Should-Cost estimate chart is used to describe program-specific Should-Cost initiatives.

Further information on these AT&L report formats is provided in the *AT&L Operating and Support Cost Management Guidebook*.

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4. O&S COST DATA

4.1 VAMOSC PROGRAM

4.1.1 Background

Each military department has developed and maintains an historical O&S cost data collection system. These data systems were developed in response to an initiative known as VAMOSC. CAPE provides broad policy guidance pertaining to the military department VAMOSC programs, but leaves the details concerning implementation to each department. This approach was taken so that each department could make maximum use of its existing unique management information systems (e.g., maintenance data collection or logistics financial management systems).

Each military department makes its VAMOSC data system readily available to its registered users—DoD government personnel and contractor personnel (when endorsed by an appropriate government sponsor)—through on-line access. The VAMOSC data systems managed by each military department are as follows:

- The Navy's VAMOSC management information systems (known as Navy VAMOSC and Marine Corps VAMOSC) collect and report US Navy and USMC historical weapon system O&S costs. VAMOSC provides the direct O&S costs of weapon systems; some indirect costs (e.g., ship depot overhead); and related non-cost information, such as flying hour metrics, steaming hours, age of aircraft, personnel counts for ships, etc. It is managed by the Naval Center for Cost Analysis. See http://www.vamosc.navy.mil for additional information.
- The Army's VAMOSC system, called the Operating and Support Management Information System (OSMIS), tracks O&S information for over 1,400 major Army weapon/materiel systems and is maintained by the Office of the Deputy Assistant Secretary of the Army for Cost and Economics. OSMIS-tracked systems include combat vehicles, tactical vehicles, artillery systems, aircraft, electronic systems, and miscellaneous engineering systems. OSMIS provides cost data for these systems, as well as non-cost information, such as aircraft flying hours or vehicle miles, fuel consumption, demand for parts, and number of end-item overhauls. See http://www.osmisweb.army.mil for additional information.
- The Air Force's VAMOSC system, called the Air Force Total Ownership Cost system (AFTOC), is managed by the Deputy Assistant Secretary of the Air

Force for Cost and Economics. It provides O&S cost information on all Air Force aircraft, space systems, and missiles. The O&S cost information collected includes unit-level manpower, fuel, depot maintenance overhaul costs, depot-level reparable costs, and other costs of major US Air Force aircraft and engines. AFTOC also provides data on aircraft quantities and flying hours, numbers of personnel, and other non-cost information. See http://aftoc.hill.af.mil for additional information.

4.1.2 Policy

The formal policy guidance for the military department VAMOSC systems is provided in DoD 5000.04-M. This guidance dictates that each military department is required to collect and manage actual O&S cost data for its fielded major systems. Each military department is responsible for the design, maintenance, and administration of its O&S cost data system. Additional statutory requirements for the VAMOSC systems are discussed in Appendix E.

CAPE is charged with executive oversight of the VAMOSC programs. In this capacity, CAPE promotes standardization of O&S cost data collection, provides a forum for the exchange of ideas and research, and encourages the effective use of VAMOSC data in O&S cost estimates. The Deputy Director for Cost Assessment convenes and conducts annual reviews of the military departments' VAMOSC programs.

In the CAPE guidance provided in DoD 5000.04-M, the military department VAMOSC data systems are expected to provide a wide variety of choices for O&S cost displays and extracts. There should be options for displays in constant dollars, derived from appropriate inflation indices. Where appropriate, O&S cost data should be provided separately for Active, Reserve, and Guard branches, as well as by Service major operational commands. In addition, where appropriate, the data should be provided separately for operational units and dedicated training units (e.g., Naval Aviation Fleet Readiness Squadrons). Where feasible, the data systems should provide users with system-level (i.e., end-item) data, as well as lower levels of data (major subsystems and components). The data systems also should provide O&S-related non-cost data, such as system quantities, manning levels, and operating tempos. VAMOSC reporting should be timely, in order to support the program/budget process and required annual O&S reporting such as the SARs.

The VAMOSC systems should support the use of a documented and well-defined taxonomy or cost element structure. The purpose of a cost element structure is to categorize and define specific cost elements that in total constitute the full range of O&S costs that could occur for any defense system. To the greatest extent feasible, the VAMOSC systems should support the CAPE cost element structure, with associated terms and definitions. A summary of the CAPE cost element structure is provided in

DoD 5000.04-M, and additional details and information are provided in Chapter 6 of this guide.

4.2 COST REPORTING FOR SUSTAINMENT CONTRACTS

The Service VAMOSC systems have limited capability to collect cost data when systems are sustained through CLS or similar arrangement. These VAMOSC systems may in some cases collect system CLS costs in aggregate, but without providing any details by cost elements such as depot maintenance or sustaining engineering.

To remedy this situation, the Defense Cost and Resource Center (DCARC) has extended the requirement for development and procurement to include sustainment for Cost and Software Data Reporting (CSDR) for major sustainment contracts and subcontracts (such as CLS, Interim Contractor Support (ICS), Performance Based Logistics (PBL), or other similar arrangements) valued at more than $50 million (then-year dollars), that are associated with pre-MDAP, MDAP, pre-Major Automated Information System (MAIS), and MAIS programs subsequent to Milestone A approval. Reporting will be continued on former MDAP and MAIS programs until waived by the CAPE Deputy Director for Cost Assessment. The requirement for high-risk or high-interest contracts valued between $20 million and $50 million is left to the discretion of the program manager, subject to the approval of the CAPE Deputy Director for Cost Assessment. Such approval is obtained as part of the CSDR planning process described in DoD 5000.04-M-1, *Cost and Software Data Reporting (CSDR) Manual* (Reference (i)).

DCARC has developed a contract report format (DD Form 1921-4, “Contractor Sustainment Report”) and associated report instructions (Data Item Description (DID) DI-FNCL-81831, “Contractor Sustainment Report”) that will be used for cost reporting on new applicable sustainment contracts or contract modifications. This report format is based on a work breakdown structure that can be easily mapped into the CAPE O&S cost element structure.

The sustainment contract cost reporting requirement is not intended to be applied retroactively to contracts awarded prior to May 2012. Both the report format and the DID are available at the DCARC web site, http://dcarc.cape.osd.mil/CSDR /FormsReporting.aspx).

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5. O&S COST ESTIMATING PROCESS

5.1 INTRODUCTION

This chapter describes a recommended analytic approach for planning, conducting, documenting, and presenting an O&S cost estimate. The recommended analytic approach for the entire O&S cost estimating process is shown in Figure 5-1.

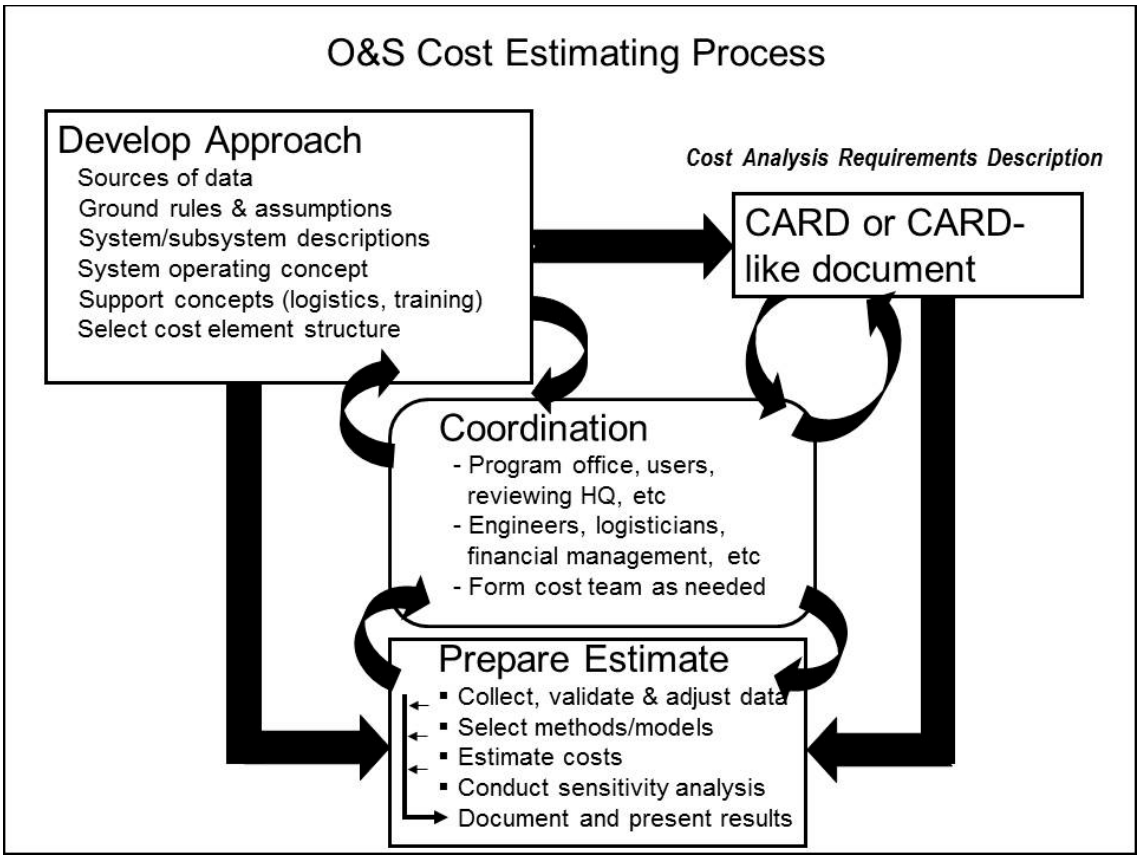

Figure 5-1. Recommended Analytic Approach for O&S Cost Estimate

The remainder of this chapter describes this process.

5.2 DEVELOP APPROACH

The first step in preparing a credible O&S cost estimate is the development of a sound analytic approach. During this step, requirements for program data and other information are determined, critical ground rules and assumptions are established, and the program to be estimated is carefully defined in a written document. The program

definition includes not only a technical description of the system (and usually major subsystems), but also a description of the system's O&S concepts. Each of these points is further amplified in the remainder of this section.

It is also important that the analytic approach to the O&S cost estimate be documented and reviewed by all potentially interested parties, before the actual work on preparing the cost estimate begins. This helps ensure that there are no false starts or misunderstandings later in the process.

Normally, O&S cost estimates sponsored by a system program office are prepared by a multi-disciplinary team with functional skills in cost analysis, financial management, logistics, engineering (including reliability and maintainability), and other talents. The team also should include participants or reviewers from major affected organizations, such as the system's operating command, product support center, maintenance depot, training center or command, and so forth. For independent O&S cost estimates, the team may be smaller and less formal, but the basic principle—complete coordination of the analytic approach with all interested parties—still applies. Moreover, the coordination efforts should also interact with the teams for the program RDT&E and Procurement cost estimates, so that the overall life-cycle cost estimate is internally consistent.

5.2.1 Establish Requirements and Sources for Data and Information

For programs that are early in the acquisition process, the planning for the O&S cost estimate should identify and document the needed cost, performance, and technical data for appropriate legacy systems in order to support parametric cost estimates (discussed in Section 5.3.1). Later in the acquisition process, plans for O&S cost estimates should establish requirements for contractor and program office predictions for O&S cost factors, reliability and maintainability parameters, and other suitability and logistics support factors; plans should also address associated test and evaluation requirements for the same factors and parameters. For mature programs, the best sources of available data that reflect actual cost experience for the program should be identified.

5.2.2 Establish Ground Rules and Assumptions

There are several assumptions that must be made before the actual O&S cost estimating can begin. Some of the more common ground rules and assumptions that need to be established are:

- **System Life.** The O&S estimate should extend over the full life expectancy of the system. Figure 5-2 displays life expectancies for several current MDAPs, as documented in the programs' SARs. These numbers are illustrative and not intended to be prescriptive. Actual life expectancies will vary, and will depend on the system's fatigue/durability requirements or specifications. Any

assumptions about mid-life upgrades or service life extension programs that are associated with the current planned system life also should be noted, including any assumptions concerning additional years of service life provided by such modifications.

Nominal Service Life Durations

COMMODITY	SUB-COMMODITY	Service Life (years)
Fixed Wing Aircraft		
	Aircraft - Fighter	20-25
	Aircraft - Cargo	25-30
	Aircraft - Tanker	40
	Aircraft - C4ISR	20 - 25
	Aircraft - CSAR	30
	Aircraft - Trainer	30-35
Ground Systems		
	Tactical Vehicle	20
	Combat Vehicle	20
	Artillery Vehicle	20
Rotary Wing Aircraft		
	Helicopter - Attack	20 - 30
	Helicopter - Utility	25 - 30
	Helicopter - Cargo	20 - 30
Surface Ships		
	Ship - Carrier	50
	Ship - Destroyer	35
	Ship - Other Combatant	25
	Ship - Amphib Assault	40
	Ship - Cargo/Ammo	40
Submarines		
	Submarine - Attack	30 - 33
UAVS		
	Aircraft - UAS	20

Figure 5-2. Nominal System Life Durations

- **O&S Phasing.** The O&S phasing will include a phase-in period, the period during which the system is in steady-state operations, and a phase-out period. The steady-state period begins when all systems are delivered, and ends when the first system retirements begin. The timing of these three periods should be consistent with the planned deployment and retirement schedule. Figure 5-3 provides an example of this phasing for a system with a twenty-year life expectancy. In this example, the program has a five-year phase-in period, fifteen years of steady-state operations, and a five-year phase-out period.

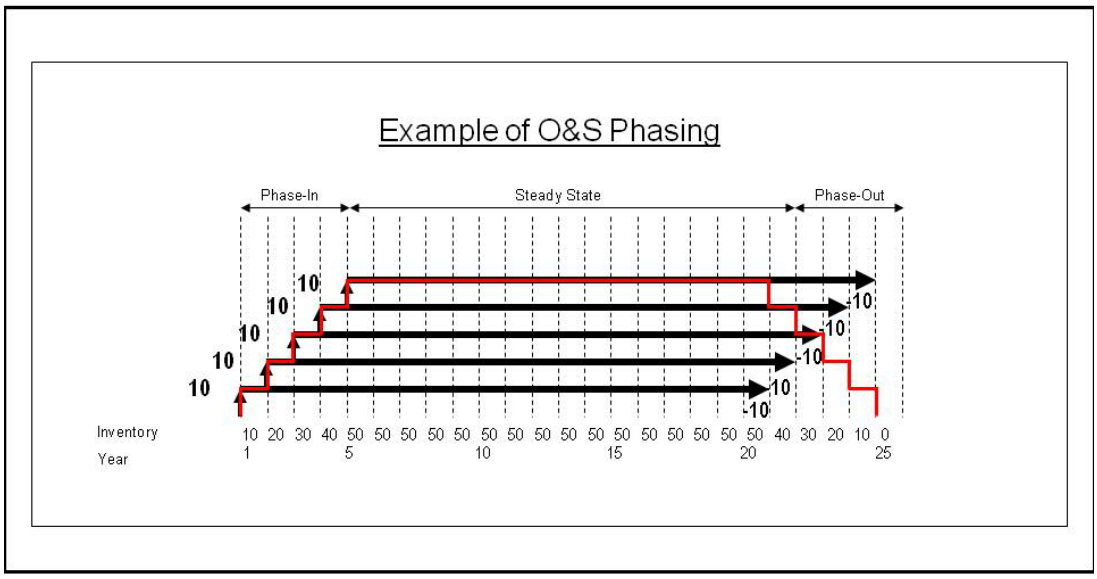

Figure 5-3. Example of O&S Phasing Convention

- **Year Dollars/Inflation Indices**. O&S costs are usually presented in constant dollars—either in the dollars of the current fiscal year, or in a baseline year associated with the specific program. In addition, in some cases, the near-term O&S costs by fiscal year are compared to the program annual O&S budget in current (then-year) dollars. The indices used to adjust for inflation should be specified and documented. Each year, the OSD Comptroller provides inflation indices specific for each appropriation category, and some programs use these OSD indices in their cost estimates. Other programs use product-specific inflation indices (that typically assume higher rates of inflation than the OSD indices) when there is significant evidence that the product-specific indices reflect the most likely cost trends based on historical data. In such cases, the cost estimates are made in base-year dollars and inflated to then-year dollars using the product-specific indices. However, to establish a program baseline, the then-year dollars are returned to base-year dollars using the OSD indices, so that the base-year dollar estimate reflects a premium for the assumed higher rate of inflation.
- **Discounting**. Normally, O&S costs are presented in constant dollars. However, when the O&S cost estimate is supporting other analyses, the annual O&S costs also will need to be discounted at the appropriate rate. For example, discounting will be necessary for return on investment decisions (see Appendix B) or for AoAs (see Chapter 3). Further information on discounting may be found in the Office of Management and Budget (OMB) Circular No. A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs (Reference (j)), and in DoDI 7041.3.

- **War/Peace Conditions**. System O&S cost estimates generally reflect peacetime conditions. DoD considers the incremental costs due to a contingency to be part of the cost of the contingency, not part of the operating cost of the system. However, for some programs, various elements or activities are resourced in peacetime to support contingency requirements. For example, some programs may stockpile support equipment, spare parts, or other materiel, or establish a surge unit-level or depot maintenance capacity, to support contingency requirements. The costs of procuring and maintaining these additional resources are included in an estimate of program costs when these resources are paid for through funding associated with peacetime conditions.
- **Scope of the Estimate**. In some cases, it is necessary to explicitly state the costs to be included and the costs to be excluded. For example, when systems have complex interfaces with other systems or programs (that are outside the scope of the system being estimated), the scope of the interfaces should be carefully defined.

Ground rules and assumptions made to estimate O&S costs should be consistent with any ground rules and assumptions made to estimate investment costs (such as initial spares or peculiar support).

5.2.3 Define Program and System Content

In addition to establishing common ground rules and assumptions, it is a good practice to completely define the program content (i.e., describe what it is that will be costed). Figure 5-4 provides a brief summary of the topics that should be addressed prior to the initiation of an O&S cost estimate.

Typical System and Support Descriptions

- System Characteristics
  - Performance characteristics
  - Technical and design characteristics
  - Advanced technologies/materials
- Reliability/Maintainability
- Operational Concept
  - Basing and deployment
  - Inventory and OPTEMPO
  - Organizational/unit structure
- Program Schedule
  - Delivery and site activation
  - System life/O&S phasing
  - Interim contractor support
- Unit-Level Manpower
  - Operations
  - Unit maintenance
  - Other unit-level
- Support Concepts
  - Maintenance
  - Software
  - Supply support
  - Training
- Special Support
  - Unique infrastructure
  - Special environmental considerations

Figure 5-4. Typical Program and System Content

For MDAPs approaching a milestone review or other acquisition decision point, the program office is required to define its program in a comprehensive formal written document known as a CARD. The format for this document is described in DoD Manual 5000.04-M. For other programs preparing an O&S cost estimate, the CARD format, with appropriate tailoring, provides a useful and flexible framework for developing a written program description suitable to support the estimate.

Any gaps or uncertainties in the various program descriptions should be acknowledged as such in the written document. This applies to uncertainties in either general program concepts or specific program data. For uncertainties in program concepts, one or more specific candidate concepts (such as organic versus contractor depot maintenance concepts) should be assumed for cost estimation purposes. For uncertainties in numerical data, ranges that bound the likely values (such as estimates of low, most likely, and high values of system reliability) should be provided. Dealing with program uncertainty will facilitate future sensitivity analyses in the O&S cost estimate.

5.2.4 Select Cost Element Structure

The final step in developing the analytic approach to an O&S cost estimate is establishing the cost element structure that will be used as the format for the estimate. The cost element structure describes and defines the specific elements to be included in

the O&S cost estimate in a disciplined hierarchy. Using a formal cost element structure (prepared and coordinated in advance of the actual estimating) identifies all of the costs to be considered, and organizes the estimate results. In instances that require both program office and independent cost estimates, a common cost element structure allows meaningful comparisons.

Chapter 6 of this guide describes the standard cost element structure, with associated terms and definitions, which the DoD Components should use when presenting O&S cost estimates to OSD, including the display of system O&S cost estimates in the program SAR. When any cost element structure other than the standard is used for any O&S cost estimate presented to OSD, the cost estimating team leader should be prepared to justify the use of the non-standard structure.

5.3 PREPARE ESTIMATE

The following paragraphs describe the normal steps in completing an O&S cost estimate. The discussion summarizes the steps entailed in collecting data, selecting estimating techniques or models, assessing program status and risk areas, estimating costs, and conducting sensitivity analysis. In addition, the importance of good documentation of the estimate is explained.

Throughout the preparation of the estimate, coordination with all interested parties remains important. Frequent in-progress reviews or meetings are a good practice.

5.3.1 Collect, Validate, and Adjust Data

Many possible sources of data can be used in O&S cost estimates. Regardless of the source, the validation of the data (relative to the purpose of its intended use) always remains the responsibility of the cost analyst. In some cases, the data will need to be adjusted or normalized. For example, in analogy estimates, the reference system cost should be adjusted to account for any differences—in system characteristics (technical, physical, complexity, or hardware cost), support concepts, or operating environment—between the reference system and the proposed system being estimated.

For most currently fielded major systems, historical cost data is available from the VAMOSC data system managed by each military service as discussed in Chapter 4. VAMOSC data should always be carefully examined before use in a cost estimate. The data should be displayed over a period of a few years (not just a single year), and stratified by organization or location (such as major command or base). This should be done so that abnormal outliers in the data can be identified, investigated, and resolved as necessary. In some cases, it may also be necessary to ensure that the content of the VAMOSC data being used is consistent with the content of what is being estimated (to avoid any gaps in coverage).

VAMOSC data is sometimes supplemented with more specialized reliability and maintainability data, which can be obtained from the military service maintenance data collection systems. The importance of data validation is equally important when this type of data is used in a cost estimate. In addition, VAMOSC data for unit-level manpower is often supplemented with information from more detailed unit manning documents (or Tables of Organization and Equipment).

Data that can be used for detailed bottoms-up engineering estimates often come from contractor databases (such as logistics management data systems). Appropriate government personnel should validate this type of data before use, possibly on a sampling basis. This is especially important in cases when the hardware being estimated is not mature (i.e., not yet tested or deployed). The validation should address the completeness of the component population, the realism of component reliability and maintainability estimates, the legitimacy of the component unit prices, and so forth.

5.3.2 Select Methods or Models

A number of techniques may be employed to estimate the O&S costs of a weapon system. The suitability of a specific approach will depend to a large degree on the maturity of the program and the level of detail of the available data. Most O&S estimates are accomplished using a combination of five estimating techniques:

- **Parametric.** The parametric technique uses regression or other statistical methods to develop Cost Estimating Relationships (CERs). A CER is an equation or algorithm used to estimate a given cost element using an established relationship with one or more independent variables. The relationship may be mathematically simple or it may involve a complex equation (often derived from regression analysis of historical systems or subsystems). CERs should be current, applicable to the system or subsystem in question, and appropriate for the range of data being considered.
- **Analogy.** An analogy is a technique used to estimate a cost based on historical data for one (or occasionally two) analogous system(s).[5] In this technique, a currently fielded system, similar in design and operation to the proposed system, is used as a basis for the analogy. The cost of the proposed system is then estimated by adjusting the historical cost of the current system to account for differences (between the proposed and current systems). Such adjustments can be made through the use of factors (sometimes called scaling parameters) that represent differences in size, performance, technology, reliability and maintainability, complexity, or other attributes. Adjustment factors based on

[5] An analogy may also be used to estimate a cost for a subsystem (such as airframe, hull, avionics, or propulsion).

quantitative data are usually preferable to adjustment factors based on judgments from subject-matter experts.

- **Engineering Estimate.** This technique uses discrete estimates of labor and material costs for maintenance and other support functions. The system being estimated normally is broken down into lower-level subsystems and components, each of which is estimated separately. The component costs, with additional factors for integration, are then aggregated using simple algebraic equations to estimate the cost of the entire system (hence the common name "bottoms-up" estimate). For example, system maintenance costs could be calculated for each system component using data inputs such as system operating tempo, component mean time between maintenance action, component mean labor hours to repair, and component mean material cost per repair. Engineering estimates require extensive knowledge of a system's (and its components') characteristics and a significant amount of detailed data (sometimes obtained from the system prime contractor). These methods are normally employed for mature programs.
- **Extrapolation of Actual Costs**. With this technique, actual cost experience or trends (from prototypes, engineering development models, and/or early production items) are used to project future costs for the same system. Such projections may be made at various levels of detail, depending on the availability of data. Such projections also may need to account for growth in reliability and maintainability (as discussed in Chapter 3).
- **Cost Factors**. Cost factors are applicable to certain cost elements not related to weapon system characteristics. Often, cost factors are simple per capita factors that are applied to direct (i.e., unit-level) manpower to estimate indirect cost elements such as base operations, military medical care, or general training and education (not associated with a specific weapon system).

In many instances, it is a common practice to employ more than one cost estimating method, so that a second method can serve as a cross-check to the preferred method. Analogy estimates are often used as cross-checks, even for mature systems.

5.3.3 Assess Program Status and Identify Risk Areas

The better O&S cost estimates are not limited to a narrow focus on cost estimating methods and available data. Cost analysts also should review available information concerning program status, issues, and risks. Cost analysts often engage in site visits to contractor plants, operational bases, and maintenance depots in order to obtain first-hand information about program status and issues. In addition, in many cases, historical precedence in programs similar to the program being estimated can provide insights into major risks areas. The information concerning program status and risk areas can be used

to guide the sensitivity analysis (see Section 5.3.5) conducted as part of the O&S cost estimate.

5.3.4 Estimate Costs

With the completion of the steps described earlier, the actual computations of the O&S cost estimate can begin. The time and energy in front-end planning for the estimate will help to minimize the amount of mid-course corrections and wasted effort. In actual practice, the planning process may be more iterative than the sequence of discrete steps described earlier. Nevertheless, the basic principles displayed in Figure 5-1 remain valid and important.

The cost estimation techniques selected typically depend on the acquisition phase and maturity of the program. In the earlier acquisition phases, cost estimates are commonly based on analogies and parametric CERs. In some cases, as the program definition is refined, the use of analogies and CERs may be improved by increasing the level of detail of the cost estimate—for some cost elements, making distinct estimates for major subsystems[6] and components. As the program enters subsequent acquisition phases, the cost analyst will attempt to incorporate any actual cost experience available from fielded EMD models and early production units. Emerging test and evaluation results, including projections of reliability and maintainability performance, also should be used to refine O&S cost estimates.

5.3.5 Conduct Sensitivity Analysis

For any system, estimates of future O&S costs are subject to varying degrees of uncertainty. The uncertainties are due not only to uncertainties in cost estimating methods, but also due to uncertainties in program definition or system technical performance. Although these uncertainties cannot be eliminated, they should be addressed in the cost estimate. For each major concern, it is useful to quantify its degree of uncertainty and its effect on the cost estimate.

Typically, for major program concerns or risk areas identified earlier, the analyst identifies the relevant cost elements and their associated cost drivers, and then examines how costs vary with changes in the cost-driver values. For example, a sensitivity analysis might examine how maintenance manning varies with different assumptions about system reliability and maintainability values, or how system fuel consumption increases with system weight growth. In good sensitivity analyses, the cost-driver values are not changed by arbitrary plus/minus percentages, but rather by a careful assessment of the underlying uncertainties.

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[6] For example, for the costs of DLR items associated with an aircraft program, distinct estimates could be made for the avionics, the engine, and the airframe and other systems.

5.3.6 Document Results

A cost estimate should be formally documented. The documentation serves as a permanent record of source data, methods, and results, and should be easy to read and well organized to allow any reviewer to understand the estimate. The documentation also serves as a valuable reference for future cost analysts, as the program moves from one acquisition decision point to the next. The key standard is that an outside professional cost analyst should be able to review the data and methods employed, and understand the results.

The documentation should address all aspects of the cost estimate: ground rules and assumptions; the description of the system and its support concepts; the selection of cost estimating methods; data sources; the actual estimate computations; and the results of the sensitivity analyses. The documentation for the ground rules and assumptions, and the system description, may be provided as an updated (final) version of the CARD or CARD-like document described in Section 5.2.2. The remaining documentation should address data, methods, and results.

5.3.7 Present Results

Typically, a presentation concerning an O&S cost estimate would include the following:

- **O&S Cost Summary.** The presentation would begin with a brief summary of ground rules and assumptions (such as O&S period, number of deployed systems, O&S concepts, etc.) and follow with a brief table format summary of total O&S costs in constant dollars by cost element and sub-elements (see Chapter 6 for the cost element structure).
- **Estimating Methods for Major Cost Elements**. The presentation would include a discussion of estimating methods (and source data) for the high-cost cost elements and sub-elements.
- **Sensitivity Analysis.** This section of the presentation would include an identification of the major cost drivers (such as system reliability and maintainability) associated with the high-cost cost elements and sub-elements, and show the sensitivity of the costs to changes in cost drivers.
- **Time-Phased O&S Display**. The presentation will include a display of time-phased O&S costs by major time periods (such as phase-in, steady-state, and phase-out periods), as well as a display of annual steady-state recurring O&S costs. Note that in the steady-state period, annual O&S costs may not be constant. In some cases, variations may occur due to long overhaul cycles or other reasons. In these cases, the annual steady-state O&S costs would be calculated as the average annual O&S cost over the steady-state period.

- **Annualized Steady-State Costs for Typical Unit.** The presentation should include a display of the annual system O&S costs for a typical deployable or operating unit (such as squadron or battalion) or single system (such as ship or missile), compared to similar costs for the predecessor and/or reference system normalized as necessary. This is the presentation format used in the program SAR.
- **Cost Track to Prior Estimate.** If applicable, the presentation should also include a comparison between the current O&S cost estimate, and the most recent previous estimate. Major differences should be explained.

Sample suggested formats for each of the topics above are provided in Appendix D. The formats may be modified as appropriate. In addition to the formats, any other information that would be helpful in understanding the O&S cost estimate is desirable. A copy of the final presentation slides should be included in the estimate documentation discussed earlier.

6. OSD COST ELEMENT STRUCTURE

6.1 INTRODUCTION

This chapter provides the OSD standard O&S cost element structure, with associated terms and definitions, which the military departments and defense agencies should use when presenting O&S cost estimates to OSD. Such presentations include briefings reviewed by CAPE, displays of system O&S cost estimates in the program SAR, and any other briefings, reports, or displays reviewed by OSD staff. When any cost element structure other than the standard is used for any O&S cost estimate presented to OSD, the cost estimating team leader should be prepared to justify the use of the non-standard structure.

The OSD standard O&S cost structure categorizes and defines cost elements that cover the full range of O&S costs that could occur in any defense system. The cost structure identifies where a specific type of cost should appear in an estimate—if that cost applies to the system for which the estimate is being created. However, some cost elements (such as Training Munitions) refer to expenses that may not apply to every system, in which case the applicable cost element would be omitted. In other cases, available data may prevent estimation at the same level of detail as the cost element structure. In these cases, the applicable cost elements may be combined to the level of detail that can be estimated.

Recent versions of the OSD cost element structure, including this one, do not use ICS or CLS as cost elements. It is intended that any contractor sustainment costs will be distributed to the appropriate functional element such as depot maintenance or DLRs. However, older versions of the cost element structure did not follow this convention, and earlier cost estimates and VAMOSC data reports may have ICS or CLS as cost elements. This version of the cost element structure is intended to apply only to current and future estimates. There is no expectation that older estimates and VAMOSC data reports will be recast to align with the current cost element structure.

The O&S cost element structure is divided into six major categories:

- **1.0 Unit-Level Manpower.** Cost of operators, maintainers, and other support manpower assigned to operating units. May include military, civilian, and/or contractor manpower.
- **2.0 Unit Operations.** Cost of unit operating material (e.g., fuel and training material), unit support services, and unit travel. Excludes material for maintenance and repair.

- **3.0 Maintenance.** Cost of all system maintenance other than maintenance manpower assigned to operating units. Consists of organic and contractor maintenance.
- **4.0 Sustaining Support.** Cost of system support activities that are provided by organizations other than the system's operating units.
- **5.0 Continuing System Improvements.** Cost of system hardware and software modifications.
- **6.0 Indirect Support.** Cost of support activities that provide general services that lack the visibility of actual support to specific force units or systems. Indirect support is generally provided by centrally managed activities that provide a wide range of support to multiple systems and associated manpower.

Beyond these six levels, the cost element structure is organized as a hierarchy. The next lower level in the hierarchy is presented in Figure 6-1. Cost estimates may be made at even lower levels in the hierarchy, depending on the availability of data.

Second-Level/Third-Level
O&S Cost Estimating Structure

1. Unit-Level Manpower
   - 1.1 Operations
   - 1.2 Unit-Level Maintenance
   - 1. 3 Other Unit-Level
2. Unit Operations
   - 2.1 Operating Material
   - 2.2 Support Services
   - 2.3 Temporary Duty
   - 2.4 Transportation
3. Maintenance
   - 3.1 Depot Level Reparables
   - 3.2 Consumable Materials and Repair Parts
   - 3.3 Intermediate Maintenance (External to Unit-Level)
   - 3.4 Depot Maintenance
   - 3.5 Other Maintenance
4. Sustaining Support
   - 4.1 System Specific Training
   - 4.2 Support Equipment Replacement and Repair
   - 4.3 Sustaining/Systems Engineering
   - 4.4 Program Management
   - 4.5 Information Systems
   - 4.6 Data and Technical Publications
   - 4.7 Simulator Operations and Repair
   - 4.8 Other Sustaining Support
5. Continuing System Improvements
   - 5.1 Hardware Modifications
   - 5.2 Software Maintenance
6. Indirect Support
   - 6.1 Installation Support
   - 6.2 Personnel Support
     - 6.2.1 Personnel Administration
     - 6.2.2 Personnel Benefits
     - 6.2.3 Medical Support
   - 6.3 General Training and Education
     - 6.3.1 Recruit & Initial Officer Training
     - 6.3.2 General Skill Training
     - 6.3.3 Professional Military Education

Figure 6-1. Second/Third Level of Cost Element Structure Hierarchy

The next section explains the types of costs that are included in each major category and provides the subcategories at lower levels in the hierarchy.

6.2 DEFINITIONS

1.0 UNIT-LEVEL MANPOWER

The Unit-Level Manpower element includes the costs of all operator, maintenance, and other support manpower at operating units (or at maintenance and support units that are organizationally related and adjacent to the operating units). Unit-Level Manpower includes active and reserve military, government civilian, and contractor manpower costs.

While the cost elements in this category make the distinction between operators, maintainers, and other unit-level manpower, that distinction may not apply to all situations. For example, in O&S cost estimates for Navy ships, the ship manpower is typically estimated and documented for the entire crew as a whole, and is not broken down into operators, maintainers, and other support.

The scope of unit-level manpower consists of the lowest-level operating unit capable of independent system operations, and associated augmenting maintenance and support units (if any) integral to system operations. For systems owned by deploying units, the scope of unit-level manpower includes the operator, maintenance, and other support personnel who are consistently deployed with the systems to their deployment locations.[7] For example, for an Air Force aircraft, the scope of unit-level manpower includes the aircraft operating squadron and associated maintenance and support units in the same wing. As another example, for an Army tank, the scope of unit-level manpower includes the tank company (resident in a brigade combat team) and associated maintenance and support companies (resident in a sustainment brigade supporting the brigade combat team). For systems not organized into units, such as ships or space systems, the unit-level concept does not apply, and unit manpower costs may be estimated on an individual system basis.

Manpower associated with general and indirect support, such as manpower supporting base level functions (i.e., Base Operating Support, Base Communications, and Facilities Sustainment, Restoration, and Modernization), is accounted for as an indirect cost, element 6.0. In other words, manpower included in functions covered by indirect costs is not regarded as unit-level manpower.

To the extent possible, government manpower costs should be based on personnel grades and skill categories.[8] Costs of military, government civilian, and contractor personnel should be shown separately in the estimate of unit-level manpower costs. For

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[7] For systems that deploy, the manpower that deploys with the system may be scenario dependent. The scope of unit-level manpower in an O&S cost estimate should include only the manpower that routinely deploys with the system, regardless of scenario.

[8] When available, the Manpower Estimate is a common source for system manpower requirements. See the *Defense Acquisition Guidebook*, Section 3.5.

contractor manpower, Field Service Representatives (FSRs) assigned to support the local unit-level maintenance activities are included in cost element 1.2 (Unit-Level Maintenance), and FSRs assigned to support other local unit-level support activities are included in cost element 1.3 (Other Unit-Level). Any FSRs assigned to support tasks other than local unit-level maintenance and support may be accounted for in cost element 2.2 (Support Services) or 3.5 (Other Maintenance).

Manpower costs for active officers and enlisted personnel include the elements of the DoD Standard Composite Rates for military personnel, which include the following items: basic pay, retired pay accrual, Medicare-eligible retiree health care accrual, basic allowance for housing, basic allowance for subsistence/subsistence- in- kind, incentive and special pays, PCS expense, and miscellaneous expenses such as the employer's contribution to social security (FICA) and uniform/clothing allowances. (See DoD *Financial Management Regulation*, Volume 11A, Chapter 6, Appendix I for full definitions of categories, or refer to the website: http://comptroller.defense.gov/fmr /11a/Volume_11a.pdf).

Each year, the OSD Comptroller issues the military personnel composite standard pay rates for each military service that can be used in cost estimates. These rates can be found at http://comptroller.defense.gov/rates/fy2014.html (Tab K). Some cost estimates use more refined variations of active-duty manpower rates, in which the rates are adjusted for specific demographic information such as years of service, occupation, and geographic location. Also, the Navy VAMOSC system described in Chapter 4 collects actual military manpower costs for a given weapon system—reflecting specific pay and allowances associated with attributes like special skill sets or special duty assignments—which can be used in cost estimates of Navy systems.

Manpower costs for reserve officers and enlisted personnel include basic pay, retired pay accrual, Medicare-eligible retiree health care accrual, basic allowance for housing, subsistence, and miscellaneous expenses. PCS costs are included for full-time members. Reserve manpower costs vary among different pay categories of reserve personnel. Cost estimates of reserve personnel should separately identify the number of personnel using the following categories:[9]

- Full-time – Active/Guard/Reserve (AGR) members
- Drill Personnel (Pay Group A) – drilling members of a Selected Reserve Unit

The cost of drill personnel depends on the extent of their annual drill time. The average annual drill time should be used and documented in developing a cost estimate.

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[9] There are other categories of reserve personnel than the two listed. These other categories are seldom used in a system O&S cost estimate, but if they are part of the manning package, they also may be considered separately.

Some military departments also have reserve military technicians, federal civilian employees who also serve in a dual status as military reservists, who receive both civilian and drill pay.

Rates for reserve personnel for each pay category can be derived from the military personnel budget justification material submitted by the military service, National Guard, and Reserve. The funding for reserve personnel can be found in the Summary of Entitlements by Subactivity, and the end-strength can be found in the Summary of Personnel.

The costs of government civilian manpower consist of the elements of the DoD Composite Standard Rates for civilian employees, which are the following: regular salaries and wages, additional variable payments (for overtime, holiday pay, night differentials, and awards), cost-of-living allowances, and the government contribution to employee benefits: insurance, retirement, Social Security contributions, and certain relocation expenses that are regarded as benefits. (See DoD *Financial Management Regulation*, Volume 2A, Chapter 3, Exhibit OP-8 or refer to the website: http://comptroller.defense.gov/fmr/02a/Volume_02a.pdf).

A version of the OP-8 budget exhibit ("Total Civilian Personnel Costs") for DoD as a whole can be found in the DoD Operations and Maintenance (O&M) budget overview. Rates are provided for the Senior Executive Schedule, General Schedule, Wage System, and other categories of US DoD employees. The exhibit also provides rates for foreign national direct and indirect hires. Also, each military department prepares a version of an OP-8 display for each appropriation with civilian personnel costs. Some cost estimates may use more precise rates of civilian manpower costs when the manpower is known by grade and step, occupation, and geographic location.

The costs of contractor manpower should be based on the fully loaded rate of contract labor to the government (i.e., with direct labor, overhead, general and administrative, and profit or fee).

DoDI 7041.04, Estimating and Comparing the Full Costs of Civilian and Active Duty Manpower and Contract Support (Reference (k)) provides guidance and procedures to compare the full costs of active duty military, DoD civilian manpower, and contract support in workforce mix decisions. DoDI 7041.04 also provides a link (https://fcom.cape.osd.mil) to the Full Cost of Manpower (FCoM) tool that implements the business rules provided in the Instruction. The FCoM tool was primarily developed for economic analyses or business case analyses in support of workforce mix decisions. The FCoM tool currently has limitations for use in system O&S cost estimates or analyses, as the tool does not follow the cost element structure and direct/indirect manpower cost conventions as described in this guide. In attempting to use the FCoM

tool in O&S cost estimates, care would need to be taken to avoid omission or double-counting of manpower cost elements.

The elements of unit-level manpower are Operations, Unit-Level Maintenance, and Other Unit-Level Manpower, as defined below.

1.1 Operations

The costs of all military, civilian, and contractor manpower required to operate a system. For example:

- Aircraft and Helicopters. Aircrews including pilots, navigators, mission specialists, load masters, etc.
- Ships. Command staff, combat information center personnel, fire control (if operations, maintenance, and other support categories are estimated separately)
- Electronic Systems. Console operators
- Armored Vehicles. Crew chief, tank commander, gunner, driver, loader
- Space Systems. Operators at the ground station or similar facility

For cases in which individuals operate more than one system, manpower costs should be allocated on a relative workload basis.

1.2 Unit-Level Maintenance

The costs of all military, civilian, and contractor manpower that performs unit-level maintenance on the primary system. This element includes the costs of organizational maintenance manpower (often resident in the system operating unit) and unit-level intermediate maintenance personnel.[10] The costs of intermediate-level maintenance personnel resident in a support organization that is not unit-level relative to the operating unit, such as a Navy shore-based Intermediate Maintenance Activity, are included in element 3.3 (Intermediate Maintenance (External to Unit-Level)). For cases in which individuals maintain more than one system, manpower costs should be allocated among the systems on a relative workload basis.

1.3 Other Unit-Level

The cost of all military, civilian, and contractor manpower that performs administrative, security, logistics, safety, engineering, and other mission support functions at the unit level. These costs include only the costs of manpower positions that exist to wholly or predominantly support the system whose costs are being estimated. For

[10] Unit-level organizational and intermediate maintenance manpower costs may be displayed separately (for example, as elements 1.2.1 and 1.2.2), if desired.

systems that deploy, these costs include the costs of manpower positions that routinely deploy to support the system.[11]

Some examples are:

- Staff. Manpower required for unit command, administration, supervision, operations control, planning, scheduling, safety, quality control of crew training and operational proficiency, etc. This may also include staff in a parent organization above the unit level where appropriate (i.e., staff is primarily dedicated to the system).
- Security. Manpower required for system security. Duties may include system-level entry control, close and distant boundary support, and security alert operations. (Does not include base level access control unless the entire facility exists solely to support the weapon system.)
- Logistics. Manpower required for logistics support. Functions may include supply, transportation, inventory control, fuel handling, etc.
- Ordnance Support. Includes manpower providing munitions handling, weapons assembly, etc. Excludes any ordnance support manpower included in element 1.2 (unit-level maintenance).
- Other Support. Manpower required to provide system-specific fixed and mobile communications, information, intelligence, photo interpretation, and other special mission support. Note that manpower associated with operations or maintenance of simulators or training devices are captured in element 4.7.

For cases in which unit-level individuals support more than one system, manpower costs should be allocated among the systems on a relative workload basis.

2.0 UNIT OPERATIONS

Unit Operations consists of the costs of operating material and various support services purchased by the unit in support of the primary system. Unit Operations includes the unit-level consumption of operating materials such as fuel, electricity, expendable stores, training munitions, and other operating materials. Also included are any unit-funded purchases for support services; temporary additional duty/temporary duty (TAD/TDY) associated with the unit's normal concept of operations; and unit-funded transportation services. Unit Operations costs provided through a system support contract should be separately identified from those provided organically for each cost element.

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[11] For example, Air Force aircraft O&S cost estimates for unit-level manpower usually include the costs of security police that deploy with the aircraft. In this instance, the security police provide "inside-the-fence" protection directly tied to the mission of the aircraft. In contrast, Army tank O&S cost estimates for unit-level manpower normally would not include any costs for the combat support brigade military police. In this instance, the military police provide broad "outside-the-fence" support to the theater commander not necessarily tied to the mission of the tank.

2.1 Operating Material

2.1.1 Energy (Fuel, Petroleum, Oil and Lubricants [POL], Electricity)

Costs of POL, propulsion fuel, and fuel additives used by systems in performing their normal peacetime missions. For fuel purchased from the Defense Logistics Agency (DLA), these costs include a surcharge for DLA overhead and operating expenses (transportation, storage, and inventory management). These costs may also include the cost of field-generated electricity and commercial electricity necessary to support the operation of a system.

2.1.2 Training Munitions and Expendable Stores

Costs of the unit-level consumption of training munitions, rockets, missiles, and expendable stores in the course of normal peacetime training missions. Includes the cost of live and inert ammunition, bombs, rockets, training missiles, sonobuoys, and pyrotechnics expended in training and non-combat firings such as firepower demonstrations. This category also includes other expendable stores such as chaff, flares, fuel tanks, travel pods, and other items that lose their identity in use and may be dropped from stock record accounts when issued or used.

2.1.3 Other Operational Material

Costs of operating material other than energy, training munitions, or expendable stores. The costs identified must be related to the system whose O&S requirements are being assessed. Illustrative examples include computer supplies, paper, diskettes, ribbons, charts, maps, and administrative supplies used for housekeeping and health and safety.

2.2 Support Services

Costs of unit-level purchased support services. These services may vary greatly from one unit to another. They may include but are not limited to:

- FSRs that support non-maintenance activities (such as training, data collection, and IT support) that are not accounted for in cost element 1.3 (Other Unit-Level Manpower).
- Unreimbursed food services, rations, postal services (postage/box rental), or laundry services.
- Lease or rental of administrative, computational, or support equipment or software.
- Lease costs of special facilities or land (e.g., for the storage of warheads and missiles).
- Unit-funded service contracts for administrative, computational, or support equipment.
- Communications services (e.g., data/voice links, dedicated lines, microwave channels), port services, and other unit-funded utilities not part of base operating support costs.

2.3 Temporary Duty

Costs of TAD/TDY pay and allowances costs, including unit personnel travel for training, administrative, or regularly scheduled training away from the unit's permanent operating location that are associated with a unit's concept of operations and support. TAD/TDY costs include military and commercial transportation charges, rental costs for passenger vehicles, mileage allowances, and subsistence expenses (e.g., per diem allowances and incidental travel expenses). Excludes temporary duty associated with contingencies or wartime operations.

2.4 Transportation

Costs of transportation funded by the unit. Typically includes the transportation costs for moving equipment, personnel, and supplies to and from training areas, remote operating sites, or test ranges. Excludes the transportation costs inherent in cost elements 2.1.1 (Energy), 3.1 (Depot Level Reparables), and 3.2 (Consumable Materials and Repair Parts); transportation costs for these elements are reflected in surcharges of various Defense Working Capital Funds (DWCFs) and normally would not be estimated separately.[12] The DWCF is a reimbursable arrangement where logistics providers (such as maintenance depots) sell goods or services to customers (operating forces such as squadrons or brigades), and prices are set for these transactions based on a full cost (direct labor, direct material, and overhead) recovery principle.

3.0 MAINTENANCE

Maintenance consists of the costs of labor (outside of the scope of unit-level) and materials at all levels of maintenance in support of the primary system. Any maintenance costs provided through support contracts should be separately identified from those provided by organic sources for each cost element where applicable.

3.1 Depot Level Reparables (DLRs)

The DLR element captures the cost the operating unit incurs for DLR items used to maintain the primary system at the unit level. The cost includes direct labor and material for item repairs, attrition, as well as transportation, storage, inventory management, and overhead reflected in the DWCF surcharge.

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[12] In contrast, the form used for contractor sustainment cost reporting (as discussed in Chapter 4) requires a distinct cost element for Packing, Handling, Shipping and Transportation (PHS&T) as part of the reporting WBS. This level of detail normally would not be available in most government data sources for organic maintenance activities.

3.2 Consumable Materials and Repair Parts

This element captures the cost the operating unit incurs for consumable materials and repair parts used to operate and maintain the primary system at the unit level. The cost includes the costs of goods sold, as well as transportation, storage, inventory management and overhead reflected in the DWCF surcharge.

3.3 Intermediate Maintenance (External to Unit-Level)

Consists of the costs of labor, material, and any other costs expended at intermediate maintenance locations (such as Navy afloat or ashore Intermediate Maintenance Activities) in support of the primary system. This cost element excludes any manpower or material costs that are considered unit-level, as described earlier.

3.3.1 Intermediate-Level Consumable Materials and Repair Parts

This element captures the costs for consumable materials and repair parts used at intermediate maintenance locations in support of the primary system.

3.3.2 Intermediate-Level Government Labor

This element captures the costs of military and government civilian manpower that performs intermediate-level maintenance on the primary system. For cases in which individuals maintain more than one system, manpower costs should be allocated on a relative workload basis.

3.3.3 Intermediate-Level Contractor Maintenance

The costs for labor, material, and overhead incurred by contractors providing intermediate-level maintenance services.

3.3.4 Other Intermediate-Level Maintenance

Any other intermediate-level maintenance costs not otherwise accounted for. If this cost element is used, the cost estimate documentation should describe the nature of the costs being presented.

3.4 Depot Maintenance

Depot maintenance is the cost of labor, material, and overhead incurred in performing major overhauls or other similar depot-level maintenance on a system or any of its major end items (e.g., aircraft engines) at centralized repair depots, contractor repair facilities, or onsite by depot teams.

Some overhaul activities occur at time intervals ranging from several months to several years. For primary systems (e.g., aircraft, tracked vehicles, ships), these costs should be included in the estimate for the years in which they are expected to occur, accompanied by documentation on the cost per event and the time interval between overhaul events.

Costs of major end items that have different overhaul cycles (i.e., structural subsystems such as hull, frame, or airframe; power subsystems such as engines or drive train; and electronic/mechanical subsystems such as fire control system, armaments, guidance, or command and control equipment) should be estimated and identified separately within this element. In some cases, the interval between end item overhauls may be expressed in terms of system operating hours (and not calendar time).

3.5 Other Maintenance

This element is used to capture any other maintenance costs not otherwise accounted for. If this cost element is used, the cost estimate documentation should describe the nature of the costs being presented. For example, this element may include transportation costs associated with periodic overhauls not funded by the unit (element 2.4) and not reflected in a DWCF surcharge.

4.0 SUSTAINING SUPPORT

This category includes support activities provided by centrally managed organizations external to the units that own the operating systems. Sustaining support costs provided through a system support contract should be identified separately from those provided organically for each cost element. The sustaining support cost elements may be combined as necessary if the costs are not available at the level of detail called for in this guide.

4.1 System-Specific Training

The cost of system-specific specialty training activities for individuals who need to be replaced due to attrition and normal rotation. Training costs should include the costs of instructors, training support personnel, as well as all the costs of trainees, per diem, and travel directly associated with the training. These three elements below capture costs for training individuals prior to their first assignment in a system operating unit. For individuals already assigned to a system operating unit, any expenses for the travel of individuals from operational units to training assignment, and return, are included in element 2.3 (Temporary Duty). The costs of maintenance or periodic refresh of the training equipment or devices is accounted for in element 4.7.

Note: This element includes the costs of recurring training activities. However, the costs of initial training equipment and training course materials are regarded as investment costs, and not as O&S costs.

4.1.1 System-Specific Operator Training

The costs for training conducted in units designated as primary training sites for individuals to become proficient in specific system knowledge. Includes units such as Air Force wings assigned a primary mission of weapon-specific aircrew training, Navy air readiness training units, Navy Afloat Training Groups, and the Army Armor Center.

These costs do not include skill training not related to a specific system, such as undergraduate aviation training. Training of a more general nature is captured in element 6.3.2 (General Skill Training).

4.1.2 System Specific Maintenance Training

The costs of advanced system-specific training associated with maintenance functions in units designated as primary training facilities.

4.1.3 System Specific Other Support Training

The costs of advanced system-specific training associated with other support functions in units designated as primary training facilities.

4.2 Support Equipment Replacement and Repair

The costs incurred to replace or repair support equipment associated with the primary system or its major subsystems at all levels of maintenance. The support equipment (e.g., tools and test sets) may be peculiar to the system or it may be common to a number of systems, in which case the costs must be allocated among the respective systems. In practice, however, in some cases replacement of organic depot support equipment of a general nature may be included in the overhead costs associated with DLRs or depot maintenance.

Note: This element includes replacement and repair of equipment. However, the cost of initial support equipment procurement is regarded as an investment cost, not as an O&S cost.

4.3 Sustaining/Systems Engineering

Costs reported in this element capture the government and contractor sustaining engineering to ensure the continuing viable operation of the system in the deployed environment. Most of the sustaining engineering effort will be a continuation of the earlier systems engineering effort that took place during program development and production. Sustaining engineering activities may be resident in the system program office organization, and/or they may be resident in external organizations. Examples of sustaining engineering activities might include aircraft structural integrity monitoring or corrosion monitoring; planning and control of technical program efforts; continuing system requirements definition; safety and human systems integration engineering; obsolescence engineering; configuration management; and continuing specialty engineering, such as R&M Engineering. Specific modifications to hardware or software are included in element 5.0 (Continuing System Improvements). Sustaining engineering costs provided through a system support contract should be identified separately from costs associated with organic sources, if possible.

4.4 Program Management

This element includes government and contractor costs for management activities associated with the administrative, business, and financial management of the program. Program management activities are, in most cases, a continuation of those performed during development or production. Program management activities may be resident in the system program office organization, and/or they may be resident in external organizations. Program management provided through a support contract should be identified separately from program management provided by organic sources, if possible.

Note: Cost elements 4.3 and 4.4 may be combined if the costs cannot be identified separately.

4.5 Information Systems

This element consists of the costs associated with ancillary automated systems hardware and software, such as mission planning systems. Excludes costs of modifications and upgrades for the embedded hardware and software associated with the primary system.

4.5.1 Tech Refresh

This element captures the costs of periodic replacement of workstations, computers, and peripherals.

4.5.2 License Fees

This element captures the costs of software licenses, whether program-wide, unit-wide, or seat-based.

4.5.3 Maintenance

This element captures the costs of maintenance and support for the ancillary automated systems.

4.6 Data and Technical Publications

The costs associated with maintaining and updating deliverable data and technical publications and manuals concerning the operation, maintenance (at all levels of maintenance—organizational, intermediate, and depot), and support of the system.

Note: This element addresses only data and publications maintenance. The cost of developing the data and publications is normally regarded as an investment cost, and not as an O&S cost.

4.7 Simulator Operations and Repair

Costs to operate and repair simulators and other training devices for the primary system or its major subsystems. This consists of the costs of labor, material, and overhead for simulator operations and repair. Also includes the cost of periodic replacement of simulator hardware and software.

4.8 Other Sustaining Support

Costs of any significant sustaining support not otherwise accounted for. This cost element may be used to identify expenses such as those listed below, if they apply to the system for which the estimate is being made:

- Test and evaluation[13] in support of deployed systems, such as range costs, test support, data reduction, and test reporting.
- Air, sea, and land support not funded by the unit and provided by other activities to verify the proper operation of an electronic, communication, sensor, or other similar system.
- Centrally provided technical assistance, such as Help Desks, that provide DoD-wide or Service-wide support.
- Communication services (e.g., data/voice links, dedicated lines, microwave channels), hardware, and software leases purchased on a DoD-wide or Service-wide basis for direct system-specific support of a system. Note that communications services purchased at the unit-level are contained in element 2.2 (Support Services).
- Centrally funded purchases for transportation of system materiel (end items and secondary items) not otherwise accounted for in the cost element structure. Note that costs of unit-funded purchases of transportation are contained in element 2.4 (Transportation), and that costs of any transportation reflected in DWCF surcharges are contained in elements 2.1.1 (Energy), 3.1 (Depot Level Reparables), 3.2 (Consumables and Repair Parts), and 3.4 (Depot Maintenance).
- Any government/contractor software center (e.g., Software Integration Laboratory (SIL)) ongoing facilities and license costs required by the system. Excludes any costs accounted for in element 5.2 (Software Maintenance).

5.0 CONTINUING SYSTEM IMPROVEMENTS

This portion of the cost element structure includes the costs of hardware and software updates that occur after deployment of a system that improve a system's safety, reliability, or maintainability, or otherwise enable the system to meet its basic original operational requirements throughout its life. These costs include government and contract labor, materials, and overhead costs. Costs should be separated into government and contractor costs within each cost element, if applicable.

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[13] This is intended to record periodic testing of operational assets, structured to confirm that the system continues to retain its operational capabilities. This would not include testing to support development activities or testing integral to development of hardware or software modifications.

5.1 Hardware Modifications

The cost of development, procurement, and installation of modification kits. Modification kits will consist of both kits of equipment to be installed (Group B) and kits for provisions such as cables, brackets, or other interface devices (Group A). May also include costs associated with the modifications for support equipment, training equipment, technical publications/data, and initial spares and repair parts (consistent with the approved modification content). This element may also include minor software costs associated with the modifications and that are not considered software maintenance. This cost element only includes those modifications needed to achieve acceptable safety levels, overcome mission capability deficiencies, improve reliability, or reduce maintenance costs. It excludes modifications undertaken to provide additional operational capability not called for in the original system design or performance specifications; such modifications costs are treated as modernization (and not O&S) costs, since most of these modifications will be considered as ACAT programs in their own right.

5.2 Software Maintenance

The labor, material, and overhead costs incurred after deployment by depot-level maintenance activities, government software centers, laboratories, or contractors for supporting the update, maintenance and modification, integration, and configuration management of software. Includes operational, maintenance, and diagnostic software programs for the primary system, major subsystems, support equipment, and simulators and other training equipment. Excludes the costs of new development or major redesigns that provide new capabilities. If the costs of new development or major redesigns that provide new capabilities cannot be isolated, these costs will be considered as part of software maintenance and should be so noted in the estimate documentation.

6.0 INDIRECT SUPPORT

Indirect support costs are those installation and personnel support costs that cannot be identified directly (in the budget or FYDP) 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.

Since indirect support costs lack direct visibility with the system under consideration, they are often allocated, either on a per-capita or some other basis. Some O&S cost estimates attempt to partition the indirect support costs into fixed and variable elements, and use only the variable costs in the estimate. The intention is to include only the costs that would likely change for the action being analyzed (e.g., new system development is initiated).

Indirect support costs are more relevant for situations in which total DoD manpower would change significantly or when installations are affected (i.e., expanded, contracted,

opened, or closed). Indirect support costs also are an important consideration in a benefit analysis, economic analysis, or business case analysis involving a choice between government and contracted support. In these cases, it is typical to include both fixed and variable indirect support costs associated with the government personnel, since these costs are being compared to fully loaded labor rates applied to the contractor personnel.

The documentation for the program cost estimate should note any assumptions about the fixed and variable composition of the indirect support costs used in the estimate.

6.1 Installation Support

The costs of services funded and provided by the host installation that support the day-to-day operations of the system's force unit. Excludes the costs of personnel support services purchased by the unit that are reflected in element 2.2 (Support Services). Consists of:

6.1.1 Base Operations Support

The costs of services for functions such as base physical security, base administration, maintenance of installation equipment, base transportation, and other base and personnel support services.

6.1.2 Base Communications

The costs of local communication services provided by the host installation. May be combined with 6.1.1 (Base Operations Support) if it cannot be identified separately.

6.1.3 Facilities Support

The costs of facilities sustainment, restoration and modernization (formerly known as real property maintenance).

6.2 Personnel Support

The costs for the management, acquisition, initial training, and quality of life programs necessary to maintain a quality force.

6.2.1 Personnel Administration

The costs of programs that acquire and administer the DoD workforce.

6.2.1.1 Personnel Management

The costs of programs to administer the DoD military and civilian workforce. Major activities include reassigning on-board personnel, and managing end strength and occupational skills to the levels needed.

6.2.1.2 Acquisition of New Personnel

The costs for recruiting, examining, and processing individuals into the military service and for advertising in support of recruiting activities.

6.2.1.3 Personnel Not Available For Duty (Transients, Prisoners, Patients, Students)

The costs for military personnel placed in the personnel holding account because they are not available for assignment to a unit for medical or disciplinary reasons, or are about to be discharged. Includes military personnel not assigned to a unit because they are in transit to the next permanent duty station, to schooling, or other training.

6.2.2 Personnel Benefits

Consists of the costs for operation and maintenance of family housing, dependent and family support programs, and DoD commissaries and exchanges.

6.2.2.1 Family Housing

The operating and maintenance costs of dwelling units, community facilities, roads, driveways, walkways, and utilities for use by family housing occupants.

6.2.2.2 Dependent Support Programs

The costs of child development centers, youth development programs, family centers, family advocacy programs, counter-drug demand reduction programs, and other similar programs necessary to support the families of service members. Includes the education of dependents of federal employees in overseas assignments and for eligible dependents of federal employees residing on federal property where an appropriate public education is unavailable in the nearby community. These education costs are primarily funded by the DoD Education Activity (DoDEA).

6.2.2.3 Commissaries and Exchanges

The appropriated costs of employee salaries and other expenses at defense commissaries. These costs are primarily funded by the Defense Commissary Agency (DeCA).

6.2.3 Medical Support

The costs for medical care for active duty personnel and their dependents. Includes provisions for in-house patient care in regional defense facilities, station hospitals, and medical clinics, and dental facilities as well as care in non-defense facilities. Also includes costs for private-sector care such as TRICARE or other similar activities. Medical care is funded by a combination of the military departments and the Defense Health Program. The active-duty composite rates described earlier also provide an acceleration factor to account for the costs of medical support.

6.3 General Training and Education

The costs for institutional or schoolhouse training and education not associated with a specific weapon or other system. Consists of the costs of:

6.3.1 Recruit and Initial Officer Training

The costs of programs that provide basic military training and indoctrination to enlisted recruits, and of programs that provide basic military training and indoctrination to officer candidates (through college commissioning programs, officer candidate/training schools, and the three service academies).

6.3.2 General Skill Training

The costs of programs that teach (1) entry-level job skills after completion of initial military training, and (2) intermediate and advanced job skills later in the career.

6.3.3 Professional Military Education

The costs of programs that provide (1) professional military education at each level of career progression, and (2) advanced academic degrees needed for work in specific organizations and tasks.

Appendix A.
References

(a) DoD Manual 5000.04-M, *DoD Cost Analysis Guidance and Procedures*, current edition (update pending).

(b) DoD 7000.14-R, *Financial Management Regulation*, current edition. Accessible at http://comptroller.defense.gov/fmr/.

(c) *AT&L Operating and Support Cost Management Guidebook*, forthcoming

(d) Interim DoD Instruction 5000.02, Operation of the Defense Acquisition System, November 25, 2013.

(e) *DoD Reliability, Availability, Maintainability and Cost Rationale Report Manual*, June 1, 2009. Accessible at http://www.acq.osd.mil/sse/docs/DoD-RAM-C-Manual.pdf.

(f) DoD Instruction 7041.3, Economic Analysis for Decisionmaking, November 7, 1995.

(g) *Defense Acquisition Guidebook*, current edition. Accessible at https://dag.dau.mil.

(h) *DoD Product Support Business Case Analysis Guidebook*, April 2011. Accessible at http://www.acq.osd.mil/log/mr/library/BCA_Guidebook _April2011.pdf.

(i) DoD Manual 5000.04-M-1, *Cost and Software Data Reporting (CSDR) Manual*, November 4, 2011.

(j) Office and Management and Budget Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, current edition. Accessible at http://www.whitehouse.gov/omb/circulars_a094.

(k) DoD Instruction 7041.04, Estimating and Comparing the Full Costs of Civilian and Active Duty Military Manpower and Contract Support, July 3, 2013.

(l) *National Defense Authorization Act for FY 2012*, Public Law 112-81.

(m) *AT&L Logistics Assessment Guidebook*, July 2011. Accessible at www.acq.osd.mil/log/mr/library/Logistics_Assessment_Guidebook _July2011.pdf.

(n) *Joint Capabilities Integration and Development System (JCIDS) Manual*, January 19, 2012. Accessible at http://jitc.fhu.disa.mil/jitc_dri/pdfs/jcids _manual_19jan12.pdf.

All DoD directives, instructions, and manuals are available online at the Washington Headquarters Services (DoD Issuances) web site at: http://www.dtic.mil /whs/directives.

Appendix B.
An Example of a Comparative Life-Cycle Cost Analysis

This appendix provides an illustrative analysis of how O&S and other cost information can be used to influence system design. This notional example concerns the choice of two alternative subsystems for a primary system based on lowest life-cycle cost (LCC). Specifically, this example concerns a major system component of a new system for which there are two competing designs. Component A is being used on a current system, while Component B has been proposed by the current supplier as a more reliable but more expensive replacement. The contractor has provided data on cost, reliability, and maintainability (including some test results) for the new component that were reviewed and validated by the program office staff. These steps correspond to "Collect, validate and adjust data" as discussed in Section 5.3 (see Figure 5-1). Although this simplified example considers only a single component, the computational approach can be easily extended to a more complex subsystem consisting of multiple components.

Some basic ground rules and assumptions for the LCC analysis are shown below:[1]

- Five hundred systems are to be purchased.
- The component under consideration is to be government furnished equipment (GFE). Its lifetime is assumed to be twenty-five years, at which time a replacement is likely to be needed for performance/safety reasons.
- Systems are expected to operate 300 hours per year.
- Component A and B deliveries of installs and spares are on comparable schedules.
- The component failure rate is constant throughout the life-cycle period.
- The hardware (i.e., prime mission product) unit costs are labeled as "buy costs per unit." The other procurement costs (initial spares, depot startup, and other peculiar support (training, documentation, support equipment, etc.)) are labeled as "Below the Line."

[1] Some assumptions have been made to simplify the presentation. For example, normally over 25 years the reliability of a component may degrade due to wearout but this analysis assumes a constant value. Also, many O&S costs due to diminished manufacturing sources and systems engineering support were not considered or assumed equal.

- The maintenance and logistics support structure for each component is similar, but some new depot equipment and training will be required along with new base support equipment for Component B.
- The new component is expected to have higher reliability but higher repair cost based on current estimates.
- There is only a minor difference in costs for sustaining support such as sustaining engineering and modifications.
- The discount rate prescribed by OMB Circular A-94 for a twenty-five-year period is 1.5 percent.

The data on the existing system provided by the contractor, and data for the new component and other relevant data, were analyzed and validated by the program office staff. The resulting cost data and related estimates are shown in Table B-1.

Table B-1. Results of LCC Analysis Comparing Two Alternative Components

Factor	Component A	Component B	Comment	Data Source (A,B)
System operational lifetime (yrs.)	25	25		Planning document
Buy Cost per Unit	$1,000,000	$1,200,000	B is 20% more expensive	Current buys, cost estimate
Total Number of Operational Units	500	500		Planning document
Mean Time Between Failures (hrs)	300	500	B has higher MTBF	Current reliability, reliability estimate
Total Operating Hours - System Lifetime	3,243,000	3,243,000		Planning document and Buy Schedule
Quantity of Initial Spares	100	60	B is more reliable	Sparing formula
Quantity of Replacement Spares	50	18	Based on expected condemnations and wearout	Estimate based on current experience
Expected Number of Failures	10,810	6,486	Based on operate hours and MTBF	Formula - Total Hours/MTBF
Cost Per Repair	$80,000	$100,000	B has better maintainability design so repair cost is not directly proportional to buy cost	Current experience, estimate
Depot Startup	0	$1,000,000	Have to set up depot repair station	Estimate based on similar startups
Training, Documentation, Support Equipment, etc.	$1,000,000	$3,000,000	More costly for new introduction	Standard factors adjusted as necessary
Maintenance manpower impact		–	Minimum staffing constraints preclude any savings for higher B reliability	Maintenance staffing constraints
Acquisition Cost	$601,000,000	$676,000,000	Qty bought * Unit price + "Below the Line"	Formula
O&S Cost	$914,800,000	$670,200,000	Added spares + Repair + Maintenance Manpower	Formula
LCC	$1,515,800,000	$1,346,200,000	$(169,526,816)	Formula
Discounted LCC	$1,322,541,196	$1,193,048,195	$(129,493,000)	Formula

Note: The above data are notional and not intended to be realistic.

This estimate indicates that on an LCC basis using constant dollars, the Component B alternative has a lower cost by about 11 percent. One important consideration is that the more reliable Component B experiences greater costs up front than Component A, so the savings it yields are mostly in O&S costs out in the future. Therefore, on a net present value basis, B's cost will not decrease as much as A's. Using the OMB-directed discount rate for a twenty-five-year period of 1.5 percent, the discounted LCC of Components A and B are $1.322 billion and $1.193 billion, respectively. Therefore, on a net-present value basis, Component B is estimated to cost roughly 10 percent less than Component A when the time value of money is accounted for.

Another factor to consider is risk. Since Component B is relatively new, there is more risk associated with its estimates of costs and related parameters such as Mean Time Between Failures (MTBF), potentially resulting in the addition of some risk costs to the Component B estimate. However, balancing this is the fact that because of the higher MTBF of B, on a cost-effectiveness basis, it may prove to be the better choice, as it will have higher system readiness and better mission reliability than Component A. Such analysis is beyond the scope of this appendix.

One final point relates to this example. If Table B-1, along with supplementary equations and inputs, is set up in a spreadsheet (as was actually done), the cost analyst can vary parameters such as buy cost and MTBF to see how the LCC changes. Figure B-1 shows how the discounted LCC of Component B changes as MTBF varies and compares with the Component A result. For B to be a viable candidate considering only LCC, the MTBF must be at least 400 hours. A lower reliability will result in greater cost than the current system. To identify the key elements that affect O&S resource usage and to be able to quantify their impact is an important tool for managing, controlling, and reducing O&S costs.

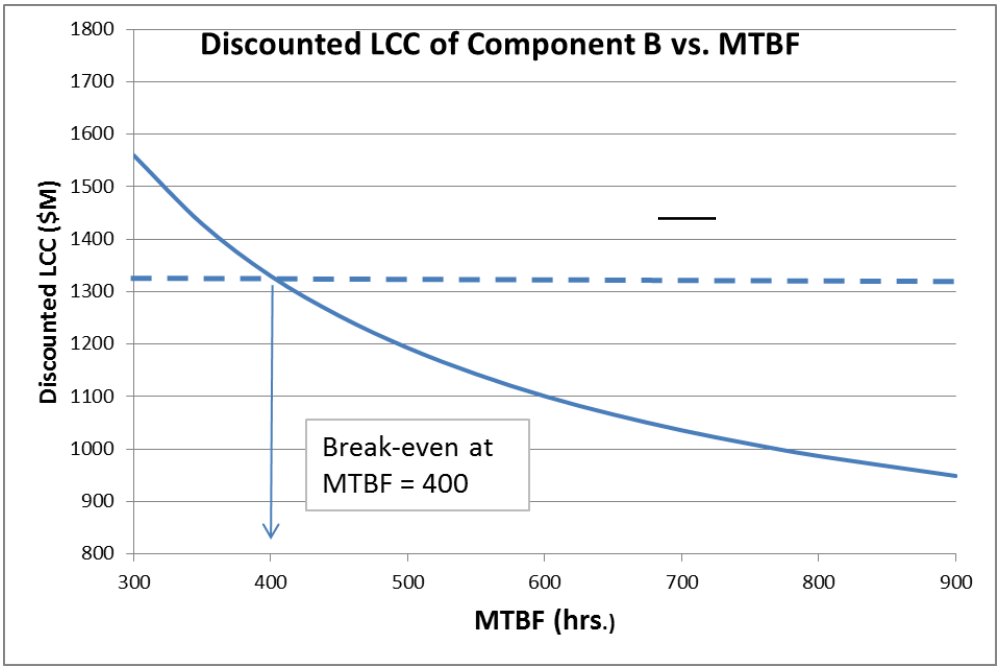

Figure B-1. Sensitivity Analysis for Component B Reliability

Summary

In this example, data from a number of different sources are likely to be used for a typical O&S estimate such as planning documents, current and past buy cost experience, contractor estimates, test data for new system cost and reliability, and standard cost factors. In addition, O&S cost-related models are likely to be employed, such as for procurement cost and spares. It is therefore important for the O&S cost estimating team to be aware of the O&S cost resources and data available for making estimates and to start early in the program to ensure necessary data and cost models are identified, collected, and usable.

Appendix C.
Evaluating the Life-Cycle Cost of Deferring Legacy System Replacement through System Upgrade

This appendix provides an example of how O&S cost estimates can be an important input to a decision that is often faced by DoD, namely whether to recapitalize a fleet of legacy systems now or upgrade the current fleet and defer replacement to sometime in the future. In this notional example, it is assumed that the legacy systems are experiencing growth in O&S costs that require mitigation. This example considers two alternatives. The first is to retire the legacy systems and replace them with new systems. The second is to upgrade the legacy systems and extend the system service life, and defer the replacement of the new systems to a later date. For the first alternative, it is assumed that the procurement cost will be lower for a system upgrade than for a new replacement system. However, it is also assumed that the new replacement system will have lower O&S costs (compared to both the legacy system and the upgrade) due to improved reliability and maintainability associated with newer technologies.

For this example the following cost factors are important inputs:

- Time period – the time period over which the cost estimate is to be made. Every LCC analysis has a defined performance period that generally is determined by the service life of the applicable systems.
- Remaining service life of legacy, upgraded, and replacement systems. It is assumed that the system upgrade will have a shorter service life compared to the new replacement system.
- Total inventory for each fleet. In this example, it is assumed that the system upgrade is a 1-for-1 replacement for the legacy system, but it is also assumed that the new replacement system is a 0.8-for-1 replacement for the legacy system due to superior capabilities.
- Procurement cost to upgrade or replace current system.
- Annual O&S cost for legacy, upgraded, and replacement systems .
- O&S growth factor. Over time, O&S costs are expected to increase as system wearout takes place and parts availability diminishes. For a replacement system, there is generally a grace period over which O&S costs are fairly constant (excluding infant mortality).

- Discount rate. This is important because it is a way to account for how the dollar expenditures differ for the two alternative strategies. Here the upgrade option will have some advantage due to any delay in large procurement expenditures for system replacement. Additional discussion on discount rates is provided in Chapter 5 of this guide.
- Residual value of current, upgraded and replacement systems. By replacing current systems now, the replacement fleet may have some residual value at the point in time associated with the service life of the upgraded fleet. Since the service life of each alternative is likely to vary for this type of analysis, residual value is one way to account for the difference. Guidance on how to calculate residual value is provided in DoDI 7041.3.

A summary of the major cost inputs is shown in Table C-1.

Table C-1. Summary of Major Cost Input Data

	Legacy	Upgrade	Replacement
Service life (years)	-	15	40
Total Inventory	100	100	80
Procurement $M per system	-	40	100
Annual O&S $M per system	5.0	4.5	4.0
Annual O&S cost growth factor	3%	1.5%	0%
		(years 1-10)	(years 1-15)
		3%	3%
		(after 10 years)	(after 15 years)
Annual discount rate: 1.1%			

Note: The above data are notional and not intended to be realistic.

These data can be used to calculate the LCC for each alternative. The resulting annual costs for Alternative 1 (Buy Replacement Now) and Alternative 2 (Upgrade Now; Buy Replacement Later) are shown in Figure C-1 and Figure C-2, respectively.

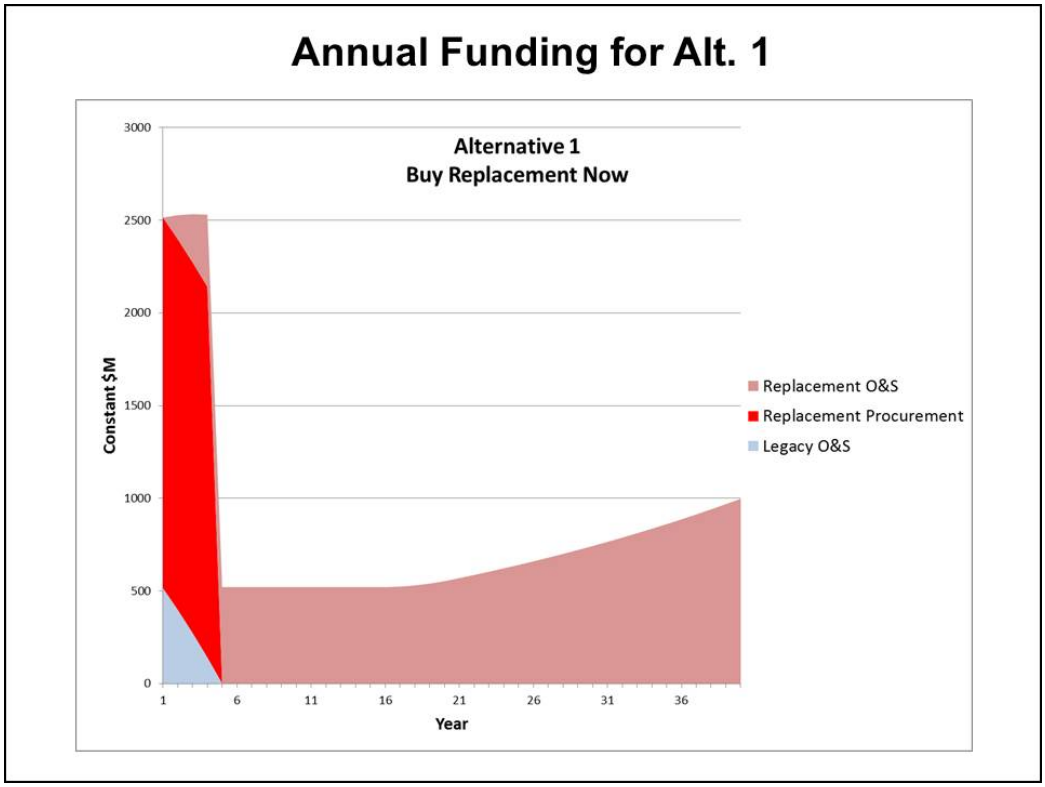

Figure C-1. Projected Annual Life-Cycle Cost for Alternative 1

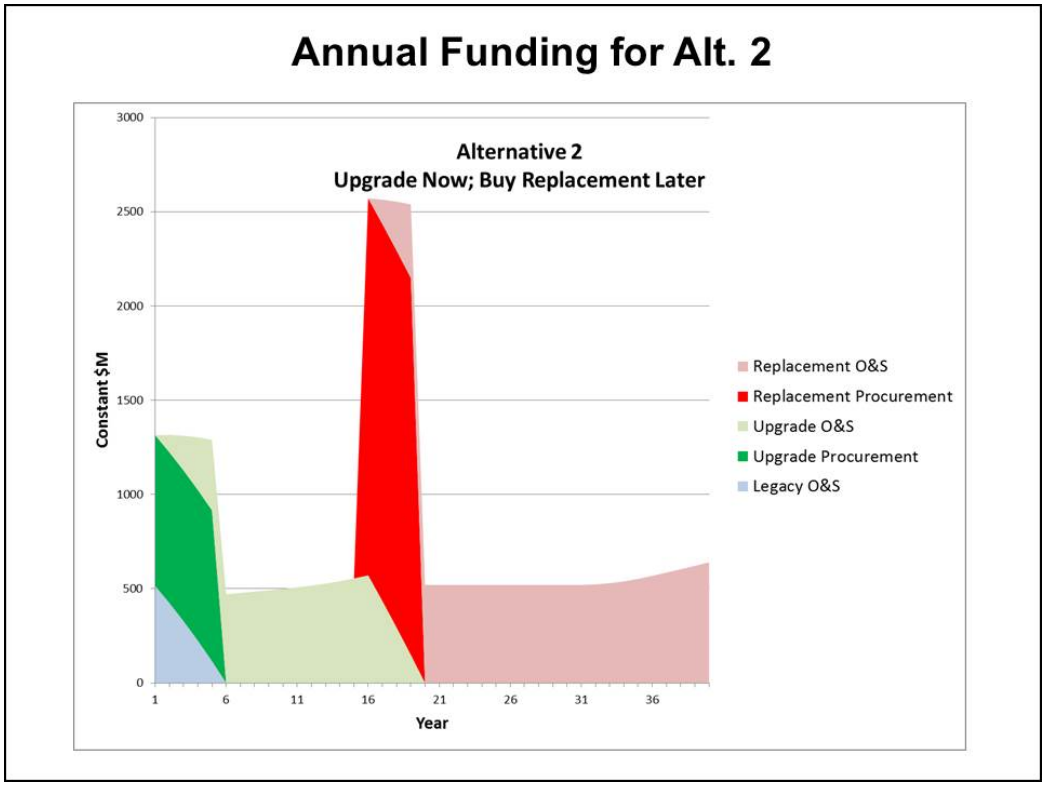

Figure C-2. Projected Annual Life-Cycle Cost for Alternative 2

A summary of the LCC comparison between the two alternatives is provided in Table C-2.

Table C-2. Life-Cycle Cost Comparison

	All costs in constant $Millions	
	Alternative 1	**Alternative 2**
	Buy Replacement Now	**Upgrade Now; Buy Replacement Later**
Legacy		
O&S	1298	1567
Upgrade		
Procurement	0	3871
O&S	0	6605
Replacement		
Procurement	7785	6607
O&S	11643	5440
Residual Value		-620
LCC Total	24370	27591
Discounted LCC	20726	23470

In the example, the discounted LCC for Alternative 1 (Buy Replacement Now) is roughly 12 percent less than the cost for Alternative 2 (Upgrade Now; Buy Replacement Later). However, this comparison is based on the assumption that the replacement system will have significantly lower annual O&S costs per system than either the legacy system or the upgrade, which is often not the case for real systems. Assumptions like this one, which often are subject to considerable uncertainty, should be subjected to additional sensitivity analysis. A sensitivity analysis for the replacement system annual O&S cost per system is shown in Figure C-3.

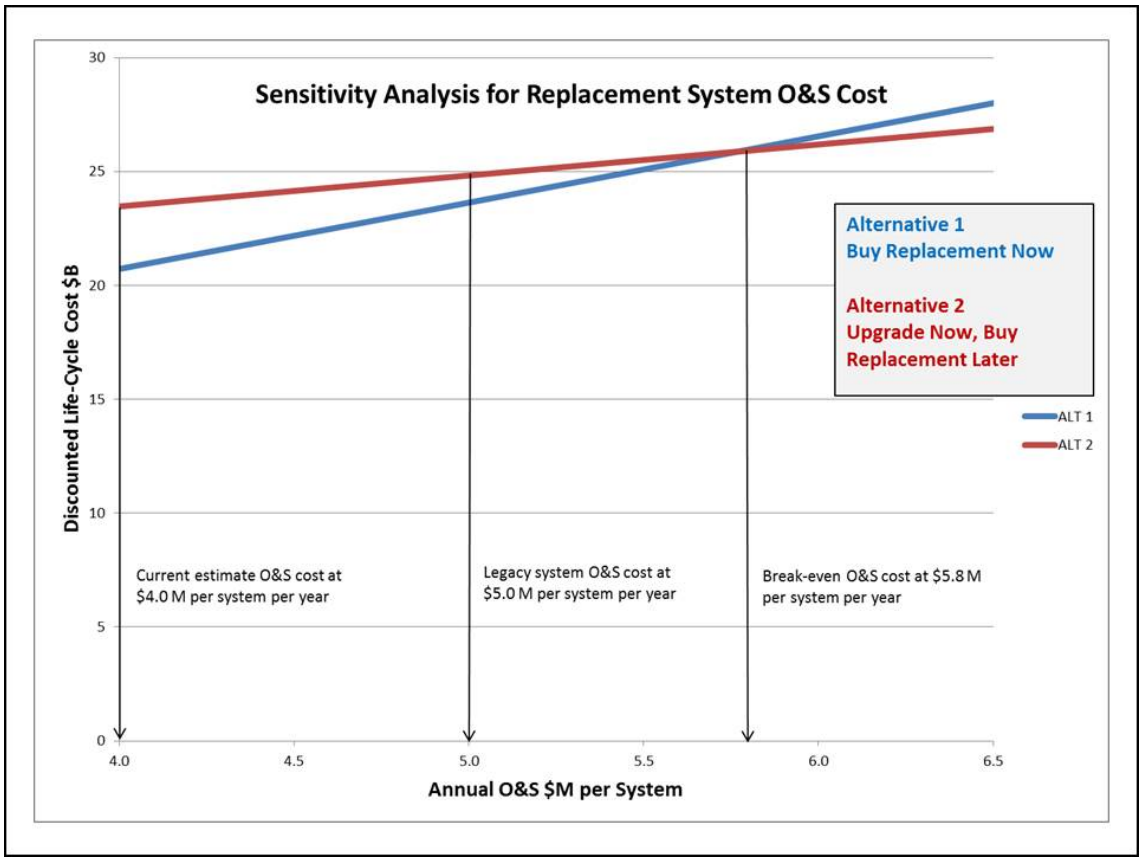

Figure C-3. Sensitivity Analysis for Replacement System Annual Unit O&S Cost

The baseline comparison assumes that the replacement system has an annual O&S cost per system of $4.0 million, compared to $5.0 million for the legacy system. If the costs for the replacement system were to turn out higher than expected, the breakeven point in the decision would occur at a replacement system O&S cost of $5.8 million. That difference provides an indicator of the margin for error permitted in the decision.

Summary

Fleet recapitalization is an expensive undertaking and should be decided only after a complete and thorough review of all relevant factors involving cost, effectiveness, and safety factors. Typically this would be done through an AoA. LCC will normally be the cost decision metric and because the cost expenditure streams can be quite different for the alternatives, discounting is required.

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Appendix D.
Sample Presentation Formats

Chapter 5 of this guide provided a suggested outline for presentations concerning O&S cost estimates. This appendix provides suggested sample formats that follow that outline. The formats may need to be modified as appropriate. In addition to the formats, any other information that would be helpful in understanding the O&S cost estimate is encouraged.

GROUND RULES AND ASSUMPTIONS
PROGRAM OFFICE ESTIMATE (POE) OR SERVICE COST POSITION (SCP)
DATE:
WEAPON SYSTEM:
CONSTANT FY___$ (000)

OPERATIONS CONCEPT	Deployed Quantity
	Average # of Systems/Unit
	System OPTEMPO
O&S PHASING	System Life
	Years of Phase-In
	Years of Steady State
	Years of Phase-Out
MAINTENANCE CONCEPT	Interim Contractor Support Period
	Organic or Contractor Maintenance
	Levels of Maintenance
SYSTEM MANNING	Crew Composition
	Unit-Level Maintenance Manpower per System

Figure D-1. Sample Ground Rules and Assumptions
(Can be modified and expanded, as needed)

O&S COST SUMMARY
PROGRAM OFFICE ESTIMATE (POE) OR SERVICE COST POSITION (SCP)
DATE:
WEAPON SYSTEM:
CONSTANT FY___$ (000)

SUMMARY

COST ELEMENT	**POE or SCP**
UNIT-LEVEL MANPOWER	
UNIT OPERATIONS	
MAINTENANCE	
SUSTAINING SUPPORT	
CONTINUING SYSTEM IMPROVEMENTS	
INDIRECT SUPPORT	
GRAND TOTAL	

Figure D-2. Sample O&S Cost Summary
(Can be presented as pie chart, if desired)

O&S COST METHODS

PROGRAM OFFICE ESTIMATE (POE) OR SERVICE COST POSITION (SCP)

DATE:

WEAPON SYSTEM:

CONSTANT FY___$ (000)

	METHODS		
COST ELEMENT	**SUB-ELEMENT**	**POE or SCP**	**METHOD**
UNIT-LEVEL MANPOWER	Operations		
	Unit Maintenance		
	Other Unit-Level		
UNIT OPERATIONS	Operating Material		
	Support Services		
	Temporary Duty		
	Transportation		
MAINTENANCE	Depot Maintenance		
	DLRs		
	Consumable Material/Repair Parts		
	Other Maintenance		

Figure D-3A. Sample O&S Cost Methods

(Can be expanded where appropriate)

O&S COST METHODS

PROGRAM OFFICE ESTIMATE (POE) OR SERVICE COST POSITION (SCP)

DATE:

WEAPON SYSTEM:

CONSTANT FY___$ (000)

	METHODS		
COST ELEMENT	**SUB-ELEMENT**	**POE or SCP**	**METHOD**
SUSTAINING SUPPORT	System Specific Training		
	Support Equipment Replacement		
	Sustaining Engineering/Program Management		
	Information Systems		
	Data and Technical Publications		
	Simulator Operations		
	Other Sustaining Support		
CONTINUING SYSTEM IMPROVEMENTS	Hardware Modifications		
	Software Maintenance		
INDIRECT SUPPORT	Installation Support		
	Personnel Support		
	General Training and Education		
GRAND TOTAL			

Figure D-3B. Sample O&S Cost Methods (cont.)

(Can be expanded where appropriate)

O&S COST SENSITIVITY ANALYSES
PROGRAM OFFICE ESTIMATE (POE) OR SERVICE COST POSITION (SCP)
DATE:
WEAPON SYSTEM:
CONSTANT FY___$ (000)

	SENSITIVITY ANALYSES					
	RANGE OF POSSIBLE VALUES			% CHANGE IN O&S COST		
COST DRIVER	**LOW**	**BASE**	**HIGH**	**LOW**	**BASE**	**HIGH**
SYSTEM RELIABILITY					-	
SYSTEM MAINTAINABILITY					-	
FUEL CONSUMPTION					-	
OVERHAUL INTERVAL					-	
SOFTWARE SIZE					-	
SYSTEM UNIT PRICE(S)					-	
OTHER					-	

Figure D-4. Sample O&S Cost Sensitivity Analyses
(Can be modified and/or expanded)

O&S COST TIME-PHASING

PROGRAM OFFICE ESTIMATE (POE) OR SERVICE COST POSITION (SCP)

DATE:

WEAPON SYSTEM:

CONSTANT FY___$ (000)

	O&S TIME-PHASING				
COST ELEMENT	**PHASE-IN FY __ to FY __**	**STEADY-STATE FY __ to FY __**	**PHASE-OUT FY __ to FY __**	**TOTAL**	**ANNUAL STEADY-STATE**
UNIT-LEVEL MANPOWER					
UNIT OPERATIONS					
MAINTENANCE					
SUSTAINING SUPPORT					
CONTINUING SYSTEM IMPROVEMENTS					
INDIRECT SUPPORT					
GRAND TOTAL					

Figure D-5. Sample O&S Cost Time-Phasing

(Can be presented as area-chart, if desired)

O&S COST TYPICAL UNIT COMPARISON
ANNUAL STEADY-STATE O&S COSTS
PROGRAM OFFICE ESTIMATE (POE) OR SERVICE COST POSITION (SCP)
DATE:
WEAPON SYSTEM:
CONSTANT FY___$ (000)

	TYPICAL UNIT ANNUAL STEADY-STATE	
TYPICAL UNIT DATA	**REFERENCE SYSTEM (NAME)**	**PROPOSED SYSTEM (NAME)**
SYSTEMS/UNIT		
SYSTEM OPTEMPO		
COST ELEMENT		
UNIT-LEVEL MANPOWER		
UNIT OPERATIONS		
MAINTENANCE		
SUSTAINING SUPPORT		
CONTINUING SYSTEM IMPROVEMENTS		
INDIRECT SUPPORT		
GRAND TOTAL		
TOTAL O&S $/SYSTEM/YEAR		

Figure D-6. Sample O&S Cost Typical Unit Comparison

(Typical unit is squadron, company, ship, or individual system. Can be presented as stacked bar chart, if desired)

O&S COST TRACK

PROGRAM OFFICE ESTIMATE (POE) OR SERVICE COST POSITION (SCP)

DATE:

WEAPON SYSTEM:

CONSTANT FY___$ (000)

COST TRACK

COST ELEMENTS	CURRENT POE or SCP	PRIOR POE or SCP (Date)	DELTA	EXPLANATION
UNIT-LEVEL MANPOWER				
UNIT OPERATIONS				
MAINTENANCE				
SUSTAINING SUPPORT				
CONTINUING SYSTEM IMPROVEMENTS				
INDIRECT SUPPORT				
GRAND TOTAL				

Figure D-7. Sample O&S Cost Track

(Can be modified and/or expanded, as needed. May need to normalize for quantity changes)

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Appendix E.
Section 832, FY 2012 National Defense Authorization Act

Assessment, Management, and Control of Operating and Support Costs for Major Weapon Systems

1. INTRODUCTION

1.1 This appendix describes the requirements and DoD implementation of Section 832, "Assessment, Management and Control of Operating and Support Costs of Major Weapon Systems," contained in the *National Defense Authorization Act for FY 2012, Public Law 112-81* (Reference (l)). These requirements call for the Department to take specific steps to improve its processes for (1) estimating Operating and Support (O&S) costs, (2) collecting and retaining data on O&S costs, and (3) using such data to inform system design and maintenance decisions. The Department is also required to conduct independent logistics assessments prior to key decision points in the acquisition process and to use these assessments to identify and address factors that drive up O&S costs.

1.2 The statutory requirements for this section apply to major weapon systems (i.e., weapon systems that are acquired as MDAPs—see Section 2379(f) of title 10, United States Code). In some cases, the regulatory implementations of these requirements have been extended to ACAT II systems.

2. RETENTION OF O&S COST ESTIMATES

2.1. Requirement. The military departments will retain each estimate of O&S costs that is developed at any time during the life cycle of a major weapon system, together with supporting documentation used to develop the estimate.

2.2 Guidance. Guidance for this requirement is provided in DoDI 5000.02, Enclosure 10, Cost Estimating and Reporting.

2.3 Discussion. Each program will provide copies of CARDs, reports, briefings, and supporting documentation concerning estimates of the program's O&S costs in electronic form to the military department's Deputy Assistant Secretary for Cost and Economics for centralized retention and administration. This will include, but is not

limited to, cost estimates prepared for acquisition milestone or other program reviews, as well as O&S cost estimates incorporated into program SARs. A sample presentation format for a briefing on a program O&S cost estimate is provided in Appendix D of this guide. Standards for supporting documentation are provided in DoD 5000.04-M.

3. TRACKING AND ASSESSING O&S COST ESTIMATES

3.1 Requirement. The military departments will update estimates of O&S costs periodically throughout the life cycle of a major weapon system, to determine whether preliminary information and assumptions remain relevant and accurate, and identify and record reasons for variances.

3.2 Guidance. Guidance for this requirement is provided in DoDI 5000.02, Enclosure 10, Cost Estimating and Reporting; and in DoD 5000.04-M.

3.3 Discussion. The DoD Components will update O&S cost estimates at each milestone review and at the post-IOC review described in Section 10 of this appendix. After IOC, the DoD Components also will update O&S cost estimates yearly throughout the system life cycle. Each update will be compared to earlier estimates and the program O&S affordability goal or cap. This comparison will identify the major reasons for significant changes, and categorize these reasons into external and internal factors. A sample presentation format for such a comparison is provided in Chapter 3, Section 3.9, of this guide. In addition, an independent cost estimate of system O&S costs will be prepared for each post-IOC review. This estimate will be prepared by either the Director, CAPE or the cognizant service cost agency. The determination as to the source of the independent O&S cost estimate will be made by the Director, CAPE in consultation with the service cost agency on a case-by-case basis.

4. COLLECTION OF O&S COST DATA

4.1. Requirement. The Director, CAPE shall establish standard requirements for the collection of data on O&S costs for major weapon systems and require the military departments to revise their VAMOSC systems to ensure that they collect complete and accurate data in compliance with such requirements and make such data available in a timely manner.

4.2 Guidance. Guidance for this requirement is provided in DoD 5000.04-M.

4.3 Discussion. Each military department has developed and maintains a historical O&S cost data collection system known as VAMOSC. The Director, CAPE is responsible for oversight of the VAMOSC programs. CAPE provides broad policy guidance to the VAMOSC programs, but leaves implementation details to the purview of each military department. Additional information about the VAMOSC programs is provided in Chapter 4 of this guide. The Director, CAPE conducts annual reviews of the

VAMOSC programs. These reviews address data accessibility, completeness, timeliness, accuracy, and compliance with CAPE guidance. The annual reviews also assess the adequacy of each military department's funding and resources for its VAMOSC program.

5. COST REPORTING FOR SUSTAINMENT CONTRACTS

5.1 Requirement. The Director, CAPE will establish standard requirements for the collection and reporting of data on O&S costs for major weapon systems by contractors performing weapon system sustainment functions in an appropriate format, and develop contract clauses to ensure that contractors comply with such requirements.

5.2. Guidance. Guidance for this requirement is provided in DoD 5000.04-M and will be updated in the next edition of DoD 5000.04-M-1.

5.3 Discussion.

5.3.1. The Director, CAPE has extended the CSDR to apply to major weapon system sustainment contracts and subcontracts (such as CLS, ICS, Performance Based Logistics (PBL), or other similar arrangements). CSDR reporting is required for all major contracts and subcontracts, regardless of contract type, for ACAT I and IA programs valued at more than $50 million (then-year dollars). Reporting will be continued on former ACAT I and IA programs until waived by the Director, CAPE. The requirement for high-risk or special-interest contracts valued between $20 million and $50 million is left to the discretion of the program manager, subject to the approval of the CAPE Deputy Director for Cost Assessment. Such approval is obtained as part of the CSDR planning process described in DoD 5000.04-M-1.

5.3.2. DCARC has developed a contract report format (DD Form 1921-4, "Contractor Sustainment Report") and associated report instructions (DID DI-FNCL-81831, "Contractor Sustainment Report") that will be used for cost reporting on new applicable sustainment contracts or contract modifications. The requirement for sustainment contract cost reporting will not apply retroactively to contracts already awarded prior to May 2012. The report format and the DID are available on the DCARC web site (see http://dcarc.cape.osd.mil/CSDR/FormsReporting.aspx).

6. RELIABILITY AND MAINTAINABILITY DATA

6.1 Requirement. The military departments shall:

(A) collect and retain data from operational and developmental testing and evaluation on the reliability and maintainability of major weapon systems, and

(B) use such data to inform system design decisions, provide insight into sustainment costs, and inform estimates of O&S costs for such systems.

6.2. Guidance. Guidance on this requirement is provided in DoDI 5000.02:

- Enclosure 3, Systems Engineering, Section 12, Reliability and Maintainability
- Enclosure 4, Developmental Test and Evaluation
- Enclosure 5, Operational and Live Fire Test and Evaluation

6.3 Discussion.

6.3.1 Enclosure 3 of DoDI 5000.02 requires the program manager to formulate a comprehensive reliability and maintainability program using an appropriate strategy to ensure reliability requirements are achieved. Reliability growth curves are included in the systems engineering plan at Milestone A, and updated in the TEMP updated at Milestone B and beyond. Enclosures 4 and 5 require the program manager and the cognizant test agencies to monitor reliability and maintainability growth and report on program status throughout the acquisition process. The DoD Components are now required to collect and retain data from operational and developmental testing and evaluation on the reliability and maintainability of ACAT I and II programs to inform system design decisions, provide insight into sustainment costs, and inform estimates of O&S costs for such systems.

6.3.2 Chapter 3, Section 3.8, of this guide provides illustrative examples of the tracking of actual reliability and maintainability data compared to baseline reliability and maintainability growth curves, and explains how revised reliability and maintainability projections can be used to update estimates of relevant high-cost O&S cost elements such as maintenance manpower.

7. CONSIDERATION OF SUSTAINMENT FACTORS

7.1 Requirement. The military departments shall ensure that sustainment factors are fully considered at key life cycle management decision points and that appropriate measures are taken to reduce O&S costs by influencing system design early in development, developing sound sustainment strategies, and addressing key drivers of costs.

7.2. Guidance. Guidance on this requirement is provided in DoDI 5000.02, Enclosure 6, Life-Cycle Sustainment Planning.

7.3 Discussion.

7.3.1 Enclosure 6 of DoDI 5000.02 describes policies and procedures for the application of life-cycle sustainment planning across the life cycle. Every program develops and maintains an LCSP that describes plans for influences on system design to improve sustainment, and the technical, business, and management activities to develop, implement, and deliver a performance-based product support package that maintains

affordable system effectiveness and readiness over the system life cycle and that seeks to reduce cost without sacrificing necessary levels of program support. The LCSP is first prepared at Milestone A, and is updated at each subsequent decision point to reflect the increased maturity of the product support strategy, any changes in the corresponding product support package, current risks, and any cost reduction activities. Program managers are now required to employ a "should cost" management and analysis approach to identify, implement, and assess sustainment cost reduction initiatives.

7.3.2 Additional information concerning consideration of sustainment factors, including "should cost" activities, is provided in the *AT&L Operating and Support Cost Management Guidebook* (Reference (l)), and the *Defense Acquisition Guidebook*, Chapter 5, Life-Cycle Logistics.

8. INDEPENDENT LOGISTICS ASSESSMENTS

8.1. Requirement. The military departments shall conduct an independent logistics assessment of each major weapon system prior to key acquisition decision points (including milestone decisions) to identify features that are likely to drive future O&S costs, changes to system design that could reduce such costs, and effective strategies for managing such costs.

8.2. Guidance. Guidance on this requirement is provided in DoDI 5000.02, Enclosure 6, Life-Cycle Sustainment Planning.

8.3 Discussion.

8.3.1 Enclosure 6 of DoDI 5000.02 requires that the DoD Components conduct independent logistics assessments for all ACAT I and II programs prior to key acquisition decision points (including milestone decisions) to assess the adequacy of the sustainment strategy and to identify features that are likely to drive future O&S costs, changes to system design that could reduce costs, and effective strategies for managing such costs. The reviews will focus on sustainment planning and execution. Each DoD Component will establish its criteria for independence, and provide guidance to ensure consistency within the respective Component. At a minimum these reviews will be chartered by the acquisition executive and conducted by logistics, program management, and business experts from outside the program office.

8.3.2 Further information is provided in the *AT&L Logistics Assessment Guidebook* (Reference (m)).

9. RELIABILITY METRICS

9.1. Requirement. The military departments shall:

(A) establish reliability metrics for major weapon systems, and

(B) such metrics shall be used as triggers—

(i) to conduct further investigation and analysis into drivers of those metrics; and

(ii) to develop strategies for improving reliability, availability and maintainability of such systems at an affordable cost.

9.2. Guidance. Guidance on this requirement is provided in the *Joint Capabilities Integration and Development System (JCIDS) Manual* (Reference (n)), Appendix E to Enclosure B, Guide for the Sustainment KPP, and in DoDI 5000.02, Enclosure 6, Life-Cycle Sustainment Planning.

9.3 Discussion

9.3.1 The *JCIDS Manual* establishes that the capabilities needs documents for all ACAT I programs will include a Sustainment KPP. This is intended to ensure that the requirements and acquisition communities consider sustainment, including reliability, as a requirement in the development of the program design. The Sustainment KPP has three elements:

- A mandatory KPP for Availability
- A supporting Key System Attribute (KSA) for Reliability
- A supporting KSA for O&S costs

This KPP is mandatory for a program's CDD and Capability Production Document and is included in the APB. Beginning at Milestone B, the parameters of the KPP are subject to reporting and tracking as the program proceeds through the acquisition phases.

9.3.2 The developers of the sustainment KPP requirements are expected to conduct up-front trade studies and other analyses to determine sustainment requirements that are balanced with program acquisition cost and what is achievable based on technology maturity. The process for conducting these trade studies are described in the *RAM-C Manual*. A RAM-C Report documents the rationale behind the development of the sustainment metric requirements, including reliability metrics, along with underlying assumptions and supporting analyses. The *RAM-C Manual* also provides guidance to the acquisition community to ensure that the sustainment requirements can be measured and tested throughout the program life cycle.

10. POST-IOC REVIEWS

10.1 Requirement. The military departments shall conduct periodic reviews of O&S costs of major weapon systems after such systems achieve IOC to identify and address factors resulting in growth in O&S costs and adapt support strategies to reduce such costs.

10.2. Guidance. Guidance on this requirement is provided in DoDI 5000.02, Enclosure 6, Life-Cycle Sustainment Planning.

10.3 Discussion. After IOC, the DoD Components will continue to conduct periodic reviews of major weapon systems at a minimum level of every five years. DoD Components will provide results of these reviews for current or former ACAT ID programs to the Assistant Secretary of Defense for Logistics and Materiel Readiness (ASD(L&MR)). The reviews will focus on the weapon system-level product support performance in satisfying warfighter needs, meeting sustainment metrics, and providing best-value outcomes. The reviews must specifically assess O&S costs to identify and address factors resulting in growth in O&S costs and adapt support strategies to reduce such costs. Review results will inform LCSP and business case analysis updates. Examples of analytic approaches for supporting these reviews are provided in Chapter 3, Section 3.11, of this guide.

11. RETENTION OF DATA ON OPERATING AND SUPPORT COSTS

11.1 Requirement.

11.1.1. The Director, CAPE shall be responsible for developing and maintaining a database on O&S estimates, supporting documentation, and actual O&S costs for major weapon systems.

11.1.2. In carrying out these responsibilities, the Director, CAPE shall:

(A) promptly receive the results of all cost estimates and cost analyses conducted by the military departments with regard to O&S costs of major weapon systems;

(B) have timely access to any records and data of the military departments (including classified and proprietary information) that the Director considers necessary to carry out such responsibility; and

(C) with the concurrence of USD(AT&L), may direct the military departments to collect and retain information necessary to support the database.

11.2 Guidance. Guidance for this requirement is provided in DoDI 5000.02, Enclosure 10, Cost Estimating and Reporting.

11.3 Discussion. Each program will provide copies of CARDs, reports, briefings, and supporting documentation concerning estimates of the program's O&S costs in electronic form to the CAPE Deputy Director for Cost Assessment for centralized retention and administration by the DCARC. This will include, but is not limited to, cost estimates prepared for acquisition milestone or other program reviews, as well as O&S cost estimates incorporated into program SARs. Any CARDs, reports, briefings, and

support documentation that contain proprietary data will be identified as such, so that the DCARC can limit access to such documents in order to protect them. The CAPE Deputy Director in turn will forward copies of the applicable documents to USD(AT&L) for inclusion in the Acquisition Information Repository.

Appendix F.
Abbreviations

ACAT	Acquisition Category
AFTOC	Air Force Total Ownership Cost
AGR	Active/Guard/Reserve
AoA	Analysis of Alternatives
APB	Acquisition Program Baseline
ASD(L&MR)	Assistant Secretary of Defense for Logistics and Materiel Readiness
CAPE	Cost Assessment and Program Evaluation
CARD	Cost Analysis Requirements Description
CDD	Capability Development Document
CER	Cost Estimating Relationship
CLS	Contractor Logistics Support
CSDR	Cost and Software Data Reporting
DAMIRS	Defense Acquisition Management Information Retrieval System
DCARC	Defense Cost and Resource Center
DeCA	Defense Commissary Agency
DID	Data Item Description
DLA	Defense Logistics Agency
DLR	Depot Level Reparable
DoD	Department of Defense
DoDEA	DoD Education Activity

DoDI	DoD Instruction
DWCF	Defense Working Capital Fund
EMD	Engineering and Manufacturing Development
FCoM	Full Cost of Manpower
FICA	Social Security (Federal Insurance Contributions Act)
FRP	Full-Rate Production
FSR	Field Service Representative
FY	Fiscal Year
FYDP	Future Years Defense Program
GFE	Government Furnished Equipment
ICS	Interim Contractor Support
IOC	Initial Operational Capability
IPS	Integrated Product Support
JCIDS	Joint Capabilities Integration and Development System
KPP	Key Performance Parameters
KSA	Key System Attribute
LCC	Life-Cycle Cost
LCSP	Life-Cycle Sustainment Plan
LRIP	Low Rate Initial Production
MAIS	Major Automated Information System
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MILCON	Military Construction
MILPERS	Military Personnel
MMH/FH	Maintenance Man-Hours per Flight Hour
MTBF	Mean Time Between Failures
MTBM	Mean Time Between Maintenance

O&M	Operations and Maintenance
O&S	Operating and Support
OMB	Office of Management and Budget
OPTEMPPO	Operating Tempo
OSD	Office of the Secretary of Defense
OSMIS	Operating and Support Management Information System
PBL	Performance Based Logistics
PCS	Permanent Change of Station
PE	Program Element
PHS&T	Packing, Handling, Shipping and Transportation
POE	Program Office Estimate
POL	Petroleum, Oil and Lubricants
R&M	Reliability and Maintainability
RAM	Reliability, Availability, and Maintainability
RAM-C	Reliability, Availability, Maintainability and Cost
RDT&E	Research, Development, Test and Evaluation
RFP	Request for Proposal
SAG	Sub-Activity Group
SAR	Selected Acquisition Report
SCP	Service Cost Position
SIL	Software Integration Laboratory
TAD/TDY	Temporary Additional Duty/Temporary Duty
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology and Logistics
USMC	US Marine Corps
VAMOSC	Visibility and Management of Operating and Support Costs

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