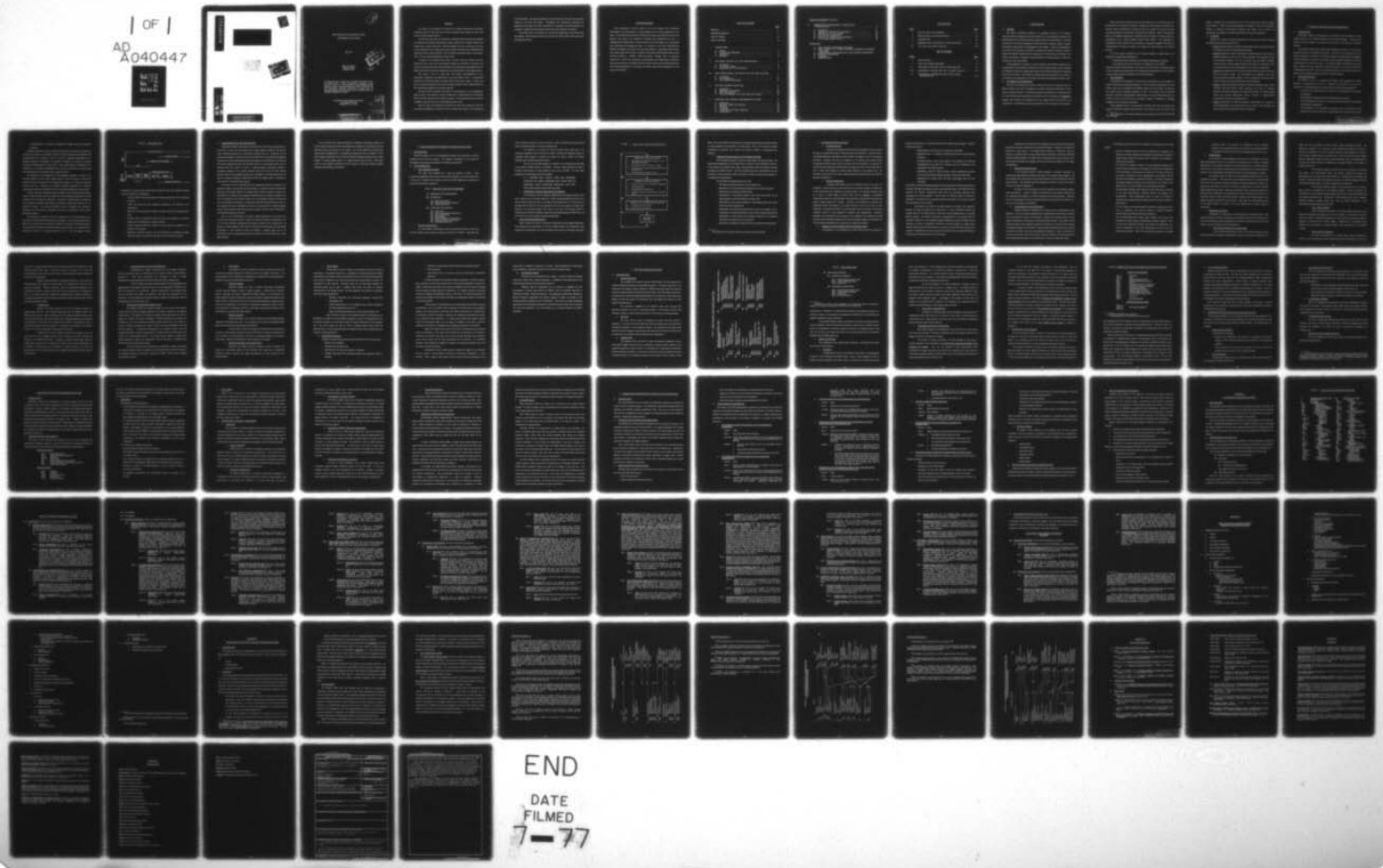
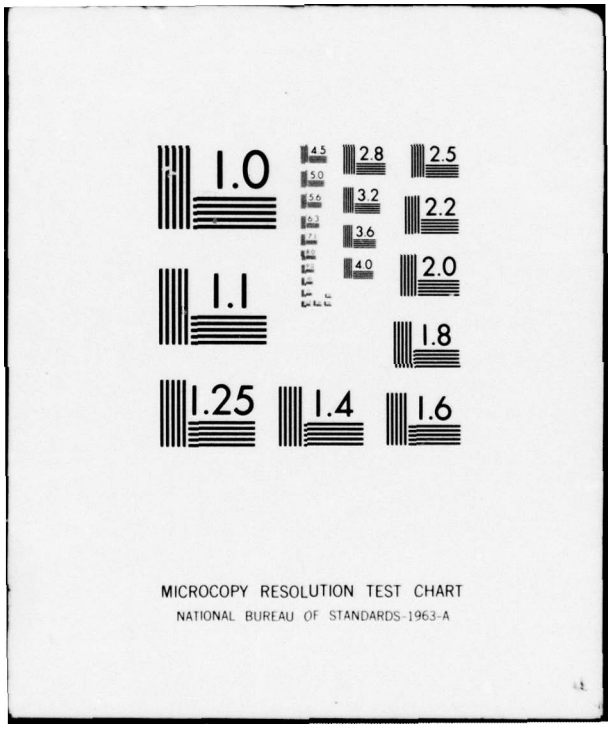
AD-A040 447 LOGISTICS MANAGEMENT INST WASHINGTON D C F/G 14/1
SHIP OPERATING AND SUPPORT COSTS: GUIDELINES FOR ANALYSIS,(U)
MAY 77 M R FIORELLO, R S SALZER, J R WILK SD-321
UNCLASSIFIED LMI-75-1/2 NL



END

DATE FILMED
7-77


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD A040447

DDC
JUN 3 1977

LOGISTICS MANAGEMENT INSTITUTE

AD No.
DDC FILE COPY

4701 SANGAMORE ROAD
WASHINGTON, D.C. 20016

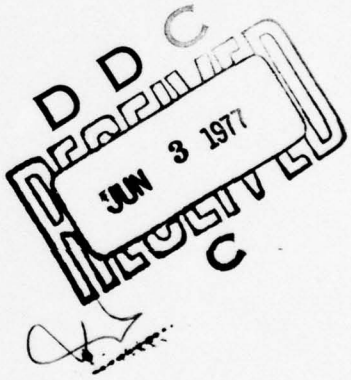
DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

14

SHIP OPERATING AND SUPPORT COSTS:

GUIDELINES FOR ANALYSIS

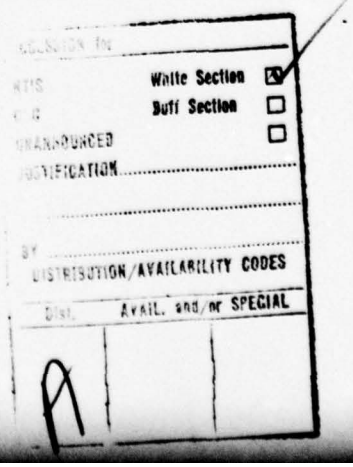
May 1977



Marco R. Fiorello
Robert S. Salzer
Joseph R. Wilk

Prepared pursuant to Department of Defense Contract No. SD-321 (Task 75-1/2). Views or conclusions contained in this document should not be interpreted as representing official opinion or policy of the Department of Defense. Except for use for Government purposes, permission to quote from or reproduce portions of this document must be obtained from the Logistics Management Institute.

LOGISTICS MANAGEMENT INSTITUTE
4701 Sangamore Road
Washington, D. C. 20016



DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

PREFACE

The Office of the Secretary of Defense, the Military Departments and defense contractors have for some time been actively concerned about rising life cycle costs (LCC) of Defense weapon systems.

Over the past two years, the Department of Defense (DoD) has placed new emphasis on examining the projected operating and support (O&S) costs of planned weapons and finding ways to reduce those costs. O&S cost analyses are now a major part of the cost review conducted at each weapon procurement decision meeting by the Defense Systems Acquisition Review Council (DSARC) and the DSARC's principal advisor on new system costs – the Cost Analysis Improvement Group (CAIG).

In support of the DSARC/CAIG review of system O&S cost impacts, LMI was assigned the task: "Life Cycle Cost Analysis in Support of the DSARC." The goal of the task was to develop O&S cost review procedures and estimating methodologies that the DSARC/CAIG will find useful in assessing the cost-effectiveness of new weapon systems.

This report is one of a series that will present recommendations for the development, assessment, and presentation of costs for DSARC review. It recommends guidelines for estimating support investment (SI) and O&S costs of ships. A reader with some cost analysis experience and a basic working knowledge of ship characteristics and their operating and support environment is assumed.

This report will be available to the CAIG for the preparation of a cost development guide for ships. Cost analysts in the Navy should find it a helpful preview of forthcoming DSARC and OSD requirements for O&S cost analysis. The study should also be of interest to defense contractors involved in estimating ship system costs.

Since the study was developed with DSARC and other DoD interests in mind, the recommended guidelines are expected to bear a strong resemblance to the forthcoming

CAIG cost guides. The space constraints for this report are not nearly as severe as those imposed on the CAIG cost guides. Accordingly, more explanatory discussions and background information have been incorporated to supplement the basic guidelines and contribute to improved communication between the DoD and defense contractors.

The overall intent of this report is to contribute conceptually to ship system O&S cost analysis. Other reports will deal with aircraft and combat vehicle cost reviews and estimating procedures.

ACKNOWLEDGMENTS

Peter Wroblewski, a former member of the LMI research staff, contributed substantially to the development of these guidelines and the initial preparation of the report. The authors had the benefit of numerous constructive comments and reviews from persons in the Office of the Secretary of Defense, Navy Department, and LMI. At OASD(I&L)(WR), Russell Shorey, Edward Cresswell, and Alvin Frager had a fundamental role in planning and developing the study. As a member of the CAIG, Frank Swofford, ODP&E, was helpful in his review of content and structure. Particularly useful reviews were received from CAPT Joseph F. Anderson of the Navy's VAMOSC (Ships) Study Group; CAPT R. E. Helms, Jr., OP-964; LCDR Len Cheshire, OP-96D; and J. J. Genovese, NAVMAT-04. Within LMI, Hal Denny, James Boisseau, and William Fisher contributed many useful comments, and Margaret Grotte's editorial review was particularly beneficial. With full acknowledgment of the above, the authors take entire responsibility for the content of this report.

TABLE OF CONTENTS

		Page
PREFACE		ii
ACKNOWLEDGMENTS		iv
LIST OF TABLES		vii
LIST OF FIGURES		vii
I.	INTRODUCTION	1
	A. Purpose	1
	B. Authority and References	1
	C. Applicability	2
	D. Overview	3
II.	THE DSARC PROCESS AND COST REQUIREMENTS	5
	A. Introduction	5
	B. The DSARC Process	5
	C. Requirements for Cost Information	8
III.	BASIC METHODOLOGY FOR SHIP SI AND O&S COST ANALYSIS	11
	A. Introduction	11
	B. Cost Perspective	11
	C. Cost Analysis Methodology	12
IV.	THE COST ELEMENT STRUCTURE	27
	A. Introduction	27
	B. Significant Cost Elements	31
	C. Data Considerations	33
	D. Costs Not Included in the SI and O&S Cost Analysis	33
V.	OPERATING AND SUPPORT REQUIREMENTS ANALYSIS	35
	A. Introduction	35
	B. Significant O&SR Cost Elements	35
	C. Objectives	36
	D. Categories	37
	E. Computation and Policy Adjustment	37
	F. Interpretation	40

TABLE OF CONTENTS (Continued)

VI. PRESENTATION REQUIREMENTS, FORMATS AND DOCUMENTATION 41

A. Introduction 41
B. Tailoring the Analysis and Presentation 41
C. Objectives of the Cost Analysis 41
D. Cost Summary Requirements 42
E. Selective Cost Analysis and Presentations 45
F. Cost Analysis Backup Material 46

APPENDICES:

A. COST ELEMENT DEFINITIONS FOR SHIPS
B. BASIC OUTLINE OF A SYSTEM PROGRAM DEFINITION STATEMENT FOR SHIPS
C. COMPATIBILITY WITH OTHER O&S COST ELEMENT STRUCTURES
D. SELECTED REFERENCES
E. GLOSSARY
F. ABBREVIATIONS

LIST OF TABLES

Table		Page
1	Ship Life Cycle Cost Categories	11
2	Ships Summary Cost Element Structure	28
3	Collateral CES	29
4	Significant O&S Cost Elements for Escort-Type Ships	32
A-1	Life Cycle Cost Element Structure	A-2

LIST OF FIGURES

Figure		Page
1	Ship Life Cycle	7
2	Basic Cost Analysis Methodology	13
C-1	Relationship of Ship O&S CES to Aircraft O&S CES	C-5
C-2	Relationship of LMI Ship O&S CES to VAMOSC Ship CES . . .	C-7
C-3	Relationship of LMI Ship O&S CES to Navy Program Factors Ship CES	C-9

I. INTRODUCTION

A. PURPOSE

This report recommends guidelines for preparing estimates of the support investment (SI) and operating and support (O&S) costs of ship acquisition programs and presenting them to the Defense Systems Acquisition Review Council (DSARC). It provides a framework for objective comparison of SI and O&S costs of program, design, or support alternatives, using consistent methodologies and terminology. A general methodology for SI and O&S cost estimating is described, a standard cost element structure for ships is defined, and specific requirements for presentation of SI and O&S cost estimates to the DSARC are proposed. Standards for the presentation and documentation of these cost estimates are also recommended.

These guidelines are intended to achieve consistent and effective preparation and documentation of SI and O&S cost estimates for major weapon systems, and to facilitate the DSARC's and the Cost Analysis Improvement Group (CAIG)'s examination of important SI and O&S cost issues. They should be understood as recommendations to the CAIG—a contribution to the preparation of an official CAIG O&S cost development guide for ships.

B. AUTHORITY AND REFERENCES

The basis for development and review of life cycle cost (LCC) estimates within the DSARC process is set forth in Department of Defense Directive (DoDD) 5000.2, "Major System Acquisition Process." The directive requires the establishment of cost parameters for major defense system acquisitions that reflect the cost of acquisition and ownership as separate cost elements and translated into firm design-to-cost and life cycle cost requirements. The DSARC's review and confirmation of LCC estimates are thus implied.

Within the concept of design-to-cost, the DoD intends that LCC objectives should be determined for each acquisition program. Although the initial design-to-cost goals were directed towards minimizing unit production costs, the reduction of future SI and O&S costs during design and development should also be an objective. Recent DoD guidance calls for the Military Departments to establish O&S cost targets for weapon systems in development, and to monitor progress towards those targets. The importance of evaluating the SI and O&S costs of new systems is recognized throughout the DoD, and implementation of methods to evaluate LCC impacts is a major element of the DSARC process.[1]

The CAIG advises the DSARC on all methods relating to weapon system cost analysis and is specifically responsible for

- Establishing criteria, standards, and procedures concerning cost estimates
- Determining what costs are relevant for consideration by the DSARC

Using the guidelines recommended in this report, the CAIG intends to establish general criteria, standards, and procedures for the preparation and presentation of cost estimates of major weapon systems for DSARC review and consideration.

C. APPLICABILITY

The guidelines recommended in this report were developed for the cost analysis of surface combatant ship acquisition programs. They are generally appropriate for other surface ships, such as auxiliaries and amphibious ships, and can be applied to submarine and aircraft carrier acquisition programs as well. For example, the cost element structure contained in these guidelines clearly applies to the non-aeronautical portion of aircraft carrier SI and O&S costs, but special problems concerning air wing/ship integration are not covered by this report.

These guidelines call for cost estimates reflecting costs that are variable with respect to acquisition program decisions; hence, the estimates are not the same as total

[1]See Appendix D for selected references which establish the need for SI and O&S cost estimates.

program or budget costs, and provide only a part of the information needed for budget impact analysis. These recommended guidelines are designed to allow the cost analyst freedom in selecting cost-estimating techniques and models, and to satisfy the institutional requirements for standard conventions and minimum requirements.

D. OVERVIEW

Sections II-VI present the DSARC requirements and a structure for ship SI and O&S cost analyses and presentations,as follows:

- Section II briefly reviews the DSARC process and the type of information needed for analysis and review of ship acquisition programs.
- Section III presents the basic methodology for performing ship SI and O&S cost analysis, describes the role of each major component, and establishes certain cost-estimating principles. The use of variable costs, pre-DSARC meetings, reference systems, system program definition statements, the application of the cost element structure, and the presentation of the results are emphasized.
- Section IV recommends the cost element structure (CES) to be used in the SI and O&S cost analysis of ships. The CES defines and categorizes those costs typically affected by DSARC decisions. The set of significant cost elements that should be central to any cost analysis effort is also identified.
- Section V discusses operating and support requirements (O&SR) analysis, which addresses trade-offs between design parameters and costs for resources associated with ship maintenance and operational manning. The O&SR analysis isolates the resource requirements related to system or design-inherent characteristics, and O&S or manning policies.
- Section VI describes the DSARC presentation requirements as a function of various uncertainties in the DSARC process, the status of the ship design, and the SI and O&S cost analysis issues under consideration.

II. THE DSARC PROCESS AND COST REQUIREMENTS

A. INTRODUCTION

DoDD 5000.1 places the responsibility for development and acquisition of major defense systems on the Military Departments and Defense Agencies. Decisions that initiate or increase program commitments are reserved for the Secretary of Defense (SecDef).

The principal mechanism for focusing DoD management attention on a major system acquisition program is the DSARC/DCP process. The DSARC is an advisory body to the SecDef, composed of the Director of Defense Research and Engineering and designated Assistant Secretaries of Defense. The DSARC reviews acquisition programs and provides recommendations for SecDef decisions. The essential program information (e.g., needs, goals, schedules, costs, and risks) and the SecDef decisions are recorded in the Decision Coordinating Paper (DCP). The DCP is frequently referred to as a contract between the SecDef and the proponent Military Department or Defense Agency.

B. THE DSARC PROCESS

The DSARC's review of a proposed ship program must encompass the entire spectrum of considerations involved in a decision by the SecDef on so major an acquisition. The considerations can be grouped into the following broad categories:

- The validity and importance of the missions to be accomplished by the proposed ship programs
- The suitability of proposed ships for accomplishing these missions
- The technological and production risks associated with development of proposed candidate ship configurations
- The affordability of the proposed ship program, from the viewpoint of both acquisition and out-year O&S costs, including significant trade-offs between cost

PRECEDING PAGE BLANK-NOT FILMED

and performance of alternative configurations, support policy and acquisition strategies

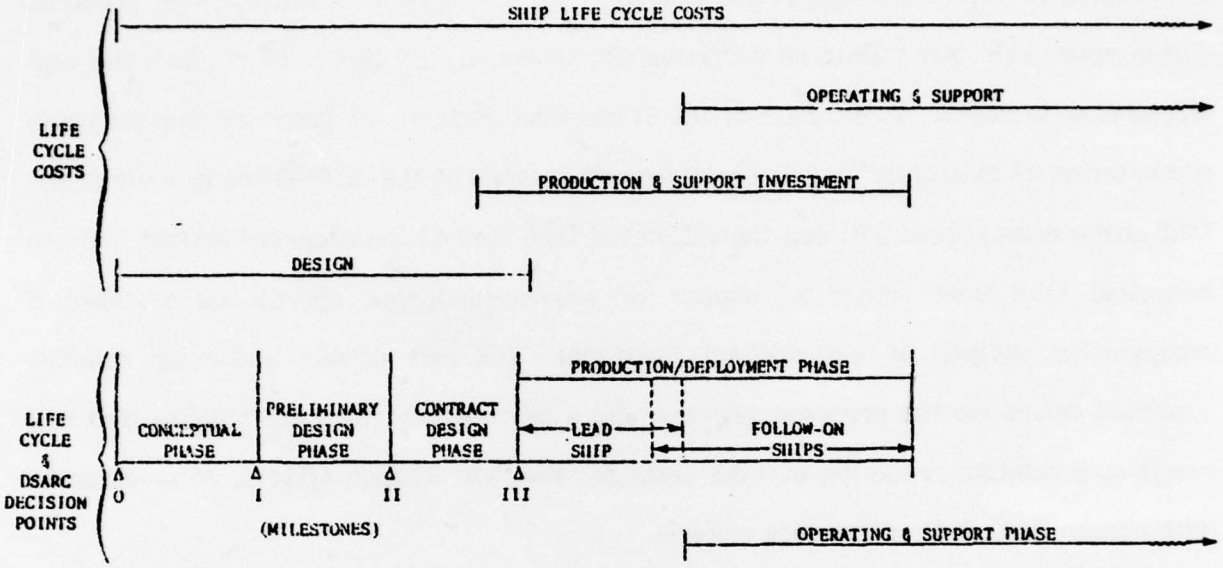
Strategic, operations research, and engineering studies, as well as military judgment, provide primary inputs to the DSARC's review of mission essentiality, ship suitability and developmental risk. However, in order to arrive at a balanced determination as to program initiation or continuation, it obviously is necessary to consider the resource requirement implications of all major issues. Thus, determination of affordability is an integral part of all DSARC deliberations, which involves consideration of logistic goals and estimated costs of ownership as well as acquisition costs.

The DSARC's cost considerations of ship acquisition programs is similar to the procedure followed for other major weapon systems in that it is based on a concept of sequential reviews at key points in the developmental process. At a minimum, these cost reviews consist of: Milestone I for program initiation, Milestone II for full-scale engineering development, and Milestone III for the production/deployment determination.

However, ships are considerably larger and usually more complex than other defense systems. Ships typically involve the combination of many separately developed and tested subsystems into an integrated configuration. Normally it is impracticable to develop and test competitive prototype ships during the preliminary design phase initiated by the Milestone I decision. The successive DSARC reviews of proposed ship acquisitions, therefore, have been tailored to coordinate them with the development cycle for ships illustrated in Figure 1.

The O&S phase of a ship's life starts with deployment of the first operational units, years after the DSARC/DCP process has been completed. Yet the major determinants of O&S costs are the decisions made during the DSARC/DCP process. DoD requires analysis of such outyear costs during development, design and procurement, with the objective of reducing the fraction of its budget allocated to the operation and support of ships.

FIGURE 1. SHIP LIFE CYCLE



Consequently, an analysis of SI and O&S costs is required at each major decision milestone to assist the DSARC in verifying that:

- DoD can afford to operate and support the proposed ship once it is in the defense inventory
- Future O&S costs have been adequately considered in the selection of the proposed ship
- O&S costs of the proposed ship compare favorably with those of existing similar ships
- Positive action to reduce SI and O&S costs has been initiated in the system design and in the development of support concepts
- Relevant historical O&S cost drivers have been explicitly considered in the design of the new system
- Significant trade-offs between cost and performance of alternative designs, support concepts, and acquisition strategies have been taken into account

C. REQUIREMENTS FOR COST INFORMATION

Fundamental DSARC requirements for SI and O&S cost information are generated by DoD's need to verify that the proposed ship is being designed, developed, and procured within reasonable constraints on performance, schedule, and LCC. In general, the cost information includes: an estimate of the SI and O&S costs of the proposed ship program; presentation of clearly defined alternatives and analysis of the differences in their SI and O&S costs; comparisons between the estimated O&S cost of the proposed system and the historical O&S cost trends of similar or mission-analogous operational systems; a comparative analysis of the relevant historical O&S cost drivers and their relative expected values for the proposed systems; and a discussion of the O&S policies that will result in a relative reduction of O&S costs for the new weapon system, commensurate with overall LCC and performance criteria.

The nature of the cost estimates and cost comparisons depends on the phase of the acquisition program and the specific issues involved. At program initiation (Milestone I) little about the detailed design of the proposed ship is likely to be known. However, the affordability of a program must be judged, alternatives must be compared, and goals must first be established at this formative stage. The most significant impacts on SI and O&S costs can be achieved at Milestone I. Initial SI and O&S cost estimates should be made for each proposed ship under consideration, and for the existing similar or mission-analogous system. Such estimates should reflect system and support concepts, mission requirements, and anticipated deployment patterns.

Prior to the commencement of contract design (Milestone II), SI and O&S cost estimates and comparisons ought to reflect the increased accuracy commensurate with the more fully developed configurations and support concepts for the proposed ship. By Milestone II, those subsystems most likely to influence SI and O&S costs, and those whose development is most uncertain, should be identified. Logistics goals need to be established for these critical subsystems and the sensitivity of SI and O&S costs to such goals evaluated.

The SI and O&S cost estimates prepared for Milestone III should be based on the current design characteristics of the proposed ship, the schedule for introducing it into the operating forces, and the plans for its support. The critical subsystems and associated logistics goals established prior to engineering development must be validated. To the extent feasible, experience from the test and evaluation program should be used to verify progress in meeting logistics goals, or to signal potential problem areas. When goals cannot be met, program alternatives and their impacts on O&S costs should be defined, evaluated, and presented to the DSARC.

III. BASIC METHODOLOGY FOR SHIP SI AND O&S COST ANALYSIS

A. INTRODUCTION

Section III presents a set of methodological principles and conventions to promote consistent SI and O&S cost analysis. The essential components of the process for developing and presenting such analyses to the DSARC are specified.

B. COST PERSPECTIVE

1. Cost Categories of Interest

The major LCC categories for a ship are outlined in Table 1. These recommended guidelines address only the SI and O&S categories, with the primary focus on O&S costs. Individual cost elements in the SI and O&S categories are presented in Section IV and defined in Appendix A.

TABLE 1. SHIP LIFE CYCLE COST CATEGORIES

100 RESEARCH AND DEVELOPMENT

200 INVESTMENT

- 201 System Investment
- 202 Conversions and Modernizations
- 205 Support Investment

300 OPERATING AND SUPPORT

- 301 Direct Unit
- 302 Direct Intermediate Maintenance
- 303 Depot Maintenance
- 304 Depot Supply
- 305 Second Destination Transportation
- 306 Personnel Support and Training
- 307 Sustaining Investments

2. Relevant Variable Costs

The cost analysis methodology in these recommended guidelines centers upon the major weapon system acquisition programs reviewed by the DSARC. Accordingly, the

PRECEDING PAGE BLANK-NOT FILMED

costs of interest are those that can be affected by OSD and Military Department actions during the DSARC process: the relevant variable costs.

The objective is to specify all relevant variable SI and O&S costs to the Government regardless of how such costs are funded. The O&S cost categories reflect the recurring outlays required to operate and support the ship to achieve the desired capability over a specific operational lifetime.

The set of SI and O&S categories is intended to be a comprehensive definition of the relevant variable costs for the DSARC. However, future analyses are bound to introduce circumstances in which additional costs will be relevant. To cover those possibilities, the following rule should be applied:

> IF A DECISION WILL AFFECT COSTS NOT DESCRIBED EXPLICITLY BY THESE GUIDELINES, SUCH COSTS MUST BE IDENTIFIED, THEIR MAGNITUDES ESTIMATED, AND THEY MUST BE INCLUDED IN THE COST ANALYSIS.

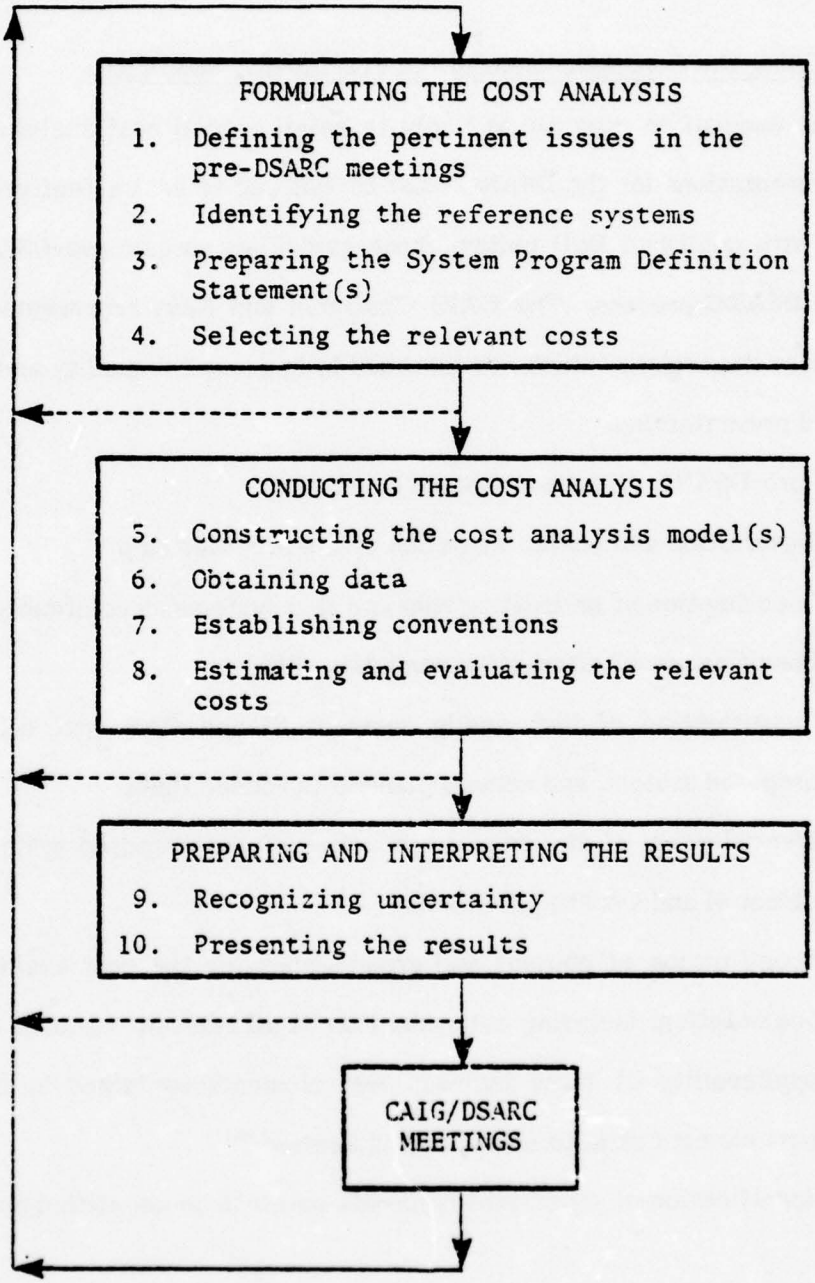
3. Relationship to Planning, Programming, and Budgeting

Cost estimates used for planning, programming and budgeting address total costs. Because the cost analysis called for in these proposed guidelines pertains only to those portions of total costs that are variable with the acquisition of a new ship class, the estimated SI and O&S costs will not necessarily be the same as program or budget costs. However, the information gained from these SI and O&S cost analyses should be compatible with approved Planning, Programming and Budgeting System (PPBS) costs and can be used to derive the impact on programs and budgets.

C. COST ANALYSIS METHODOLOGY

Figure 2 outlines the basic cost analysis methodology for these suggested guidelines. The development and presentation of the cost analysis involves ten fundamental steps, organized into three groups. The major headings state the themes of the steps within each

FIGURE 2. BASIC COST ANALYSIS METHODOLOGY



group. The arrows indicate the necessity for repeating individual steps and groups of steps to refine perception and assessment of critical issues. Most of the steps are standard components of systematic cost analyses, and should be familiar to experienced cost analysts.[2]

1. Defining the Pertinent Issues in the Pre-DSARC Meetings

Each acquisition program is likely to entail special cost analysis issues. The analyses and presentations for the DSARC must be tailored to deal effectively with them. In accordance with published DoD policy, these guidelines assume pre-DSARC meetings throughout the DSARC process. The CAIG Chairman and Navy representatives are the principals in these discussions, which are intended to improve the quality and relevance of the analyses and presentations.

The pre-DSARC discussions should cover the:

- Description and characterization of the proposed ship
- Specification of an existing ship and ship systems as reference systems
- Specification of alternative candidate ships
- Identification of historically relevant SI and O&S cost drivers for the proposed system, and actions planned to reduce them
- Identification of the unique properties of the proposed system that could affect SI and O&S requirements
- Specification of content and ground rules for the cost evaluation and its presentation, including determination of all relevant variable costs and the applicability of those indirect cost elements contained in the collateral cost element structure set forth in Section-IV
- Specification of significant trade-off issues to be quantified and presented

[2]See Appendix D for selected references on systems and cost analysis.

2. Identifying the Reference Systems

a. The Reference Ship

To provide the required contemporary baseline against which to compare the costs of a proposed ship class, a reference ship must be identified. A reference ship is an existing operational ship having a mission similar or analogous to that of the proposed ship class. Frequently, the ship to be replaced is the reference ship, unless another existing ship provides a better point of reference for the cost analysis. For example, for the LSD 28 Class replacement, the reference ship might be an LPH or LPD rather than an LSD, if there were emphasis on vertical assault capability in the proposed ship. The Chairman of the CAIG and the Navy's representative should jointly select the reference ship prior to Milestone I.

b. Benchmark Subsystems

A proposed ship's O&S costs are not simply the sum of the costs of its subsystems. Certain costs (e.g., hotel services) are not directly allocable to subsystems, or have requirements that combine in a non-linear fashion. For example, manpower costs for a ship as a whole might be 10-20% lower than the aggregate of subsystem requirements because of cross-utilization of personnel (e.g., personnel with administrative support ratings standing CIC watches). However, cost estimates for proposed ship acquisitions should be developed to the extent feasible in terms of the costs of their subsystems. The preferred method is to use benchmarks, which are defined as operational subsystems similar to those proposed for candidate ship configurations. Benchmark subsystem cost experiences can be applied to the candidate ship subsystems through standard cost–estimating techniques, such as direct analogy, scaling, the development of cost–estimating relationships (e.g., parametrics) or engineering analysis.

3. Preparing the System Program Definition Statement (SPDS)

A prerequisite to the development of useful SI and O&S cost estimates for

proposed ship programs is a detailed definition of the weapon system program. The SPDS satisfies this need by:

- Reflecting how the Navy will use and support the ship class
- Supplying the essential assumptions and information for the cost estimates submitted
- Providing historical data on the evolution of the design of the ship and corresponding SI and O&S cost estimates from the beginning to the completion of the DSARC process
- Establishing a basis for critical review of mission requirements and how well the proposed system design and support concept will satisfy them
- Highlighting the design areas with high technological risks and cost uncertainty

In particular, the SPDS includes descriptions of the ship's mission, physical characteristics, manning, maintenance and support policies, and acquisition policy. The SPDS effectively augments the Decision Coordinating Paper (DCP) by providing additional basic assumptions for the cost analysis. A basic outline of a SPDS for ships is presented in Appendix B. The SPDS can also reference selected information in the backup material that documents the cost estimates.

The substance and detail of the SPDS depend on the phase of the acquisition program, and must be tailored to the O&S issues. At each pre-DSARC meeting, the specific content of the SPDS should be reviewed to ensure responsiveness to the pending DSARC milestone. The SPDS for Milestone I will generally be less extensive than for subsequent Milestones. As the acquisition program progresses, however, the SPDS must be expanded to reflect the progressive refinement of the ship design and support plans. Detailed analysis below the initial system or top-level cost estimates will be required, for example. The SPDS will then have to furnish such information as a detailed O&S scenario to allow proper interpretation of the cost estimates.

The SPDS is a dynamic document, changing as many initial expectations about ship design and support change during the acquisition program. Changes to the SPDS must therefore be made explicit. The original SPDS, presented at Milestone I, should be retained as a baseline, and the revised SPDS should be annotated at subsequent Milestone reviews to identify changes. The DSARC and CAIG would then know that a premise of the initial O&S cost estimate had changed, and they would have to determine if the impact was significant.

4. Selecting the Relevant Costs

A cost element structure (CES) establishes a standard vocabulary for identifying and classifying the variable costs relevant to a weapon system program. The cost categories that make up the first and second echelons of the recommended CES were shown in Table 1. The complete ship CES is discussed in Section IV, and the cost element definitions are given in Appendix A.

At Step 4 of the cost analysis, the CES is applied to the acquisition program under consideration. A check is required to determine if all the relevant variable costs are represented and defined in a manner compatible with the cost analysis. Deviations from the recommended CES must be approved jointly by the Navy and the CAIG prior to their use in the analysis for the DSARC.

5. Constructing the Cost Analysis Model

Specific models for calculating SI and O&S costs are not prescribed in these guidelines. There are several acceptable ways of generating SI and O&S cost estimates, and no one approach is best for all situations. In general, the problem context and cost analysis considerations determine the estimating process selected. The problem context includes the phase of the acquisition program, the decisions to be made, and the accuracy and resolution required in the estimate. The cost analysis considerations are the resources available for the task: time, data, methodology and manpower. A point of reference for the total cost estimate should be provided, along with visibility of key SI and O&S cost driver subsystems and policies, and an assessment of actions to reduce their impact.

The following criteria are useful for comparing and selecting cost-estimating models:

- Decisions involving trade-offs must use techniques that emphasize cost differences between alternatives; affordability estimates used as inputs to budget impact analysis may utilize macro techniques that emphasize a system-level perspective.
- For trade-off or program decisions, the cost-estimating technique must provide the accuracy required to distinguish the relative cost consequences of the alternatives. Such accuracy is a function of the design maturity of the system or subsystem, the cost consequences of the decision, and the data and time available for making the decision. The amount of detail and the expected degree of accuracy of cost estimates to be provided at each DSARC are to be reviewed explicitly in the pre-DSARC meetings.
- The estimating techniques must reflect the SI and O&S costs as a function of the ship's characteristics, operating profile, and program level considerations. Such considerations come into play, for instance, if alternative ship programs assume different numbers of ships to perform a given mission.
- The cost models must provide subsystem visibility by associating relevant costs to subsystems, and must be sensitive to specific subsystem characteristics and differences between alternatives.
- The cost-estimating model should, where feasible, be the same when alternatives at similar stages of development are being compared. This is to ensure that differences between cost estimates of alternatives are a result of differences in the actual alternatives, and not in the cost-estimating approaches. When the cost-estimating approach is changed,

information about the resultant cost differences must be provided. However, when conceptual systems are compared with prototype systems or operational systems, different cost-estimating approaches may be used.

6. Obtaining Data

In the context of these guidelines, data are facts or assumptions about the ship's characteristics, the way it is operated and supported, and the costs or essential resources (i.e., fuel, manpower, spare parts, etc.) associated with it. The SPDS, combined with the DCP, is one source of essential data for the preparation of an SI and O&S cost estimate. For these guidelines, data about both proposed and existing ships are needed.

For proposed ships, the Navy and the participating contractors will be the principal data sources. The Navy will be the principal data source for existing ships. Much of the data required for O&S cost analysis is currently abstracted (in reports or as planning and cost factors or rates) or will soon be available from the Navy's VAMOSC (Ships) implementation efforts. These data will provide a basis for both the estimation of O&S costs and an assessment of the predominant cost driver subsystems and elements. Of particular interest are data that could be used to establish cost reduction targets in the design and support concepts for the new system. When there is an insufficiency of data of the quality desired, the effect on the cost analysis and its results should be documented.

7. Establishing Conventions

Conventions for consistency in cost-estimating are presented below. They should be followed in all ship cost analyses for the DSARC, unless the CAIG Chairman and the Navy representative agree beforehand that a deviation would better serve the need for clarity. Any such deviations should be documented.

a. The Normative Approach to Cost Estimating

These recommended guidelines focus on the relevant variable costs that should be incurred by a specific weapon system under the O&S conditions specified in the

SPDS; they are not designed to estimate future budget expenditures directly. The difference is important. An estimate of actual expenditures presumes the ability to predict how institutions that control resource allocation and expenditures will behave. The normative approach used here attempts only to estimate what the future variable resource requirements should be, given certain assumptions about the characteristics of the ship, the tactical doctrine for deployment, the support policies, the intensity of operations, and so on.

The normative approach requires more than a projection of historical cost trends. The cost-estimating model must provide a logical link between the assumptions about the ship and the O&S conditions in the SPDS, and the resulting cost estimate. These cause-effect relationships are crucial. If the SPDS is changed, either the cost estimate should change, or the lack of change should be explained.

The normative approach applies to an existing ship used as a reference ship, as well as to alternatives for an acquisition program. Insofar as practical, the assumptions and cost-estimating methods should be the same for both the reference ship and proposed candidate ships. Differences in O&S conditions (e.g., level of support, operating intensity, manning policies, etc.), must not obscure differences in ship characteristics affecting O&S resource needs.

b. Use of Constant Dollars

Future costs should be estimated in constant budget year dollars of the fiscal year following the calendar year of the cost estimate. For example, if an SI and O&S cost estimate is made during calendar year 1977, then the cost estimate should be presented in fiscal year 1978 constant dollars. Adjustments for discounting and/or inflation can be presented in a separate analysis, when agreed upon in a pre-DSARC meeting.

c. Mature System Assumptions

The O&S characteristics of a weapon system change throughout its lifetime. As the weapon system matures, O&S requirements should approach a level more

indicative of its design characteristics than was the case earlier in its development. When estimating annual O&S costs, a mature ship should be assumed. The mature ship characteristics are those that are most likely to be experienced and might not always be the same as the design goals.

However, when developing a time-phased estimate, not only the rate at which new ships will be added to the fleet ought to be considered, but also the rate of expected maturation. Different maturation rates are particularly significant when alternatives that differ markedly in their use of common subsystems are compared, as well as in the efforts devoted to finding and correcting design or support weaknesses, in the support strategies for the early years in the systems' lives, and in the rates at which operating experience is gained.

d. Personnel Costs

Military and civilian personnel costs are the largest component of weapon system O&S costs. The treatment of personnel costs is therefore central to the DSARC decision process. When conducting O&S cost analyses for DSARC/CAIG review, the Military Departments will use the military and civilian personnel pay and allowances rates published in DoD's Five Year Defense Plan (FYDP) for estimating the costs of manpower (retirement costs are excluded). For example, if the analysis is to be done in constant FY 77 dollars, the January FYDP pay rates will be used.

In addition to the above standard personnel cost perspective, there are times when the use of marginal economic costs of military and civilian personnel are relevant to the DSARC/CAIG review. Examples are selected capital-labor trades and organic versus contractor repair comparisons in which retirement cost considerations can be relevant. In those cases, and in response to a specific request by the CAIG, the Military Departments will submit separate cost analyses reflecting the pertinent personnel economic costs.

e. Capital Investment Lead Time Considerations

Requirements for support investment items (e.g., support equipment, facilities, repairable spares) are determined by the mission scenario, buildup schedule, workload, etc. When these requirements are interpreted in terms of budget appropriations, explicit procurement lead time allowances must be incorporated.

For the constant year dollar estimates called for by these guidelines, the aggregated sum of the support investments will be the same, regardless of whether or not lead time allowances are incorporated. However, presentations of time-phased costs, even if in constant year dollars, are sensitive to the lead time assumptions for the investment. The time-phased cost estimates should be reflected for those years when the appropriation would most likely be made.

8. Estimating and Evaluating the Relevant Costs

The analysis of O&S costs during the DSARC review is vital to the selection, improvement, and control of design, development, and support concepts for the proposed weapon system. The purposes of the O&S cost analyses recommended here are: first, to explore and quantify the relative advantages of different concepts (for example, the comparison of new and old systems, alternative support policies, etc.); and, second, to provide a means of estimating the impact of O&S costs upon affordability and force structure planning. A fundamental consideration in the DSARC process is that the proposed ship satisfy its mission requirements at the lowest O&S costs commensurate with overall LCC and performance criteria. DoD policy requires analysis of outyear costs during development, design, and procurement, with the objective of reducing future allocations for such operation and support.

The cost analysis and its formulation (e.g., parametrics, scaling, etc.) needed for a specific program review will depend on the characteristics of the ship, the stage of the acquisition program, and the issues concerning the DSARC. Several types of analysis are frequently required.

a. Cost Analysis

Cost analysis is used to determine the full set of relevant variable costs and how they compare between the reference system and program alternatives. The analysis places the cost estimate(s) in perspective, and explains why the proposed ship is expected to require the O&S resources estimated.

b. Trade-Off Analyses

Trade-off analyses are used to explore cause-effect relationships between costs and changes in design or support concepts. A special kind of trade-off analysis, operating and support requirements (O&SR) analysis, is recommended here. O&SR analyses are directed toward such issues as the effects of design characteristics and support policies on maintenance costs and of ship system performance on manpower costs. They are often significant in the selection of subsystems, evaluation of support policies, and establishment of O&S goals. Section V of this report discusses O&SR analysis and its relationship to total system O&S cost analysis.

c. Sensitivity Analysis

Sensitivity analysis is used to identify aspects of the acquisition program important in controlling O&S costs. It can influence such activities as establishing O&S goals and determining test and evaluation requirements.

A special case of sensitivity analysis is the assessment of demand-driven uncertainty. Such analyses explore the impact on O&S costs of varying the assumptions of a cost estimate, the characteristics of the ship, or the support policies, over a range of likely values. Technical uncertainties are often analyzed in this manner.

d. Statistical and Budget Uncertainty Analysis

Statistical and budget uncertainty analysis is used to interpret and present the uncertainties inherent in the particular cost model and its application (technical, demand, statistical and budget assumptions), and their meaning for the program budget.

e. Trend Analysis

Trend analysis is used to compare the proposed ship with its historical counterparts. Of particular interest are: comparisons of hardware subsystems, design, characteristics, and support policies and procedures that have historically dominated O&S costs; extent of departure from historical practices; and actions planned to reduce the consumption of O&S resources. Historical trends for the ship class (including the reference system) can be used to establish O&S bounds and goals for selected characteristics of the proposed system. For each significant cost element, the principal cost drivers can be classified by:

- Hardware subsystems (e.g., armament, propulsion, command and surveillance, etc.)
- Design characteristics of the subsystems (e.g., limited modularity, poor fault diagnosis accuracy, etc.)
- Support policy and procedures (e.g., level of repair decision, etc.)

Each historical cost driver thus identified should be accompanied by an explanation of whether or not the problem is expected to occur in the proposed ship, and the actions necessary to control and/or reduce the future requirements for the proposed ship. The trend analysis can then be used to establish bounds within which the characteristics of the proposed ship would be considered normal, and to establish goals for reduction of O&S requirements.

9. Recognizing Uncertainty

Estimates of future O&S costs are beset by uncertainties from many sources:

- Quality of data available
- Methods used to estimate costs
- Decisions yet to be made about design or utilization
- Changes in the scope of the acquisition program (e.g., quantities, costs, or schedule)

- Technical or technological problems encountered during development
- O&S environment
- Characteristics that will become evident only after years of operational experience

No O&S cost analysis can consider all these uncertainties. Nor does it need to. Many variables in an O&S cost estimate can be treated deterministically, as long as the explicit assumptions made about their values are reasonable, and the impact of changes has been explored through parametric comparisons. For example, mission and steaming profiles are variables with significant impacts on O&S cost. Yet, unless these factors are an issue in the DSARC review, O&S cost estimates can reasonably be based on the profiles set forth in the SPDS.

Certain aspects of uncertainty must be communicated to the DSARC under all circumstances. First, the DSARC must be apprised of the major risks of the acquisition program, their likely impact on O&S costs, and feasible alternatives for reducing them. For example, an O&S cost estimate is sensitive to the manpower requirements of the ship and of selected critical subsystems. If meeting these requirements appears doubtful during the development phase, the cost impact of changes in crew size on O&S and acquisition costs should be investigated and, if significant, presented to the DSARC.

Second, the DSARC needs to know the effect of uncertainty upon the relative merits of alternatives. If the current O&S estimates are too uncertain to be the basis of comparison, the DSARC may either have to use some other parameter (e.g., acquisition cost) or defer action until the O&S uncertainties can be resolved. It is essential, therefore, that presentations quantify the degree of uncertainty associated with cost estimates, whenever practicable.

Presentation formats should provide a quantitative range for the estimate. Use of a range is a simple means of showing the uncertainty attributable to a point estimate. When a range is used, backup material should include an explanation of the

method used to establish the bounds of the range. When quantification of uncertainty proves infeasible, a qualitative assessment of the estimate should be made.

10. Presenting the Results

The goals for cost presentations are twofold: to present timely and relevant results, and to place them in proper perspective. A discussion of the presentation of the relevant variable costs for ships is given in Section VI.

Different types of presentation may be required to highlight the cost consequences of various issues before the DSARC, such as subsystem trade-offs or operating and support requirements analysis. The presentation requirements described in Section VI should be augmented with selective displays to present the results of cost analyses specifically requested by the CAIG/DSARC. There must be a logical consistency underlying all the presentations throughout the DSARC process to insure that the outputs and trend data generated in the cost analysis can be tracked between the DSARC milestones.

IV. THE COST ELEMENT STRUCTURE

A. INTRODUCTION

1. General Description

This standard cost element structure (CES) defines the O&S functions and resource categories affected by the acquisition program. It promotes consistency in the computation and display of costs, and helps the DSARC concentrate upon those decisions having the greatest impact on future O&S resource needs. The CES includes elements for investments that facilitate the operating and support of the ship class. Most analyses that address the O&S cost impact of alternatives must also address the impacts on those support investment costs.

The structure is designed for the DSARC's needs when reviewing ship acquisition programs, and not for accounting purposes. The relevant variable costs defined do, however, provide useful information for force structure or budget analysis.

2. Basic CES

The basic CES for ships is summarized in Table 2 and fully defined in Appendix A. The basic CES covers those SI and O&S cost elements that normally will be considered as variable in a ship acquisition program. The hierarchical numbering scheme used for the CES is designed to accommodate cost breakouts at such level of detail as may be required for the particular trade-off analysis under consideration.

3. Collateral CES

The collateral CES, as set forth in Table 3 and defined in Appendix A, covers those indirect support costs that may be considered as variable indirect support in some acquisition programs or fixed in others. The operating cost of intermediate maintenance facilities provides an example. In many cases, those costs cannot be allocated accurately to particular ships, but are properly considered as an element of Navy overhead. When

TABLE 2. SHIPS SUMMARY COST ELEMENT STRUCTURE

100 RESEARCH, DEVELOPMENT TEST, AND EVALUATION

200 INVESTMENT

- 201 System Investment
  - 201.1 Sailaway Cost
  - 201.2 Project Management
  - 201.3 Performance Modifications
- 202 Conversions and Modernizations
  - 202.1 Sailaway Cost
  - 202.2 Project Management
- 203 Unassigned
- 204 Unassigned
- 205 Support Investment
  - 205.1 Support Equipment
  - 205.2 Training
  - 205.3 Documentation and Software
  - 205.4 Facilities
  - 205.5 Initial Spares and Repair Parts
  - 205.6 Other Investment

300 OPERATING AND SUPPORT

- 301 Direct Unit
  - 301.1 Personnel
  - 301.2 Material
- 302 Direct Intermediate Maintenance
  - 302.1 Tenders and Repair Ships
  - 302.2 Ashore IMA

300 OPERATING AND SUPPORT (Continued)

- 303 Depot Maintenance
  - 303.1 Regular Ship Overhaul
  - 303.2 Non-Scheduled Ship Repair
  - 303.3 Fleet Modernization Program
  - 303.4 Recore
  - 303.5 Selected Restricted Availability
  - 303.6 Repairable Component Repair
- 304 Depot Supply
  - 304.1 General Support
  - 304.2 Engineering and Technical Services
- 305 Second Destination Transportation
- 306 Personnel Support and Training
  - 306.1 Individual Training
  - 306.2 Health Care
  - 306.3 Personnel Activities
  - 306.4 Personnel Support
- 307 Sustaining Investments
  - 307.1 Replenishment Spares
  - 307.2 Special Program Material
  - 307.3 Training Expendable Stores

TABLE 3. COLLATERAL CES*

400 ASSOCIATED SYSTEMS

401 SUPPORT INVESTMENT

401.1 Mobile Logistic Support Force
401.2 Tenders and Repair Ships
401.3 Ashore IMA

402 OPERATING AND SUPPORT

402.1 Mobile Logistic Support Force
402.2 Tenders and Repair Ships
402.3 Ashore IMA
402.4 Embarked Systems

*Definitions of each of the elements of the collateral CES are contained in Appendix A immediately following the definitions of the basic CES.

requirements for additional or modified support facilities are generated primarily by a decision to acquire a new ship class, the acquisition and O&S costs of those facilities are properly chargeable to ships of that class.

The collateral CES also includes a provision for the costs of embarked systems, such as helicopters. When such systems are required to make the ship a complete weapon system, it is appropriate for DSARC purposes to account for the embarked system's O&S cost with the ship, even though such costs will be charged elsewhere in the planning, programming, and budgeting process.

4. Special Cost Elements

Two categories of cost require special treatment: alterations and mid-life conversions or modernizations.

a. Alterations

Modifications are made to commissioned naval ships on a continuing basis through the Fleet Modernization Program (FMP). Some of those changes are made to enhance military capabilities, and these should be accounted for in System Investment

under cost element 201.3. Other changes affect the safety, habitability, maintainability, or technical characteristics of the ship and should be accounted for in O&S cost elements 303.3 and 307.2. As a practical matter, however, a distinction among types of alterations may not be possible. In such cases, all indistinguishable alterations should be accounted for in O&S cost elements 303.3 and 307.2.

For new ship programs, it is clearly impossible to forecast or cost the specific alterations that could be made on a proposed ship. A continuing stream of alterations for all ship classes is considered normal, and it generates significant costs. The DSARC should be given an estimate of the likely magnitude of such costs for use in assessing overall budgetary impact. Accordingly, in the absence of better data, the average of the historical FMP installation and acquisition costs associated with the reference ship should be used for cost elements 303.3 and 307.2.

b. Conversions or Modernizations

In addition to alterations, ships frequently undergo a major conversion or modernization after they have been in service for some years. Such conversions or modernizations are a major element of total life cycle cost, and should be considered a System Investment rather than an O&S cost.

5. Compatibility with Other Cost Structures

This section discusses the compatibility of the ship CES with other relevant cost structures in the DoD. The subject is addressed first for the support investment cost category and then for the O&S cost category.

With respect to support investment, the CES presented in this report is virtually identical to the CES contained in Aircraft System Operating and Support Costs: Guidelines for Analysis. Also, with the exception of cost element 205.6 (Other Investment), the support investment cost elements are consistent with those reported in the Selected Acquisition Report (see DoDI 7000.3), and the Work Breakdown Structures for Defense Materiel Items (see DoDD 5010.20).

For the O&S cost category, the subject is more complicated. The cost structures presented in this report and in the report of recommended guidelines for aircraft are both based on the principle of relevant variable cost. As a result, these cost structures are basically compatible in cost coverage as well as cost element notation and definition. Still, it has not proven practicable to structure the O&S cost elements for aircraft and ships identically. The differences are discussed in Appendix C.

An important reason for the differences in these O&S cost structures stems from the unique nature of ships, the structure of the organizations for their operation and support, and the information systems developed along these organizational lines. The cost element structure presented in the Navy's Visibility and Management of Support Costs-Ships (VAMOSC) study report reflects such information systems. The O&S cost element structure presented in this report is basically compatible with the VAMOSC cost structure and also with the cost elements in the Navy Program Factors Manual. This compatibility supports an OSD objective to foster consistency in the cost analyses for the DSARC/CAIG and the Military Departments' O&S cost analysis of operational weapon systems. A discussion of the relationship between the recommended O&S CES and the structures in the VAMOSC study report and the Navy Program Factors Manual is presented in Appendix C.

B. SIGNIFICANT COST ELEMENTS

Not all cost elements require or deserve the same attention when developing cost estimates for a new ship. The greatest analytic effort should be devoted to those that account for a substantial part of the total SI and O&S costs, or can be affected by acquisition program decisions, or assist in distinguishing among alternatives.

For the support investment category, those cost elements normally deserving the greatest attention are 205.1 (Support Equipment) and 205.5 (Initial Spares and Repair Parts). For the O&S category, the major cost elements listed in Table 4 comprise the bulk (> 70%) of the annual O&S costs of an average escort-type ship. Maintenance supplies (for

TABLE 4. SIGNIFICANT O&S COST ELEMENTS FOR ESCORT-TYPE SHIPS

MAJOR COST ELEMENTS

301.1.1	Manpower
301.2.1	Fuel
303.1	Regular Ship Overhaul*
303.3	Fleet Modernization Program
303.4	Recore
303.5	Selected Restricted Availability*
303.6	Repairable Component Repair*
307.1	Replenishment Spares
307.2	Special Program Material
307.3	Training Expendable Stores
402.1	Mobile Logistic Support Force
402.2, 402.3	IMA O&S
402.4	Embarked Systems

OTHER SIGNIFICANT COSTS

301.2.2, 302.1.2, 302.2.2	Maintenance Supplies**

* Includes subordinate cost categories.
** At organizational & intermediate maintenance levels.

both organizational and intermediate levels of maintenance) have been added because of their direct relationship to reliability and maintainability issues. For each of these cost elements, cost estimates should reflect explicitly the characteristics of the ship and its operating and support philosophy.

Other cost elements not pertinent to distinguishing between alternatives can usually be addressed in a straightforward manner by using planning factors. For example, cost element 304.1 (General Support) is included in the structure to provide the DSARC with an appreciation of the full variable costs of operating and supporting the proposed ship. However, the magnitude of General Support costs usually is more a function of the Navy Department's doctrine for logistics organization and operation than a function of ship characteristics. The same rationale applies to 306.2 (Health Care). For the non-significant cost elements, planning factors should be used, unless there is a good reason to compare alternatives in greater detail.

C. DATA CONSIDERATIONS

Support investments involve one-time expenditures and vary widely in magnitude among different classes of ships. Such costs are highly dependent upon the particular characteristics of each ship class, and the training/maintenance support requirements resulting from those characteristics. These features of support investment have previously discouraged centralized collection of a historical cost data base. It is highly desirable that historical SI costs be collected systematically in the future, in order to provide the DSARC with a basis of comparison for new ship programs, and especially for benchmark subsystems. In the absence of historical data, SI costs may frequently have to be developed on the basis of engineering studies and analyses.

Data sources for O&S costs have not been specified in this report. Detailed information on the availability of historical data for O&S costs is contained in the Navy's VAMOSC (Ships) study report.

D. COSTS NOT INCLUDED IN THE SI AND O&S COST ANALYSIS

The underlying principle of the cost analyses called for by these guidelines is the inclusion of all variable SI and O&S costs associated with the proposed weapon system that are relevant to the decisons made during the DSARC process. The following costs are excluded:

1. Research and Development

   All RDT&E costs, including:

   - Research and development costs incurred in developing the production design of the new ship, ship subsystems and components, and ship support equipment
   - Costs associated with the test and evaluation of the new ship system through the end of the ship system acquisition process.

2. System Investment

   All ship system sailaway costs and investment costs (except those noted under cost category 205--Support Investment).

3. Base Headquarters and Services[3]

Costs of personnel and material primarily dependent on the existence of the base; they are considered to be fixed base costs, independent of the class of ship operating from the base, specifically, the personnel and material that either supervise or maintain activities pertaining to:

- Base facilities, such as building and road construction and repair, police and fire protection, trash and sewage disposal, and utility services
- Base personnel and dependents' standard of living, such as commissaries, exchanges, religious activities, and sports and entertainment facilities

4. Central Support Overhead

The cost of headquarters organizations that provide administrative guidance and oversee the operation of maintenance depots, supply depots, and training activities. These headquarters activities include, for example, the Naval Material Command and subordinate Systems Commands.

5. Command Structure Overhead

The costs of operational headquarters/commands and staffs above the ship level (e.g., task force, and fleet and type commands). Collectively, headquarters directly supervise the operation of the ships and provide overall policy formulation and administration.

6. Selected Non-Service Appropriated Funds

The cost of programs, such as family housing, not directly identifiable with a specific Navy appropriation.

---

[3]This BOS exclusion does not pertain to those activities where allocated portions of BOS costs are billed to customers as a part of overhead on funded job orders (e. g., depot maintenance activities, which are industrially funded, or contractor facilities where overhead costs are included in the price of a contract).

V. OPERATING AND SUPPORT REQUIREMENTS ANALYSIS

A. INTRODUCTION

Operational manning and maintenance at all levels consume most of the O&S resources for ships. The resource requirements for these cost elements should therefore be subjected to rigorous trade-off analysis. Such analysis, called operating and support requirements (O&SR) analysis, should be directed towards such issues as the effect of design characteristics and support policies on maintenance costs, and the effect of ship performance and operational policies on manpower costs. Section V discusses the significant O&SR cost elements, the objectives of O&SR analysis, the distinction between O&S requirements influenced by system design and those influenced by policy, guidelines for computation of O&SRs, and interpretation of the results of O&SR analysis in terms of system-level O&S costs.

B. SIGNIFICANT O&SR COST ELEMENTS

The subset of cost elements that represents the cost of ship manpower and maintenance is especially important. The sets of maintenance and manpower related cost elements identified below represents those typically included in O&SR analysis.

Maintenance Related

205.1	Support Equipment
205.5	Initial Spares and Repair Parts
301.1.1	Manpower
301.2.2	Repair Parts
302	Direct Intermediate Maintenance
303	Depot Maintenance (except 303.3 and 303.4)
307.1	Replenishment Spares

Manpower Related

205.2	Training
301.1	Personnel
306.1	Individual Training
306.2	Health Care
306.4	Personnel Support

Any other cost elements significantly affected by the O&SR should be incorporated into the analysis. Such elements as transportation, for example, may be relevant to the trade-off analysis under certain circumstances.

C. OBJECTIVES

The objectives of O&SR analyses are:

- To state clearly the rationale for estimating the O&SR-related cost elements. In other words, to explain how the estimates for the O&SR-related cost elements are derived as a function of the weapon system's logistics characteristics (e.g., reliability, maintainability, etc.), and support policy.
- To structure selected trade-offs between system design and policy alternatives and O&S costs, and to link the results functionally to system-level O&S cost impacts. This analysis is geared to such questions as: "For a given capability, what alternative system O&SRs will provide opportunities to reduce O&S costs, and by how much?" and "What are the O&S cost implications of using existing components in the proposed system instead of developing a new and unique component?"

At a minimum, the O&SR analyses should:

- Identify significant O&SR-related cost elements
- Functionally incorporate logistics characteristics and support policies relevant to the weapon system
- Use a pertinent measure of weapon system or subsystem capability (e.g., availability rate) in comparing and conducting trade-off analysis among alternatives
- Interpret the output of the O&SR analysis in terms of expected impact on system–level O&S costs
- Be adequately documented (the documentation should be available to the DSARC)

D. CATEGORIES

O&SRs can be separated into two categories: system-driven and policy-driven. System-driven requirements can be characterized as inherent or design requirements. Policy-driven requirements arise from the Navy's policies for deployment, surge activity allowance, personnel skills, training, and so on. Hardware designers can affect system-driven requirements directly, but they can influence policy-driven requirements only indirectly. Policy-driven requirements are basically controlled by the Navy. Both categories of O&SRs must be taken into account before realistic estimates of O&S costs and their impacts can be made.

E. COMPUTATION AND POLICY ADJUSTMENT

1. Computation

The computation of O&SRs explicitly involves both hardware characteristics and support policy-related variables. A number of different techniques will generally be potentially applicable at any one time. Selection of a model necessarily depends upon the situation, and ultimately upon the analyst's confidence in the technique chosen. Several criteria should be observed when selecting and applying a model for estimating O&SRs.

a. System Perspective

O&SR analysis of trade-offs concerning subsystems and components generally reflects a subset of the system-level requirements. The critical task is to isolate the level of the O&SR analysis and to define the models, requirements, and input data consistently. The observed O&SRs can thus be attributed to the system, component, or item of interest. Selection of the appropriate level of analysis should be based on the status of the system design and the pending O&S cost issues.

b. Relevance to DSARC Issue

The O&SR analysis must fit the DSARC issue under investigation. If affordability is the issue, then the O&SR analysis must include all relevant system O&S requirements for developing cost estimates. If, on the other hand, the issue is

improvement of a given design, then an O&SR trade-off model that can distinguish between the pertinent alternatives must be used.

c. Incorporation of the Right Variables

The O&SR analysis should show functional relationships among the variables relevant to the decision. An expression for estimating the impact of a design change on spares investment in terms of displacement and speed is not particularly useful, for example. Displacement and speed are not decision variables for spares investments. An appropriate model would explicitly relate reliability, maintainability, availability and support policy to the spares investment. The model must also be susceptible to modification, so as to deal only with the pertinent variables and allow the others to be ignored or factored as constants.

d. Satisfaction of DSARC Information Requirements

Output from the model should address the issues and alternatives directly. For example, if the impact of a design or policy change on organizational-level manpower requirements is in question, that specific impact should be an output, and not be buried in a total manpower estimate. The estimate of such an impact should be realistic and sufficiently documented. A related issue is how well the model output identifies the degree of certainty or uncertainty inherent in the analysis and input data. As more information is obtained, the associated growth in certainty should be explicitly reflected.

e. Satisfaction of Similarity Assumptions

In order to make projections, many models depend heavily upon assumptions requiring explicit similarity between old and new items. It is vital to recognize whether or not such assumptions can be satisfied. Analogy, for example, requires a direct, obvious relationship between one or more historical data points and a future application. If such a relationship does not exist, then analogy is inappropriate.

f. Operational Feasibility

Even if all the above criteria are satisfied, the use of certain models may not be practical. Either the constraints must be relaxed, or different models used. Three critical dimensions of operational feasibility are data, time, and level of effort. Some detailed engineering analyses and simulations require an extensively detailed and validated data base. A great deal of time (e.g., several months) and exclusive use of skilled personnel and computer resources may also be needed.

2. Adjustment for Policy-Driven Requirements

Distinguishing between design-inherent resource requirements and policy-related resource requirements offers useful insight into the drivers of system-level O&S costs. O&SRs calculated at subsystem or lower levels of indenture are indicative of demand-related and design-inherent requirements. The approach generally concentrates on direct operating and support requirements generated by the subsystem and/or its parts. Consequently, these O&SR values are usually less than the "real-life" O&SR for the system.

To assess a reliability, maintainability or support policy impact properly, the "basic" O&SR model output must be adjusted to reflect the most likely value that would occur. The process can be understood as linking the basic O&SR model output with other system-level and management policy requirements to generate a system-level O&S cost estimate. These additional requirements reflect the ship's demands for: support services, facility maintenance, hotel services, training, and other subsystem maintenance; and scheduled maintenance not directly related to reliability.

For example, the design-related maintenance manpower requirements at the organizational level will be lower than the actual manning levels, which also reflect policy and training considerations. Such considerations include the necessity to man to accommodate an organizational deployment or a surge in utilization. Personnel assignment policies and the requirement for cross-utilization of maintenance and support personnel for operational watchstanding also necessitate the calculation of whole

quantities and associated costs. Early in the DSARC process, a linkage between the O&SR and system-level O&S calculations should be established that accounts for policy impacts, yet does not mask the effects of the hardware characteristics of the proposed subsystem.

F. INTERPRETATION

What system-level O&S cost impacts can be inferred from an O&SR trade-off analysis? The issue is complex, and the inferences must be carefully documented as part of the backup material for the CAIG.

When O&SR results are used to estimate certain cost elements, and when those results are used directly as one of the inputs to the system-level O&S cost estimate, changes in the O&SR results can be related directly to an O&S cost impact. This interpretation is straightforward.

Generally, however, the interpretation of O&SR results is more difficult. The initial, or available, system-level O&S cost estimate is usually derived from an entirely separate analysis, which could have utilized different data sources and different techniques. These "top-level" analyses may not identify estimates for O&SR-related cost elements separately. It may therefore be inappropriate to say that a change in the estimate for a selected cost element based on an O&SR trade-off analysis will in fact be the impact on the future system-level O&S cost. The two results are the products of two different models or analyses. Still, they must be based on the same SPDS, which allows them to be used in the context of the same weapon system.

The most difficult case is estimating an O&S cost impact of an O&SR trade-off analysis applied to a below-system-level of assembly (e.g., the propulsion subsystem). The O&SR analysis necessarily reflects the values for the change to that level only. Even when the results are fully adjusted for policy requirements, they are still representative of requirements at that particular level only. In this case, the interpretation of the O&SR trade-off analysis must take into account the dual adjustments for the system hierarchy and the separate cost estimates. The inferred O&S cost impact attributable to the O&SR trade-off must be explicitly qualified and clearly documented.

VI. PRESENTATION REQUIREMENTS, FORMATS AND DOCUMENTATION

A. INTRODUCTION

This section describes the SI and O&S cost information needed by the DSARC for review of a ship acquisition program. The presentation requirements described below are guidance; they represent expected information needs. They are in no way intended to limit the use of imagination and good judgment in presenting additional cost information relevant to acquisition program decisions.

B. TAILORING THE ANALYSIS AND PRESENTATION

The presentation of SI and O&S cost analyses must be tailored to the phase of the acquisition program and the cost issues involved. As a program progresses from concept formulation through each DSARC decision milestone, the issues change, and both the uncertainties involved in SI and O&S cost estimation and the opportunities to affect those costs diminish. Consequently, the nature of the DSARC decisions and the related cost analyses will change as the design progresses.

Prior to each DSARC review, the Navy and the Chairman of the CAIG should agree upon the specific composition of, and ground rules for, cost presentations. Depending on the phase of the program and the specific issues involved, the cost analysis might address (singly or collectively) alternative ship systems, subsystems, or support plans. Interest frequently will focus on the sensitivity of certain costs to the goals established for mission performance and support of the ship, also.

C. OBJECTIVES OF THE COST ANALYSIS

Although each cost analysis and its format must be tailored to the decision at hand, any such presentation should always:

- Define each alternative
- Identify differences between alternatives

- Show cost impacts of the differences, taking uncertainty into account
- Explain the rationale of the cost analysis (assumptions, limitations, methods and data) and note any deviations from the guidelines
- Relate the results to decisions being considered by the DSARC

D. COST SUMMARY REQUIREMENTS

The results of the cost analysis should be presented in summary form, to direct the attention of the DSARC principals and other senior DoD officials to the SI and O&S cost impacts of the decisions they are considering. The summary is a concise, results-oriented presentation of the key points of the analysis, including as a minimum the following nine items.

1. Time-Phased SI and O&S Cost Estimates for the Proposed Ship by Cost Element

   - Format: Table
   - Rows: SI and O&S costs of the ship class
   - Columns: Fiscal years covering the point from which appropriations for support investment items are made, and the operational life of the ship
   - Entries:
     a. Constant year dollars, as per the convention noted in III.C.7.b.
     b. Total number of ships by fiscal year
     c. Uncertainty range indicated for all column cost totals

2. Time-Phased SI and O&S Cost Estimates for the Proposed Ship by Appropriation

   - Format: Table
   - Rows: Major or Prime Appropriations, as defined in DoD 7110-1-M, and applicable to the cost analysis
   - Columns: Fiscal years covering the point from which appropriations for support investment items are made, and the operational life of the ship
   - Entries: Constant year dollars, as per the convention noted in III.C.7.b. (Note: The sum of this matrix must equal the total in the above time-phased cost matrix. Appropriate adjustments for

personnel budget costs versus economic costs, and considerations for the lead time allowances for capital investments as well (e.g., support equipment, spares, etc.), must be documented.)

3. Total SI and O&S Cost for the Proposed Ship by Selected Subsystem

   - Format: Table
   - Rows: Significant cost elements from Table 2
   - Columns: Subsystems defined in NAVSHIPS 0900-039-9010, or others (e.g., DoDD 5010.20) of specific interest to the DSARC
   - Entries: Constant year dollars accumulated over the operational life of the ship, with an uncertainty range indicated for each column total

4. Comparison of the Annual O&S Costs of the Proposed Ship at Maturity with the O&S Costs of the Reference Ship

   - Format: Table
   - Rows: O&S cost elements listed in Table 2
   - Columns: *Reference ship, Proposed—Baseline, Proposed—Current.* (*Note:* The baseline and current estimates are the same at Milestone I; at subsequent presentations the baseline becomes the Milestone I estimate, and the current estimate is the latest estimate.)
   - Entries:
     a. Constant year dollars (as per the convention noted in III.C.7.b. for a single ship). (Note: Clearly indicate if the reference and proposed ship have different deployment concepts.)
     b. Uncertainty range indicated for each column total. (Note: The cost estimates for the reference ship are normative costs; that is, the costs the ship would most likely incur if it were used to perform the mission under consideration. As part of the documentation for these cost estimates, the historical costs for the reference ship must be identified in the backup material.)

5. Comparison of Life Cycle Support Investment Costs of the Proposed Ship Class with the SI Costs of the Reference Ship Class

   - Format: Table
   - Rows: SI cost categories
   - Columns: Reference Ship, Proposed—Baseline, Proposed—Current. (See Note on above item #4.)

- Entries:
  a. Constant year dollars (as per the convention noted in III.C.7.b.) for an equivalent class for both Reference and Proposed Ships
  b. Uncertainty range for each column total

6. Summary of Ship's Manning Requirements

- Format: Table
- Rows: Ship Organizational Divisions
- Columns: Work Category
- Entries: Number of enlisted personnel for each division by work category; totals by work category; and divisional totals for petty officers, designated strikers, non-rated, and total assigned

7. Historical O&S Cost Drivers and Corrective Actions for the Proposed System

- Format: Table
- Rows: Selected Subsystems/Components/Activities Driving Costs
- Columns:
  a. Percentage of ship maintenance costs
  b. Major problem(s) contributing to maintenance costs
  c. Cost reduction action planned for the proposed ship
- Entries:
  a. Numerical percentages (%)
  b. Narrative descriptions of problems and actions

8. Operating and Support Requirements Analysis Results and Documentation

For each of the O&SR-related cost elements, a documentation module must be submitted providing:

- Estimated value of the cost element
- Background for the O&SR analysis
- Description of how the value of the cost element was derived—in particular, interpretation of the O&SR analysis for O&S cost impacts
- Record (narrative and mathematical) of the expression used to derive the value of the cost element

- Description of the bounds within which the expression applies. (Pertinent assumptions must be discussed explicitly.)
- Definition of each input variable
- Discussion of how individual values were derived (particularly reliability and maintainability measures)
- Record of the source(s) and references used in the determination of input variables

These descriptions can include tabular, mathematical, or graphical data relationships, reflecting cost as a function of pertinent physical, performance, and deployment data from the history of the ship or the reference ship.

9. Sensitivity Analysis

An analysis of the sensitivity of the projected costs to all the critical assumptions in the cost analysis is also required. The presentation may be graphical or tabular, and must cover the SI and O&S cost impacts of changes in the following SPDS categories:

- Mission profile
- Ship characteristics
- Acquisition policy
- Deployment policy
- Support policy
- Logistics goals

E. SELECTIVE COST ANALYSIS AND PRESENTATIONS

Additional cost analyses and trade-off studies expressly for the ship under DSARC consideration will also be required. Results for each specific request must be presented in a manner consistent with the presentation and backup documentation called for in VI. D.

F. COST ANALYSIS BACKUP MATERIAL

Complete documentation of the required SI and O&S cost analysis should be submitted to the CAIG as backup material. Other relevant backup material should be made available to the CAIG upon request. The purpose of such material is to permit a detailed review of the assumptions, cost-estimating methods, data sources, and rationale of the analysis; it will therefore be organized for rapid examination. Each entry in the O&S cost presentation should be sufficiently documented for reproduction by a competent analyst, using the assumptions, methods and data included in the SPDS and backup material. The backup material should also explain the rationale of the cost estimate.

Backup material for the cost analysis ought to document the development of the following:

1. SPDS for the reference ship and any alternative under consideration
2. Total SI costs of the reference ship, and any alternative under consideration
3. Annual O&S costs of the reference ship and alternatives
4. Time-Phased SI and O&S Costs for the proposed program and alternatives
5. Sensitivity of the SI and annual O&S costs to the ship characteristics, support policies, or cost-estimating assumptions that have the greatest influence on costs
6. Documentation of each cost element estimate, including:
   - Description of derivation
   - Record (narrative and mathematical) of the expression used to derive its value
   - Description of the bounds within which the expression applies (pertinent assumptions must be noted explicitly)
   - Definition of each input variable
   - List of values assigned to input variables
   - Discussion of derivation of individual values
   - Record of source(s) and references used in determining input variables

APPENDIX A

COST ELEMENT DEFINITIONS FOR SHIPS

A. INTRODUCTION

This appendix presents definitions of the cost elements for support investment (SI) and operating and support (O&S) contained in the basic cost element structure (CES) and the associated systems contained in the collateral CES. The definitions are annotated to indicate those costs most important to O&S budget impact analysis.

Table A-1 provides a convenient reference for the full spectrum of life cycle costs for ships. Although these guidelines focus on the support investment and the operating and support portions of life cycle costs, definitions for elements of investment are also given in order to demonstrate how the SI and O&S costs complement the investment cost category.

B. DEFINITIONS FOR THE BASIC CES

The cost elements have been assigned numbers for ease of identification, reference, and discussion. The numbering scheme has been devised to accommodate future additions of cost elements to the structure and still retain the integrity of the numbering scheme.

For the major categories of cost, the following identification numbers apply:

100 Research, Development, Test and Evaluation

200 Investment

- 201 System Investment
- 202 Conversions and Modernizations
- 205 Support Investment (See Note 1.)

300 Operating and Support

Since this report focuses on the support investment (SI) and particularly the operating and support (O&S) portions of life cycle cost, the definitions given for other categories of cost are provided only to present a life cycle cost perspective.

TABLE A-1. LIFE CYCLE COST ELEMENT STRUCTURE

100	RESEARCH, DEVELOPMENT, TEST & EVALUATION
200	INVESTMENT
201	- System Investment
201.1	- Sailaway Cost
201.2	- Project Management
201.3	- Performance Modifications
202	- Conversions & Modernizations
202.1	- Sailaway Cost
202.2	- Project Management
205	- Support Investment
205.1	- Support Equipment
205.1.1	- Peculiar Support Equipment
205.1.1.1	Organizational
205.1.1.2	Other
205.1.2	- Common Support Equipment
205.1.2.1	Organizational
205.1.2.2	Other
205.2	- Training
205.2.1	- Services
205.2.2	- Equipment
205.2.3	- Shipboard Training Aids
205.3	- Documentation & Software
205.3.1	- Publications and Technical Data
205.3.2	- ADP Software Development
205.4	- Facilities
205.4.1	- Repairable Component Repair Facilities
205.4.2	- Industrial
205.4.3	- Training
205.4.4	- Other Ashore Facilities
205.5	- Initial Spares and Repair Parts
205.5.1	- Spares
205.5.1.1	Organizational
205.5.1.2	Other
205.5.2	- Repair Parts
205.5.2.1	Organizational
205.5.2.2	Other
205.6	- Other Investment
205.6.1	- Expendable Stores
205.6.2	- War Reserve Stocks

300	OPERATING AND SUPPORT
301	- Direct Unit
301.1	- Personnel
301.1.1	- Manpower
301.1.2	- Temporary Additional Duty
301.2	- Material
301.2.1	- Fuel
301.2.2	- Repair Parts
301.2.3	- Supplies
302	- Direct Intermediate Maintenance
302.1	- Tenders & Repair Ships
302.1.1	- Labor
302.1.2	- Material
302.2	- Ashore IMA
302.2.1	- Labor
302.2.2	- Material
303	- Depot Maintenance
303.1	- Regular Ship Overhaul
303.1.1	- Labor
303.1.2	- Material
303.2	- Non-Scheduled Ship Repair (RA/TA)
303.2.1	- Labor
303.2.2	- Material
303.3	- Fleet Modernization Program
303.4	- Recore
303.5	- Selected Restricted Availability
303.5.1	- Labor
303.5.2	- Material
303.6	- Repairable Component Repair
303.6.1	- Labor
303.6.2	- Material
304	- Depot Supply
304.1	- General Support
304.2	- Engineering and Technical Services
305	- Second Destination Transportation
306	- Personnel Support and Training
306.1	- Individual Training
306.1.1	- Special Training
306.1.2	- General Training
306.2	- Health Care
306.3	- Personnel Activities
306.4	- Personnel Support
307	- Sustaining Investments
307.1	- Replenishment Spares
307.2	- Special Program Material
307.3	- Training Expendable Stores

BASIC COST ELEMENT DEFINITIONS FOR SHIPS

200 INVESTMENT—The sum of cost elements 201 through 205.

201 SYSTEM INVESTMENT—The "sailaway" cost of the ship plus any other costs to the Government of producing or procuring the ship, managing the acquisition program, and providing for performance modifications. This element is the sum of subelements 201.1, 201.2, and 201.3.

201.1 Sailaway Cost—The cost of acquiring the basic ship as accounted for by these cost categories: basic unit, propulsion equipment, electronics, armament, other installed GFE, non-recurring costs, and allowance for engineering change orders. (See DoD 7110-1-M, Department of Defense Budget Guidance Manual.)

201.2 Project Management—The cost of personnel in the project management office who manage the ship acquisition program.

201.3 Performance Modifications—The cost of changes, modifications, alterations, or other improvements in the ship's subsystems designed to enhance the performance, or improve or alter the mission capability of, the ship. The cost of changes, modifications, alterations or other improvements related to safety, habitability, maintainability, or technical aspects of the ship's subsystems is excluded. The categories covered by this exclusion are more logically O&S–related and, therefore, will be included in the O&S elements 303.3 and 307.2, as appropriate. If it is not feasible to distinguish among modifications, then all modifications will be included in the O&S elements 303.3 and 307.2.

202 CONVERSIONS AND MODERNIZATIONS—The cost of major changes in a ship's configuration subsequent to commissioning that significantly alter the military characteristics of the ship, but are not accounted for by incremental improvements or subsystem modernizations accomplished during periodic overhauls. Conversions and modernizations are funded with the major acquisition appropriation, i.e., Shipbuilding and Conversion, Navy (SCN). This element is the sum of subelements 202.1 and 202.2.

202.1 Sailaway Cost—The cost of acquiring the converted or modernized ship, as accounted for by the "sailaway cost" categories enumerated in the DoD 7110-1-M, DoD Budget Guidance Manual. (It is noted that much of the sailaway cost has been previously incurred and, therefore, those costs will be regarded as "sunk costs.")

202.2 Project Management—The cost of personnel in the project management office who manage the ship conversion or modernization program.

203 Not assigned.

204 Not assigned.

205 SUPPORT INVESTMENT—The sum of elements 205.1 through 205.6.

205.1 Support Equipment—The cost of the peculiar and common support equipment procured to perform all three levels of maintenance for these particular ships. This element is the sum of subelements 205.1.1 and 205.1.2.

205.1.1 Peculiar Support Equipment—The cost of the tools and test equipment, including portable equipment, which have application only to these particular ships and are required to maintain them. An item of equipment may be required at all three levels of maintenance. Industrial plant equipment and the modification of facilities, which are covered under 205.4, are excluded. Installation of peculiar support equipment, if required at intermediate and depot levels, is covered under 205.4. This element is the sum of subelements 205.1.1.1 and 205.1.1.2.

205.1.1.1 Organizational—The cost of the peculiar support equipment to perform organizational maintenance.

205.1.1.2 Other—The cost of the peculiar support equipment to perform intermediate and depot level maintenance.

205.1.2 Common Support Equipment—The cost of the tools and test equipment procured to maintain these particular ships. Common support equipment is distinct from peculiar support equipment only in that "common" items are for support of more than one defense system. An item of equipment may be required at all three levels of maintenance. General purpose handtools and equipage, operating space items of a general nature delivered with the ship, and industrial plant equipment and the modification of facilities, which are covered under 205.4 are all excluded. Only increments directly relatable to the maintenance requirement of the ship shall be considered. Installation of common support equipment, if required at intermediate and depot levels, is covered under 205.4. This element is the sum of subelements 205.1.2.1 and 205.1.2.2.

205.1.2.1 Organizational—The cost of the common support equipment to support organizational maintenance.

205.1.2.2 Other—The cost of the common support equipment to support intermediate and depot level maintenance.

205.2 Training—The cost of the initial specialized training of nucleus crews; and the devices, accessories, aids, equipment spares and repair parts for the instruction of Government personnel in the operation and maintenance of these particular ships. Training of a general nature, with Navy-wide applicability, such as firefighting, damage control, etc., or training related to particular subsystems currently in use elsewhere in the Navy is excluded. Training devices, accessories, aids, equipment, and associated spares and repair parts delivered with the ship are covered under element 205.2.3. This element is the sum of subelements 205.2.1, 205.2.2, and 205.2.3.

205.2.1 Services—The cost of the instructors, training aids, and course materials for the initial training of Government personnel.

205.2.2 Equipment—The cost of the end items of training equipment, such as simulators, cutaways, mock-ups and models designed, developed, engineered, or fabricated to meet the training requirements at off-ship facilities.

205.2.3 Shipboard Training Aids—The cost of the training devices, accessories, aids, equipment, and parts delivered with the ship.

205.3 Documentation and Software—The cost of the initial publications and technical data and ADP software for the operation and maintenance of these particular ships. This element is the sum of subelements 205.3.1 and 205.3.2.

205.3.1 Publications and Technical Data—The cost of the initial manuals and drawings, including technical documentation and data, for operation and maintenance.

205.3.2 ADP Software Development—The cost of the initial development and installation of the computer programs for the ships' operations and support systems and equipment.

205.4 Facilities—The cost of the construction, conversion, alteration, or modification of facilities and equipment for the maintenance, training, and logistic support of these particular ships. The procurement and installation of industrial plant equipment and the installation (if required), of peculiar and common support equipment are included. Procurement of peculiar and common support equipment, which is covered under 205.1, and replacements for existing facilities are excluded. This element is the sum of subelements 205.4.1 through 205.4.4.

205.4.1 Repairable Component Repair—The cost of the construction, conversion, alteration, or modification of major facilities designed for the purpose of rebuilding, repairing, maintaining, or modifying spare components, assemblies, subassemblies, equipments or end items, such as in the rotatable pool concept.

205.4.2 Industrial—The cost of the construction, conversion, alteration, or modification of naval shipyards or other maintenance support facilities to accomplish depot level maintenance. Investments made solely for repairable component repair facilities, which should be reflected in 205.4.1, are excluded.

205.4.3 Training—The cost of the portion of construction, conversion, rearrangement, or expansion of facilities allocable to the ships to meet the training requirement.

205.4.4 Other Ashore Facilities—The cost of the construction, conversion, alteration, or modification of piers, docks, anchorages, fuel storage sites, ammunition depots, etc., to support operations.

205.5 Initial Spares and Repair Parts—The cost of the initial spares and repair parts stocked for the service and repair of these particular ships. This element is the sum of subelements 205.5.1 and 205.5.2.

205.5.1 Spares—The cost of the initial spares to service and repair these particular ships. Recurring replenishment of spares is covered in 307.1. Spares are recoverable components, subassemblies, assemblies, equipments, or end items installed or placed in use while replaced items are undergoing maintenance, repair, or overhaul. This element is the sum of subelements 205.5.1.1 and 205.5.1.2.

205.5.1.1 Organizational—The cost of those spares carried on-board in accordance with the ship's allowance list.

205.5.1.2 Other—The cost of those spares added to system stocks, specifically as a result of the ships' requirements. Those spares carried at intermediate activities in accordance with prescribed load lists are included.

205.5.2 Repair Parts—The cost of the initial repair parts to service and repair these particular ships. Repair parts are those individual parts for the maintenance or repair of installed equipments and spares. This element is the sum of subelements 205.5.2.1 and 205.5.2.2.

205.5.2.1 Organizational—The cost of the repair parts carried on-board in accordance with the ship's allowance list.

205.5.2.2 Other—The cost of the repair parts added to system stocks, specifically as a result of the ships' requirements. Those repair parts carried at intermediate activities in accordance with prescribed load lists are included.

205.6 Other Investment—The cost of the initial fill of expendable ordnance and war reserve stocks for these particular ships. This element is the sum of subelements 205.6.1 and 205.6.2.

205.6.1 Expendable Ordnance—The cost of the expendable ordnance, ammunition, pyrotechnics, missiles, ballistic weapons, guided weapons, torpedoes, mines, depth charges, sonobuoys, etc., for initial fill of ships' magazines and for the increment of system stocks to support that ship fill.

205.6.2 War Reserve Stocks—The cost of supplies of specific spares and repair parts for war reserve requirements. (These costs should not also be counted in element 205.5. If the costs of war reserve stocks cannot be distinguished from the costs of initial provisioning reflected in element 205.5, they will be counted only in that element.)

300 OPERATING AND SUPPORT The sum of elements 301 through 307.

301 DIRECT UNIT—The direct costs associated with the operation of the ship, composed of the sum of elements 301.1, Personnel and 301.2, Material.

301.1 Personnel—The direct personnel costs at the organizational (unit) level. These are the sum of the subelements 301.1.1, Manpower and 301.1.2, Temporary Additional Duty (TAD).

301.1.1 Manpower—The cost of the services of all active ships' personnel, computed at the standard rate as defined in the Navy Comptroller Manual. The standard rate includes the following elements: basic pay, quarters, subsistence, clothing allowances, incentive and special pay, and miscellaneous expense for the ship's active personnel. Indirect personnel support costs are accounted for in 306. Actual organizational maintenance manpower may be separately identified, if feasible. (See Note 2.)

301.1.2 Temporary Additional Duty (TAD)—The cost associated with the temporary assignment of shipboard personnel away from the ship for training, administrative, or other purposes. It consists of transportation, lodging, mileage allowances, per diem allowances, and incidental travel expenses.

301.2 Material The cost of material expended or used by the ship and her crew during the ship's operational assignments and maintenance periods, except for those materials covered in 307, Sustaining Investments. It is the sum of subelements 301.2.1, 301.2.2, and 301.2.3.

301.2.1 Fuel—The cost of propulsion and ship's service fuel consumed by the ship. (See Note 2.)

301.2.2 Repair Parts—The cost of repair parts used in the organizational maintenance of the ship. Repair parts are those individual parts used for equipment repair, but not considered repairable in themselves. Repairable items, which are termed "replenishment spares" and covered in 307.1, are excluded. (See Note 2.)

301.2.3 Supplies—The cost of consumable supplies (e.g., janitorial supplies, office material, personnel support supplies, medical and dental material, etc.) and equipage items (e.g., binoculars, typewriters, clocks, etc.) not directly related to the support of specific equipment or systems. This element also includes oils and lubricants.

302 DIRECT INTERMEDIATE MAINTENANCE—The cost of the direct labor, material, services, and repair parts expended during afloat or ashore intermediate maintenance activity (IMA) availabilities. Direct labor is defined as that manpower specifically applied to those tasks necessary to accomplish maintenance and repair services for these particular ships. The cost of direct labor is construed to include basic pay, quarters, subsistence, clothing allowances, incentive and special pay, and miscellaneous expense. If the Top Level Requirement (TLR) or other planning documents call for scheduled intermediate maintenance, the scheduled timing and workload must be shown. (The ship's own repair parts expended by the ship's force during IMA availability will be included under 301.2.2. Material, services, and repair parts furnished by a shipyard or other industrial activity will be included under 303. Material, parts, and labor used for supporting rotatable pools will be included in 303.6.). If these particular ships require particular IMAs, the cost associated with those IMAs must be shown; otherwise, average costs may be used. The direct IMA cost consists of the sum of elements 302.1 and 302.2.

302.1 Tenders and Repair Ships—The cost of the material and direct labor expended by the tenders and repair ships (i.e., AD, AS, and AR) in support of ships serviced. This element is the sum of subelements 302.1.1 and 302.1.2.

302.1.1 Labor—The cost of the direct labor expended by the tenders and repair ships.

302.1.2 Material—The cost of the material and repair parts expended by the tenders and repair ships. (See Note 2.)

302.2 Ashore IMA—The cost of the material and direct labor expended by ashore IMAs in support of ships serviced. This element is the sum of subelements 302.2.1 and 302.2.2.

302.2.1 Labor—The cost of the direct labor expended by the IMA.

302.2.2 Material—The cost of the material and repair parts expended by the IMA. (See Note 2.)

303 DEPOT MAINTENANCE—The funded costs of direct labor, direct material, other direct costs, and applied overhead chargeable to job orders for overhaul, progressive maintenance, analytical rework, modification, repair, inspection and test, manufacture, reclamation, and storage of ship subsystems, components, parts and support equipment. The cost of similar work accomplished via contractor maintenance or interservice maintenance support is also included. (See DoD 7220.29-H, Department of Defense Depot Maintenance and Maintenance Support Cost Accounting and Production Reporting Handbook.) Industrial facilities are to include commercial facilities, naval shipyards and other industrial facilities that perform depot level maintenance. Significant industrial maintenance costs incurred by contract will be separately identified where feasible. (The ship's own repair parts expended by the ship's force during industrial availabilities will be included under 301.2.2. Material, parts, and labor used for supporting rotatable pools will be included in 303.6.) This element is the sum of elements 303.1, Regular Ship Overhaul, 303.2, Non-Scheduled Ship Repair, 303.3, Fleet Modernization, 303.4, Recore, 303.5, Selected Restricted Availability, and 303.6, Repairable Component Repair. For those elements of Depot Maintenance that call for a separate breakout of labor and material costs, aggregation of those costs at the next higher level of indenture is acceptable when such a breakout would be impractical.

303.1 Regular Ship Overhaul—The cost of the shipyard periods scheduled in advance for the accomplishment of major maintenance and repair in accordance with the requirements set forth in the Top Level Requirement (TLR) or other planning documents. This element is the sum of subelements 303.1.1 and 303.1.2. (See Note 2.)

303.1.1 Labor—The cost of the labor expended by the shipyard in support of ships serviced. The labor cost will be a fully-loaded cost to account for a pro rata share of direct, indirect, and overhead costs.

303.1.2 Material—The cost of the material and repair parts expended by the shipyard in support of ships serviced. (Replenishment spares, which are covered in 307.1, are excluded.)

303.2 Non-Scheduled Ship Repair (RA/TA)—The cost of the maintenance and repair, performed at shipyards or other industrial facilities, resulting from casualties, voyage damage, etc. These are repairs between scheduled overhauls that are beyond the capacity of the ship's force to accomplish. This element is the sum of subelements 303.2.1 and 303.2.2.

303.2.1 Labor—The cost of the labor expended by the shipyard, or other industrial facility, in support of ships serviced. The labor cost will be a fully-loaded cost to account for a pro rata share of direct, indirect, and overhead costs.

303.2.2 Material—The cost of the material and repair parts expended by the shipyard, or other industrial facility, in support of ships serviced. (Replenishment spares, which are covered in 307.1, are excluded.)

303.3 Fleet Modernization Program—The cost of the installation of alterations and improvements (i.e., SHIPALTS, ORDALTS, field changes, other modifications) to effect changes in a ship's configuration or equipment to improve its safety, habitability, maintainability, or technical characteristics. (Changes, modifications, alterations, or other improvements designed to enhance the performance, or improve or alter the mission capability of the ship are excluded. The categories covered by this exclusion are investments in the system and therefore will be included in the System Investment element 201.3. If it is not feasible to distinguish among modifications, then all modifications may be included in the O&S elements 303.3 and 307.2.) This is primarily a labor cost, although common miscellaneous industrial material (such as wire, cable, piping, fittings, sheet metal, locally procured or fabricated items, etc.) may be provided by the installation activity. The labor cost will be a fully-loaded cost to account for a pro rata share of direct, indirect, and overhead costs. Special material required for these alterations or modifications is covered in element 307.2. (See Note 3.)

303.4 Recore—The cost of the recore of nuclear reactors. This element includes the acquisition cost of the replacement core and the costs associated with the disposition of the replaced core. Labor and other material expended in support of recoring nuclear-powered ships will be included in Regular Ship Overhaul costs (303.1). (See Note 2.)

303.5 Selected Restricted Availability (SRA)—The cost of shipyard periods scheduled in advance in accordance with the requirements set forth in the Top Level Requirement (TLR) or other planning documents for the accomplishment of maintenance. SRA schedules and duration shall be specified. This element is the sum of subelements 303.5.1 and 303.5.2. (See Note 2.)

303.5.1 Labor—The cost of the labor expended by the shipyard in support of ships serviced. The labor cost will be a fully-loaded cost to account for a pro rata share of direct, indirect, and overhead costs.

303.5.2 Material—The cost of the material and repair parts expended by the shipyard in support of ships serviced. (Replenishment spares, which are covered in 307.1, are excluded.)

303.6 Repairable Component Repair—The cost of the repair, calibration, and testing of the ship's equipment and components at industrial facilities. Missiles and other ordnance, ordnance equipment and components, and electronic, hull, mechanical, and electrical equipment and components

designated for repair at industrial facilities are included. Each facility is to be accounted for separately. This element is the sum of subelements 303.6.1 and 303.6.2. (See Note 2.)

303.6.1 Labor—The cost of the labor expended on repairable components. The labor cost will be a fully-loaded cost to account for a pro rata share of direct, indirect, and overhead costs.

303.6.2 Material—The cost of the material and repair parts expended on repairable components. (Replenishment spares, which are covered in 307.1, are excluded.)

304 DEPOT SUPPLY—The cost of procuring, receiving, storing, issuing, managing, and controlling the inventories of materials (i.e., wholesale supply functions) needed for the ship's operation and maintenance; and the cost of providing engineering and technical services, technical documentation, and logistics information systems support. This element is the sum of subelements 304.1 and 304.2.

304.1 General Support—The cost of supply and information functions that support the ships, but the costs for which are not easily allocable and/or are small in relation to the total. Such functions as the operation of Inventory Control Points (ICPs), Supply Depots, other field support, technical documentation update, 3-M support, etc., are included.

304.2 Engineering and Technical Services—The cost of engineering and technical support services other than those supplied by IMAs and depot maintenance activities.

305 SECOND DESTINATION TRANSPORTATION—The cost of transportation of material for the ships subsequent to its initial receipt by the Government, except for deliveries by the Mobile Logistic Support Force, which are accounted for in 312.1. Transportation of repairable items is included.

306 PERSONNEL SUPPORT AND TRAINING—The cost of individual training (initial and replacement), health care, permanent change of station (PCS), and other personnel support. This element is the sum of subelements 306.1 through 306.4.

306.1 Individual Training—The cost of recruit, specialized, and professional training, including the basic pay and allowances for instructors and for personnel in training. The cost of pay and allowances for personnel attached to the ship is included in element 301.1. This element is the sum of subelements 306.1.1 and 306.1.2.

306.1.1 Special Training—These costs cover that personnel training uniquely related to the characteristics of the ship.

306.1.2 General Training—These costs cover all personnel training except that uniquely related to the characteristics of the ship.

306.2 Health Care—The cost of providing ashore medical support to personnel attached to the ship. Organizational medical support, which is accounted for in element 301, is excluded.

306.3 Personnel Activities—The permanent change of station (PCS) costs to move personnel assigned to staff or support positions for the ship. The cost of these moves includes a proportionate share of personnel pipeline PCS costs of moves for accessions, separations, rotations, operations, and training.

306.4 Personnel Support—The costs to operate training facilities and medical facilities. These costs include supplies, services, and material; travel expenses; and other variable personnel-oriented support costs incurred at training facilities and medical facilities.

307 SUSTAINING INVESTMENTS—The cost of direct investment support to the ship, such as replenishment spares, special program material, and training expendable stores. This element is the sum of subelements 307.1, 307.2, and 307.3.

307.1 Replenishment Spares—The cost of the recurring procurement of spares to replenish rotatable pools of repairable components depleted through abandonment, loss, or survey. Spares are recoverable components, subassemblies, assemblies, equipments, or end items installed or otherwise placed in use while replaced items are undergoing maintenance, repair, overhaul, or salvage at other than the organizational level. The acquisition of initial spares, covered in 205.5, is excluded. (See Note 2.)

307.2 Special Program Material—The cost of the acquisition of special material for alterations or modifications (i.e., SHIPALTS, ORDALTS, field changes, other modifications) needed for effecting improvements in the ship's safety, habitability, maintainability, or technical characteristics. (Changes, modifications, alterations, or other improvements designed to enhance the performance, or improve or alter the mission capability of the ship are excluded. The categories covered by this exclusion are investments in the system and therefore will be included in the System Investment element 201.3. If it is not feasible to distinguish among modifications, then all modifications may be included in the O&S elements 303.3 and 307.2.) Miscellaneous material and installation labor are counted under element 303.3. (See Note 3.)

307.3 Training Expendable Stores—The cost of the expendable ordnance, ammunition, pyrotechnics, missiles, ballistic weapons, guided weapons, torpedoes, mines, depth charges, sonobuoys, etc., used by the ship in training exercises. (See Note 2.)

C. DEFINITIONS FOR THE COLLATERAL CES

The definitions presented here illustrate those cost elements that may be considered as variable in the context of a particular program. The cost elements have been assigned numbers for ease of identification, reference, and discussion. The numbering scheme is identical to that used in the presentation of the basic CES above.

COLLATERAL COST ELEMENT DEFINITIONS FOR SHIPS

400 ASSOCIATED SYSTEMS—*The sum of cost elements 401 and 402.*

401 SUPPORT INVESTMENT—The sum of cost elements 401.1, 401.2, and 401.3.

401.1 Mobile Logistic Support Force—The cost of constructing, converting, altering, or modifying oilers, ammunition ships, supply ships, etc., to support the operation of these particular ships.

401.2 Tenders and Repair Ships—The cost of constructing, converting, altering, or modifying tenders and repair ships for the intermediate maintenance of these particular ships.

401.3 Ashore IMA—The cost of constructing, converting, altering, or modifying of shore facilities to provide intermediate maintenance for these particular ships. Investments made solely for repairable component repair facilities, which should be reflected in 205.4.1, are excluded.

402 OPERATING AND SUPPORT—The sum of cost elements 402.1 through 402.4.

402.1 Mobile Logistic Support Force (MLSF)—The significant incremental costs of operating and supporting the MLSF (except tenders and repair ships) that result from the introduction and operation of these particular ships. The O&S cost of the MLSF ship is to include the cost categories in the 300 series defined by this report. Each MLSF ship type is to be accounted for separately (i.e., by AE, AF, AFS, AK, AO, AOE). (See Note 2.)

402.2 Tenders and Repair Ships—The significant incremental costs of operating and supporting the tenders and repair ships that result from the introduction and operation of these particular ships. The O&S cost of the tenders and repair ships is to include the cost categories, (except for direct labor, covered in 302.1.1) in the 300 series defined by this report. If these particular ships require particular tenders or repair ships, the costs associated with them must be shown separately. (See Note 2.)

402.3 Ashore IMA—The significant incremental costs of operating and supporting the ashore IMAs that result from the introduction and operation of these particular ships. The O&S cost of the ashore IMAs includes manpower, (except for direct labor, covered in 302.2.1), training, personnel support, and other support as defined by the 300 series of this report. These costs also include support services received from host facilities. If these particular ships require particular IMAs, the costs associated with them must be shown separately. (See Note 2.)

402.4 Embarked Systems—Pro rata share of the operation and support costs of embarked systems, such as helicopters, RPVs, etc., not intended to be permanently affixed to the ship. The pro rata allocation of aviation systems is to be based on a proportionate share of the total squadron O&S costs as defined by the cost categories in the aircraft guidelines report. Costs will be shown separately for each kind of "embarked system." The "embarked systems" will be specifically identified. (See Note 2.)

---

[1]It is recognized that some elements of cost are defined in the CES as "Support Investment," although the material defined by that element actually may be procured under an acquisition (i.e., Shipbuilding and Conversion, Navy (SCN)) appropriation. An example of a support investment of that kind is shipboard repair parts provided to the ship as initial outfitting under the SCN appropriation. Regardless of the funding source, an acquisition of that nature is considered more properly as an investment in support rather than a system investment.

[2]This is a cost element of significant impact on overall O&S cost and, therefore, should be the subject of considerable emphasis during O&S costing efforts.

[3]This is a cost element of significant impact on overall O&S cost and, therefore, should be the subject of considerable emphasis during O&S costing efforts. However, during ship design, it is not possible to forecast, or estimate the costs of the specific alterations to be made on a new ship. In lieu of better data, it is desirable that these costs for the reference ship be presented to the DSARC.

APPENDIX B

BASIC OUTLINE OF A SYSTEM PROGRAM DEFINITION STATEMENT FOR SHIPS

A. MISSION PROFILE (See Note 1)

1. Warfare
2. Mobility
3. Command and Control
4. Fleet Support Operations
5. Non-Combatant Operations
6. Other Inherent Capabilities

B. SHIP CHARACTERISTICS

1. Physical Description (Platform)

   a. Length
   b. Beam
   c. Draft
   d. Displacement (full load and light ship)

2. Physical Description (Subsystems)

   a. Propulsion
      - Type and Number of Shafts
      - Speed and Endurance:
        Maximum (knots, nautical miles)
        Cruise (knots, nautical miles)
        Economical (knots, nautical miles)

   b. Electrical
      - Type, number and capacity of ship's service and emergency generators
      - Condition I and III electrical loads

   c. Auxiliary
      - Type, number and capacity of significant components (e.g., air conditioning, fire pumps, etc.)

   d. Armament
      - Type ASW, ASMD ASUW, and AAW Systems

- Associated Sensors
- Unreplenished Endurance (expendable stores capacity, by type)

e. Command & Surveillance
- Command and Control
- Navigation
- Interior Communications
- Exterior Communications
- Surveillance (Surface)
- Surveillance (Underwater)
- Countermeasures
- Fire Control

f. Air Systems
- Aircraft Capacity (number and type)
- Flying hours per month
- Air Control Capabilities
- All Weather Handling Capability
- Aviation Fuel Capacity (flight hours)
- Unreplenished Aviation Stores Endurance (expendable stores, by type)
- Maintenance Support (Organizational or IMA)

g. MLSF Systems (See Note 2)
- Carrying Capacity (by commodity)
- Transfer Rate (by commodity)
- Number of Replenishment Stations (by type)

h. Amphibious Systems (See Note 2)
- Troop Capacity
- Vehicular Capacity
- Cargo Capacity
- Helicopter Spots
- Ship-to-Shore Movement Systems

i. Support Systems (See Note 2)

(Specialized capabilities for towing, salvage, and repair)

3. Design Characteristics

a. Habitability (square feet per person)

b. Hardening
- Shock
- Airblast
- NBC

c. Damage Control Provisions (e.g., compartmentation, separation of vital systems, etc.)

d. Radiated Noise Characteristics; Cavitation Speed

e. Margins for Growth (See Note 3)
   - Accommodations (percent of complement)
   - Future Combat Systems (space, weight, moment)
   - Electrical (kw)
   - Capabilities and Constraints for Future Aircraft (e.g., hangar size, deck loading, etc.)

4. Expected Operational Life

   a. Platform
   b. Major Subsystems

5. Crew Requirements

   a. Officers
   b. Rated Enlisted
   c. Non-Rated Enlisted

C. ACQUISITION PROGRAM

1. Design-to-Cost Goal

2. Number of Ships

3. Production/Utilization Schedule

4. Contract Commitments on Support Cost Control

5. Special Considerations for Multi-National Application

6. GFE Policy

7. Standardization Provisions

D. DEPLOYMENT

1. Peacetime

   a. Basing and Deployment Plan
   b. Speed-Time Profile
   c. Maintenance and Overhaul Cycle

2. Contingency/Wartime

   a. Basing and Deployment Plan
   b. Speed-Time Profile
   c. Maintenance and Overhaul Cycle

E. SUPPORT CONCEPT

1. Initial Support Plan

   a. Peacetime
   b. Contingency/Wartime

2. Sustaining Support Plan

   a. Peacetime
   b. Contingency/Wartime

F. LOGISTICS GOALS

   1. Weapon System Availability (by mission area)

   2. Subsystem Availability (by mission area)

---

[1]This section should conform generally to Section 2 of the Top Level Requirements.

[2]These systems are to be included in the SPDS when appropriate to the type of ship being considered.

[3]CNO controlled margins only.

APPENDIX C

COMPATIBILITY WITH OTHER O&S COST ELEMENT STRUCTURES

A. INTRODUCTION

This appendix discusses the compatibility of the LMI ship O&S CES contained in these guidelines with other relevant O&S cost structures. The cost structures addressed are:

- Aircraft
- VAMOSC (Ships)
- Navy Program Factors[1]

B. AIRCRAFT

These ship guidelines are being published concurrently with those for aircraft. The cost structures developed for both reports are based on the principle of relevant variable cost. Both are basically compatible in cost coverage as well as cost element notation and definition. However, it has not proven practicable to structure the O&S cost elements for aircraft and ships identically. The aircraft O&S CES is functionally organized, while the ship CES is organizationally oriented, for these reasons:

- The aircraft CES must be applicable to systems in each of the three Military Departments, which have dissimilar organizations for operating and supporting those weapon systems. As a result, the orientation of the aircraft O&S CES has to be functional, in order to be more easily adaptable to the organizations and cost data systems of each Military Department.
- All DoD ship development and acquisition is conducted by the Navy. The structure of most Navy cost information systems reflects the manner in which

[1]The aircraft CES is from Aircraft System Operating and Support Costs: Guidelines for Analysis; the VAMOSC (Ships) CES is from the final report on Visibility and Management of Support Costs—Ships; the CES for the Navy Program Factors is from the ship section of the Navy Program Factors Manual (Revised 1 July 1976). Complete citations for these documents are given in Appendix D.

ships are operated and supported. Thus, it was judged preferable that the O&S CES be directly relatable to existing and planned Navy cost systems.

In summary, the aircraft O&S CES and the ship O&S CES are compatible in that they include the same kinds of costs and are based on the same concept of relevant variable costs. However, they are not definitionally comparable on a cost element-by-cost element basis. This latter point must be kept in mind in any cost comparisons between ships and other weapon systems (e.g., aircraft) that are capable of performing the same mission (e.g., shore bombardment).

Figure C-1 displays the ship O&S CES together with the aircraft O&S CES. The lines indicate the linkage between the major elements of both structures. Numbers along the links refer to notes accompanying the figure, which explain the linkage and the unique characteristics of the ship O&S CES. Figure C-1 shows that the structures are basically compatible at the second level of indenture, although subsequent levels of indenture differ.

C. VAMOSC (SHIPS)

The VAMOSC (Ships) study was initiated with the objective of structuring a management information system (MIS) that would identify maintenance and operations costs by weapon and support system. One assumption underlying that effort was that the recommended MIS would utilize existing systems for input data. Another was that costs collected or allocated would be those resulting from a direct demand for material or services by an individual ship; total O&S costs were not intended to be identified and collected. The development of the CES recommended in this report was not constrained by such assumptions. Consequently, the VAMOSC CES and the recommended CES differ, although a high degree of compatibility between the two structures still remains.

Figure C-2 shows the relationship between the recommended CES and the VAMOSC CES. Lower levels of indenture are shown only when necessary to establish comparability

or for illustrative purposes. Lines connecting the two structures indicate comparability at the highest possible level of indenture. Lines shown at a particular level of indenture mean that subordinate cost elements are included. Numbers along the lines refer to the notes accompanying Figure C-2, which describe the salient differences between the two annotated cost elements.

D. NAVY PROGRAM FACTORS

The Navy Program Factors Manual is used to estimate the resources required to operate and support individual ships. The factors are computed by the Navy Resource Model (NARM) from the data base used in the Five-Year Defense Program (FYDP) and the Program Objective Memorandum. The cost element structure of the Navy Program Factors Manual is represented by cost factors for elements of direct and indirect average costs to operate and support a ship for one year.

There is a high degree of compatibility between the individual cost elements in the Navy Program Factors Manual and those of the ship O&S CES recommended in this report. The grouping of cost elements in the two structures is different, however.

The relationship between the Navy Program Factors and the recommended cost element structures is depicted in Figure C-3. Lower levels of indenture for the recommended CES are not shown for all cost breakdowns, but only when necessary to establish comparability, or for illustrative purposes. Lines connecting the two structures indicate comparability at the highest possible level of indenture. Lines shown at a particular level of indenture mean that subordinate cost elements are included. Numbers along the lines refer to the notes accompanying Figure C-3. The notes describe the salient differences between the two annotated cost elements.

NOTES FOR FIGURE C-1

[1]All of the aircraft cost category 301 is subsumed in the ship cost category 301, although the detailed sub-element breakout is not identical. However, the ship O&S CES does not account for distant boundary support as does the aircraft cost element for "Security" (301.4). The ship cost category 301 also implicitly includes other costs inherent in the uniquely self-sustaining nature of ships, which in the aircraft CES are explicitly categorized and displayed differently. These costs are more specifically addressed in the subsequent footnotes.

[2]All of the ship O&S cost category for "Direct Intermediate Maintenance" is subsumed in the aircraft cost category for "Below Depot Maintenance," but the ship's organizational maintenance manpower and material are contained in the ship cost elements 301.1 and 301.2, respectively. Also, the ship O&S CES does not account for "Personnel Support" cost for intermediate maintenance personnel, although personnel support costs for organizational maintenance personnel are included in the ship cost element 301.

[3]These costs are not explicitly accounted for in the ship O&S CES, although most of the functions and capabilities associated with "Installation Support" are inherent in the ship's organization and facilities which are designed for self-supporting operations.

[4]For nuclear-powered ships, the cost of the nuclear core is included in the ship CES, though it is not relevant to other weapon systems.

[5]The extent of coverage of these cost categories is generally comparable; however, the detailed sub-element breakout is not. In addition, the ship O&S CES includes the cost of other miscellaneous field support to ships, such as maintenance of fleet moorings and service craft, maintenance and material management information systems, base communications at supply activities, etc.

[6]Re 307.2: The ship O&S CES does not include medical support to below depot maintenance and installation support (except insofar as the personnel in these categories are assigned to the ship, e.g., organizational equipment and facilities maintenance personnel). In addition, the cost of that portion of health care received by deployed unit personnel (i.e., ship's company—which also includes organizational equipment and facilities maintenance personnel) on board the ship is included in the ship cost elements 301.1 and 301.2.

Re 307.4: The cost of supplies, services, and equipment to support medical personnel assigned to the deployed unit (i.e., the ship) is included in the ship cost elements 301.1 and 301.2

[7]The ship O&S CES does not include a cost element for the "Replenishment of Ground Support Equipment."

FIGURE C-1. RELATIONSHIP OF RECOMMENDED SHIP O&S CES TO RECOMMENDED AIRCRAFT O&S CES

SHIP			AIRCRAFT	
301	DIRECT UNIT	① → 301		DEPLOYED UNIT OPERATIONS
301.1	Personnel		301.1	Air Crews
301.2	Material		301.2	Command Staff
			301.3	POL
			301.4	Security
			301.5	Other Deployed Manpower
			301.6	Personnel Support
302	DIRECT INTERMEDIATE MAINTENANCE	② → 302		BELOW DEPOT MAINTENANCE
302.1	Tenders & Repair Ships		302.1	Aircraft Maintenance Manpower
302.2	Ashore IMA		302.2	Ordnance Maintenance Manpower
			302.3	Maintenance Materiel
			302.4	Personnel Support
		③ → 303		INSTALLATIONS SUPPORT
			303.1	Base Operating Support
			303.2	Real Property Maintenance
			303.3	Personnel Support
303	DEPOT MAINTENANCE	④ → 304		DEPOT MAINTENANCE
303.1	Regular Ship Overhaul		304.1	Manpower
303.2	Non-Scheduled Ship Repair		304.2	Materiel
303.3	Fleet Modernization Program			
303.4	Recore	④		
303.5	Selected Restricted Availability			
303.6	Repairable Component Repair			
304	DEPOT SUPPLY	⑤ → 305		DEPOT SUPPLY
304.1	General Support		305.1	Materiel Distribution
304.2	Engineering & Technical Services		305.2	Materiel Management
			305.3	Technical Support
305	SECOND DESTINATION TRANSPORTATION	→ 306		SECOND DESTINATION TRANSPORTATION
306	PERSONNEL SUPPORT & TRAINING	⑥ → 307		PERSONNEL SUPPORT & TRAINING
306.1	Individual Training		307.1	Individual Training
306.2	Health Care		307.2	Health Care
306.3	Personnel Activities		307.3	Personnel Activities
306.4	Personnel Support		307.4	Personnel Support
307	SUSTAINING INVESTMENTS	⑦ → 308		SUSTAINING INVESTMENTS
307.1	Replenishment Spares		308.1	Replenishment Spares
307.2	Special Program Material (Mods)		308.2	Modifications
307.3	Training Expendable Stores		308.3	Replenishment GSE
			308.4	Training Ordnance

NOTES FOR FIGURE C-2

[1]LMI cost element 301.2.3 contains oils and lubricants other than fuel.

[2]In the VAMOSC CES, labor performed in private shipyards for installation of FMP (Fleet Modernization Program) material is contained in cost element 3.1.

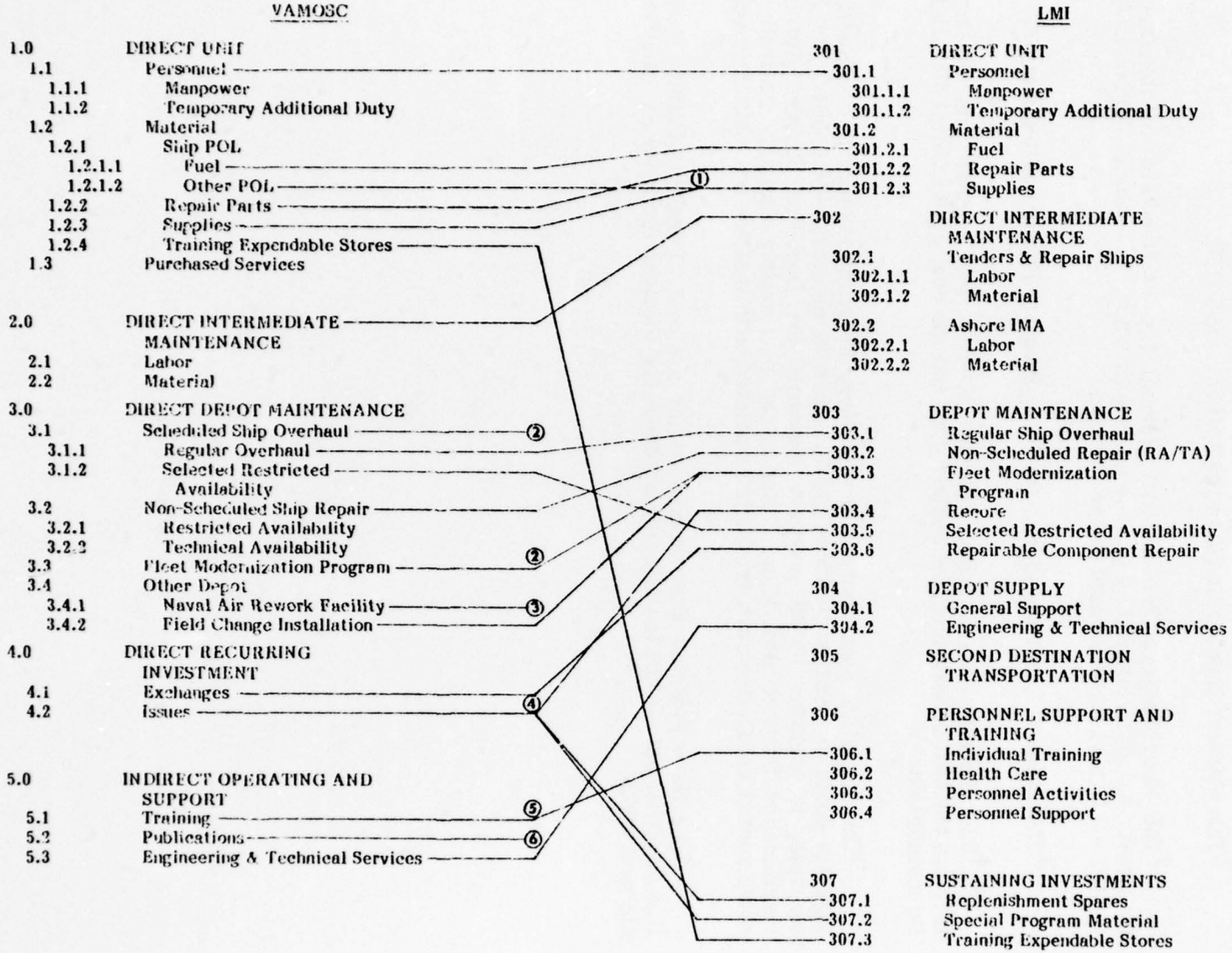
[3]Costs for VAMOSC element 3.4.1 are not separately identified in the recommended CES, but are otherwise accounted for in elements 303.1, 303.2, and 303.5, as appropriate.

[4]VAMOSC cost element 4.2 is an aggregation of costs for recore, replenishment spares, and special program material, as contained separately in cost elements 303.4, 307.1 and 307.2, respectively.

[5]VAMOSC cost element 5.1 contains enlisted training only, and excludes recruit training and depot level training on new or modified equipments.

[6]VAMOSC cost element 5.2 is accounted for in the more inclusive cost element 304.1 for general support.

FIGURE C-2. RELATIONSHIP OF NAVY VAMOSC SHIP CES TO RECOMMENDED SHIP O&S CES



NOTES FOR FIGURE C-3

[1]This element is not included in the LMI ship O&S CES.

[2]The Navy Program Factors cost element for intermediate maintenance includes O&MN funded material used by tenders and repair ships. It excludes Ashore IMAs, except for O&MN funded material used by the FMAGs.

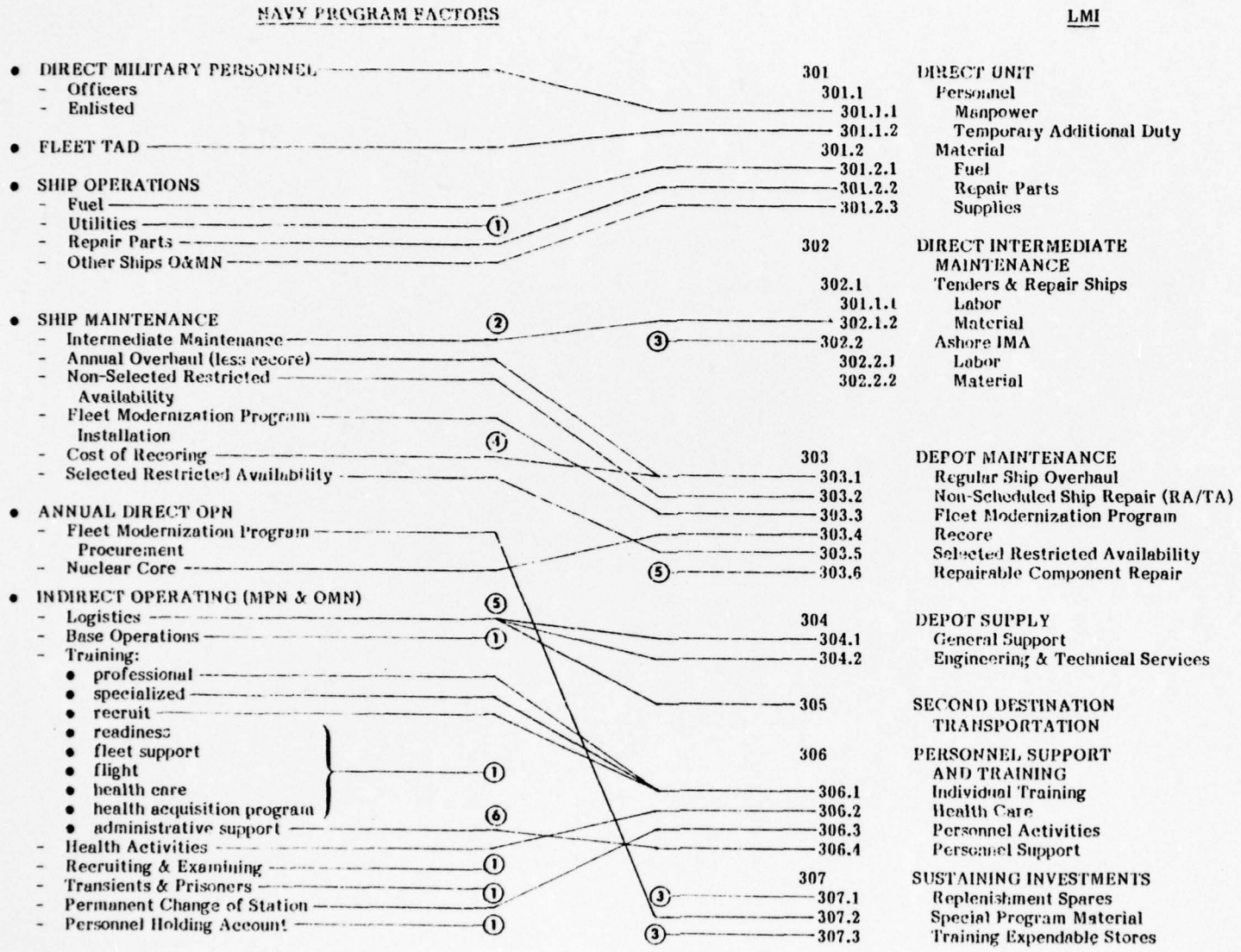
[3]This element is not included in the Navy Program Factors cost structure.

[4]For nuclear-powered ships, the cost element for Regular Ship Overhaul (303.1) includes the cost of installing the nuclear core and the cost of incidental material used for its installation.

[5]The Logistics cost element in the Navy Program Factors is composed of many logistics costs in addition to those related to cost elements 304.1, 304.2, and 305. For example, it includes FYDP program elements for Logistics Support Activities and Maintenance Support Activities. The latter particularly includes centrally-managed equipment rework. However, the costs associated with that are not distinguishable.

[6]The Navy Program Factors provide for the cost of training facility operations in this element, but do not include similar costs for medical facilities as specified in cost element 306.4.

FIGURE C-3. RELATIONSHIP OF NAVY PROGRAM FACTORS SHIP CES TO RECOMMENDED SHIP O&S CES



APPENDIX D

SELECTED REFERENCES

A. COST ANALYSIS AND SYSTEMS ANALYSIS

Fisher, G. Cost Considerations in Systems Analysis. New York: American Elsevier, 1971.

Hitch, C. J. and McKean, R. H. The Economics of Defense in the Nuclear Age. Cambridge: Harvard University Press, 1960.

OSD Comptroller. Economics Analysis Handbook, 2nd Edition, January 15, 1975.

Quade, E. S., ed. Analysis for Military Decisions. Chicago: Rand McNally, 1964.

Quade, E. and Boucher, W. M. Systems Analysis and Policy Applications in Defense. New York: American Elsevier, 1968.

Spurr, W. and Bonini, C. P. Statistical Analysis for Business Decisions. Homewood: Richard D. Irwin, 1967.

B. MISSION EFFECTIVENESS

Woisard, E. L., ed. Mission Effectiveness of General Purpose Naval Forces (U). Chief of Naval Operations, Systems Analysis Division, June 1974. Secret LD 32938A.

C. SHIP DESIGN

Graham, Clark, LCDR USN "The Impact of Subsystems on Naval Ship Design." Naval Engineers Journal, December 1975.

Leopold, R. "Gas Turbines in the U. S. Navy: Analysis of an Innovation and its Future Prospects as Viewed by a Ship Designer." Naval Engineers Journal, April 1975.

_____, Johns, O., and Drewry, J. "Design to Cost of Naval Ships." The Society of Naval Architects and Marine Engineers, Transactions, Vol. 82, 1974.

Neggin, J., and Wright, R. A Survey of Management Trade-Offs Through the Ship Acquisition Life Cycle. Naval Postgraduate School, September 1974, LD 32859A.

PRECEDING PAGE BLANK-NOT FILMED

D. DIRECTIVES, INSTRUCTIONS AND OTHER PUBLICATIONS

DoDD 5000.1 Major System Acquisitions, January 18, 1977.

DoDD 5000.2 Major System Acquisition Process, January 18, 1977.

DoDD 5000.3 Test and Evaluation. Jan. 19, 1973.

DoDD 5000.4 OSD Cost Analysis Improvement Group. June 13, 1973.

DoDD 5000.26 Defense Systems Acquisitions Review Council (DSARC). Jan. 21, 1975.

DoDD 5000.28 Design to Cost. May 23, 1975.

DoDD 5000.XX Operating and Support Cost Management in the Systems Acquisition Process (forthcoming).

DoDD 5010.20 Work Breakdown Structure for Defense Materiel Items. July 31, 1968.

DoDI 7041.3 Economic Analysis and Program Evaluation for Resource Management. October 18, 1972.

DoDI 7220.24 Guidance for Cost Accounting and Production Reporting for Depot Maintenance and Maintenance Support. Oct. 20, 1975.

Cost Analysis Improvement Group. Operating and Support Cost Development Guide for Aircraft Systems. May 1974 (revision in progress).

Deputy Secretary of Defense Memorandum for the Secretaries of the Military Departments. "Reduction of Outyear Operating and Support (O&S) Costs." Feb. 28, 1976.

Joint AFSC/AFLC Commanders' Working Group on Life Cycle Cost, ASD/ACL. Life Cycle Cost Reference Library Bibliography. WPAFB, Ohio 45433, March 1976.

Navy Program Factors Manual. Revised. Chief of Naval Operations (OPNAV-90P-02), 1 July 1976.

Aircraft System Operating and Support Costs: Guidelines for Analysis. Washington, D. C.: Logistics Management Institute, April 1977.

Visibility and Management of Support Costs (VAMOSC) - Ships. Final Report. Chief of Naval Operations, Systems Analysis Division, Sept. 21, 1976.

APPENDIX E

GLOSSARY

Conceptual Design—That stage of the conceptual phase wherein the alternative candidate ships defined by feasibility studies are verified as being feasible, are further refined, and a conceptual baseline is prepared for DSARC review. Initial resolution of identified technical risks is made.

Conceptual Phase—That phase of the ship design process that defines a series of feasible ships and results in the selection of one or more candidate ship systems whose principal performance and cost characteristics are defined. The conceptual stage consists of Feasibility Studies and the Conceptual Design.

Contract Design—That phase of the ship design that results in an allocated baseline suitable for Milestone II or III and provides the documentation required to contract for the ship's construction.

Cost Analysis Improvement Group—An advisory body to the DSARC on matters related to cost. (DoDD 5000.4)

Defense Systems Acquisition Review Council—An advisory body to the Secretary of Defense on the acquisition of major defense system programs and related policies. (DoDD 5000.26)

Design-to-Cost—A management concept wherein rigorous cost goals are established during development, and the control of system costs (acquisition, operating and support) for these goals is achieved by practical trade-offs between operational capability, performance, cost, and schedule. Cost, as a key design parameter, is addressed on a continuing basis and as an inherent part of the development and production process. (DoDD 5000.28)

Decision Coordinating Paper—A document that defines program issues, including special logistics problems, program objectives, program plans, performance parameters, areas of major risk, system alternatives and acquisition strategy. (DoDD 5000.1)

Feasibility Studies—The first stage of the conceptual phase, in which a series of ships is defined and compared to operational and cost constraints, leading to the selection of one or more candidate ships. Major technical risks are defined.

Life Cycle Cost—Total cost to the Government of acquisition and ownership of a system over its full life. It includes the cost of development, acquisition, operation, support, and, where applicable, disposal. (DoDD 5000.28)

Maintainability—A characteristic of design and installation, which is expressed as the probability that an item will conform to specified conditions within a given period of time, when maintenance action is performed in accordance with prescribed procedures and resources. (MIL-STD-721B)

Navy Resources Model—A model used to estimate resource requirements to support Navy ships and aircraft for use in the Five Year Defense Plan, and to estimate the dollar and manpower resources required to operate or acquire a single ship or aircraft.

Operating and Support Costs—Those costs associated with the maintenance, logistics support and operation of a system over its life.

Preliminary Design—That phase of the ship design process where the selected ship is further defined and hardware and ship entity characteristics are optimized and selected. A functional baseline is prepared for DSARC review.

Reliability—The probability that material will perform its intended function for a specified period of time under stated conditions. (DoD 5155.11)

Subsystem—A major functional grouping of weapon system equipments, e.g., Propulsion System.

Support Investment—One-time costs associated with a weapon system that are required to ensure the achievement of its planned support. It includes initial spare and repair parts, facilities investment, special tools and test equipment, initial training in the operation and maintenance of the system and documentation and software required to maintain the ship.

System—A complete weapons system, i.e., a ship.

Visibility and Management of Support Costs—An effort to establish management information systems that will identify the direct and appropriate indirect costs of supporting individual weapon systems, with particular emphasis on the maintenance function. (DoD–MBO–9–2, 1975)

APPENDIX F

ABBREVIATIONS

AAW--Anti-Air Warfare

ASD (MRA&L)--Assistant Secretary of Defense (Manpower Reserve Affairs and Logistics)

ASMD--Anti-Ship Missile Defense

ASUW--Anti-Surface Warfare

ASW--Anti-Submarine Warfare

CAIG--Cost Analysis Improvement Group

CES--Cost Element Structure

CIC--Combat Information Center

CNO--Chief of Naval Operations

DCP--*Decision Coordinating Paper*

DSARC--Defense Systems Acquisition Review Council

FMP--Fleet Modernization Program

GFE--Government Furnished Equipment

IMA--Intermediate Maintenance Activity

LCC--Life Cycle Cost

MLSF--Mobile Logistic Support Force

NARM--Navy Resources Model

NBC--Nuclear, Biological, Chemical (Warfare)

O&S--Operating and Support

O&SR--Operating and Support Requirements

ORDALT--Ordnance Alteration

OSD--Office of the Secretary of Defense

RA/TA--Restricted Availability/Technical Availability

RPV—Remotely Piloted Vehicle

SecDef—Secretary of Defense

SI—Support Investment

SHIPALT—Ship Alteration

SPDS—System Program Definition Statement

VAMOSC—Visibility and Management of Support Costs

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) Ship Operating and Support Costs: Guidelines for Analysis	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER (14) LMI ~~Task~~ 75-1/2
7. AUTHOR(s) (10) Marco R. Fiorello, Robert S. Salzer, Joseph R. Wilk	8. CONTRACT OR GRANT NUMBER(s) (15) SD-321
9. PERFORMING ORGANIZATION NAME AND ADDRESS Logistics Management Institute, 4701 Sangamore Road, Washington, D. C. 20016	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (12) 89p.
11. CONTROLLING OFFICE NAME AND ADDRESS Office of the Assistant Secretary of Defense (Manpower and Reserve Affairs and Logistics)	12. REPORT DATE (11) May 1977
	13. NUMBER OF PAGES 87
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/ DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

"A" Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Operating and Support costs, DSARC, DSARC Process, CAIG, Ship System Acquisition, Life Cycle Costs, Cost Analysis

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Military Departments and defense contractors have for some time been actively concerned about rising life cycle costs (LCC) of Defense weapon systems.

Over the past two years, the Department of Defense (DoD) has placed new emphasis on examining the projected operating and support (O&S) costs of planned weapons and finding ways to reduce those costs. O&S cost analyses are now a major part of the cost review conducted at each weapon procurement decision

next page

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE 210 475 UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

cont

meeting by the Defense Systems Acquisition Review Council (DSARC) and the DSARC's principal advisor on new system costs--the Cost Analysis Improvement Group (CAIG).

This report recommends guidelines for preparing estimates of the support investment (SI) and O&S costs of ship acquisition programs and presenting them to the DSARC. It provides a framework for objective comparison of SI and O&S costs of program, design, or support alternatives, using consistent methodologies and terminology. A general methodology for SI and O&S cost estimating is described, a standard cost element structure for ships is defined, and specific requirements for presentation of SI and O&S cost estimates to the DSARC are proposed. Standards for the presentation and documentation of these cost estimates are also recommended.

These guidelines are intended to achieve consistent and effective preparation and documentation of SI and O&S cost estimates for major weapon systems, and to facilitate the DSARC's and the CAIG's examination of important SI and O&S cost issues. They should be understood as recommendations to the CAIG--a contribution to the preparation of an official CAIG O&S cost development guide for ships.