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Edition 4

SHIP COSTING

April 2006

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Edition 4

NORTH ATLANTIC TREATY ORGANIZATION

NATO STANDARDIZATION AGENCY (NSA)

NATO LETTER OF PROMULGATION

10 April 2006

1. ANEP-41 (Edition 4) - **SHIP COSTING** is a **NATO UNCLASSIFIED** publication.

2. ANEP-41 (Edition 4) is effective NATO-wide upon receipt. It supersedes ANEP-41 (Edition 3) which shall be destroyed in accordance with the local procedure for the destruction of documents.

J. MAJ
Brigadier General, POL(A)
Director, NSA

RECORD OF CHANGES

CHANGE DATE	DATE ENTERED	EFFECTIVE DATE	BY WHOM ENTERED

FOREWORD

This ANEP was initially developed (Edition 1 dated March 1991) by an Ad Hoc Working Group (AHWG) of ship cost experts established under IEG/6 as a result of tasking from the 62nd meeting of the NNAG. Subsequently, Edition 2 (July 1992) and Edition 3 (December 2003) were prepared by the Specialist Team on Ship Costing (formerly the AHWG) under tasking from the NG/6 (formerly IEG/6). The ANEP provides:

(1) A comprehensive list of known ship cost elements in terms of a NATO Ship Cost/Work Breakdown Structure;

(2) A Hierarchy of Ship Cost Terms extending from the NATO Ship Cost/Work Breakdown Structure up to the total program cost,

(3) Broad guidance on the use of Ship Cost Models; and

(4) A framework of elements that make up Life Cycle Cost, Total Ownership Cost, and Whole Life Cost.

The ANEP derives from the IEG/6 Ship Costing Report, reference (a), published in February 1990; NG/6 WP 9 published in November 2000, reference (b); and a working paper in Total Ownership Costing published in December 2002, reference (c). Active participation in the document development was provided by the following nations: Belgium, Canada, France, Germany, Italy, Netherlands, Norway, Spain, United Kingdom and the United States. Other nations providing input were Australia, Denmark, Greece, and Turkey.

The ANEP provides a framework for discussion of ship costs between NATO nations. It is intended as a common basis of costing terminology and a frame of reference for use in application to future NATO Collaborative ship acquisition programs. It may also serve as a reference document to enable comparisons of ship costs or ship cost elements between nations.

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NATO SHIP COSTING

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CHAPTER 1. INTRODUCTION

The design and procurement of modern complex naval warships is an involved process. The development of the associated cost estimates for both initial acquisition and those incurred during the life of the warship is a difficult task that involves the assignment of values to several hundred cost elements. Further, in a multinational program:

- The issues of cost sharing and work sharing must also be addressed, and
- Differences in national budgeting practice for total ship costs leads to difficulty in comparing cost estimates prepared by different countries.

Resolutions of both of these require a sufficient level of detail in the estimates. Therefore, it is essential that the cost element definitions and Cost/Work Breakdown Structure (CWBS) be clearly defined at the beginning of any multinational development and acquisition program for such ships.

The purpose of this publication is to establish a framework and overall process for developing future ship cost estimates for NATO collaborative programs. The principal elements of this process are: definitions of cost-related terms, a cost/work breakdown structure, an agreed costing methodology (including a baseline ship design, industrial scenario and cost model), and multinational program considerations (cost sharing, work sharing, and currency conversion). In any future collaborative program, the generic NATO cost/work breakdown structure described in this publication should be the starting point from which the specific Project Cost/Work Breakdown Structure is developed (completely defining the project). The Cost Analysis Requirements and Assumptions document provides the ship project description and is essential to ensure a common understanding of that which the cost estimate is being prepared.

This publication derives from references (a), (b) and (c) and is intended as a common basis of costing terminology and frame of reference for use in application to future NATO collaborative ship acquisition programs. It may also serve as a reference document to enable comparison of costs between nations.

The scope of this document covers all aspects of the costs incurred in the design, development, procurement, operation, support and disposal of the ship or class of ships.

CHAPTER 2. SHIP COST TERMS AND DEFINITIONS

To enhance a common understanding and enable the national budgeting process to occur as efficiently as possible, Annex A provides a listing of relevant ship cost terms and definitions. Annex A is not considered to be all encompassing and may be added to or amended in the future as needed. Although some terms contained in Annex A are not referred to in the text of this document, they are routinely used as part of the costing dialect and thus are considered essential to the purpose of common understanding. To facilitate a mutual understanding of key costing terms, a hierarchy of the composition of NATO Ship LCC is provided in Figure 1, which also serves as a point of reference to aid in making cost comparisons between nations. The distinction of various levels of LCC when expanded to cover Total Ownership Cost (TOC) and Whole Life Cost (WLC) are discussed in Chapter 4.

References (d) through (i) provide estimate classifications of various nations. The classification categories provide an indication of the relative quality and accuracy of a given estimate in those nations and are noted in this publication for information.

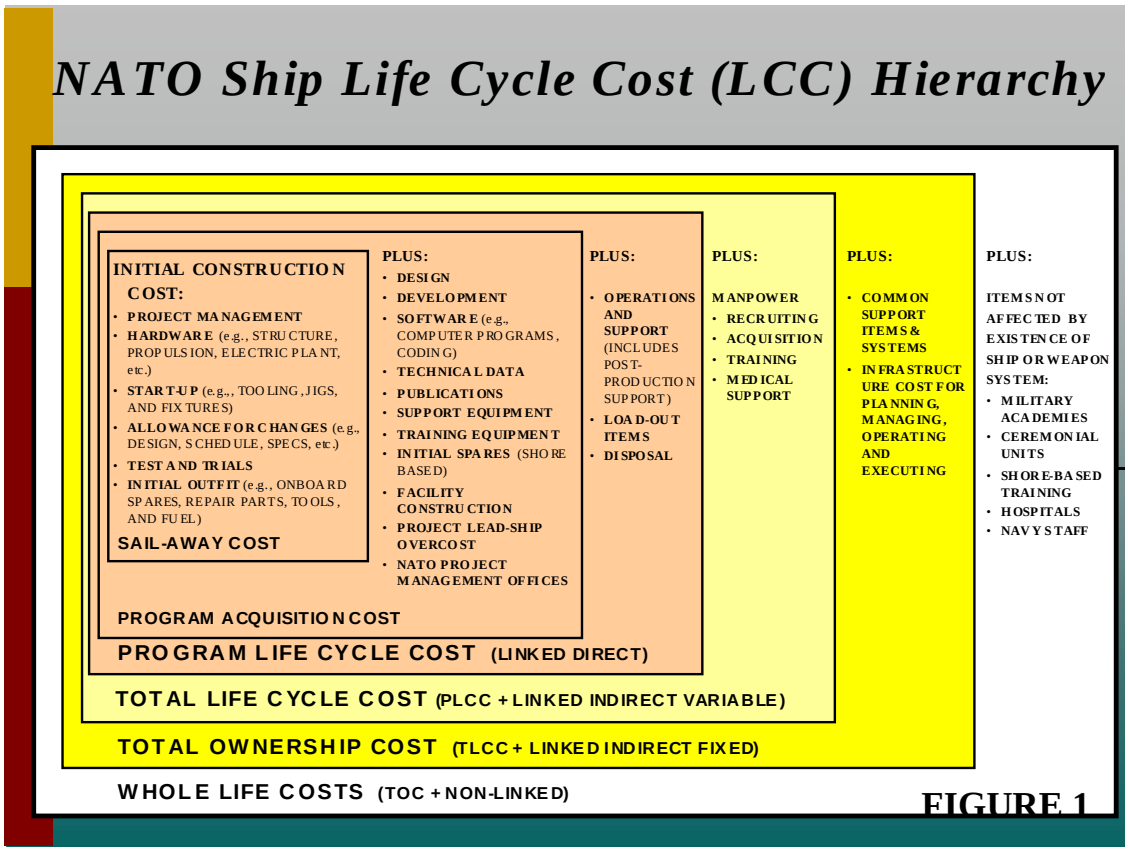


FIGURE 1

CHAPTER 3. NATO SHIP COST/WORK BREAKDOWN STRUCTURE

The NATO hierarchy of life cycle costing terms for a naval ship is shown in Figure 1. The NATO Phased Armaments Programming System (PAPS), references (k) and (l), describes the seven life cycle phases of a NATO program. The NATO Ship CWBS (Figure 2) is intended to enable the participating nations to effectively account for all **affected** costs through all seven phases of a NATO ship program and is fully compatible with Figure 1. The CWBS presented here represents a comprehensive system that is an effective means of accounting for all elements of cost. Recognizing that other CWBS breakdowns exist, those may be substituted or merged to the NATO CWBS as the nations agree (e.g., see Section 3(c), In-Service Cost Categories).

The process of developing a finalized, project specific CWBS is evolutionary, requiring guidance and recommendations from all involved nations to achieve a CWBS that is acceptable and understandable by all. Therefore, unique aspects associated with a specific multinational program may require that deviations from the generic NATO Ship CWBS be made in certain areas. For example, a further segregation of cost elements may be required to provide visibility necessary to determine cost sharing.

Figures 3 and 4 provide the expansion of Common and Unique Elements through the third and fourth level of the CWBS, respectively. Annex B provides an index of the numeric addresses and titles of Expanded Ship Work Breakdown Structure (ESWBS) elements. Reference (j) provides detailed definitions of each ESWBS element. Annex C provides the nomenclature and numbering system for Programmatic elements of cost. Annex D provides a correlation of the NATO Ship CWBS elements to the NATO Ship LCC Composition.

NATO SHIP COST/WORK BREAKDOWN STRUCTURE (Levels 1, 2 & 3)

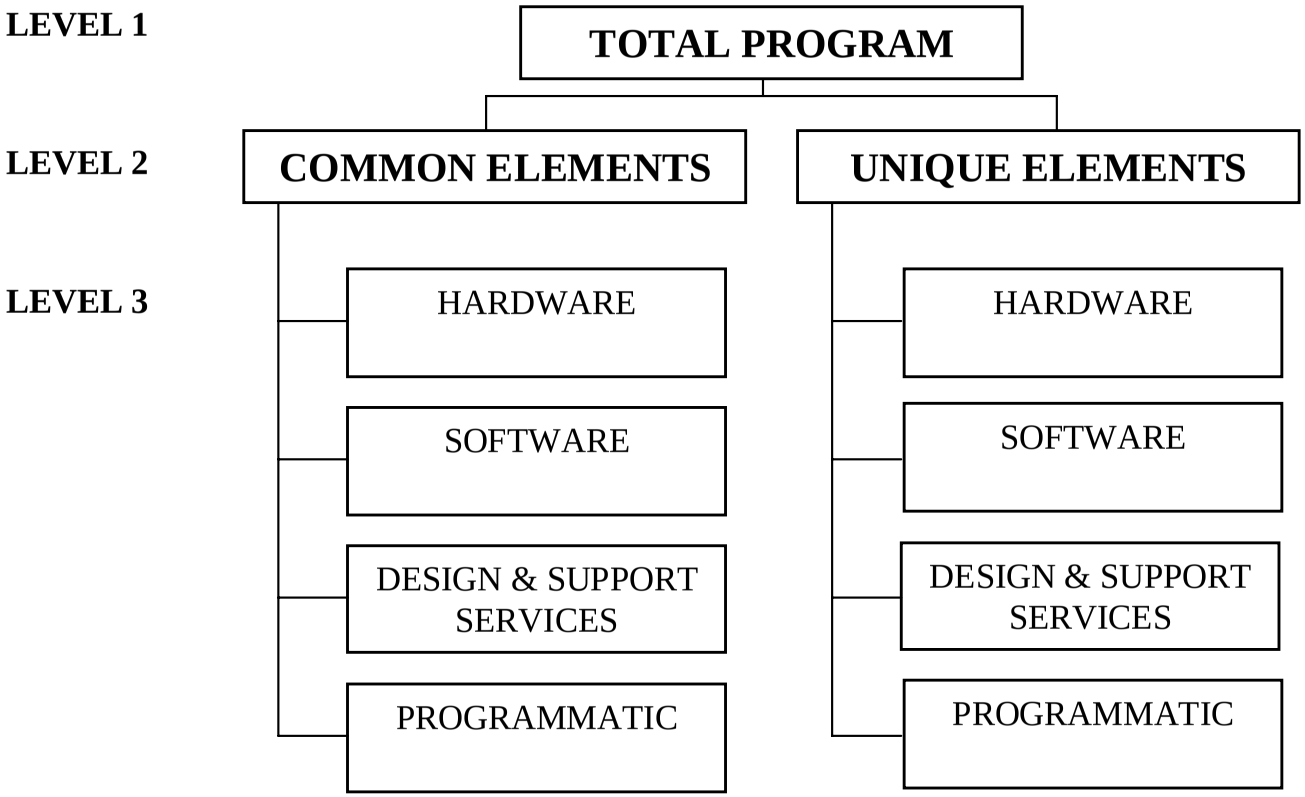


FIGURE 2

NATO SHIP COST/WORK BREAKDOWN STRUCTURE (Levels 2, 3 & 4)

FIGURE 3

NATO SHIP COST/WORK BREAKDOWN STRUCTURE (Levels 2, 3 & 4)

FIGURE 4

SECTION 3(a) Application of Expanded Ship Work Breakdown Structure

The generic NATO Ship CWBS is derived from the US ESWBS, reference (j). The ESWBS is a product-oriented family tree of ship work breakdown structure elements that provides distinct numeric addresses for component elements of ship design, development, construction, operation and support. However, the ESWBS requires a supplemental list of Programmatic elements in order to provide distinct addresses for some costs, such as contingencies, margins, growth reserves, escalation, insurance, taxes, tariffs, disposal, etc.

ESWBS is broken down into ten major subgroups shown below with an expanded structure shown in Annex B. A further breakdown of load items and margins provided in the "F" and "M" categories in Appendix A of reference (j).

Group 000--General Guidance and Administration
Group 100--Hull Structure
Group 200--Propulsion Plant
Group 300--Electric Plant
Group 400--Command and Surveillance
Group 500--Auxiliary System
Group 600--Outfit and Furnishings
Group 700--Armament
Group 800--Integration/Engineering
Group 900--Ship Assembly and Support Services

ESWBS, as utilized in the generic NATO Ship CWBS, is applicable across the seven phases of the NATO PAPS:

Mission Need Evaluation
Pre-Feasibility
Feasibility
Project Definition
Design and Development
Production
In-Service

The lead and follow ship construction costs are included in the NATO Production phase. Although all elements of cost, across all seven phases of a NATO program, are accounted for in the NATO Ship CWBS, costs for the in-service phase are also expressed in the following major categories: Personnel, Consumables, Direct Maintenance, Sustaining Investment, Other Direct Costs and Indirect Costs. These categories are discussed in more detail in Section 3.c.

A program estimate using the generic NATO Ship CWBS (ESWBS plus Programmatic elements) format should be established for each phase of a NATO ship program. This approach for future NATO ship acquisition programs is the most practical approach to account for multinational cost and work sharing which is generally tailored to each program phase. The total program life cycle cost estimate (depending on the level of the NATO ship LCC hierarchy chosen) consists of the summation of the cost estimates for each of the seven NATO program phases.

Included in Figures 2, 3, and 4 are four primary groups: Hardware, Software, Design and Support Services, and Programmatic elements. The Hardware group consists of elements contained in ESWBS Groups 100 through 700. The Software group consists of all costs for the development, procurement and maintenance of computer programs for ESWBS Groups 100 through 700.[1] The Design and Support Services group consists of elements contained in ESWBS Groups 000, 800, and 900. Elements of costs which are not captured in ESWBS Groups 000 through 900 are designated Programmatic and include such general items as: budgeting practices, compliance with government laws and regulations, escalation, contingencies, government support activities, NATO Program Office activities, and shipboard load-out items. The relationship of the four primary categories to the ESWBS and program phases is depicted in Figure 5 on page 10.

(i) Hardware Elements

The Hardware group pertains to all cost elements identified in ESWBS Groups 100 through 700 (excluding software) and generally covers the industrial type effort[2] only (Government Support and NATO Program Office operations are covered in the Programmatic group). In general, Hardware costs are not incurred until the Production phase of a NATO program. Prototypes, Models, and mock-ups associated with the earlier design and development phases are generally captured in Groups 000, 800 and 900. Included in the Hardware group is the material, direct labor and overhead cost of the item, whether the item is supplied to the shipbuilder, as Government Furnished Equipment (GFE) or Government Furnished Material (GFM), or is procured or fabricated by the shipbuilder. The cost of hardware items that will serve as shipboard spares are accounted for in appropriate hardware elements. The following are types of work

[1] As used in the generic NATO Ship CWBS, the term software deviates from the US ESWBS terminology in that it is limited to that which is associated with computer functions only. In the US terminology, technical documentation and architectural drawings are referred to as software as well.

[2] In some instances, a portion of industrial type efforts may be performed by a government activity, e.g., ship construction, maintenance or overhaul in a government owned facility.

included in ESWBS 100 through 700 elements (where applicable): vendor equipment, fabrication, installation, survey, inspection, compartment testing, calibration, cleaning, alignment, maintenance, balancing, structural fitting, painting, priming, replacement, repair, testing, and check-out. A further description of the ESWBS groups that pertain to the Hardware Group (Groups 100 through 700) are listed below.

NATO SHIP PROGRAM PHASE
CWBS CORRELATION

PHASE	* CWBS ELEMENTS	* ESWBS ELEMENTS
MISSION NEED EVALUATION	DESIGN & SUPPORT PROGRAMMATICS	GROUPS 000, 800
PRE-FEASIBIITY	DESIGN & SUPPORT PROGRAMMATICS	GROUPS 000, 800
FEASIBILITY	DESIGN & SUPPORT PROGRAMMATICS	GROUPS 000, 800
PROJECT DEFINITION	DESIGN & SUPPORT PROGRAMMATICS	GROUPS 000, 800
DESIGN AND DEVELOPMENT	SOFTWARE	GROUPS 100 – 700
	DESIGN & SUPPORT PROGRAMMATICS	GROUPS 000, 800
PRODUCTION	HARDWARE	GROUPS 100 – 700
	SOFTWARE	GROUPS 100 – 700
	DESIGN & SUPPORT PROGRAMMATICS	GROUPS 000, 800, 900 “M” (MARGINS) “F” (LOAD-OUT ITEMS)
IN-SERVICE	HARDWARE	GROUPS 100 – 700
	SOFTWARE	GROUPS 100 – 700
	DESIGN & SUPPORT PROGRAMMATICS	GROUPS 000, 800, 900 “F” (LOAD-OUT ITEMS)

* Denotes phase at which costs are generally incurred

FIGURE 5

Group 100 Hull Structure--Group 100 refers to the assembled main hull body with all structural subdivisions. Group 100 includes items such as: shell plating, longitudinal and transverse framing, platforms, decks, superstructure, foundations, structural bulkheads, enclosures, sponsons, castings, forgings, weldments, fixed ballast, doors, closures, kingposts, masts, service platforms, and sonar domes.

Group 200 Propulsion Plant--Group 200 refers to those major components installed primarily for propulsion and the systems necessary to make these components operable. Group 200 includes items such as: boilers, energy converters, propulsion units, main condensers, air injectors, shafting, bearings, propellers, combustion air supply system, uptakes, propulsion control equipment, main steam, feed-water and condensate, circulating and cooling water, fuel oil service and lubricating oil systems, on- board spares, repair parts and tools.

Group 300 Electric Plant--Group 300 refers to the power generating and distribution system installed primarily for ship service and emergency power and lighting. Group 300 includes items such as: the electric power generation system, power distribution switchboards, power distribution system, lighting system, on-board spares, repair parts and tools.

Group 400 Command and Surveillance--Group 400 refers to all equipment and associated systems installed to receive information from off-ship sources, to transmit to off-ship receivers, and to distribute information throughout the ship. It also refers to sensing and data systems required for navigation and weapon fire control. Group 400 includes items such as: navigation equipment, interior communication systems, gun fire control systems, non-electronic countermeasure systems, electronic countermeasure systems, missile fire control systems, ASW fire control systems, torpedo fire control systems, radar systems, radio communication systems, electronic navigation systems, space vehicle electronic systems, sonar systems, electronic tactical data systems, on-board spares, repair parts, and tools.

Group 500 Auxiliary Systems--Group 500 refers to those systems required for ship control, safety, provisioning, and habitability. Group 500 includes items such as: auxiliary machinery, rudders, hydrofoils, diving planes, heating, ventilation, air-conditioning systems, refrigerating spaces, all liquid cargo piping, oxygen system, nitrogen system, aviation fuel systems, lubricating oil systems, plumbing installations, saltwater service systems, fire extinguishing systems, fresh water systems, scuppers, deck drains, fuel and diesel systems, tank heating systems, compressed air systems, steam drains, buoyancy control systems, distilling plant, steering system, mooring systems, towing systems,

anchor systems, deck machinery, elevators, moving stairways, stores strike-down and handling equipment, operating gear for retracting and elevating units, replenishment-at-sea and cargo handling systems, on-board spares, repair parts and tools.

Group 600 Outfit and Furnishings--Group 600 refers to the outfit equipment and furnishings required for habitability and operability, which are not specifically included in other Hardware Elements. Group 600 includes items such as: hull fittings, boats, boat stowage and handling, rigging and canvas, ladders and gratings, non-structural bulkheads, doors, painting, deck covering, hull insulation, storerooms, stowages and lockers, utility spaces equipment, workshops, laboratories, test areas, galley outfit, pantry outfit, scullery outfit, commissary outfit, living space furnishings, office furnishings, control center furnishings, machinery space furnishings, medical/dental/pharmaceutical space furnishings, non-propulsion space shielding, on-board spares, repair parts, and tools.

Group 700 Armament--Group 700 refers to armament and related ammunition handling, stowage, and support facilities; and cargo munitions handling, stowage, and support facilities. Group 700 includes items such as: guns and gun mounts, ammunition handling and stowage systems, special weapons handling and storage, missile launching devices, missile handling systems, missile stowage systems, torpedo tubes, torpedo handling and stowage, small arms and pyrotechnic stowage, air launched weapons handling system and stowage, cargo munitions handling and stowage, on-board spares, repair parts, and tools. The costs of expendable ordnance (missiles, mines, torpedoes, ammunition, etc.) or attached air assets (helicopters, Remotely Piloted Vehicles (RPVs), etc.) are not included in Hardware Group 700 as these are covered under Programmatic elements (ESWBS item F20 of Shipboard Load-out Items).

(ii) Software Elements

The Software group pertains to all cost elements identified in ESWBS Group 100 through 700 for developing, implementing, and maintaining computer programs and, like the Hardware group, generally pertains to the industrial type effort only.[3] In general, Software costs are not incurred until the Design and Development phase of a NATO Program. Included in the cost of software is all labor, material and overhead cost required for the following types of work:

[3] Some computer software is developed for functions that fall under the CWBS Design and Support Service and Programmatic groups such as: Land Based Test Sites (LBTS), ship tests and trials, logistics, training, Computer Aided Design and Manufacturing (CAD/CAM), Cost and Schedule Control, Project Management, etc. Firmware, the material medium on which software circuitry is implemented, is included in the Hardware group.

developing requirements, specifications, and prototypes; writing source code; compiling and debugging; installation; testing; training; developing documentation; and maintenance. The Software group can be separated into two categories:

(1) Ship Systems Software

This category refers to software developed for platform subsystems (CWBS Hardware Groups 100, 200, 300, 500, and 600). This includes software for: ship control systems, damage control systems, data-bus systems, etc.

(2) Command, Control, Communication (C^3), and Armament Software

This category refers to software developed for payload sub-systems (CWBS Hardware Groups 400 and 700). This includes software for: the ship's combat direction systems, C^3 data processing systems, data-bus systems, etc. and shipboard software for load items such as aircraft, missiles, etc.

(iii) Design and Support Service Elements

The Design and Support Service group includes all elements identified in ESWBS Groups 000, 800, and 900 and, like the Hardware group, generally pertains to the industrial type effort only. Design and Support Service costs are incurred across all phases of a NATO program. Two areas of major support services, Government Support and the NATO Program Office operations, are not included in the Design and Support Services group, but are listed separately in the Programmatic group. Due to the uniqueness of the responsibilities associated with these activities as well as the international funding considerations and unique national budgeting requirements, a special address in the Programmatic group is provided for them. A brief description of the ESWBS Groups 000, 800, and 900 is provided below:

Group 000 General Guidance and Administration--Group 000 contains elements, which accommodate a wide variety of applications. The major subgroups within Group 000 include:

Combat Capabilities	010
Strategic and Special Capabilities	020
Operational Support Capabilities	030
Ship System Management	040
Ship System Performance	050
Subsystem Characteristics	060
General Requirements for Design and Construction	070
Integrated Logistics Support (ILS) Requirements	080
Quality Assurance (QA) Requirements	090

Only the costs for development and preparation of general requirements (for ship system performance, planning, development, design, construction, and documentation associated with ship acquisition and maintenance) should be carried in Group 000; costs to execute ship acquisition and maintenance should be carried in the appropriate elements of Groups 100-900. Without a specific CWBS (see Chapter 7, Implementation Guidelines) or sufficient definition to enable a division of costs between Groups 000 and 800, costs should be allocated to Group 000 in the Mission Need Evaluation, Pre-Feasibility, Feasibility and Project Definition phases.

The work involved in determining capabilities, performance concepts, and characteristics includes assessment of threats, identification of mission, preliminary selection of ship system equipment, researching alternative solutions, preparation of written documentation, and establishing requirements for design, construction, ILS, and QA. Work required in the early stages of development (Mission Need Evaluation, Pre-Feasibility, Feasibility) would be located in Group 000. These types of work may also be applicable to the subsequent project phases.

Group 800 Integration/Engineering-- The integration and engineering element refers to that engineering effort and related materials associated with the design and development of the ship. The work included in Group 800 includes: drawing development and maintenance, production engineering, mass properties engineering, design support, quality assurance, integrated logistic support engineering, repair planning, and preparation and planning for special purpose items and systems. The types of tasking identified by the Group 800 elements are applicable in all phases of NATO programs. Software associated with Group 800 should be accounted for in Group 834.

Group 900 Ship Assembly and Support Services--The ship assembly element refers to work associated with ship construction and testing which is not included in ESWBS Groups 000 through 800. The elements in Group 900 include: staging, scaffolding and cribbing, temporary utilities and services, molds, patterns, templates, jigs, fixtures, special production special tools and test equipment, dry-docking, contractual and production support services, insurance, trials, tests and inspection, and delivery. In general, the types of work identified by the Group 900 elements principally apply commencing with the production phase of a NATO program.

(iv) Programmatic Elements

The cost elements that are incurred in a NATO ship program, but are not readily captured by the ESWBS Groups 000 through 900 format are designated as Programmatic. Annex C provides a listing of Programmatic elements.

Programmatic costs are incurred across all phases of a NATO program and pertain to both the governmental (excluding GFE or GFM) and industrial type effort. These elements include peculiar budgeting requirements, escalation provisions, government regulatory requirements, contingencies, government support activities, and NATO program office activities. In addition, the shipboard load-out items (specified as "F" items in the ESWBS) are categorized as Programmatic items. The major subgroups in the Programmatic category include:

P10 Budgeting Practices--This subgroup includes a variety of cost elements involved in establishing sell prices from actual shipbuilder's production costs. These elements include factors such as contract incentives, shipbuilder profit, revenue dependency, industrial benefits, etc., when not covered in the Hardware, Software or Design and Support Services elements.

P20 Escalation--This subgroup accounts for the costs incurred as a result of inflation from the reference date (base date) of the estimate through the actual planned contract execution period. Included in this category are costs incurred as a result of both year-to-year inflation and within-contract, time-phased escalation outlays.

P30 Law and Government Regulations--This subgroup accounts for costs incurred as a result of the inclusion of taxes, tariffs, duties, social security, etc., as well as costs associated with data rights, licensing, and royalties, when not covered in the contractors' overhead rates.

P40 Contingencies--This subgroup accounts for costs that may arise in certain foreseeable circumstances but which cannot be accurately quantified. Some types of contingency factors that are used in establishing ship cost estimates are margins, contract change orders, and management reserves. Typically these allowances are estimated to cover unanticipated delays and technical problems that occur during design development and contract execution.

Margins differ somewhat from other contingencies. Margins specifically allow for changes in the ship's weight that generally takes place during design, development and construction of the ship. Margins cover inherent limits of precision in initial weight estimates, undefined variations of component weight and unknown additions. These weight margins allow for changes in all ship design parameters (propulsion power, electric power, crew size, survivability requirements, ship's speed, etc.). As the weight of the ESWBS Hardware group increases during the design process, margins are depleted (consumed) in equivalent amounts. These margin weights are accounted for in ship cost estimates and provide cost contingencies to cover the various changes in the ship design as it matures. Margin types are listed below (ESWBS "M" Group):

SUBMARINE	SURFACE	TITLE
M10	M10	Contractor Controlled Margins
M11	M11	Design and Building Margins
M12	M12	Building Margin (Reserved--see below note)
M30	M20	Government Controlled Margins
M31	M21	Preliminary Design Margin
M32	M22	Contract Design Margin
M33	M23	Contract Modification Margin
M33	M24	Government Furnished Material Margin
M35	M25	Future Growth Margin
-	M26	Service Life Margin
M34	M27	Nuclear Machinery Margin
M36	-	Stability Lead Status
M37	-	Trimming Lead Status
M40	-	Ballast Status (Lead and Steel)

Note: M12 is only used in the event that visibility for the Building Margin is desired to be separate from the M11 element.

P50 Government Support Activities--This subgroup accounts for costs incurred by government activities (national project management offices, laboratories, ranges, etc.) which support the ship program. This subgroup includes government support activities for: design, ILS planning, test and evaluation, systems engineering, project management, data, technical publication, maintenance, and computer software. The costs incurred with the establishment and operation of land based test site(s) are included in this group. Government support is applicable in all NATO program phases.

P60 NATO Program Management Office (PMO) Activities--This subgroup accounts for costs incurred in establishing and operating an international NATO Program Management Office. NATO PMO activities are applicable during all phases of the program.

P70 Shipboard Load-out Items--The cost of providing the carried-on-board stores, fuels, lubricants, water, and expendable ordnance are included in this subgroup. Load-out item types are listed below (ESWBS "F" group):

F10 Ships Force, Amphibious Force, Troops & Passengers
F20 Mission Related Expendables and Systems
F30 Stores

F40 Fuels and Lubricants
F50 Liquids and Gases
F60 Cargo
F70 Sea Water Ballast

P80 Disposal—This subgroup accounts for the act of getting rid of surplus, scrap, or salvage property. It includes the processing of the ship for disposal at the final phase of its life cycle such as environmental compliance, sale, donation, destruction, etc. as the case may be.

SECTION 3(b) Common and Unique Elements

The NATO Ship CWBS provides for a breakdown between elements that are common to all nations and elements that are unique to some nations. When the location of the element within the CWBS is established, the element should be identified as common or unique (see Figures 3 and 4). Common elements are those cost elements of the baseline configuration of a collaborative NATO ship program that are applicable to all participating nations. Unique elements are those cost elements which either differ from the baseline configuration of a collaborative NATO ship program or otherwise are not applicable to all participating nations. The common and unique elements are further separated into nonrecurring and recurring categories as specified below:

(i) Nonrecurring Elements

(1) Common: In any phase of a NATO program, nonrecurring cost elements are one-time items that are part of the NATO baseline design requirements or configuration. The cost of these items is generally limited to the industry effort and the cost of operating an international program office. These costs may be shared between the participating nations (the cost sharing may be based on quantities procured during production or allocated based on the capital outlay of the respective nations or other agreed means).

(2) Unique: In any phase of a NATO program, unique nonrecurring cost elements are one-time cost items that are the result of national deviations from the baseline design requirements or configuration. For example, if one or more of the participating nations require that their ships be outfitted with a radar system different from the radar system specified in the baseline design, all nonrecurring elements associated with the design of the alternative configuration are considered unique. The nation(s) requiring the alternative configuration would bear all costs associated with the nonrecurring design effort for the alternative configuration.

(ii) Recurring Elements

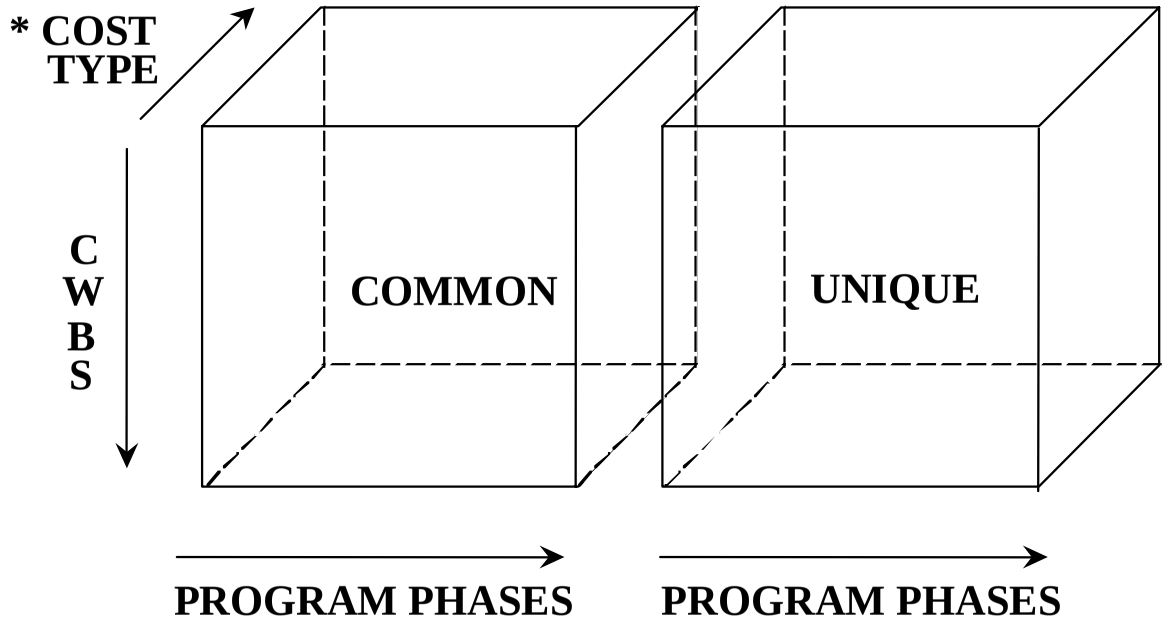
(1) Common: Items in the Production and In-Service phases that pertain to the baseline design requirements or configuration and are repeated for each ship are identified as recurring common elements. The costs of these items are borne by each nation in the cost of their respective ship purchases and generally include only the industrial effort. The respective national government support costs are considered unique and are not included.

(2) Unique: Items in the Production and In-Service phases that deviate from the baseline design requirements or configuration and are repeated for each ship are identified as unique recurring elements. For example, as with the nonrecurring unique, if one or more of the participating nations require that their ships be outfitted with a radar system different from the radar system specified in the baseline design, all associated hardware and installation costs are considered unique to those nations. The nation(s) requiring the alternative configuration would bear all costs associated with the alternative configuration.

(iii) Multi-Dimensional Aspects

Figures 6 and 7 graphically depict the multidimensional character of the NATO CWBS. These figures show how the NATO CWBS accounts for cost type (e.g., by recurring and nonrecurring, by nation, by cost share, by work share, etc.) across the NATO Program Phases and the separation of common and unique costs. The summation of all costs equals the Program total cost to the level of the NATO LCC hierarchy desired. The cost type axis also provides flexibility to use any agreed to alternative CWBS and to map from a particular cost breakdown to the NATO CWBS described herein.

NATO SHIP CWBS
MULTIDIMENSIONAL ASPECT



* Cost Type can pertain to many categories (e.g.; Recurring or Nonrecurring, by nation, by cost share, by work share)

FIGURE 6

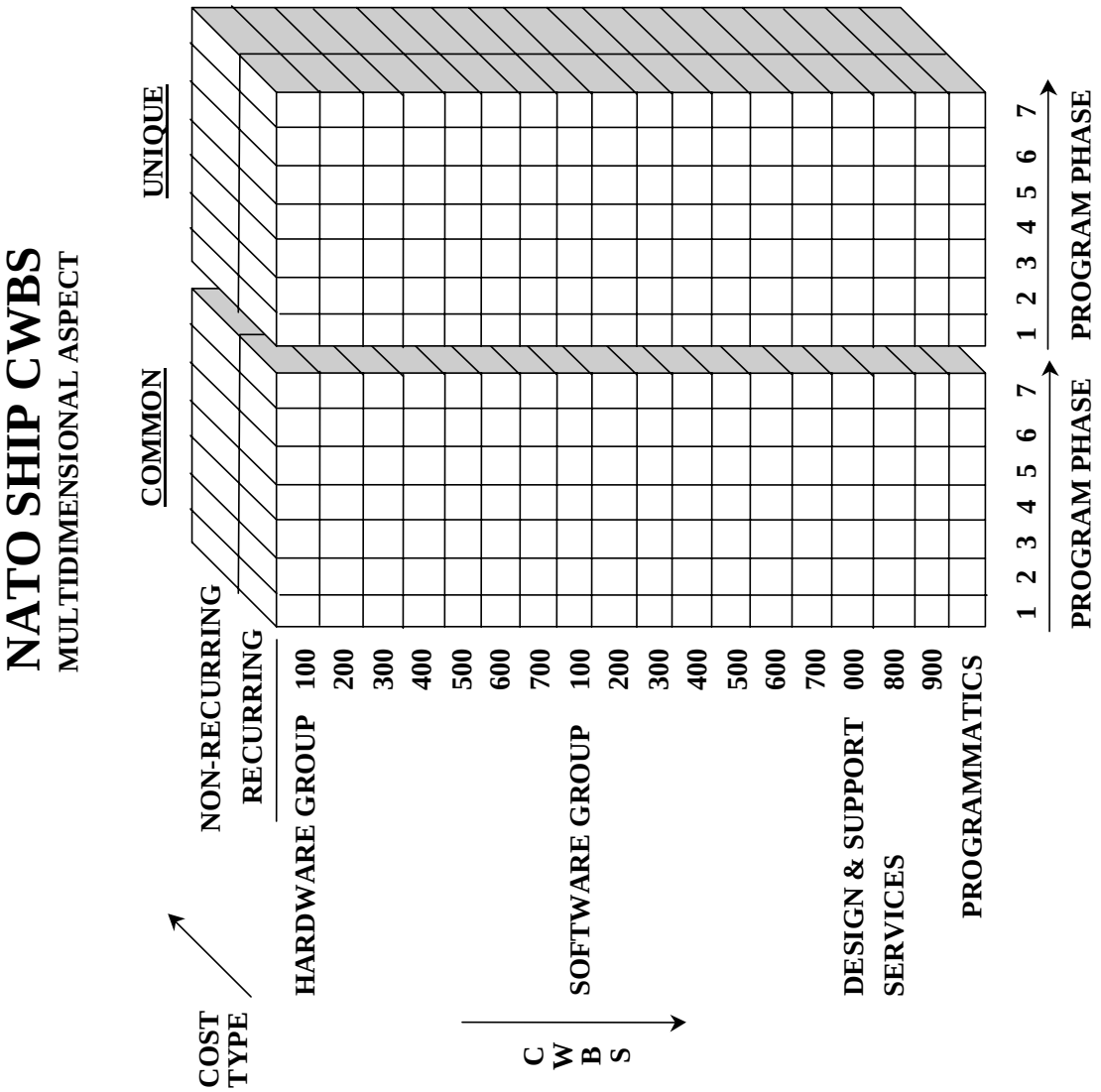

NATO SHIP CWBS
MULTIDIMENSIONAL ASPECT
COMMON
UNIQUE
NON-RECURRING
RECURRING
COST TYPE
HARDWARE GROUP 100 200 300 400 500 600 700
SOFTWARE GROUP 100 200 300 400 500 600 700
DESIGN & SUPPORT SERVICES 000 800 900
PROGRAMMATICS
CWBS
1 2 3 4 5 6 7
PROGRAM PHASE
1 2 3 4 5 6 7
PROGRAM PHASE

FIGURE 7

SECTION 3(c) In-Service (Operating and Support) Cost Categories

A system-oriented CWBS is reflected in the NATO Ship CWBS and may be the desired breakdown of costs in some situations (e.g., identification of cost drivers by ship system or management of the industrial effort in a shipyard or depot). All elements of Operating and Support (O&S) costs are accounted for in the NATO Ship CWBS. In some cases, the alternate NATO O&S cost categories contained in Figure 8 may be more conducive to estimating and presenting O&S costs (e.g., for analysis or review purposes, organizational accounting or availability of data). Consequently, O&S costs may be displayed in either the CWBS format or the format of Figure 8. The choice may be driven by, *inter alia*, the need to align with the way nations estimate ship ownership costs, the way nations collect data, and the availability of databases. Depending on the need, O&S costs may also be determined on a cost per ship per year basis and then be summed over the ship's service life to arrive at the total In-Service portion of life cycle cost. In any case, the O&S cost estimate should be presented in a manner that provides the visibility necessary and relevant to the review of issues and cost drivers that are of key importance in the decision process. The element structure should be selected to illuminate and facilitate the review of cost drivers and accounting elements as the need indicates. However, the selected O&S cost categories should not arbitrarily change as the project progresses through the NATO ship program phases. O&S costs are generally not incurred prior to the Production phase. A further description of the alternative major O&S categories is provided below and Annex E provides a more detailed breakdown to the next level of each category. Reference (m) lists national life cycle cost breakdown structures for military systems for Belgium, France, Netherlands, Turkey, United Kingdom and United States. The O&S portion of these structures is listed in Annex E herein for these nations.

Personnel--This category contains the cost of pay and allowances for personnel assigned to the ship. It includes the personnel necessary to meet combat readiness, training and administrative requirements and covers base pay, allowances, and contributions by the government to federal social security and retirement funds. Costs are based on manning levels and skill categories rather than cost per hour. The elements of cost included or not included in the cost of navy personnel vary from nation to nation. Annex F provides a delineation of Personnel elements of cost.

Consumables--This category contains the costs of energy required for peacetime operations, the costs of material consumed in the operation, maintenance and support of the ship, and the costs of expendable stores consumed in the training of the crew. It includes items such as the following: petroleum, oil, lubricants, additives, batteries, nuclear power, commercial and field electricity, stores materials, supplies, ammunition, sonobuoys, pyrotechnics, etc.

NATO Alternate Operating & Support Cost Categories for Ships

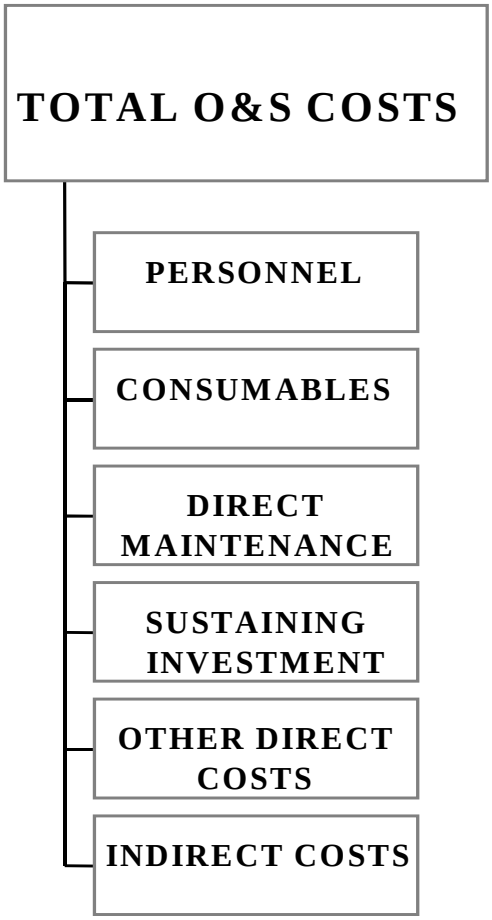


FIGURE 8

Direct Maintenance--This category covers the cost of personnel, material, contractual services required to perform maintenance or modification of the ship, ship system, components and support equipment at government or industry repair facilities or on site by repair teams or at intermediate repair activities (Ashore or Afloat).

Sustaining Investment--This category covers the replenishment of the inventory of spares and repair parts that are retained in stock, the costs of modifying ship platform or payload systems and support and training equipment (to achieve acceptable safety levels, overcome capability deficiencies, improve reliability, etc.). Also included are mid-life conversions and refit programs.

Other Direct Costs--This category covers other significant logistic or operating and support costs for items not specifically included in another O&S category. Included are the costs of equipment, services, information, helicopter O&S costs, trainers, simulators, second destination transportation, etc.

Indirect Costs--This category applies to costs that are required during the service life of the ship but are not directly related to a particular ship or subsystem. These costs include installation support (base operation), personnel, medical and dental personnel, personnel support (operations maintenance and permanent change of station), personnel acquisition and training (recruiting and basic and technical schools).

SECTION 3(d) CWBS Implementation

Application of the aforementioned CWBS concept will enable the participating nations to effectively capture all affected costs through all phases of a NATO program. The costs incurred in the development phases of a program are captured in the Design and Support Services and Programmatic groups. The costs incurred in the Production and In-Service phases of a program are captured in the Hardware, Software, Design and Support Services, and Programmatic groups. However, in any multinational program, it is conceivable that a further segregation of cost elements may be required to facilitate the accounting necessary to isolate shared and unshared costs or other peculiar requirements. Therefore, flexibility may be employed in structuring the CWBS of future ship programs but its practice is not recommended in the interest of preserving the maximum standardization among NATO ship programs. Adherence to the NATO CWBS described herein, to the maximum extent practicable, is recommended but special accounts may be added where deemed necessary.

CHAPTER 4. TOTAL OWNERSHIP COST

SECTION 4(a) Total Ownership Cost, Program Life Cycle Cost, and Whole Life Cost

The name used to describe the sum of all "attributable" costs of a program is the phrase "Total Ownership Cost" or "TOC". TOC analysis is a holistic approach to understanding all the costs that are affected by the existence or introduction of a naval program or project and is a key affordability assessment and decision-making tool. Although national experience, definitions, opinions and approaches vary widely, the concept of TOC is considered by nations to be an important method and the “way of the future” towards identifying *all affected* costs as a consequence of a program decision. TOC analysis aids in balancing near-term acquisition phase affordability constraints with the long-term life cycle cost objectives. The goal is to reduce the cost of ownership and thereby free up funding for modernization and re-capitalization of weapon systems, e.g., ships.

TOC is defined synonymously with the term "Program Life Cycle Cost"(PLCC) in terms of capturing direct costs associated with the design, development, procurement, operation, support, and disposal of a weapon system. However, as described in reference (b), PLCC does not generally include all indirect elements that are linked to a program’s existence. So when referring to TOC, the aim is to present an LCC that unambiguously includes all elements of cost (direct and indirect) that are linked to (affected by) the existence of a program. Linked-indirect costs (included in TOC but not PLCC) include variable indirect costs of manpower[4] and fixed indirect costs for such things as common support systems that benefit more than one program and the infrastructure that plans, manages, and executes programs. Thus, TOC captures all direct and indirect costs of an acquisition program (e.g., costs or cost impacts that would not occur if the program did not exist).

Beyond the bounds of TOC exist other costs (e.g., family housing, ceremonial units, basic training, headquarters and staff, etc) that are required in a nation’s navy or defence operations that are not linked and not affected by a program’s or project’s existence or introduction. These are referred to as “non-linked” costs and when added (by allocation) to TOC are referred to as “Whole Life Costs” (WLC)[5].

[4] See Appendix F.
[5] See reference (m).

The following terms, applied at the navy ship program level, are key to the discussion of PLCC, TOC and WLC:

- Linked Costs
- Non-Linked Costs
- Fixed Costs
- Variable Costs
- Direct Costs
- Indirect Costs

The definitions of these terms are found in ANNEX A.

Combinations of the above terms are used when determining the elements of cost that apply to PLCC, TOC and WLC as shown below in Figure 9.

TOC Cost Domain

	Cost Type	PLCC	**TOC**	WLC
Affected	Linked-Direct-Fixed	X	**X**	X
	Linked-Direct-Variable	X	**X**	X
	Linked-Indirect-Fixed		**X**	X
	Linked-Indirect-Variable		**X**	X
	Non-Linked			X

- PLCC = Program Life Cycle Cost
- TOC = Total Ownership Cost
- WLC = Whole Life Cost

FIGURE 9

SECTION 4(b) Total Ownership Cost Concept

The purpose of determining the TOC of a vessel is to enable informed and improved cost management (determining the use of services between systems, budgeting, financial analysis, optimization, and in-service program management). The aim is to provide more transparent information that can be used to:

- Make design tradeoffs between capability features and affordability constraints,

- Improve the quality and completeness of information for use in balancing near-term affordability effects with the long-term objectives of reducing the “ownership costs” of programs, while sustaining or improving military performance and safety; and
- Reduce the cost of ownership (operating, supporting and disposing) and thereby free up funding for modernization and re-capitalization.

SECTION 4(c) TOC Approach as a Cost Analysis Tool

Reference (m) lists the following definitions and uses for PLCC, TOC and WLC:

PLCC – Program Life Cycle Cost consists of all direct costs plus indirect-variable costs associated with the procurement, O&S and disposal of the system. Indirect costs may include linked costs such as additional common support equipment, additional administrative personnel and non-linked costs such as new recruiters to recruit additional personnel. All indirect costs related to activities or resources that are not affected by the introduction of the system are not part of PLCC. PLCC comprises the marginal costs (both direct and indirect) of introducing a new equipment or capability. PLCC is used as a minimum for the analysis of alternatives; it does not include notional allocation of costs, whereas TOC and WLC might do so. PLCC is often used for economic analyses. (Note: This definition is the same as the NATO Ship Cost LCC Hierarchy term TLCC)

TOC – Total Ownership Cost consists of all elements that are part of PLCC plus the indirect, fixed, linked costs. These latter may include items such as common support equipment, common facilities, personnel required for unit command, administration, supervision, operations planning and control, fuel and munitions handling. TOC represents all costs associated with the ownership of a system except non-linked fixed costs that are related to the running of the organization. TOC is used for budgeting purposes, determining the use of services between systems, for optimization purposes and for financial analysis.

WLC - Whole Life Cost consists of all elements that are part of TOC plus indirect, fixed, non-linked costs. These latter may include items such as family housing, medical services, ceremonial units, basic training, headquarters and staff, academies, recruiters. In WLC, all

costs or expenses that are made by the organization are attributed to the systems or products they produce. As WLC represents the total budget provision including such elements as headquarters cost, it allows the visibility of the complete allocation of funds. WLC is used for a strategic view and high level studies.

In addition to the economic, financial and strategic uses cited in reference (m), an aim of TOC as an analysis tool is to more completely account for all costs affected by the introduction of a new system or capability, and to do so in a way that permits a comprehensive understanding of the cost drivers and costs versus benefits of ship design and program decisions. This will permit a cost-conscious design trade-off perspective of choices and alternatives at stages of programs where cost reduction and cost effectiveness can be most influential. It will also highlight opportunities for leveraging common products and processes across programs (e.g., balancing or optimizing industrial base resource utilization).

It is highly desirable to identify a comprehensive picture of all affected costs of a decision alternative along with identification of the cost drivers and the phasing of the cost impacts to be able to perform a cost-benefit analysis for the scenario or scenarios being analyzed. For a ship program, the high level cost drivers are illustrated versus the capabilities desired in Figure 10. These cost drivers can be time-phased and discounted to obtain the present value cost-versus-benefit of the new system or capability as compared to the predecessor system or system alternative. Informed decision-makers, ship designers and program managers can then set realistic cost thresholds and objectives and take steps to manage within economic constraints or resource limitations.

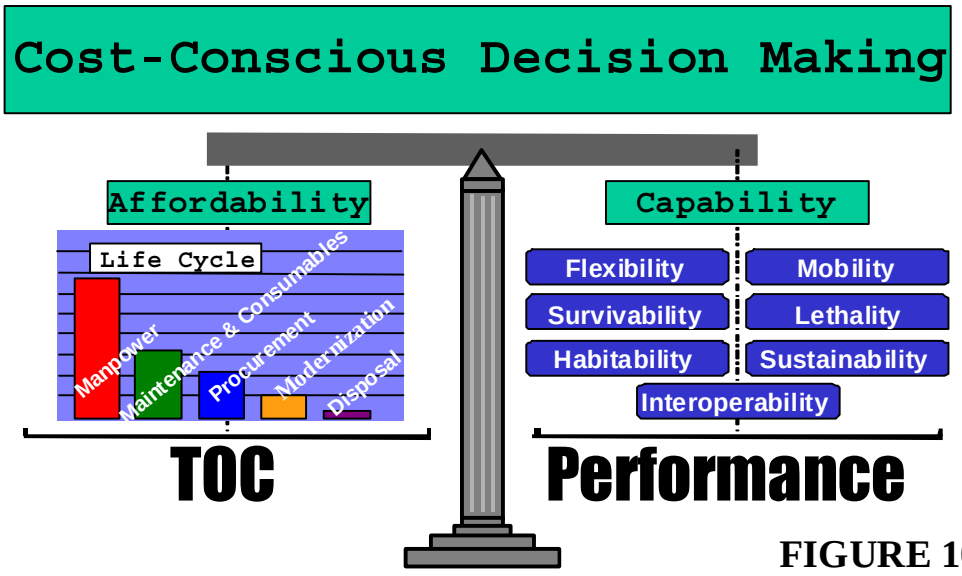


FIGURE 10

SECTION 4(d) Approach to TOC for NATO Ship Costing

Consideration of total ownership cost is important in system acquisition, design, logistical planning, budgeting and financial analysis due to the significant amount of money involved and the associated opportunity for cost reduction, cost avoidance, capability improvement, and the ability to modernize and re-capitalize assets. However, databases and methodologies may not permit the more comprehensive TOC approach to be readily applied amongst all NATO nations. Therefore, a pragmatic and flexible approach may be employed to address the various levels of TOC but with the aim of making transparent all the “affected” costs of a ship program.

The flexible approach involves a hierarchical build-up of the LCC. First the Initial Construction Sail-away and Acquisition costs are determined. Then the remaining linked-direct costs of the In-Service and Disposal Phases are added to achieve the lowest LCC level, the PLCC. Subsequently, linked indirect variable costs of manpower are added to achieve the next highest level of LCC, the TLCC. Finally, linked indirect fixed costs are added to achieve the TOC level that reflects all the affected costs of the ship project or program. Should the need arise, there is one additional level in the hierarchy, the WLC, that adds any non-linked costs to reflect the total budget provision.

The flexible approach described above is depicted in the hierarchy of costs shown in Figure 1. This structure in intended as a guide to make it possible to address costs in a common way depending on the needs of a NATO ship project, the need for transparency, and the abilities of the participating nations to address them. In tabular form, the levels of the hierarchy from lowest to highest are:

- Sail-away Cost (or Initial Construction Cost)
- Program Acquisition Cost
- Program Life Cycle Cost (includes all life cycle linked-direct costs)
- Total Life Cycle Cost (PLCC plus indirect-variable manpower costs)
- Total Ownership Cost (TLCC plus linked- indirect-fixed costs)
- Whole Life Costs (TOC plus non-linked costs)

The cost composition of each hierarchy level is described below.

Sail-Away Cost: Sail-away cost (or Initial Construction Cost) includes:

- SWBS elements such as basic structure, propulsion, electronics, etc., Shipyard Project Management, and System Test and Evaluation.
- All costs of the initial construction Non-Recurring and Recurring cost categories, including allowances for changes, warranties, first destination transportation, etc., and

- Allowances for excise duty, applicable sales taxes, freight and shipbuilder's overhead and profit.

Program Acquisition Cost: This cost includes the Sail-Away Cost plus the additional design and development costs of planning for and producing the ship and its systems, including modeling, simulation, prototypes, initial spares, etc., and associated program management. Program acquisition cost includes costs incurred during the first six phases of the NATO phased armaments programming system (PAPS): mission need evaluation, pre-feasibility, feasibility, project definition, design and development, and production. Program Acquisition Cost includes both recurring and non-recurring costs.

Program Life Cycle Cost: PLCC includes Program Acquisition Costs plus in-service and disposal costs of the program. PLCC includes only what is referred to as linked direct costs, since they are specifically associated with the development, procurement, operation and support of the specific weapon system, and would not otherwise be incurred by the Navy.

Total Life Cycle Cost: TLCC includes all costs covered in the Program Life Cycle Cost plus the variable indirect costs associated with Navy manpower. Examples of variable indirect costs include such things as recruiting, training, medical support and the costs of acquiring facilities or support materials.

Total Ownership Cost: TOC includes all linked direct and indirect costs associated with the research, development, procurement, operation, logistical support and disposal of a weapon system, including the total supporting infrastructure that plans, manages, and executes the program over its full life. TOC includes the cost of requirements for common support items and systems (e.g. supply ships, ashore facilities, etc.) that are incurred because of the introduction of the weapon system but **excludes** “non-linked indirect ” infrastructure costs that are not affected by the individual weapon system development, introduction, deployment or operation.

Whole Life Cost: WLC includes all TOC elements plus any non-linked costs allocable to the new system or capability (used for a strategic view and high level studies). Non-linked costs include such items as: family housing, medical services, ceremonial units, naval staff, naval academies, naval postgraduate schools, etc., which are not specifically linked to the ship or ship systems, i.e., not linked to the ownership of a specific ship or weapon system.

CHAPTER 5. COSTING METHODOLOGY

The following discussion regarding costing methodology addresses the acquisition technical, program, and economic data, the in-service phase data, estimating approach and cost models for a NATO ship program.

SECTION 5(a) System and Program Definition

The framework for developing the cost estimates for a NATO collaborative ship program is complex and involves the establishment of a baseline ship design, industrial scenario and cost modelling approach. Additionally, national requirements that deviate from the baseline design must be identified.

To effectively create a program cost model and cost estimate for a project; it is essential to have a complete description of the project covering its entire life cycle span. For NATO collaborative programs, such a description should be laid out in a Cost Analysis Requirements and Assumptions (CARA) document as outlined in ANNEX H.[6] The CARA describes the ship program to be estimated and delineates the relevant data and assumptions that apply, with the aim of giving a complete representation of the ship program. As outlined, the CARA addresses twelve major elements pertaining to the associated cost estimate as follows:

- Purpose of Estimate
- Project Cycle
- Ship Capabilities
- Ship Characteristics
- Build Program
- Operational Profile
- Support Profile
- Manning Complement
- Acquisition Strategy
- Economic Conditions
- Environmental Issues
- Risk

Thus the CARA is the document that sets out the project technical description and key assumptions that then establish the basis of the estimate.

The types of data required in order to price out any NATO ship construction program include ship design data, program schedule and acquisition strategy (industrial scenario), and economic data. The In-Service data includes

[6] Some nations have documents similar to the CARA that support their respective cost estimating processes. Two examples are the Master Data and Assumptions List (MDAL) of the UK and the Cost Analysis Requirements Description (CARD) of the US.

the particulars of the crew size, fuel consumption, maintenance cycle, modernization updates, etc, environmental compliance requirements and the end of life disposal method for the given ship type. The types of data required are outlined below and further detailed in ANNEX H.

The ship design data includes:

- Ship architectural design weights,
- Ship characteristics (physical and performance, design standards, technologies, etc.), and
- Equipment lists (including the ship's payload).

The program schedule and acquisition strategy include:

- Number of participating nations,
- Number of ships and building yards per nation,
- Work sharing plan,
- Cost sharing plan,
- List of items to be centrally procured,
- Potential sources of the various commodities and major equipment or ship subsystems, and
- Competition strategy.

The economic data includes:

- The historical first unit costs for labor and material,
- Labor and material learning curves,
- Cost estimating relationships (CER's),
- Material quotations,
- Analogous subsystem costs,
- Shipyard labor and overhead rates,
- Currency exchange rates, and
- Inflation forecasts.

The In-Service data includes (assuming peacetime operations):

- Manpower estimate (ship’s crew/complement),
- Maintenance cycle (depot availability schedule and length)
- Maintenance concept (crew, depot, rules subject to, etc.)
- Modernization cycle or planned schedule
- Fuel consumption rate(s)
- Steaming hours underway and not underway
- Disposal method(s)

Ship design data must be obtained from the Program Management Office (PMO) for the program. The program schedule, acquisition strategy, and in-service data must be obtained from the PMO. Economic data must generally be obtained from the participating nations based on their national experience or from

industry quotations in response to a request for quotation specifically for the program (except for items such as currency exchange rates that are openly published).

During the phases prior to Production, inflation forecasts and escalation estimates should be made using generally applicable official publications--such as those from National Statistical Offices--since these are the only accessible, relevant sources of information available at that early point of time. Examples of publications of the National Statistical Offices are: (to be checked with during program execution)

BE INDICE MENSUEL DES PRIX À LA PRODUCTION INDUSTRIELLE
Ministère des Affaires Economique-Bruxelles

CA DND Economic Model (A Price Trend Forecast) Department of National Defence

GE STATISTISCHES BUNDESAMT WIESBADEN
Preise und Preiseindizes für industrielle Produkte

FR BULLETIN MENSUEL DE STATISTIQUE
Institut National de la Statistique et des Etudes Economiques Paris
BULLETIN OFFICIEL
Bulletin Officiel Des Services des Prix

IT BOLLETTINO MENSILE DI STATISTICA
Instituto Centrale di Statistica Roma

NL MAANDSTATISTIEK VAN DE PRIJZEN
Centraal Bureau voor de Statistiek

SP INSTITUTO NATIONAL DE ESTADÍSTICA
Bolitín de Estadística
Indicadores de Coyutura
Indices de Precios Industriales

UK TRADE AND INDUSTRY
Statistics Division, Department of Industry,
Sanctuary Buildings
Great Smith Street, London SW1P 3DB

US WHOLESALE PRICES AND PRICE INDICES
US Department of Labor

During the course of program execution, this data should be reviewed and may require modifications to serve project related needs or to supply detailed figures required for the respective contract agreements.

When making comparisons of technical concepts, the influence of the cost accounting method of every individual nation must be reduced as far as possible or preferably eliminated. The following principles represent guidelines towards commonly applicable cost calculation and cost allocation procedures:

1) The prices for industrial efforts are to be determined in accordance with national pricing and accounting practices. The prices should include: (a) all elements usually incorporated in similar national contracts and (b) the value of any subsidies provided to the supplier.

2) Services provided by the public or governmental sector must include all directly attributable cost, such as work time and material. If overhead costs and/or costs for deprecation of used equipment is included, this should be explicitly identified.

3) The cost of any Government Furnished Equipment is to be included and stated as part of the cost of the governmental sector and should appear against the relevant CWBS element.

SECTION 5(b) Estimating Approach

All costing terms referred to in this portion of the report are as defined in Annex A. For cost estimating purposes the agreed level of life cycle cost (PLCC, TOC or WLC) may be divided into two basic categories, Acquisition costs and In-service costs. However the approach with respect to ship design, program definition, and economic factors is essentially the same. The phase of the program affected dictates whether the costs are categorized as Acquisition or In-Service.

The recommended estimating approach for acquisition and in-service costs is addressed in the following paragraphs by major CWBS element: Hardware, Software, Design and Support Service, and Programmatic. The level of detail to be provided in the estimate must be determined according to the availability of data at the time of the estimate. Average ship costs will be determined for three scenarios: Collaborative, Collaborative National, and Non-collaborative. Costs will be expressed in agreed currency units (e.g., Dollar, EURO, British Pound, etc.) with an agreed reference date to establish constant (with respect to time) units of cost. A single reference currency may be desirable for expression of multinational cost estimates and cost targets. However, the participating nations will agree on the selected currency at the start of the project

along with the means to convert from source national currencies to the selected currency.

All cost elements will be defined and categorized as either common or unique and recurring or nonrecurring as previously described in the CWBS portion of this section. The multinational average ship cost estimate will include only those items of scope that are contained in the baseline configuration. Project lead ship over-cost elements are excluded from average ship costs and will be identified and estimated in the same manner with respect to reference date and currency. National lead ship nonrecurring costs are excluded from the average ship costs. Each nation is responsible for separately determining the average ship cost provided by the PMO to its own national currency. Likewise, each nation is responsible for determining its own unique cost element estimates (with respect to scope, government support costs, budgeting practice, national lead ship, or other requirements) and adding or subtracting from the average ship cost estimate to determine its national cost estimate (suitable for national budgeting and decision making purposes).

In-Service costs are a function of the mission and operational tempo of a ship for a given nation. For purposes of a collaborative program, peacetime operations will normally be assumed. In-Service costs depend on the crew size, fuel consumption, maintenance cycle, modernization updates, etc, environmental compliance requirements and the end of life ship disposal method for the given ship type. For collaborative program costing purposes, it may be useful to establish a design reference mission profile as a baseline for costing. A manpower estimate reflecting the ship's workload and watch-station policy for the ship should be provided by the PMO. The respective manpower rates (direct and indirect) can then be applied to arrive at the manpower cost estimate. Fuel costs and consummables can be determined based on the steaming hours of the design reference mission. Other elements of O&S costs may be estimated by analogy, parametric or bottoms-up engineering approaches as the data permits or as deemed appropriate. Each nation must determine its own estimate of In-Service costs of its ships.

(i) **Hardware Elements**

(1) **Platform**--Platform costs consist of ESWBS Groups 100, 200, 300, 500, 600, Group 700 handling and stowage equipment, and the installation and integration costs for Groups 400 and 700 equipment. The platform direct labor and material costs are generally determined in the following manner. The man-hours per ton for the first ship of an average shipyard are applied to the ship design weights for ESWBS Groups 100-700 to arrive at the

shipyard construction man-hours for the first ship.[7] An average labor learning curve is applied to arrive at each subsequent ship's required man-hours. Average labor rates (direct and indirect) are then applied to the estimated man-hours to arrive at total labor costs. Average learning curves are applied to average experience data for non-quoted material. The non-quoted material is then added to material quotations from industry (potential sources for major equipment) to arrive at total shipbuilder-supplied material costs. The total labor and material costs are added and a shipbuilder profit is added to arrive at total average shipbuilder costs. Any government-furnished items are estimated separately and added to the shipbuilder costs to arrive at the total platform hardware cost.

(2) **Payload**--Payload costs consist of the electronic and ordnance equipment (ESWBS Groups 400 and 700), excluding installation, integration, and Group 700 handling and stowage equipment costs. The Group 400 and 700 equipments are separately estimated through analogy, parametric or engineering bottoms-up estimates. These may be performed by the PMO or may be received as direct industry quotations or may be provided by a supporting PMO for the particular subsystem.

(ii) **Software Elements**

Software costs are generally arrived at by estimating the required volume (source lines of code (SLOC)) of each type of software required, through parametric, analogy or engineering bottoms-up means. A productivity rate (SLOC volume that can be produced per day) for the various types of software code (mission critical, tactical, integration, maintenance, safety, security, COTS, etc.) is then determined and applied to the respective SLOC estimates to arrive at the number of man-days required. Then an average cost per man-day (in agreed currency units) is determined and applied to arrive at the software estimate total(s).

[7] Although weight is utilized as a parameter of cost in ship cost estimating, other parameters may be more appropriate to reflect actual design requirements (e.g., horsepower, kilowatts, speed, length of cable, pipe, etc.). Also, the use of weight as a parameter of cost must be applied carefully as a weight change may not always result in a proportional cost change. For example, a decrease in weight could produce an increase in cost.

(iii) **Design and Support Service Elements**

The ESWBS Group 000, 800 and 900 categories are generally estimated through engineering analysis or as a function of Hardware costs. For the pre-production effort, these costs are usually derived from engineering analysis. For production estimates, percentage factors are derived from appropriate national data of the participating nations and are applied against ESWBS Groups 100- 700 total costs to arrive at the Design and Support Services cost for each ship.[8]

(iv) **Programmatic Elements**

The programmatic elements, including government support costs that are common to or shared by the nations, are estimated using the appropriate international average data. These costs are estimated using parametric, analogy or bottoms-up engineering approaches as the data permits or as deemed appropriate.

(v) **Capital Cost**

The sum of the common portion of "Platform" and "Payload" recurring acquisition costs equals the "Capital Cost" of a ship in NATO terminology. **Capital Cost represents the highest level of commonality of costs among NATO nations at which a comparison of acquisition costs can feasibly be made.** This term derives from experience in NATO and the scope of effort included is the same as for the NATO terms "average ship cost" and "average ship cost target."

(vi) **Linked Costs**

It is important in a NATO collaborative ship program to have complete transparency in the cost estimates. Thus it is necessary to address all “affected” costs of such a program. Affected costs means all costs that are “linked” to a program’s introduction or existence and encompass cost elements of every phase of the PAPS. Cost elements that should be carefully scrutinized when evaluating the cost impacts of a program should include the following linked indirect costs:

[8] Adjustments may be necessary where the historical factors are not fully representative of the actual effort anticipated. These adjustments are generally made through the application of engineering judgement or analogies that better represent the technical or other parameters of the scenario.

- Variable indirect manpower (recruiting, training, medical support, etc.)
- Common support systems (trainers, facilities, etc.) and
- Infrastructure that plans, manages, operates and executes the program.

SECTION 5(c) Cost Models

A cost model is an economic representation of a program, project, system, or component that is used to predict the costs of the item being emulated. At the life cycle level, the model will contain variables and equations to estimate the cost elements of the item represented. It will take into account inflation and economic factors, schedules, market place productivity, learning curve, nonrecurring, recurring, operations, support, and disposal costs or some portion thereof depending on the need. The collaborating parties of a NATO multinational program should agree upon the cost model(s) to be used at the beginning of the project.

A life cycle cost model for a ship project must account for all cost elements and all phases of the program. Such a model may consist of many models (or embedded models) that are used to calculate various types of cost within a project such as design development, software, procurement, operations, maintenance, disposal, etc. As such, the model(s) will emulate from an economic standpoint the following basic parameters of the project: the technical design of the ship, the quantities to be considered, the acquisition strategy and associated acquisition schedule, the ship operation and maintenance cycle, and the assumed life span.

To effectively create a program cost model and cost estimate of a project, it is essential to have a complete description of the project covering its entire life cycle span. For NATO collaborative programs, such a description should be laid out in the CARA. The CARA describes the ship program to be estimated and delineates the relevant data and assumptions that apply, with the aim of giving a complete representation of a ship program. Along with the CARA, ANNEX I provides an Input Template and an Output Template to facilitate a common approach for development of the respective nations' cost estimates. The Input Template documents the data used for the estimate as described in Chapter 5, Section 5(a) for the Acquisition and In-Service phases and aligns them to the major elements of the CARA. The Output Template arrays the cost estimates to the NATO Total Ship CWBS life cycle cost hierarchy. The program cost model(s) can then be developed and tailored to incorporate embedded algorithms and data to most accurately predict the costs of the program.

Although modern computerized spreadsheets can be effectively utilized, many cost models are already in existence and in use by the respective nations.

These models have generally not been tailored for multinational program use, although they could be suitable starting points as off the shelf tools. . A number of these cost models and a short description of each are listed in ANNEX G. It should be noted that this is not a complete list and a further survey should be made at the appropriate stage of a NATO collaborative project.

CHAPTER 6. MULTINATIONAL PROGRAM CONSIDERATIONS

NATO collaborative ship programs involve three principal areas of multinational concern: cost sharing, work sharing and currency conversion.

SECTION 6(a) Cost Sharing

One of the mutual benefits of a NATO collaborative program is the economic saving that accrues due to cost sharing. In a NATO collaborative program, the principal area of cost sharing occurs in the common nonrecurring cost elements and the operation of the international PMO. Cost shares may be determined or allocated to the participating nations in a number of ways (e.g., costs may be allocated based on quantities procured during production, capital outlay of the respective nations, or other agreed means).

SECTION 6(b) Work Sharing

The work sharing methodologies are discussed in more detail in reference (a). A similar technique should be utilized in future NATO ship program cost estimating applications The methodology requires an equitable distribution of work shares for engineering, manufacturing and service related activity across the participating nations according to the capital outlay of the respective nations or as they otherwise may agree. The goal is to achieve an overall sharing balance through an optimum mix of development and management work, centrally procured major equipment, domestically procured miscellaneous material, land based facilities, and national ship construction activity. Additionally, offsets may be necessary in some cases and cost effectiveness must be considered.

An objective evaluation is necessary to determine the optimum mix (technical requirements met and cost effectiveness within work sharing constraints) of centrally procured shipboard equipment. This process involves assessing bids from participating national industries to establish an optimal distribution based on technical, cost, and work sharing considerations. Due to the large number of possible combinations, a computer assisted evaluation model is helpful if not essential.

SECTION 6(c) Currency Conversion

Generally, the cost data utilized as input to a multinational program is initially specified in the currency of the supplier nation. For non-domestic work and items subject to international influence of the participating nations, exchange rates between the national currencies are utilized as the currency conversion mechanism to develop national cost estimates. Application of escalation formulae using indices from the supplier nation allows for changes due to

national inflation prior to conversion to other currencies.

With the advent of the European Union, more and more nations have adopted the EURO in lieu of their former national currencies. This development reduces the number of currencies now in use among NATO nations but it still may be necessary to agree on a reference currency in order to determine cost targets and work sharing. A reference currency may be useful for performing design trade-offs or pricing the average ship cost for comparison against an established cost target. Where the use of a reference currency for expression of multinational cost estimates and cost targets is necessary, the chosen currency should be as agreed among the participating nations (e.g., Dollar, EURO, Pound, etc.) at the start of the project.

Some past programs have utilized Purchasing Power Parities (PPP) as the currency exchange mechanism for domestic work under the direct control of the respective nations, e.g., shipyard labor. PPP are rates of currency conversion that equalize the purchasing power of the different national currencies. Variations in PPP over time are mainly governed by the difference of inflation rates between countries. PPP vary slowly in contrast to currency exchange rates that are subject to market stresses. PPP may be useful when comparing costs between specific nations and may provide insight useful to planning purposes of the respective nations or for trend forecasting associated with NATO collaborative program ship cost estimates.

Notwithstanding the need for a reference currency and the issues of currency exchange that must be agreed upon, it is recommended that each nation apply its own cost model and applicable data (shipyard CER's, labor rates, etc.) to arrive at its national cost estimate.

SECTION 6(d) International Complexity

The co-operation of several nations within a multinational program may result in higher absolute costs than that of a national program due to international complexity. Additional expenses that cause this are: travel, accommodations, communication, information exchange, standardization agreements, approval of procedures, etc. These additional expenses should be considered and included in the NATO collaborative program cost estimates.

When sharing this higher total amount, the share per nation will usually be lower than for the same cost elements of a national program thus resulting in overall program savings from a national perspective. Some of these initial additional efforts such as developing a common methodological approach, standardization agreements, etc. may be incurred only once and then be available for future programs at no additional cost. Also, in some instances, reverting to national practices could be more costly.

CHAPTER 7. IMPLEMENTATION GUIDELINES

The inter-relationships of the proposed approach for costing of NATO ship programs are summarized in Figure 11. The hub of Figure 11, NATO Ship Life Cycle Cost, further breaks down according to the hierarchy of Figure 1. Costs must be determined (estimated) in an agreed CWBS for each NATO program phase and then be summed up to arrive at the desired level of the NATO hierarchy (Figure 1).

The following steps should be followed in the implementation of the recommended NATO ship costing methodology:

1. The **baseline ship design, technical requirements (including maintenance and upkeep cycle), and configuration** must be established. National requirements that deviate from the baseline must be identified.

2. The **acquisition strategy** must be defined for all phases of the program. Identification of milestone scheduling, cost sharing, national work content, work sharing, and design and integration oversight responsibilities must be clearly understood by all participating nations.

3. Agree to a **CWBS** and **cost element definitions** for use as the common basis for costing the proposed ship for comparison to the agreed cost target.

4. All **cost elements** must be identified at the agreed level of the NATO Ship LCC Hierarchy.

5. Each cost element identified must be assigned to the **applicable life-cycle phase(s)** of the NATO program.

6. The cost elements identified must be placed within the structure of the **CWBS**.

7. Each identified element must be designated as either **common** or **unique**.

8. Cost models and databases for use in the development of **Cost Estimating Relationships (CER's)** must be established and agreed upon.

9. Cost estimates must be developed for **each phase** of the NATO ship program using the CWBS format and agreed **cost model(s)**. For the first five phases of a NATO ship program (Mission Need Evaluation, Pre-Feasibility, Feasibility, Project Definition, and Design and Development), costs for common efforts may be shared among all participating nations, while unique efforts would be borne by individual nation(s). During the Production phase, the costs incurred for common and unique efforts will be borne by each nation depending on national requirements. In the In-Service phase, a portion of the costs incurred for common efforts may be shared among all participating nations, e.g., training of operators to staff the program Land Based Test Sites(s), while the remainder of the costs incurred in common efforts, e.g., fuel costs during ship operation, along with costs incurred for unique efforts are borne by the respective nations according to their national requirements.

10. The above process should occur at the **beginning of all NATO ship programs** in order to provide a frame of reference for all ship design and cost decisions.

Following these guidelines should permit the development of a comprehensive program life cycle cost estimate that is understandable by all participating nations. This model can also be used for other applications such as design trade-off studies and subsequent baseline changes.

NATO SHIP COSTING APPROACH

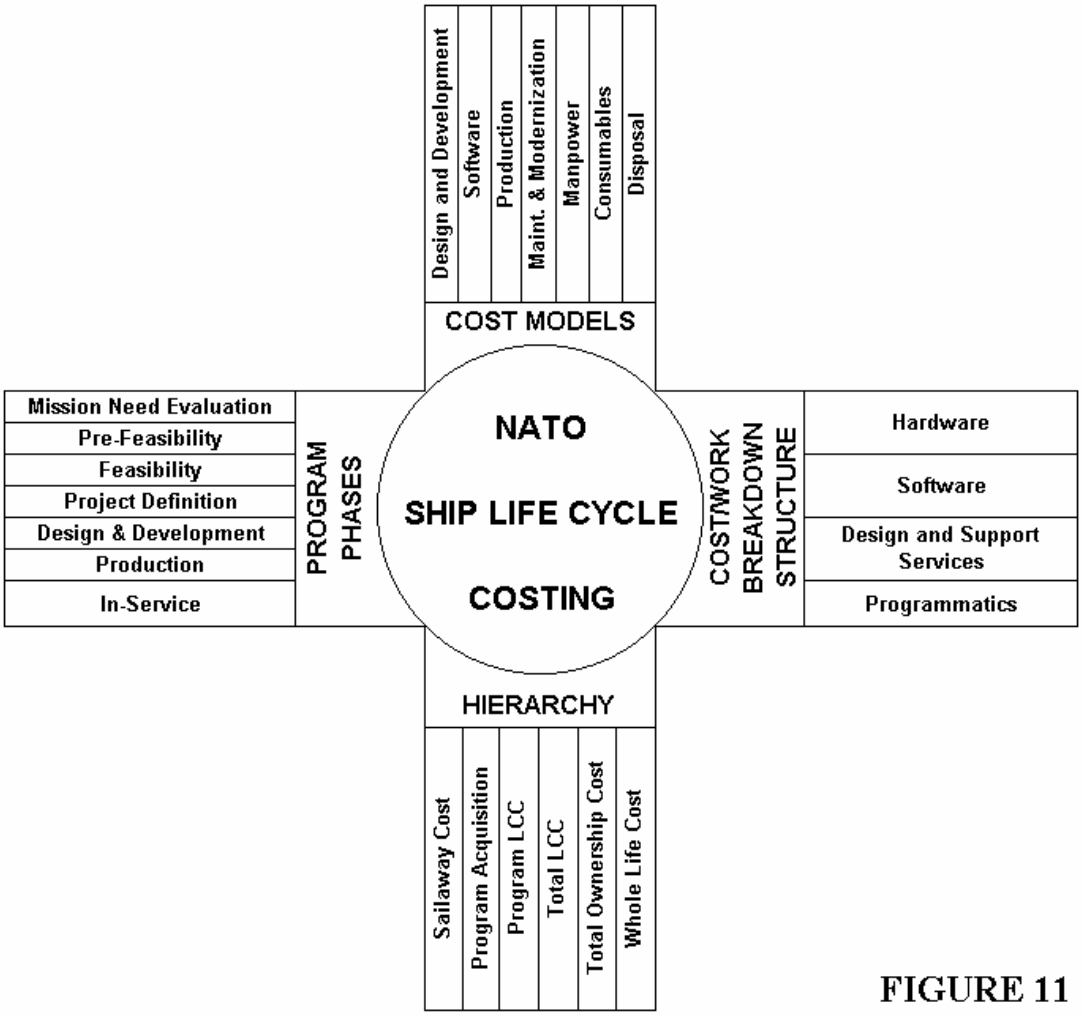


FIGURE 11

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LIST OF ACRONYMS

AHWG	AD HOC WORKING GROUP
ANEP	ALLIED NAVAL ENGINEERING PUBLICATION
ASW	ANTI-SUBMARINE WARFARE
AUS	AUSTRALIA
BAFO	BEST AND FINAL OFFER
BE	BELGIUM
BLS	BUREAU OF LABOR AND STATISTICS
BSMI	BASIS STANDAARD MATERIEELSINDELING (DUTCH SWBS)
C3	COMMAND, CONTROL AND COMMUNICATION
CA	CANADA
CAD/CAM	COMPUTER AIDED DESIGN/COMPUTER AIDED MANUFACTURING
CARA	COST ANALYSIS REQUIREMENTS AND ASSUMPTIONS
CARD	COST ANALYSIS REQUIREMENTS DESCRIPTION (UNITED STATES)
CER	COST ESTIMATING RELATIONSHIP
CWBS	COST/WORK BREAKDOWN STRUCTURE
DND	DEPARTMENT OF NATIONAL DEFENSE (CANADIAN SYSTEM)
EEC	EUROPEAN ECONOMIC COMMUNITY
ESWBS	EXPANDED SHIP WORK BREAKDOWN STRUCTURE (US SYSTEM)
ECU	EUROPEAN CURRENCY UNIT
EURO	EUROPEAN UNION CURRENCY
FAT	FACTORY ACCEPTANCE TRIALS
FR	FRANCE
FY	FISCAL YEAR
GE	FEDERAL REPUBLIC OF GERMANY
GFE	GOVERNMENT FURNISHED EQUIPMENT
GFM	GOVERNMENT FURNISHED MATERIAL
HAT	HARBOR ACCEPTANCE TRIALS
IEG	INFORMATION EXCHANGE GROUP (NATO)
ILS	INTEGRATED LOGISTICS SUPPORT
IMA	INTERMEDIATE MAINTENANCE ACTIVITY
IT	ITALY
LBTS	LAND BASED TEST SITE
LCC	LIFE CYCLE COST

MBT	MAIN BALLAST TANK
MDAL	MASTER DATA ASSUMPTIONS LIST (UNITED KINGDOM)
NATO	NORTH ATLANTIC TREATY ORGANIZATION
NES	NAVAL ENGINEERING STANDARD
NG	NAVAL GROUP (NATO)
NL	NETHERLANDS
NNAG	NATO NAVAL ARMAMENTS GROUP
O&S	OPERATING AND SUPPORT
OSD/OMB	OFFICE OF THE SECRETARY OF DEFENSE/OFFICE OF MANAGEMENT AND BUDGET (OF US EXECUTIVE BRANCH)
OSD PA&E	OFFICE OF THE SECRETARY OF DEFENSE/ PROGRAM ANALYSIS AND EVALUATION (OF US OSD)
PAPS	PHASED ARMAMENTS PROGRAMMING SYSTEM
PJT	PRE-JOINING TRAINING
PLCC	PROGRAM LIFE CYCLE COST
PMO	PROGRAM MANAGEMENT OFFICE
POL	PETROLEUM, OIL, AND LUBRICANTS
PPP	PURCHASING POWER PARITIES
QA	QUALITY ASSURANCE
RFQ	REQUEST FOR QUOTATION
RPV	REMOTELY PILOTED VEHICLE
SAS	STUDIES, ANALYSIS AND SIMULATION (NATO AC/323)
SAT	SEA ACCEPTANCE TRIALS
SLOC	SOURCE LINES OF CODE (SOFTWARE)
STSC	SPECIALIST TEAM ON SHIP COSTING (NATO NG/6)
SP	SPAIN
SWBS	SHIP WORK BREAKDOWN STRUCTURE
TLCC	TOTAL LIFE CYCLE COST
TOC	TOTAL OWNERSHIP COST
TU	TURKEY
UK	UNITED KINGDOM
US	UNITED STATES
WLC	WHOLE LIFE COST
WP	WORKING PAPER

ANNEX A

NATO Ship Cost-Related Terms and Definitions

NATO SHIP COST-RELATED TERMS AND DEFINITIONS

ITEM NUMBER	TERM	DEFINITION
1	AFFECTED COSTS	All costs that are linked (attributable) to a program's (ship and associated systems) existence that would not otherwise be incurred by the respective navy(s).
2	ALLOWANCE FOR CHANGES	Contingency included in an estimate to cover changes in the design, specifications, or program plan of an item.
3	AVERAGE SHIP COST	The average recurring acquisition cost of the common cost elements for procurement of the "Platform" and the "Payload", excluding aircraft and expendable ordnance, for a specified number of ships, including the lead ship.
4	AVERAGE SHIP COST TARGET	The average ship cost goal as specified by the participating nations. The figure specified defines a common point of reference for comparison of costs and is usually established based on affordability considerations. The scope of effort included is as defined in the "Average Ship Cost."
5	BUDGETARY COST CEILING	Upper cost limit not to be exceeded (predetermined cost limit).

6	CAPITAL COST	The sum of the common portion of "Platform" and "Payload" recurring acquisition cost. Note: Capital costs are used as a point of commonality when comparing recurring costs between nations for a given ship design and its payload. It does not include "unique" national costs as defined by the NATO CWBS. (See "Average Ship Cost" and "Average Ship Cost Target")
7	COLLABORATIVE PROGRAM	A multi-national program wherein costs of items within an agreed scope are shared among the nations in an agreed formula. Common baseline nonrecurring costs are shared equitably among the nations. In this scenario, the cooperation of the nations in a multi-national program may result in higher total costs than for a national program (due to standardization, travel accommodations, communication, information exchange, approval procedures, etc.). However, the division of the total costs equitably among the participating nations results in a lower cost per nation than for a national program. Recurring costs for centrally procured items result in a cost savings to each nation relative to a national program as a result of larger lot quantities. (See Notes after Item 8, Collaborative National Program)

8	COLLABORATIVE NATIONAL PROGRAM	A multi-national program wherein non-recurring costs are shared the same as for a collaborative program, but recurring costs are in accordance with each nation's selected configuration and planned lot quantities. There may be some partial commonality cost benefits where more than one nation agrees to common items within their national designs. (See Notes below) Note--COLLABORATIVE and COLLABORATIVE NATIONAL PROGRAMS: (1) any additional nonrecurring costs of a national variant from the international baseline must be borne by the country requiring the change (2) the costs of operating an international project management office (PMO) are shared equitably among the participating nations (3) for the recurring cost portion of centrally procured common items, the goal is to have a work-share distribution among the participating nations proportional to the number of ships each country procures, and (4) generally, each nation will build its own ships in its own national shipyards.
9	COMMON SUPPORT ITEMS and SYSTEMS	Items that benefit more than one program. Requirements for common support items and systems including supply ships and ashore facilities that are incurred because of the introduction or existence of the program (excludes non-linked indirect infrastructure

		costs that are not affected by the individual weapon system development, introduction, deployment or operation)
10	CONSUMABLES	All resources that are consumed in order to operate the ship. They include: 1) Petroleum, Oil and Lubricants 2) Energy (Fuel) 3) Training Ammunitions 4) Non repairable parts (That are not included in initial spare parts) 5) Raw Materials 6) Water, Food and Clothing
11	CONTINGENCIES	Elements included in an estimate to allow for costs which may arise in certain foreseeable circumstances, but which cannot be accurately quantified.
12	COST	The definition of "cost" changes with one's point of view. As used in this publication for total life cycle cost, definition "C" below applies. a. Industrial view -- The effort required for a certain product(s) or service(s) (subdivided into Development, Production, and Operation and Support) converted into its monetary equivalent, independent of the actual expenses in terms of money. b. Government view Re Industry costs -- The price paid to acquire, produce, accomplish, or maintain anything.

		c. Government view Re Total costs -- All costs to be incurred and paid for by the government including both the Industry and Government effort associated with all phases of the life cycle of a military project.
13	COST DRIVERS	Particularly expensive cost elements that result in a considerable cost impact, when applied. Elements, features, requirements, or processes of an item that drive costs.
14	COST ESTIMATE CLASSIFICATION	A group of defined categories of cost estimates staggered according to the accuracy and quality of the result obtainable thus achieving a ranking sequence. BE SYSTEM (see reference (d)): “H” = High accuracy; “A” = Low accuracy A Military survey (Rough Order of Magnitude – ROM) - Specification phase B Request for Purchase to the Procurement Division of the General Directorate Material Resources C Request for Quotation (RFQ) - Industry Bid sometimes (according to the purchase procedure) followed by the Best and Final Offer (BAFO) D Contract Price with or without price control (according to the purchase procedure) The price of D may not exceed the cost estimate of B by more than 15 %.

CA SYSTEM (see reference (e)): "A" = High accuracy; "D" = Low accuracy

A Contract Quality Estimate
B Budget Quality Estimate
C Preliminary Estimate
D Rough Order of Magnitude Estimate

GE SYSTEM (see reference (f)):"H" = High accuracy; "A" = Low accuracy

A First Rough Estimate
B Estimated during Concept Phase
C Estimated during Definition Phase
D Estimated during or after Definition
E Non-binding Industry Statement
F Industry Bid
G Contract Price
H Paid Price

NL SYSTEM (see reference (g)):
MAX (= upper limit)
MIN (= lower limit) or
ACCURACY +/- ... %

SP SYSTEM (see reference (h)):
"A" = High accuracy; "F" = Low

A Detailed Cost Estimate
B Cost Estimate for Bid Evaluation
C Budget Quality Estimate
D Feasibility and/or Conceptual Estimate
E Parametric Estimate
F Preliminary Estimate
X Directed or Modified Estimate

US SYSTEM (see reference (i)):

		"C" = High accuracy; "R" = Low accuracy C Budget Quality Estimate (New Ship Construction) D Budget Quality Estimate (Ship Modernization or Conversion) F Feasibility Study "Ball Park" Estimate R Rough Order of Magnitude (ROM) X Directed or Modified Estimate
15	COST MODEL	An economic representation of a program, project, system, or component that is used to predict the costs of the item being emulated. Computation model/program to carry out cost calculations usually by means of electronic data processing --includes special correlation and simulation features, subroutines, etc. --built upon a cost structure.
16	COST TARGET	A "goal" (cost figure) to be used as guideline in planning, i.e. cost objective.
17	COST/WORK BREAKDOWN STRUCTURE (CWBS)	A product-oriented family tree of ship work breakdown structure elements and programmatic elements which provides distinct numeric addresses for all elements of Life Cycle Cost.
18	CURRENCY EXCHANGE RATES	A mechanism used to convert costs between monetary systems. This mechanism reflects the strength of one nation’s currency expressed in another nation’s currency on the monetary market.

19	CURRENCY PARITIES	Valid monetary indicators that provide price/cost conversions into any currency; e.g., Currency Exchange Rates, Purchasing Power Parities.
20	“DEGRESSION” CURVE or COST IMPROVEMENT CURVE	Curve showing how costs decrease, as a function of increasing numbers of items (ships) procured, including: - “LEARNING CURVES” (labor) - “NONRECURRING TOOLING UP” (yards, manufacturers) to be written off over an increased number of units
21	DESIGN	The application of scientific and engineering efforts to: (a) transform an operational need into a description of system performance parameters and a system configuration ; (b) integrate related technical parameters and ensure compatibility of all physical, functional, and program interfaces in a manner that optimizes the total system; and (c) integrate reliability, maintainability, safety, survivability, human engineering, and other such factors into the total engineering effort to meet cost, schedule, supportability, and technical performance objectives. The design effort culminates in the production of the detailed specifications, drawings, inspection and testing criteria, and other technical documentation or media required for the construction, testing, and acceptance of the delivered ship.

22	DEPOT MAINTENANCE	Depot level maintenance of the ship or subsystem component performed by public or private shipyards or other facilities.
23	DEVELOPMENT COST	Cost required for research, development, test and evaluation of a program. This includes costs for prototypes, instrumentation, project management, training, specialized support equipment, data, operational and site activation, tests and industrial facilities.
24	DIRECT COST	Costs that can be easily allocated, measured and identified, without ambiguity and further analysis, to a product (system, equipment, ship platform, etc.).
25	DIRECT LABOR COST	The cost of the man-hours directly associated with the engineering, manufacture and construction of an item or product.
26	DIRECT UNIT COSTS	The summation of labor, material, and purchased services directly assignable to a given unit.
27	DISPOSAL	Refers to the act of getting rid of surplus, scrap, or salvage property. This may be accomplished by, but not limited to, transfer, donation, sale, abandonment, or destruction. When specifically applied to the final phase of a ship's life-cycle, it entails the orderly processing of the ship for disposal

		which may include break-up or sinking of the hull.
28	EURO	Official currency of most countries of the European Union.
29	FACILITY CONSTRUCTION	Refers to the construction, expansion, or conversion of industrial facilities for production, inventory, depot maintenance, and other related activities. This includes real estate, the preparation of peculiar facilities, the acquisition/modernization of equipment, and maintenance of the facilities and equipment.
30	FISCAL YEAR (FY)	The yearly accounting period for a government.
31	FIXED COSTS	Costs that do not vary because of the introduction or existence of a product (system, equipment, platform, etc.). Such costs are associated to the naval organization rather than specific navy products and tend to be constant and not affected by the introduction or existence of a product (system, equipment, platform, etc.). Examples are ceremonial units, hospitals, naval bases, etc. that remain essentially fixed between at least certain ranges or volumes. (Note however, even fixed costs can change given political needs, budget considerations or multiple program effects of collective procurements).

32	HARDWARE COST	All costs contained in Groups 100-700 excluding software.
33	INDIRECT COST	Costs associated to more than one product (system, equipment, ship platform, etc.) and hence shared by those products and so attributed to the introduction or existence of those products. A cost item incurred for common objectives such that it cannot be allocated to a specific objective such as a product, project, service or program. When referring to industry cost, it is often associated with the term “overhead cost”. When referring to TOC, indirect cost refers to linked costs that are affected by a product’s existence that are attributable to more than one product, project, service or program.
34	INDIRECT OPERATING and SUPPORT COST	Costs which are incurred during the In-Service phase of a ship’s life which are not specific to a particular ship such as: - cost of equipment - cost of personnel training - cost of publications - cost of engineering and technical services other than during IMA and depot maintenance - cost of ammunition handling by ashore stations

35	INITIAL CONSTRUCTION COST	Synonymous with Sailaway Cost (See SAILAWAY COST)
36	INITIAL INVESTMENT COST	Cost, essentially referring to the Design and Development and Production (Acquisition) phases, including spares, maintenance and training facilities, etc.
37	INITIAL OUTFIT	Includes all necessary costs to equip the ship after completion of the building phase and before the sea trials in order to enter service. This cost covers the acquisition of: - onboard spares, - stores items, - special tools, - onboard repair parts, - onboard test equipment, - documentation, - factory courses, - fuel and lubricants, - basic loads.
38	INITIAL SPARES	Initial Spares provisioning to support the operation of defense equipment. Initial Spares are described as the spares required to support the introduction into service of a new equipment for the first two years of operational life. They comprise those spares that will be carried onboard together with two years replenishment stocks held ashore.

39	INDUSTRIAL SCENARIO	A set of conditions assumed to prevail and having a substantial impact on ship acquisition cost, e.g. - Number of nations involved - Number of ships (to be) built - Number of shipyards tasked with building ships - Degree of commonality between the national designs
40	INFLATION RATE	A percentage (usually per year) indicating the decrease in value of monies paid for an item due to inflation (the rate of increase per unit of time in currency required to purchase a given amount of goods or services, causing a rise in price levels).
41	INFRASTRUCTURE	The basic, underlying framework or features of a system or organization, e.g., the organization for planning, managing, operating and executing the associated program. The fundamental facilities serving military installations of a country (e.g., transportation and communication systems, power plants, roads, bases, etc.)
42	INTERMEDIATE MAINTENANCE	Cost for labor and material expended by “Afloat” (tenders and repair ships) and “Ashore” (bases) Intermediate Maintenance Activities (IMA).

43	INTERNATIONAL COMPLEXITY FACTOR	Ratio between the national and the multinational costs of individual elements (excluding quantity effects).
44	ITEMS NOT AFFECTED BY THE EXISTENCE OF THE SHIP/WEAPON SYSTEM	(See Non-linked Costs) Costs (apportioned or allocated to WLC) that are not affected by the existence of the program (e.g., military academies, ceremonial units, shore-based training, hospitals, navy staff).
45	LEARNING CURVE	A curve showing how recurring costs for labor services or activities decrease as a function of increasing quantity (e.g., number of ships built). (See also “Digression” Curve)
46	LIFE CYCLE COST (LCC)	The total cost for a system or program over its full life, including the cost of development, procurement, operating, support and disposal, where applicable. It includes all cost elements and encompasses both the industrial and the government effort.
47	LINKED COSTS	Costs that are readily associated to the design, development, procurement, operation and support of a product (system, equipment, ship platform, etc.). Costs that are caused by (thus affected by) the introduction or existence of a product . (See Affected Costs)

48	LINKED-INDIRECT COSTS	Indirect costs that are affected by the existence of a product (system, equipment, ship platform, etc.). Linked-indirect costs include items such as indirect manpower costs, common support systems or across-program infrastructure costs that relate to other ships or weapon systems as well as the given ship or weapon system. (See Affected Costs, Indirect and Variable-Indirect Costs)
49	MANAGEMENT	Refers to the business and administrative planning, organizing, directing, coordinating, controlling, and approval actions designated to accomplish overall project objectives which are not associated with specific hardware or software elements. Examples of these activities are project management, logistics management, cost/schedule/performance management, contract management, data management, and vendor liaison.
50	MANPOWER	Costs of military manpower. These costs may be direct or indirect and are linked to the program. Direct costs include the pay or salary of military personnel while indirect costs include such costs as recruiting, acquisition, training and medical support.

51	MARGIN (WEIGHT)	An allowance for possible growth in a ship's weight to cover inherent limits of precision in initial weight estimates; undefined variations of component weight; and unknown additions that will take place during design, development and construction of the ship.
52	MATERIAL COST	Cost of the constituent elements of hardware (produced and supplied) from which a ship is designed, constructed and supported.
53	NON-COLLABORATIVE PROGRAM	A single nation program wherein no costs, either recurring or nonrecurring, are shared between nations; i.e., a National program.
54	NON-LINKED COSTS	Costs that cannot be readily associated to the product (system, equipment, platform, etc.) such as generalized organizational costs associated with such items as military family housing, ashore hospitals, medical services, ceremonial units, basic training (not specialized to a specific product), navy headquarters staff, naval bases, service academies)
55	NONRECURRING COST	Initial investment occurring only once which may be distributed to several items later, as appropriate.
56	OFFSETS	Compensation for economic imbalances in work sharing agreements in a collaborative program.

57	OPERATING and SUPPORT COST (IN-SERVICE COST)	Costs associated with the operation and support of a ship after commissioning including those costs associated with operating, modifying, maintaining, supplying, and supporting a ship and its payload throughout the remainder of its life cycle including refit programs and mid-life conversions, alterations and improvements.
58	OVERHEAD	That part of engineering, manufacturing or production costs for which cost per unit produced is not readily assignable to individual cost elements. (See "Indirect Cost").
59	PAYLOAD COST	Payload costs consist of the electronic and ordnance equipment (ESWBS groups 400 and 700) costs excluding: handling and stowage equipment, installation and integration, and also excluding aircraft and expendable ordnance costs.
60	PLATFORM COST	Platform costs consist of ESWBS groups 100, 200, 300, 500, 600, group 700 handling and stowage equipment, and the installation and integration costs for groups 400 and 700 equipment.
61	PRE-JOINING TRAINING (PJT)	PJT is undertaken as a direct result of an equipment's or ship's specification and should therefore be attributed to the equipment or ship. PJT is therefore excluded from the marginal cost rates but

		included in the full costs of training. PJT may be known as specialized training in some nations.
62	PRICE	The amount quoted, negotiated or charged for a certain supply or service - or to be paid by the customer under the prevailing market conditions, i.e., including profit, taxes, etc.
63	PRICE ESCALATION (or ADJUSTMENT) CLAUSE	A formula or means for adapting prices to changing economic conditions (e.g. to take into account inflation, labor and material escalation, price indices, etc.).
64	PRICE INDEX	A statistically determined value (published by respective national statistical offices) indicating the price variation of a certain product or service over a period of time, relative to a base year.
65	PROGRAM ACQUISITION COST	This cost includes the Sail-Away Cost plus the associated design and development costs of planning for and producing the ship and its systems, including modeling, simulation, prototypes, and associated program management. Program acquisition cost includes costs incurred during the first six phases of the NATO phased armaments programming system (PAPS): mission need evaluation, pre-feasibility, feasibility, project definition, design and development, and production.

66	PROGRAM LIFE CYCLE COST (PLCC)	PLCC includes only the linked direct costs that are specifically associated with the development, procurement, operation and support of the ship, and would not otherwise be incurred by a Navy. PLCC includes the Program Acquisition Cost (design, development and production) plus the Operating and Support and Disposal costs of a ship. PLCC includes costs incurred during all seven phases of the NATO PAPS.
67	PROGRAMMATIC ELEMENTS	Cost elements that are incurred in a ship program, but that are not readily captured by the ESWBS Groups 000 through 900. These elements include peculiar budgeting requirements, government regulations and law, contingencies, government support activities, NATO Program Management Office activities, and shipboard load-out items.
68	PROJECT LEAD SHIP COSTS	All elements to bring the ship from detailed design to governmental acceptance: a. Direct unit costs of the first ship b. Shipyard services and facilities c. Special tools for building, testing and managing the ship's production d. Design of tools as mentioned under C. e. Design and production of facilities for prototype testing, mock-ups, etc. f. Project Management Office/lead company liaison and associated documentation g. Harbor and sea trials for the lead ship

h. Redesign and/or rework of agreed upon modifications

69	PROJECT LEAD SHIP OVER-COST	The costs of all internationally agreed upon and financed tests, trials, redesign and resultant rework which are relative to the first ship of the program, but which are not repeated for follow ships. (The results are provided to all participating nations for use in their respective shipbuilding programs.)
70	PROJECT MANAGEMENT	In the Initial Construction Cost, Project Management means the cost made by the Prime contractor in order to manage the program within the 3 dimensions of a project (e.g., product, time, and cost). In the Program Acquisition Cost, Project Management means the cost made by the Administration (Government side) in order to establish and maintain an international project office manned by officers and civilians of the nations participating to the international program. The cost for the personal is not part of this item. The current name is NATO Project Management. This office is the counterpart of the Prime contracting project office. The NATO Project Manager is mandated by all participating nations to be the single POC for the decision-making process with the Prime contractor. The office ensures the daily follow on of the project under the authority of the NATO Project Manager.

		The NATO Project Manager is reporting to a steering committee.
71	PUBLICATIONS	Refers to those formal technical manuals for installation, operation, maintenance, overhaul, and training; reference material and manuals for hardware and software; instructional materials; inspection documentation; and historical type records that may accompany individual items of equipment.
72	PURCHASING POWER PARITIES (PPP)	Rates of currency conversion that equalize the purchasing power of different currencies. This means that a given sum of money in a given national currency, when converted into different national currencies at the PPP rates, will buy the same basket of goods and services in all countries.
73	RECURRING COST	Elements of cost which are repeatedly incurred for each successive unit or system.
74	ROUGH ORDER of MAGNITUDE (ROM) ESTIMATE	Rough estimate to be taken as a preliminary guideline and is based on limited information.
75	SAILAWAY COST	Sailaway is used as a generic term related to the creation of a completed ship up to governmental acceptance. Sailaway cost includes: 1) SWBS elements such as basic structure, propulsion, electronics, etc., Shipyard Project Management, and System Test

and Evaluation, and

2) All costs of the “initial construction” Nonrecurring and Recurring cost categories, including allowances for changes, warranties, first destination transportation, etc.

Note: Sailaway Cost also includes allowances for excise duty, applicable sales taxes, freight and shipbuilder's overhead and profit.

76	SALARY RELATED COSTS	These costs include: basic pay, additional pay, earnings related national insurance contributions (health care and state pensions), and pensions. Additional pay includes special service pay for specialization such as flying, diving, and submarines. There may be other salary related costs (depending on the nation) such as allowances for subsistence, education, bonuses, and separation pay.

77	SHIP WORK BREAKDOWN STRUCTURE (SWBS)	A product-oriented family tree composed of hardware, software, services and data which result from project engineering efforts during the development and production of a ship, and which completely defines the project/program. DUTCH SYSTEM:"BASIS STANDAARD MATERIEELSINDELING" (BSMI) VVKM21 (1987) – Voorschriften betreffende het configuratiebeheer van schepen. FRENCH SYSTEM: "Catalogue des Rubriques de Prix, de Poids, et de Spécification" GERMAN SYSTEM: "Baugruppenverzeichnis" structured as follows: HBA "Hauptbauabschnitt" BA "Bauabschnitt" HBGr "Hauptbaugruppe" BGr "Baugruppe" SPANISH SYSTEM: "NDCS: Nomenclator de Delimitatión de Componentes de Sistemas Para Buques de Superficie" UK SYSTEM: Naval Engineering Standard (NES) 163 "Classification of Weight Groups for Surface Ships" US SYSTEM: "Expanded Ship Work Breakdown Structure (ESWBS) for All Ships and Combat Systems."

78 SOFTWARE

The term Software designates all computer programs available for an automated data processing system. Software has no material substance, but requires a material carrier - viz. Hardware to function. Computer programs implemented in the form of circuits as well as documentation and rules of application are part of Hardware. Software designates exclusively the actual programs available, i.e., source code.
Software can be subdivided into System and User Software. System Software is intended to ensure the total operation of sequence on a data processing system as well as its economic applications. It consists of Control Programs, Compilers, and Utility Programs.
Control Programs (Operating Systems) control and monitor the operational sequence on a data processing system.

Compiling Programs are used to convert programs from programming language in which they have been written (source code) into the machine language (object code).

Utility Programs are auxiliary programs e.g. for administration of libraries, testing of programs, etc.

Application or User Software refers to all programs used for performing the actual

		data processing jobs of the user (e.g. Administration Programs, Financial Calculation)
79	START-UP	Refers to nonrecurring costs directly associated with production including production tooling and testing set-up.
80	SUPPORT EQUIPMENT	Refers to tender or shore-based equipment and tools required to maintain and care for the system or portions of the system while not directly engaged in the performance of its mission. It also includes all effort required to assure the availability of this equipment.
81	TECHNICAL DATA	Encompasses all types of specifications, standards, engineering drawings, instructions, reports, manuals, tabular data, and test results used in the development, production, testing, operation, maintenance, and disposal of military items, equipment, and systems.
82	TEST AND TRIALS	The test cost includes all necessary costs made in order to validate concepts and prototypes during the design phase, to check materials and to verify subassemblies during the construction phase. The trials cost includes all costs incurred to verify compliance with government specifications and that all systems are in proper working order prior to ship delivery.

		Acceptance trials include: testing in the factory (Factory Acceptance Trials -FAT), outfitting onboard ship (Harbor Acceptance Trials – HAT), and Sea Acceptance Trials (SAT).
83	TOTAL LIFE CYCLE COST (TLCC)	TLCC includes PLCC plus linked Variable Indirect costs of manpower. TLCC is used to compare options and alternatives. (See Variable Indirect Costs).
84	TOTAL OWNERSHIP COST (TOC)	Total Ownership Cost (TOC) includes all linked costs associated with the research, development, procurement, operation, logistical support and disposal of a weapon system, including the total supporting infrastructure that plans, manages, and executes the program over its full life. TOC includes the cost of requirements for common support items and systems (e.g. supply ships, ashore facilities, etc.) that are incurred because of the introduction of the weapon system but excludes “non-linked” infrastructure costs that are not affected by the individual weapon system development, introduction, deployment or operation. TOC includes costs incurred in all seven phases of the NATO PAPS. TOC is used for design and operational optimization purposes, reducing cost of ownership, and aiding in cost management.

85	TRAINING EQUIPMENT	Refers to any equipment used by either a contractor or a military service to meet specific training objectives; for example: operational trainers and simulators; maintenance trainers; and other items such as cutaways, mock-ups, and models.
86	VARIABLE-INDIRECT COSTS	Variable indirect costs refer to infrastructure, manpower, and support costs (e.g. supply and replenishment, etc.) that are affected by, and therefore vary because of, the existence of a weapon system or ship. Variable indirect manpower costs refer to military personnel costs that are in addition to basic pay and are included as part of life cycle costs and total ownership costs. Variable indirect costs include manpower recruiting (considered fixed by some nations (e.g., U.K.), system specific training, medical support, and the costs of acquiring facilities or support materials.
87	WHOLE LIFE COSTS (WLC)	Whole Life Costs (WLC) includes all TOC elements plus all non-linked costs allocated to the new system or capability. WLC is used for a strategic view and high level studies. Non-linked costs include such items as: family housing, medical services, ceremonial units, naval staff, naval academies, naval postgraduate schools, etc., that are not specifically allocable to the ship or ship systems, i.e., not linked to the ownership of a specific ship or weapon system. These non-linked costs are

necessary to the operation of the Navy that but are not included in the Total Ownership Cost category because:

- The existence or introduction of the weapon system, e.g., a ship, does not affect these costs;
- These costs are not under the control of the respective programs, rather they are at the discretion of the Navy or MOD management; and
- It is not feasible or practical to allocate these costs to specific customers, ships or weapon systems.

ANNEX B

Expanded Ship Work Breakdown Structure Title Index

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
000	GENERAL GUIDANCE AND ADMINISTRATION
010	COMBAT CAPABILITIES (OFFENSIVE AND DEFENSIVE)
011	AIR WEAPONS VS AIR TARGETS
012	AIR WEAPONS VS SURFACE TARGETS
013	AIR WEAPONS VS UNDERWATER TARGETS
014	SURFACE WEAPONS VS AIR TARGETS
015	SURFACE WEAPONS VS SURFACE TARGETS
016	SURFACE WEAPONS VS UNDERWATER TARGETS
017	UNDERWATER WEAPONS VS SURFACE TARGETS
018	UNDERWATER WEAPONS VS UNDERWATER TARGETS
020	STRATEGIC AND SPECIAL CAPABILITIES
021	SURFACE BASED DETERRENTS
022	UNDERWATER BASED DETERRENTS
023	AMPHIBIOUS WARFARE
024	MINE AND MINE COUNTERMEASURE WARFARE
025	INSHORE WARFARE
030	TACTICAL AND STRATEGIC OPERATION SUPPORT CAPABILITIES
031	COMMAND/CONTROL/COMMUNICATIONS
032	SURVEILLANCE/RECONNAISSANCE/INTELLIGENCE
033	ELECTRONIC WARFARE AND NUC/BIO/CHEMICAL DEFENSE
034	LOGISTICS/SEALIFT
035	OTHER SUPPORT
040	SHIP SYSTEM MANAGEMENT
041	PROJECT MANAGEMENT
042	GENERAL ADMINISTRATIVE REQUIREMENTS
043	LIFE CYCLE COSTING
044	SHIP OPERATION
045	CARE OF SHIP DURING CONSTRUCTION
050	SHIP SYSTEM PERFORMANCE
051	SHIP SYSTEM PERFORMANCE CONCEPTS
052	SHIP SUBSYSTEM PERFORMANCE CONCEPTS
053	SELECTED CONCEPTS
054	COMPONENT DEVELOPMENT
060	SUBSYSTEM CHARACTERISTICS (INTERFACES AND CNO CONT.)
061	HULL STRUCTURE
062	PROPULSION PLANT
063	ELECTRIC PLANT
064	COMMAND AND SURVEILLANCE
065	AUXILIARY SYSTEMS
066	OUTFITTING
067	WEAPONS
068	INTEGRATION AND ENGINEERING
069	SHIP ASSEMBLY
070	GENERAL REQUIREMENTS FOR DESIGN AND CONSTRUCTION

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
071	ACCESS
072	SURVIVABILITY (FORMERLY SHOCK, SEE INCLUDES LISTING)
073	NOISE AND VIBRATION
074	CASTING ,WELDING, RIVETING, ALLIED PROCESSES (GENERAL)
075	THREADED FASTENERS STANDARDS
076	RELIABILITY AND MAINTAINABILITY
077	SAFETY
078	MATERIALS
079	SEAWORTHINESS
080	INTEGRATED LOGISTIC SUPPORT REQUIREMENTS
081	MAINTENANCE
082	SUPPORT AND TEST EQUIPMENT
083	SUPPLY SUPPORT
084	PACKAGING, HANDLING, STORAGE AND TRANSPORTATION
085	ENGINEERING DRAWINGS
086	TECHNICAL MANUALS AND OTHER DATA
087	FACILITIES
088	MANPOWER AND PERSONNEL
089	TRAINING AND TRAINING SUPPORT(FORMERLY TRAINING EQUIPMENT)
090	QUALITY ASSURANCE (FORMERLY QUALITY ASSURANCE REQT)
091	SHIP INSPECTIONS
092	SHIP TESTS
093	COMBAT SYSTEMS CHECKOUT
094	REGULAR SHIP TRIALS
095	WHOLE SHIP TESTING
096	MASS PROPERTIES CONTROL
097	INCLINING EXPERIMENT AND TRIM DIVE
098	MODELS AND MOCKUPS
099	PHOTOGRAPHS
100	HULL STRUCTURE, GENERAL
1001	HULL ACCESSES, TEMPORARY (DELETED SEE 8636)
101	GENERAL ARRANGEMENT-STRUCTURAL DRAWINGS
110	SHELL AND SUPPORTING STRUCTURE
1101	HULL, UNDERWATER BODY
1102	HULL STRUCTURE ABOVE UNDERWATER BODY
111	SHELL PLATING, SURFACE SHIP AND SUBMARINE PRESSURE HULL
1111	SHELL PLATING, SUBMARINE PRESSURE HULL
112	SHELL PLATING, SUBMARINE NON-PRESSURE HULL
1121	SHELL PLATING SUBMARINE NON-PRESSURE HULL
113	INNER BOTTOM
114	SHELL APPENDAGES
115	STANCHIONS
116	LONGIT. FRAMING, SURF SHIP AND SUBMARINE PRESSURE HULL
117	TRANSV. FRAMING, SURFACE SHIP AND SUBMARINE PRESSURE HULL

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
1171	TRANSVERSE FRAMING SUBMARINE PRESSURE HULL
118	LONGITUDINAL AND TRANSVERSE SUBMARINE NON-PRESSURE HULL
1181	LONGITUDINAL AND TRANSVERSE SUBMARINE NON-PRESSURE HULL
119	LIFT SYSTEM FLEXIBLE SKIRTS AND SEALS
120	HULL STRUCTURAL BULKHEADS
1201	STRUCTURAL BULKHEADS LESS SUPERSTRUCTURE
121	LONGITUDINAL STRUCTURAL BULKHEADS
122	TRANSVERSE STRUCTURAL BULKHEADS
1221	TRANSVERSE STRUCTURAL BULKHEADS (SUBMARINES)
123	TRUNKS AND ENCLOSURES
1231	TANKS
1231	TANKS
1233	TRUNKS AND ENCLOSURES, SUBMARINE
124	BULKHEADS IN TORPEDO PROTECTION SYSTEM
125	SUBMARINE HARD TANKS
1251	SUBMARINE HARD TANKS
126	SUBMARINE SOFT TANKS
1261	BUILT-IN SOFT TANKS
1262	BUILT-IN INTERMEDIATE TANKS
130	HULL DECKS
1301	HULL DECKS
131	MAIN DECK
132	2ND DECK
133	3RD DECK
134	4TH DECK
135	5TH DECK AND DECKS BELOW
136	01 HULL DECK (FORECASTLE AND POOP DECKS)
137	02 HULL DECK
138	03 HULL DECK
139	04 HULL DECK AND HULL DECKS ABOVE
140	HULL PLATFORMS AND FLATS
1401	HULL PLATFORM AND FLATS
141	1ST PLATFORM
1411	SUBMARINE INTERNAL PLATFORMS AND FLATS
142	2ND PLATFORM
143	3RD PLATFORM
144	4TH PLATFORM
145	5TH PLATFORM
149	FLATS
150	DECK HOUSE STRUCTURE
1501	SUPERSTRUCTURE
151	DECKHOUSE STRUCTURE TO FIRST LEVEL
1511	SUBMARINE SUPERSTRUCTURE AND FAIRWATER
152	1ST DECKHOUSE LEVEL

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
153	2ND DECKHOUSE LEVEL
154	3RD DECKHOUSE LEVEL
155	4TH DECKHOUSE LEVEL
156	5TH DECKHOUSE LEVEL
157	6TH DECKHOUSE LEVEL
158	7TH DECKHOUSE LEVEL
159	8TH DECKHOUSE LEVEL AND ABOVE
160	SPECIAL STRUCTURES
161	STRUCTURAL CASTINGS, FORGINGS, AND EQUIV. WELDMENTS
1611	STRUCTURAL CASTINGS, FORGINGS AND EQUIV. WELDMENTS
162	STACKS AND MACKS (COMBINED STACK AND MAST)
1621	STACKS AND MACKS
163	SEA CHESTS
1631	SEA CHESTS
164	BALLISTIC PLATING
165	SONAR DOMES
1651	SONAR DOME
166	SPONSONS
167	HULL STRUCTURAL CLOSURES
1671	HULL STRUCTURAL CLOSURES (WATERTIGHT)
168	DECKHOUSE STRUCTURAL CLOSURES
1681	DECKHOUSE STRUCTURAL CLOSURES (WATERTIGHT)
169	SPECIAL PURPOSE CLOSURES AND STRUCTURES
170	MASTS, KINGPOSTS, AND SERVICE PLATFORMS
171	MASTS, TOWERS, TETRAPODS
1711	MASTS
172	KINGPOSTS AND SUPPORT FRAMES
1721	KINGPOSTS
179	SERVICE PLATFORMS
180	FOUNDATIONS
181	HULL STRUCTURE FOUNDATIONS
182	PROPULSION PLANT FOUNDATIONS
183	ELECTRIC PLANT FOUNDATIONS
184	COMMAND AND SURVEILLANCE FOUNDATIONS
185	AUXILIARY SYSTEMS FOUNDATIONS
186	OUTFIT AND FURNISHINGS FOUNDATIONS
187	ARMAMENT FOUNDATIONS
190	SPECIAL PURPOSE SYSTEMS
191	BALLAST, FIXED OR FLUID, AND BUOYANCY UNITS
1911	BALLAST, PERMANENT
192	COMPARTMENT TESTING
1921	TESTING, COMPARTMENT (EXCLUSIVE OF TANK TESTING)
195	ERECTION OF SUB SECTIONS (PROGRESS REPORT ONLY)
198	FREE FLOODING LIQUIDS

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
199	HULL REPAIR PARTS AND SPECIAL TOOLS
1991	HULL MISCELLANEOUS PARTS
1992	HULL SPECIAL TOOLS
200	PROPULSION PLANT, GENERAL
201	GENERAL ARRANGEMENT - PROPULSION DRAWINGS
202	MACHINERY PLANT CENTRAL CONTROL SYSTEMS
210	ENERGY GENERATING SYSTEM (NUCLEAR)
211	(RESERVED)
212	NUCLEAR STEAM GENERATOR
213	REACTORS
214	REACTOR COOLANT SYSTEM
215	REACTOR COOLANT SERVICE SYSTEMS
216	REACTOR PLANT AUXILIARY SYSTEMS
217	NUCLEAR POWER CONTROL AND INSTRUMENTATION
218	RADIATION SHIELDING (PRIMARY)
219	RADIATION SHIELDING (SECONDARY)
220	ENERGY GENERATING SYSTEM (NON-NUCLEAR)
221	PROPULSION BOILERS
2211	BOILERS, PROPULSION
2212	BOILER, MANUAL/AUTOMATIC CONTROLS
2213	BOILER BLOW SYSTEMS
2214	BOILER STEAM ESCAPE SYSTEMS
2215	ENERGY CYCLE RECOVERY PROPULSION SYSTEM
222	GAS GENERATORS
223	MAIN PROPULSION BATTERIES
2231	MAIN STORAGE BATTERY
2232	HYDROGEN DETECTION SYSTEM (HY)
2233	BATTERY AIR FLOW SYSTEM (HG)
224	MAIN PROPULSION FUEL CELLS
230	PROPULSION UNITS
231	PROPULSION STEAM TURBINES
2311	PROPULSION STEAM TURBINES, MAIN
232	PROPULSION STEAM ENGINES
233	PROPULSION INTERNAL COMBUSTION ENGINES
2331	PROPULSION DIESEL ENGINES, MAIN
234	PROPULSION GAS TURBINES
2341	PROPULSION GAS TURBINES, MAIN
235	ELECTRIC PROPULSION
2351	PROPULSION GENERATORS, MAIN
2352	PROPULSION MOTORS, MAIN
236	SELF-CONTAINED PROPULSION SYSTEMS
237	AUXILIARY PROPULSION DEVICES
2371	PROPULSION DEVICES, AUXILIARY
238	SECONDARY PROPULSION (SUBMARINES)

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
2381	SECONDARY PROPULSION
239	EMERGENCY PROPULSION
2391	EMERGENCY PROPULSION
240	TRANSMISSION AND PROPULSOR SYSTEMS
241	PROPULSION REDUCTION GEARS
2411	PROPULSION REDUCTION GEARS
2412	PROPULSION REDUCTION GEARS-FOILBORNE
242	PROPULSION CLUTCHES AND COUPLINGS
2421	PROPULSION CLUTCHES AND COUPLINGS
2422	PROPULSION COUPLING-FOILBORNE
2422	PROPULSION COUPLING-FOILBORNE
243	PROPULSION SHAFTING
2431	PROPULSION SHAFTING
244	PROPULSION SHAFT BEARINGS
2441	PROPULSION SHAFT BEARINGS
245	PROPULSORS
2451	PROPELLERS AND PROPULSORS
246	PROPULSOR SHROUDS AND DUCTS
2461	PROPULSOR SHROUDS AND DUCTS
247	WATER JET PROPULSORS
2471	PROPULSORS, WATER JET - HULLBORNE
2472	PROPULSORS, WATER JET-FOILBORNE
248	LIFT SYSTEM FANS AND DUCTING
250	PROPULSION SUPPORT SYS. (EXCEPT FUEL AND LUBE OIL)
251	COMBUSTION AIR SYSTEM
2511	BLOWERS, FORCED DRAFT
2512	BLOWERS, LIGHT OFF
2512	BLOWERS, LIGHT OFF
2513	INTAKES, COMBUSTION AIR, GAS TURBINE
252	PROPULSION CONTROL SYSTEM
2521	PROPULSION CONTROL SYSTEM, AUTOMATIC
2522	PROPULSION CONTROL SYSTEM, AUTOMATIC-FOILBORNE
2523	PROPULSION CONTROL SYSTEM, SUBMARINES
253	MAIN STEAM PIPING SYSTEM
2531	PIPING, MAIN STEAM
254	CONDENSERS AND AIR EJECTORS
2541	MAIN CONDENSERS AND AIR EJECTORS
2542	CONDENSERS AND AIR EJECTORS, AUXILIARY
2543	CONDENSERS AND FANS, AUXILIARY GLAND EXHAUST
2544	PIPING/ACCESSORIES, MAIN/AUX CONDENSERS AND AIR EJECTORS
255	FEED AND CONDENSATE SYSTEM
2551	PIPING AND ACCESSORIES, MAIN FEEDWATER
2552	PUMPS, MAIN FEED
2553	PUMPS, MAIN FEED BOOSTER, EMERGENCY FEED

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
2554	PIPING AND ACCESSORIES, MAIN/AUXILIARY CONDENSATE
2555	PUMPS, MAIN CONDENSATE
2556	PUMPS, AUXILIARY CONDENSATE
2557	TANKS, DEAERATING FEED
2558	PUMPS, AUXILIARY CONDS., COOLANT PUMP, TURBINE GENERATOR
256	CIRCULATING AND COOLING SEA WATER SYSTEM
2561	PIPING, CIRCULATING AND COOLING SEA WATER
2562	PUMPS, MAIN CIRCULATING
2563	PUMPS, AUXILIARY CIRCULATING
2564	PUMPS, AUX. CIRCULATING, COOLANT PUMP, TURBINE GENERATOR
2565	PIPING, FIREMAIN SUPPLIED SEA WATER COOLING SYSTEM
2566	PIPING, CENTRALIZED CIRCULATING AND COOLING SEA WATER
2567	PUMPS, CENTRALIZED SEA WATER COOLING SYSTEM
258	HP STEAM DRAIN SYSTEM
2581	DRAIN SYSTEM, HIGH PRESSURE STEAM
259	UPTAKES (INNER CASING)
2591	EXHAUST UPTAKES AND BAFFLES, INNER CASING
260	PROPULSION SUPPORT SYSTEMS (FUEL AND LUBE OIL)
261	FUEL SERVICE SYSTEM
2611	PIPING AND MISCELLANEOUS, FUEL SERVICE
2612	PUMPS, FUEL SERVICE
2613	PURIFIERS, FUEL SERVICE
262	MAIN PROPULSION LUBE OIL SYSTEM
2621	PIPING AND ACCESSORIES, MAIN LUBE OIL
2622	TANKS, MAIN LUBE OIL, NON-STRUCTURAL
2623	PUMPS, MAIN LUBE OIL ATTACHED
2624	PUMPS, MAIN LUBE OIL, NON-ATTACHED
263	SHAFT LUBE OIL SYSTEM (SUBMARINES)
264	LUBE OIL FILL, TRANSFER, AND PURIFICATION
2641	LUBE OIL FILL, TRANSFER AND PRFCN. PIPING AND HAND PUMPS
2642	PUMPS, LUBE OIL FILL AND TRANSFER
2643	PURIFIERS, LUBE OIL
290	SPECIAL PURPOSE SYSTEMS
298	PROPULSION PLANT OPERATING FLUIDS
299	PROPULSION PLANT REPAIR PARTS AND SPECIAL TOOLS
2991	PROPULSION PLANT MISCELLANEOUS PARTS
2992	PROPULSION PLANT SPECIAL TOOLS
300	ELECTRIC PLANT, GENERAL
301	GENERAL ARRANGEMENT-ELECTRICAL DRAWINGS
302	MOTORS AND ASSOCIATED EQUIPMENT
303	PROTECTIVE DEVICES
304	ELECTRIC CABLES
305	ELECTRICAL DESIGNATING AND MARKING
310	ELECTRIC POWER GENERATION

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
311	SHIP SERVICE POWER GENERATION
3111	GENERATOR SETS, SHIP SERVICE STEAM TURBINE
3112	GENERATOR SETS, SHIP SERVICE DIESEL
3113	GENERATOR SETS, SHIP SERVICE GAS TURBINE
3114	GENERATOR SETS, SPECIAL FREQUENCY TURBINE
3115	GENERATOR SETS, COOLANT PUMP (NUCLEAR)
312	EMERGENCY GENERATORS
3121	GENERATOR SETS, EMERGENCY DIESEL
3122	GENERATOR SETS, EMERGENCY GAS TURBINE
313	BATTERIES AND SERVICE FACILITIES
3131	BATTERIES AND SERVICE FACILITIES
314	POWER CONVERSION EQUIPMENT
3141	MOTOR GENERATORS, 60 HZ
3142	MOTOR GENERATORS,400 HZ
3143	POWER CONVERSION, SPECIAL PURPOSE COMPONENTS
3144	POWER SUPPLIES, DC
320	POWER DISTRIBUTION SYSTEMS
321	SHIP SERVICE POWER CABLE
3211	SHIP SERVICE POWER CABLE
3212	POWER DISTRIBUTION SYSTEMS
322	EMERGENCY POWER CABLE SYSTEM
3221	EMERGENCY POWER CABLE SYSTEM
323	CASUALTY POWER CABLE SYSTEM
3231	CASUALTY POWER CABLE SYSTEM
324	SWITCHGEAR AND PANELS
3241	SWITCHGEAR AND PANELS, 60 HZ POWER
330	LIGHTING SYSTEM
331	LIGHTING DISTRIBUTION
3311	LIGHTING DISTRIBUTION
332	LIGHTING FIXTURES
3321	LIGHTING FIXTURES
340	POWER GENERATION SUPPORT SYSTEMS
341	SSTG LUBE OIL
3411	LUBE OIL SYSTEMS, SHIP SERVICE TURBINE GENERATOR
3412	LUBE OIL SYSTEMS, COOLANT PUMP TURBINE GENERATOR
342	DIESEL SUPPORT SYSTEMS
3421	GENERATOR SUPPORT SYSTEMS, SHIP SERVICE DIESEL
3422	GENERATOR SUPPORT SYSTEMS, EMERGENCY DIESEL
3423	SNORKEL (SUBMARINES)
343	TURBINE SUPPORT SYSTEMS
3431	GENERATOR SUPPORT SYSTEMS, SHIP SERVICE GAS TURBINE
3432	GENERATOR SUPPORT SYSTEMS, EMERGENCY GAS TURBINE
3433	GENERATOR SUPPORT SYSTEMS, SPECIAL FREQUENCY TURBINE
390	SPECIAL PURPOSE SYSTEMS

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
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ESWBS	TITLE
398	ELECTRIC PLANT OPERATING FLUIDS
399	ELECTRIC PLANT REPAIR PARTS AND SPECIAL TOOLS
3991	ELECTRIC PLANT MISCELLANEOUS PARTS
3992	ELECTRIC PLANT SPECIAL TOOLS
400	COMMAND AND SURVEILLANCE, GENERAL
401	GENERAL ARRANGEMENT - COMMAND AND SURVEILLANCE
402	SECURITY REQUIREMENTS
403	PERSONNEL SAFETY
404	RADIO FREQUENCY TRANSMISSION LINES
405	ANTENNA REQUIREMENTS
406	GROUNDING AND BONDING
407	ELECTROMAGNETIC INTERFERENCE REDUCTION (EMI)
4071	SURVEY, ELECTROMAGNETIC INTERFERENCE
408	SYSTEM TEST REQUIREMENTS
409	COMBAT SYSTEM GENERAL REQUIREMENTS
410	COMMAND AND CONTROL SYSTEMS
4101	TESTING, COMMAND AND CONTROL INTRA-SYSTEM
411	DATA DISPLAY GROUP
4111	TACTICAL DATA DISPLAY
412	DATA PROCESSING GROUP
4121	TACTICAL DATA PROCESSING
413	DIGITAL DATA SWITCHBOARDS
414	INTERFACE EQUIPMENT
4141	TACTICAL DATA SYSTEM SWITCHBOARD AND INTERFACING EQUIPMENT
415	DIGITAL DATA COMMUNICATIONS
4151	TACTICAL DATA SYSTEM COMMUNICATIONS
417	COMMAND AND CONTROL ANALOG SWITCHBOARDS
420	NAVIGATION SYSTEMS
4201	TESTING, NAVIGATION SYSTEM INTRA-SYSTEM
421	NON-ELECTRICAL/NON-ELECTRONIC NAVIGATION AIDS
4211	NAVIGATION AIDS, NON-ELECTRICAL/NON-ELECTRONIC
422	ELECTRICAL NAVIGATION AIDS (INCL NAVIG. LIGHTS)
4221	NAVIGATION AIDS, ELECTRICAL
423	ELECTRONIC NAVIGATION SYSTEMS, RADIO
4231	ELECTRONIC NAVIGATION SYSTEMS, ELECTRICAL
4232	NAVIGATION, HI SPEED COLLISION AVOIDANCE SYSTEM
424	ELECTRONIC NAVIGATION SYSTEMS, ACOUSTICAL
4241	DEPTH SOUNDING EQUIPMENT
4241	DEPTH SOUNDING EQUIPMENT
425	PERISCOPES
4251	PERISCOPES
426	ELECTRICAL NAVIGATION SYSTEMS
4261	GYROCOMPASS SYSTEM
4262	NAVIGATION SYSTEM, ELECTRICAL (LESS GYRO AND DEPTH DETECTOR)

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4263	SUBMARINE DEPTH DETECTOR SYSTEM
427	INERTIAL NAVIGATION SYSTEMS
4271	INERTIAL NAVIGATION SYSTEMS
4272	NAVIGATION ALIGNMENT SYSTEM, AIRCRAFT INERTIAL
428	NAVIGATION CONTROL MONITORING
4281	NAVIGATION CONTROL, MONITORING AND SUPPORT
430	INTERIOR COMMUNICATIONS
431	SWITCHBOARDS FOR INTERIOR COMMUNICATION SYSTEMS
4311	SWITCHBOARDS, IC
4312	SHIPBOARD DATA MULTIPLEX SYSTEM
432	TELEPHONE SYSTEMS
4321	TELEPHONE SYSTEMS
433	ANNOUNCING SYSTEMS
4331	ANNOUNCING SYSTEMS
434	ENTERTAINMENT AND TRAINING SYSTEMS
4341	AUDIO VISUAL EQUIPMENT, TRAINING AND ENTERTAINMENT
435	VOICE TUBES AND MESSAGE PASSING SYSTEMS
4351	VOICE TUBES AND MESSAGE PASSING SYSTEMS
436	ALARM, SAFETY, AND WARNING SYSTEMS
4361	ALARM, SAFETY AND WARNING SYSTEMS
437	INDICATING, ORDER, AND METERING SYSTEMS
4371	INDICATING, ORDER, AND METERING CIRCUITS
4372	TANK LEVEL INDICATING SYSTEMS
4373	WIND INDICATING SYSTEMS
438	CONSOLIDATED CONTROL AND DISPLAY SYSTEMS
4381	INTEGRATED CONTROL SYSTEMS
4382	DEPTH AND COURSE CONTROL SUBSYSTEM (DC), SUBMARINES
4383	HOVERING CONTROL SUBSYSTEM (HC), SUBMARINES
4384	MISSILE COMPENSATING CONTROL SUBSYSTEM (MC), SUBMARINES
4385	STRATEGIC WEAPONS SUPPORT SYSTEM, SUBMARINES
439	RECORDING AND TELEVISION SYSTEMS
4391	TELEVISION, CLOSED CIRCUIT
4392	AUDIO RECORDING SYSTEMS
440	EXTERIOR COMMUNICATIONS
4401	TESTING, INTEGRATED RADIO SYSTEMS
441	RADIO SYSTEMS
4411	COMMUNICATION ANTENNA SYSTEMS
4412	ANTENNA MULTICOUPLERS-TUNERS
4413	COMMUNICATION TRANSMITTERS
4414	COMMUNICATION RECEIVERS
4415	COMMUNICATION TRANSCEIVERS
4416	COMMUNICATION DEVICES, REMOTE & MISCELLANEOUS
4417	COMMUNICATION SYSTEMS, SATELLITE
4418	CONTROL SYSTEMS, QUALITY MONITORING

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4419	MESSAGE PROCESSING DISTRIBUTION SYSTEMS (MPDS)
442	UNDERWATER SYSTEMS
4421	COMMUNICATION SYSTEM, UNDERWATER
443	VISUAL AND AUDIBLE COMMUNICATION SYSTEMS
4431	COMMUNICATION SYSTEMS, VISUAL AND AUDIBLE
444	TELEMETRY SYSTEMS
445	TELETYPE AND FACSIMILE SYSTEMS
4451	TELETYPE AND FACSIMILE SYSTEMS
446	SECURITY EQUIPMENT SYSTEMS
4461	SECURITY EQUIPMENT
4462	TEMPEST INSPECTION AND DISCREPANCY RESOLUTION
450	SURVEILLANCE SYSTEMS, SURFACE AND AIR
4501	RADAR DISTRIBUTION SYSTEMS
451	SURFACE SURVEILLANCE RADAR SYSTEMS
451X	RADAR, SURFACE SEARCH
452	AIR SEARCH RADAR (2D)
452X	RADARS, AIR SEARCH (2D)
453	AIR SEARCH RADAR (3D)
453X	RADARS, HEIGHT FINDING (3D)
454	AIRCRAFT CONTROL APPROACH RADAR
454X	RADAR, AIRCRAFT CONTROL APPROACH
455	IDENTIFICATION SYSTEMS (IFF)
4551	IDENTIFICATION SYSTEMS (IFF)
456	MULTIPLE MODE/FUNCTION RADAR
456X	RADARS, MULTIPLE MODE
459	SPACE VEHICLE ELECTRONIC TRACKING
460	SURVEILLANCE SYSTEMS (UNDERWATER)
461	ACTIVE SONAR
461X	SONAR SYSTEMS, ACTIVE
462	PASSIVE SONAR
462X	SONAR SYSTEMS, PASSIVE
463	MULTIPLE MODE SONAR
463X	SONAR SYSTEMS, MULTIPLE MODE
464	CLASSIFICATION SONAR
464X	SONAR SYSTEMS, CLASSIFICATION
465	BATHYTHERMOGRAPH
4651	BATHYTHERMOGRAPH
466	MULTI-PURPOSE SHIP EQUIPMENT SYSTEMS
4661	LAMPS SHIPBOARD EQUIPMENT
470	COUNTERMEASURE SYSTEMS
4701	TESTING, ELECTRONIC COUNTERMEASURES INTRA-SYSTEM
471	ACTIVE EW (INCL COMBINATION ACTIVE/PASSIVE)
4711	ELECTRONIC COUNTERMEASURES, ACTIVE
472	PASSIVE ECM

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4721	ELECTRONIC COUNTERMEASURES, PASSIVE
473	UNDERWATER COUNTERMEASURES
4731	TORPEDO DECOYS
474	DECOY SYSTEMS
4741	COUNTERMEASURES DECOYS
475	DEGAUSSING SYSTEMS
4751	DEGAUSSING SYSTEMS
476	MINE COUNTERMEASURE SYSTEMS
4761	MINESWEEPING SYSTEMS
4762	MINEHUNTING SYSTEMS
480	FIRE CONTROL SYSTEMS
4801	TESTING, GUN WARFARE INTRA-SYSTEM
4802	TESTING, GUIDED MISSILE INTRA-SYSTEM
4803	TESTING, ANTI-SUBMARINE WARFARE INTRA-SYSTEM
481	GUN FIRE CONTROL SYSTEMS
481X	FIRE CONTROL SYSTEM, GUN
482	MISSILE FIRE CONTROL SYSTEMS
482X	FIRE CONTROL SYSTEM, MISSILE
483	UNDERWATER FIRE CONTROL SYSTEMS
483X	FIRE CONTROL SYSTEM, ANTI-SUBMARINE WARFARE
484	INTEGRATED FIRE CONTROL SYSTEMS
484X	FIRE CONTROL SYSTEMS, COMBINED
489	WEAPON SYSTEMS SWITCHBOARDS
490	SPECIAL PURPOSE SYSTEMS
491	ELECTRONIC TEST, CHECKOUT, AND MONITORING EQUIPMENT
4911	ELECTRONIC TEST, CHECKOUT, AND MONITORING EQUIPMENT
492	FLIGHT CONTROL AND INSTRUMENT LANDING SYSTEMS
4921	LIGHTING SYSTEM, VISUAL AID (AIRCRAFT CARRIERS)
4922	LANDING SYSTEMS, FRESNEL LENS OPTICAL (FLOLS)
4923	PILOT LANDING AID TELEVISION SYSTEM (PLAT)
4924	LANDING SIGNAL OFFICERS STATION SYSTEM (LSO)
4925	LANDING AID SYSTEM, MANUAL OPERATED VISUAL (MOVLAS)
4926	LIGHTING SYSTEM, VISUAL AID (AIR CAPABLE)
4927	LIGHTING SYSTEM, VISUAL AID (AMPHIBIOUS ASSAULT SHIPS)
493	AUTOMATED DATA PROCESSING SYSTEMS (NON-COMBAT)
4931	MANAGEMENT DATA PROCESSING SYSTEMS
4932	MONITORING SYSTEM
494	METEOROLOGICAL SYSTEMS
4941	METEOROLOGICAL SYSTEMS
495	SPECIAL PURPOSE INTELLIGENCE SYSTEMS
4951	INTELLIGENCE SYSTEMS, INTEGRATED OPERATIONAL
4952	INTELLIGENCE SYSTEM, NAVAL PROCESSING (NIPS)
4953	TACTICAL SUPPORT CENTER
498	COMMAND AND SURVEILLANCE OPERATING FLUIDS

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4991	COMMAND AND SURVEILLANCE MISCELLANEOUS PARTS
4992	COMMAND AND SURVEILLANCE SPECIAL TOOLS
4993	MAINTENANCE ASSIST MODULE (MAM) KITS
500	AUXILIARY SYSTEMS, GENERAL
501	GENERAL ARRANGEMENT-AUXILIARY SYSTEMS DRAWINGS
502	AUXILIARY MACHINERY
503	PUMPS
504	INSTRUMENTS AND INSTRUMENT BOARDS
505	GENERAL PIPING REQUIREMENTS
506	OVERFLOWS, AIR ESCAPES, AND SOUNDING TUBES
507	MACHINERY AND PIPING DESIGNATION AND MARKING
508	THERMAL INSULATION FOR PIPING AND MACHINERY
5081	LAGGING REMOVAL AND INSTALLATION
509	THERMAL INSULATION FOR VENT AND A/C DUCTS
510	CLIMATE CONTROL
511	COMPARTMENT HEATING SYSTEM
5111	HEATING SYSTEMS
512	VENTILATION SYSTEM
5121	VENTILATION SYSTEM, NON-MACHINERY PROPULSION SPACES
513	MACHINERY SPACE VENTILATION SYSTEM
5131	VENTILATION SYSTEM, MACHINERY SPACES
5132	VENTILATION SYSTEM (VH), SUBMARINES
514	AIR CONDITIONING SYSTEM
5141	WATER, CHILLED, COOLING DISTRIBUTION
5142	AIR CONDITIONING PLANTS
5143	AIR CONDITIONING UNITS, SELF CONTAINED
515	AIR REVITALIZATION SYSTEMS (SUBMARINES)
5151	CO/H2 BURNERS
5152	MAIN OXYGEN SYSTEM (O)
5153	ATMOSPHERE ANALYZING SYSTEM (ATM)
5154	OXYGEN GENERATION SYSTEM (OG)
516	REFRIGERATION SYSTEM
5161	REFRIGERATION, SHIP SERVICE
5162	REFRIGERATION, CARGO
517	AUXILIARY BOILERS AND OTHER HEAT SOURCES
5171	BOILERS, AUXILIARY
5172	WASTE HEAT SYSTEMS
5173	REBOILER (WITHIN MACHINERY SPACES)
520	SEA WATER SYSTEMS
5201	SEA VALVES
521	FIREMAIN AND FLUSHING (SEA WATER) SYSTEM
5211	PIPING, FIREMAIN AND FLUSHING
5212	PUMPS, FIREMAIN AND FLUSHING

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522	SPRINKLER SYSTEM
5221	SPRINKLER SYSTEMS, SEA WATER
523	WASHDOWN SYSTEM
5231	COUNTERMEASURE WASHDOWN SYSTEM
524	AUXILIARY SEA WATER SYSTEM
5241	AUXILIARY MACHINERY SEA WATER SYSTEM
5242	PUMPS, AUXILIARY MACHINERY SEA WATER
526	SCUPPERS AND DECK DRAINS
5261	SCUPPERS AND DECK DRAINS
527	FIREMAIN ACTUATED SERVICES - OTHER
528	PLUMBING DRAINAGE
5281	DRAINS, PLUMBING
5282	PLUMBING DRAINAGE, SUBMARINES
529	DRAINAGE AND BALLASTING SYSTEM
5291	PIPING, DRAINAGE AND BALLASTING SYSTEM
5292	PUMPS AND CONTROLLERS, DRAINAGE AND BALLASTING SYSTEM
5293	PIPING, AMPHIBIOUS SHIP'S BALLASTING AND DEBALLASTING SYS
5294	PUMPS, AMPHIBIOUS SHIP'S BALLASTING AND DEBALLASTING SYS
5295	CONT. STATIONS, AMPH. SHIPS BALLASTING/DEBALLASTING SYS
5296	COMPRESSORS, AIR DEBALLAST
530	FRESH WATER SYSTEMS
531	DISTILLING PLANT
5311	DISTILLING PLANT, FLASH TYPE
5312	DISTILLING PLANT, VAPOR COMPRESSION
5313	DISTILLING PLANT, HEAT RECOVERY
5314	DISTILLING PLANT, SUBMERGED TUBE TYPE
5315	DISTILLING PLANT, REVERSE OSMOSIS
5316	DISTILLING PLANT, BASKET TYPE
532	COOLING WATER
5321	COOLING WATER, ELECTRONICS, DW/CW
533	POTABLE WATER
5331	WATER, POTABLE SERVICE
5332	DISTILLED WATER SERVICE
534	AUXILIARY STEAM AND DRAINS WITHIN MACHINERY BOX
5341	AUXILIARY STEAM SYSTEM, PIPING AND CONTROLS
5342	GLAND SEAL AND VENT EXHAUST SYSTEMS
5343	GLAND LEAK-OFF SYSTEMS, AUXILIARY
5344	STEAM EXHAUST/ESCAPE SYSTEM, AUXILIARY
5345	DRAIN COLLECTING SYSTEM, FRESH WATER
5346	DRAIN SYSTEM, CONTAMINATED
5347	DRAIN SYSTEM, LOW PRESSURE STEAM
535	AUXILIARY STEAM AND DRAINS OUTSIDE MACHINERY BOX
5351	AUXILIARY STEAM AND DRAINS
536	AUXILIARY FRESH WATER COOLING

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5361	AUXILIARY FRESH WATER COOLING
5362	COOLING WATER, ELECTRONICS, DW/SW
540	FUELS AND LUBRICANTS, HANDLING AND STORAGE
541	SHIP FUEL AND FUEL COMPENSATING SYSTEM
5411	SHIP FUEL, FILLING, AND TRANSFER SYS (NON COMPENSATING AND COMPENSATING)
5412	PUMPS, FUEL TRANSFER, NON COMPENSATING AND COMPENSATING SYSTEMS
5413	SHIP FUEL AND FUEL COMPENSATING SYSTEM (RO), SUBMARINES
542	AVIATION AND GENERAL PURPOSE FUELS
5421	PIPING, AVIATION AND GENERAL PURPOSE FUEL SYSTEM
5422	PUMPS AND PURIFIERS, AVIATION AND GENERAL PURPOSE FUEL
5423	MOGAS HANDLING AND PIPING
543	AVIATION AND GENERAL PURPOSE LUBRICATING OIL
5431	LUBE OIL SYSTEM, AVIATION AND GENERAL PURPOSE
544	LIQUID CARGO
5441	LIQUID CARGO HANDLING SYSTEMS
5442	PUMPS AND CONTROLLERS, LIQUID CARGO HANDLING
545	TANK HEATING
5451	TANK HEATING SYSTEM
546	AUXILIARY LUBRICATION SYSTEMS
5461	LUBRICATION, OUTBOARD
5462	LUBRICATION, INBOARD
549	SPECIAL FUEL AND LUBRICANTS, HANDLING AND STOWAGE
550	AIR, GAS, AND MISCELLANEOUS FLUID SYSTEMS
551	COMPRESSED AIR SYSTEMS
5511	AIR SYSTEM, HIGH PRESSURE
5512	AIR SYSTEM, LOW AND MEDIUM PRESSURE
5513	AIR SYSTEM, DRY
5515	COMPRESSORS, AIR
5516	BLEED AIR SYSTEM
5517	AIR TO TORPEDO FIRE CONTROL SYSTEM (ATF), SUBMARINES
5518	CONTROL AIR SYSTEM (CAC) SUBMARINES
5519	EMERGENCY BREATHING AIR SYSTEM (AEB)
552	COMPRESSED GASES
5521	COMPRESSED GAS SYSTEM, NITROGEN
553	O2 N2 SYSTEM
5531	O2 N2 STORAGE AND DISTRIBUTION SYSTEM
5532	COMPRESSORS, O2N2
5533	O2N2 PLANTS
554	MAIN BALLAST TANK BLOW AND LIST CONTROL SYSTEM
5541	LOW PRESSURE BLOW SYSTEM (ABT)
5542	EMERGENCY MAIN BALLAST TANK BLOW AND LIST CONTROL
555	FIRE EXTINGUISHING SYSTEMS
5551	FOG, FOAM AND AFFF SYSTEMS

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5552	FIRE EXTINGUISHING SYSTEMS, DRY CHEMICAL
5553	FIRE EXTINGUISHING SYSTEMS, CO2 & HALON
5554	FIRE EXTINGUISHING SYSTEMS, STEAM SMOTHERING
5555	FIRE EXTINGUISHING SYSTEMS, FRESH WATER
5556	FIRE EXTINGUISHING SYSTEM, DEEP FAT FRYER
5557	FIRE EXTINGUISHING SYSTEM, TWIN AGENT
556	HYDRAULIC FLUID SYSTEM
5561	HYDRAULIC POWER SYSTEM, SHIP'S SERVICE
5562	EXTERNAL HYDRAULIC SYSTEM, SUBMARINES
557	LIQUID GASES, CARGO
558	SPECIAL PIPING SYSTEMS
5581	PIPING SYSTEMS, SPECIAL
560	SHIP CONTROL SYSTEMS
561	STEERING AND DIVING CONTROL SYSTEMS
5611	STEERING SYSTEM
5612	STEERING AND DIVING HYDRAULIC POWER PLANT (HD), SUBMARINES
5613	STEERING AND DIVING CONTROL SYSTEM (HD & HR), SUBMARINES
562	RUDDER
5621	RUDDER
563	HOVERING AND DEPTH CONTROL (SUBMARINE)
5631	BUOYANCY CONTROL, SUBMARINES
5632	DEPTH AND CAPACITY GAGE SYSTEM (CG)
5633	HOVERING SYSTEM (HOV)
564	TRIM AND DRAIN SYSTEMS (SUBMARINES)
5641	TRIM, DRAIN, AND AUXILIARY DRAIN SYSTEM, SUBMARINES
5642	GRAVITY AND CAVITY DRAIN SYSTEMS, SUBMARINES
565	TRIM AND HEEL SYSTEMS (SURFACE SHIPS)
5651	STABILIZING FINS
566	DIVING PLANES AND STABILIZING FINS (SUBMARINES)
5661	DIVING PLANES AND STABILIZING FINS (AND RUDDER), SUBMARINES
567	STRUT AND FOIL SYSTEMS
5671	HYDROFOILS
568	MANEUVERING SYSTEMS
5681	STEERING CONTROL THRUSTERS
570	REPLENISHMENT SYSTEMS
5701	TESTING, UNDERWAY REPLENISHMENT-AT-SEA (RAS)
571	REPLENISHMENT-AT-SEA SYSTEMS
5711	WINCHES, REPLENISHMENT-AT-SEA (RAS)
5712	REPLENISHMENT-AT-SEA RAM-TENSIONING DEVICES
5713	RAS TRANSFER HEADS, SLIDING BLOCKS AND SLIDING PADEYES
5714	REPLENISHMENT-AT-SEA BOOMS, RIGGING AND HARDWARE
5715	CONTROL STATIONS, REPLENISHMENT-AT-SEA
572	SHIP STORES AND EQUIPMENT HANDLING SYSTEMS
5721	SHIP STORES HANDLING EQUIPMENT

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573	CARGO HANDLING SYSTEMS
5731	CARGO HANDLING, ELEVATORS
5732	CONVEYORS, CARGO
5733	HANDLING EQUIPMENT, CARGO, BELOW DECK
5734	FORK LIFT TRUCKS
5735	WINCHES, CARGO HANDLING
5736	CARGO BOOMS, RIGGING AND MISCELLANEOUS HARDWARE
574	VERTICAL REPLENISHMENT SYSTEMS
5741	VERTICAL REPLENISHMENT SYSTEMS (VERTREP)
575	VEHICLE HANDLING AND STOWAGE SYSTEMS
580	MECHANICAL HANDLING SYSTEMS
581	ANCHOR HANDLING AND STOWAGE SYSTEMS
5811	ANCHOR HANDLING AND STOWAGE
582	MOORING AND TOWING SYSTEMS
5821	MOORING AND TOWING
583	BOATS, BOAT HANDLING AND STOWAGE SYSTEMS
5831	BOAT HANDLING AND STOWAGE
5832	LIFESAVING EQUIPMENT (OTHER THAN BOATS)
5833	SMALL BOATS
5834	LANDING CRAFT
584	LANDING CRAFT HANDLING AND STOWAGE SYSTEMS
5841	DOORS AND HATCHES, MECHANICALLY OPERATED
5842	MECHANICALLY OPERATED GATES
5843	MECHANICALLY OPERATED RAMPS
5844	MECHANICALLY OPERATED TURNTABLES
585	ELEVATING AND RETRACTING GEAR
5851	PERISCOPE MECHANISMS, SUBMARINES
5852	MAST MECHANISMS, SUBMARINES
586	AIRCRAFT RECOVERY SUPPORT SYSTEMS
5861	ARRESTING GEAR AND BARRICADES
587	AIRCRAFT LAUNCH SUPPORT SYSTEMS
5871	CATAPULTS
5872	CATAPULT SUPPORT SYSTEMS
5873	JET BLAST DEFLECTORS
5874	JET BLAST DEFLECTORS SUPPORT SYSTEMS
5875	CATAPULT STEAM SYSTEM
588	AIRCRAFT HANDLING, SERVICING AND STOWAGE
5881	AIRCRAFT ELEVATORS
5882	HANDLING AND SUPPORT FACILITIES, AIRCRAFT/HELO
589	MISCELLANEOUS MECHANICAL HANDLING SYSTEMS
5891	CRANES, ROTATING
5892	CRANES AND HOISTS
5893	PERSONNEL ELEVATORS
5894	PERSONNEL ESCALATORS

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591	SCIENTIFIC AND OCEAN ENGINEERING SYSTEMS
592	SWIMMER AND DIVER SUPPORT AND PROTECTION SYSTEMS
5921	SWIMMER AND DIVER SUPPORT FACILITIES
593	ENVIRONMENTAL POLLUTION CONTROL SYSTEMS
5931	SEWAGE AND WASTE WATER POLLUTION CONTROL SYSTEM
5932	OIL POLLUTION CONTROL SYSTEM
5933	SOLID AND INDUSTRIAL WASTE POLLUTION CONTROL
5934	TRASH DISPOSAL (SUBMARINES)
594	SUBMARINE RESCUE, SALVAGE, AND SURVIVAL SYSTEMS
5941	SUBMARINE RESCUE, SALVAGE, AND SURVIVAL SYSTEMS
595	TOWING, LAUNCHING AND HANDLING FOR UNDERWATER SYS.
5951	TOWING, LAUNCHING, AND HANDLING FOR ACOUSTIC CM
5952	TOWING, LAUNCHING, AND HANDLING FOR TOWED SONAR
5953	INTERIOR LAUNCHERS, SUBMARINES
5954	EXTERIOR LAUNCHERS, SUBMARINES
596	HANDLING SYS. FOR DIVER AND SUBMERSIBLE VEHICLES
597	SALVAGE SUPPORT SYSTEMS
5971	SURVIVOR AND SALVAGE SUPPORT SYSTEM
598	AUXILIARY SYSTEMS OPERATING FLUIDS
599	AUXILIARY SYSTEMS REPAIR PARTS AND TOOLS
5991	AUXILIARY SYSTEMS MISCELLANEOUS PARTS
5992	AUXILIARY SYSTEMS SPECIAL TOOLS
600	OUTFIT AND FURNISHINGS, GENERAL
601	GENERAL ARRANGEMENT - OUTFIT AND FURN. DRAWINGS
602	HULL DESIGNATING AND MARKING
6021	LABEL PLATES (MANUFACTURE)
603	DRAFT MARKS
604	LOCKS, KEYS, AND TAGS
605	RODENT AND VERMIN PROOFING
610	SHIP FITTINGS
611	HULL FITTINGS
6111	HULL FITTINGS
6112	PADEYES AND INSTALLED LIFTING DEVICES, SUBMARINE
612	RAILS, STANCHIONS, AND LIFELINES
6121	RAILS, STANCHIONS, AND LIFELINES
6122	SAFETY NETS
613	RIGGING AND CANVAS
6131	RIGGING AND CANVAS (STANDING)
620	HULL COMPARTMENTATION
621	NON-STRUCTURAL BULKHEADS
6211	NON-STRUCTURAL BULKHEADS
622	FLOOR PLATES AND GRATINGS
6221	FLOOR PLATES AND GRATINGS

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623	LADDERS
6231	LADDERS, OTHER THAN ACCOMMODATION
6232	LADDERS, ACCOMMODATION
624	NON-STRUCTURAL CLOSURES
6241	NON-STRUCTURAL CLOSURES
625	AIRPORTS, FIXED PORTLIGHTS, AND WINDOWS
6251	AIRPORTS, FIXED PORTLIGHTS, AND WINDOWS
630	PRESERVATIVES AND COVERINGS
631	PAINTING
6311	PAINTING, INTERIOR
6312	PAINTING, EXTERIOR
6313	PAINTING AND BLASTING, UNDERWATER HULL, SURFACE SHIPS
6314	PAINTING AND BLASTING, FREEBOARD, SURFACE SHIPS
6315	PAINTING, EXTERIOR & BUILT-IN TANKS, SUBMARINES
632	ZINC AND METALLIC COATINGS
6321	ZINC COATINGS
6322	FLAME SPRAY ALUMINUM
6323	METALLIC CLADDINGS AND METALLIC SPECIAL PURPOSE COATINGS
633	CATHODIC PROTECTION
6331	CATHODIC PROTECTION, SACRIFICIAL ANODE
6332	CATHODIC PROTECTION, IMPRESSED CURRENT
634	DECK COVERING
6341	DECK COVERING
6342	DECK COVERING, NON-SKID FLIGHT AND HANGAR
635	HULL INSULATION
6351	HULL INSULATION
636	HULL DAMPING
6361	HULL DAMPING
637	SHEATHING
6371	SHEATHING AND COVERING
638	REFRIGERATED SPACES
6381	SPACES, REFRIGERATED SHIP'S PROVISIONS
6382	SPACES, REFRIGERATED CARGO
639	RADIATION SHIELDING
6391	RADIATION SHIELDING AND CANNING PLATES
640	LIVING SPACES
641	OFFICER BERTHING AND MESSING SPACES
6411	OFFICER BERTHING SPACES
6412	OFFICER MESSING SPACES
642	NONCOMMISSIONED OFFICER BERTHING AND MESSING SPACES
6421	NONCOMMISSIONED OFFICER BERTHING SPACES
6422	NONCOMMISSIONED OFFICER MESSING SPACES
643	ENLISTED PERSONNEL BERTHING AND MESSING SPACES
6431	ENLISTED PERSONNEL BERTHING SPACES

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
6432	ENLISTED PERSONNEL MESSING SPACES
644	SANITARY SPACES AND FIXTURES
6441	SPACES, SANITARY
645	LEISURE AND COMMUNITY SPACES
6451	LEISURE AND COMMUNITY SPACES
650	SERVICE SPACES
651	COMMISSARY SPACES
6511	SPACES, COMMISSARY
652	MEDICAL SPACES
6521	FURNISHINGS AND EQUIPMENTS, MEDICAL SPACES
653	DENTAL SPACES
654	UTILITY SPACES
6541	UTILITY SPACE EQUIPMENT
655	LAUNDRY SPACES
6551	SPACES, LAUNDRY AND DRY CLEANING
656	TRASH DISPOSAL SPACES
6561	TRASH DISPOSAL SPACES
660	WORKING SPACES
661	OFFICES
6611	OFFICES
662	MACHINERY CONTROL CENTERS FURNISHINGS
6621	MACHINERY CONTROL CENTERS FURNISHINGS
663	ELECTRONICS CONTROL CENTERS FURNISHINGS
6631	ELECTRONIC CONTROL CENTERS FURNISHINGS
664	DAMAGE CONTROL STATIONS
6641	DAMAGE CONTROL STATIONS
665	WORKSHOPS, LABS, TEST AREAS (INCL PORTABLE TOOLS, EQUIP)
6651	WORKSHOPS, LABS, AND TEST AREAS, HULL, MECHANICAL, ELECT.
6652	WORKSHOPS, LABS, AND TEST AREAS, ELECTRONICS
6653	WORKSHOPS, LABS, AND TEST AREAS, AVIATION RELATED
6654	WORKSHOPS, LABS, AND TEST AREAS, WEAPONS
670	STOWAGE SPACES
671	LOCKERS AND SPECIAL STOWAGE
6711	LOCKERS AND SPECIAL STOWAGE
672	STOREROOMS AND ISSUE ROOMS
6721	STOREROOMS AND ISSUE ROOMS
673	CARGO STOWAGE
6731	STOWAGE, CARGO
690	SPECIAL PURPOSE SYSTEMS
698	OUTFIT AND FURNISHINGS OPERATING FLUIDS
699	OUTFIT AND FURNISH. REPAIR PARTS AND SPECIAL TOOLS
6991	OUTFIT AND FURNISHINGS MISCELLANEOUS PARTS
6992	OUTFIT AND FURNISHINGS SPECIAL TOOLS
700	ARMAMENT, GENERAL

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
701	GENERAL ARRANGEMENT - WEAPONRY SYSTEMS
702	ARMAMENT INSTALLATIONS
703	WEAPONS HANDLING AND STOWAGE, GENERAL
710	GUNS AND AMMUNITION
711	GUNS
7111	GUNS AND MOUNTS
7112	GUNS, SELF CONTAINED
712	AMMUNITION HANDLING
7121	HANDLING, GUN AMMUNITION
713	AMMUNITION STOWAGE
7131	STOWAGE, GUN AMMUNITION
720	MISSILES AND ROCKETS
721	LAUNCHING DEVICES (MISSILES AND ROCKETS)
7211	LAUNCHING RAIL SYSTEMS, MISSILE
7212	LAUNCHING SYSTEMS, ASW/ASUW ROCKET
7213	COMBINED LAUNCHING, STWG AND HDLG SYS, MSL
7214	MISSILE TUBES, SUBMARINES
7215	VERTICAL LAUNCH SYSTEM (VLS), SUBMARINE
722	MISSILE, ROCKET, AND GUIDANCE CAPSULE HANDLING SYS.
7221	HANDLING, MISSILE
7222	HANDLING, ASW/ASUW ROCKET
7223	MISSILE GUIDANCE CAPSULE HANDLING, SUBMARINES
723	MISSILE AND ROCKET STOWAGE
7231	STOWAGE, MISSILE
7232	STOWAGE, ASW/ASUW ROCKET
724	MISSILE HYDRAULICS
725	MISSILE GAS
7251	MISSILE GAS SYSTEM (MG), SUBMARINES
7252	MISSILE DEHUMIDIFICATION AND DRYING SYSTEM (MDD), SUB
726	MISSILE COMPENSATING
7261	MISSILE COMPENSATING WATER SYSTEM (MCW)
727	MISSILE LAUNCHER CONTROL
728	MISSILE HEATING, COOLING, TEMPERATURE CONTROL
729	MISSILE MONITORING, TEST AND ALIGNMENT
7291	MISSILE ENVIRONMENTAL MONITORING, SUBMARINES
7292	MISSILE TEST AND READINESS EQUIPMENT (MTRE), SUBMARINES
7293	TEST INSTRUMENTATION, SUBMARINES
7294	MISSILE OPTICAL AND ELECTRICAL ALIGNMENT, SUBMARINES
730	MINES
731	MINE LAUNCHING DEVICES
732	MINE HANDLING
733	MINE STOWAGE
740	DEPTH CHARGES
741	DEPTH CHARGE LAUNCHING DEVICES

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
742	DEPTH CHARGE HANDLING
743	DEPTH CHARGE STOWAGE
750	TORPEDOES
751	TORPEDO TUBES
7511	TORPEDO TUBES
752	TORPEDO HANDLING
7521	TORPEDO HANDLING
753	TORPEDO STOWAGE
7531	TORPEDO STOWAGE
754	SUBMARINE TORPEDO EJECTION
7541	SUBMARINE TORPEDO EJECTION
755	TORPEDO SUPPORT, TEST AND ALIGNMENT
7551	TORPEDO OPTICAL AND ELECTRICAL ALIGNMENT, SUBMARINES
760	SMALL ARMS AND PYROTECHNICS
761	SMALL ARMS AND PYROTECHNIC LAUNCHING DEVICES
7611	SMALL ARMS AND PYROTECHNIC LAUNCHING DEVICES
762	SMALL ARMS AND PYROTECHNIC HANDLING
7621	SMALL ARMS AND PYROTECHNIC HANDLING
763	SMALL ARMS AND PYROTECHNIC STOWAGE
7631	SMALL ARMS AND PYROTECHNIC STOWAGE
770	CARGO MUNITIONS
772	CARGO MUNITIONS HANDLING
7721	HANDLING AND STOWAGE, AMMUNITION CARGO
7722	AMMUNITION HANDLING ELEVATORS (NON-CV/CVN SHIPS)
773	CARGO MUNITIONS STOWAGE
780	AIRCRAFT RELATED WEAPONS
782	AIRCRAFT RELATED WEAPONS HANDLING
7821	HANDLING EQUIPMENT, AIRCRAFT WEAPONS
783	AIRCRAFT RELATED WEAPONS STOWAGE
7831	STOWAGE, AIRCRAFT RELATED WEAPONS
784	AIRCRAFT RELATED WEAPONS ELEVATORS, UPPER STAGES
784X	UPPER STAGE WEAPONS ELEVATORS, ON CV/CVN SHIPS
785	AIRCRAFT RELATED WEAPONS ELEVATORS, LOWER STAGES
785X	LOWER STAGE WEAPONS ELEVATORS, ON CV/CVN SHIPS
786	AIRCRAFT RELATED WEAPONS, HYDRAULICS
786X	ELEVATOR HYDRAULIC POWER PLANTS
790	SPECIAL PURPOSE SYSTEMS
792	SPECIAL WEAPONS HANDLING
7921	ELEVATORS, SPECIAL WEAPONS (DELETED-SEE 7722X)
7922	HANDLING EQUIPMENT, SPECIAL WEAPONS
7923	WEAPON MONITORING, SUBMARINES
793	SPECIAL WEAPONS STOWAGE
7931	STOWAGE, SPECIAL WEAPONS
797	MISCELLANEOUS ORDNANCE SPACES

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
798	ARMAMENT OPERATING FLUIDS
799	ARMAMENT REPAIR PARTS AND SPECIAL TOOLS
7991	ARMAMENT MISCELLANEOUS PARTS
7992	ARMAMENT SPECIAL TOOLS
800	INTEGRATION/ENGINEERING (SHIPBUILDER RESPONSE)
801	SHIPBUILDERS INFORMATION DRAWINGS
802	CONTRACT DRAWINGS
803	STANDARD DRAWINGS
804	TYPE DRAWINGS
806	STUDY DRAWINGS
807	INSTALLATION CONTROL DRAWINGS
808	INTERFACE CONTROL DRAWINGS
810	PRODUCTION ENGINEERING
811	CONFIGURATION MANAGEMENT (DELETED - SEE 8612 & 8613)
8111	CONTROL OF SHIP'S CONFIGURATION
812	CHANGE PROPOSALS, SCOPING AND SHIPCHECKING
813	PLANNING AND PRODUCTION CONTROL
8131	PLANNING AND ESTIMATING SERVICES (NOT CHARGEABLE TO OVHD)
8132	SHIPYARD SFOMS ASSIST
8133	SARP PREPARATION
820	SPECIAL DRAWINGS FOR NUCLEAR PROPULSION SYSTEMS
830	DESIGN SUPPORT
8301	SERVICES, DESIGN (NOT CHARGEABLE TO OVERHEAD)
8302	SHIP'S SELECTED RECORDS
8303	SERVICES, REPRODUCTION
831	CONSTRUCTION DRAWINGS
832	SPECIFICATIONS
833	MASS PROPERTIES ENGINEERING
834	COMPUTER PROGRAMS
835	ENGINEERING CALCULATIONS
836	MODELS AND MOCKUPS
837	PHOTOGRAPHS
8371	SERVICES, SPECIAL PHOTOGRAPHIC
838	DESIGN/ENGINEERING LIAISON
8381	WATERFRONT LIAISON ENGINEERING SERVICE
839	LOFTING
840	QUALITY ASSURANCE
841	TESTS AND INSPECTION, CRITERIA, AND PROCEDURES
8411	TEST PREPARATION AND TEST COORDINATION
842	TRIALS AGENDA PREPARATION, DATA COLLECTION AND ANAL.
843	INCLINING EXPERIMENT AND TRIM DIVE
8431	INCLINING EXPERIMENT, WEIGHT, STABILITY, AND REBALLASTING
844	COMBAT SYSTEMS CHECKOUT CRITERIA AND PROCEDURES
8441	COMBAT SYSTEMS LIAISON SERVICES, WATERFRONT

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
8442	COMBAT SYSTEMS ALIGNMENT
8443	TEST, INTEGRATED COMBAT SYSTEMS
845	CERTIFICATION STANDARDS
850	INTEGRATED LOGISTIC SUPPORT ENGINEERING
851	MAINTENANCE
852	SUPPORT AND TEST EQUIPMENT
853	SUPPLY SUPPORT
8531	SUPPLY OPERATION (OVERHAUL) ASSTN PRGM (SOAP), SY ASSTN TO
8532	CONSOLIDATED SHIP'S ALLOWANCE LIST (COSAL)
8533	SUPPLIES, CONSUMABLE SHIPS FORCE
854	TRANSPORTATION
855	ENGINEERING DRAWINGS AND SPECIFICATIONS
856	TECHNICAL MANUALS AND OTHER DATA
857	FACILITIES
8571	FACILITIES SUPPORT
858	PERSONNEL AND TRAINING
859	TRAINING EQUIPMENT
880	AUTHORIZED REPAIR PLANNING
881	FUNDS
8811	FUNDS RESERVATION (GROWTH)
8812	FUNDS RESERVATION (NEW WORK)
890	SPECIAL PURPOSE ITEMS
891	SAFETY
892	HUMAN FACTORS
893	STANDARDIZATION
894	VALUE ENGINEERING
895	RELIABILITY AND MAINTAINABILITY
896	DATA MANAGEMENT
897	PROJECT MANAGEMENT
900	SHIP ASSEMBLY AND SUPPORT SERVICES
901	901 THRU 979 RESERVED FOR IDENT. OF ASSEMBLIES
980	CONTRACTUAL AND PRODUCTION SUPPORT SERVICE
9801	ASSIST SHIP'S FORCE
9802	GAUGES AND THERMOMETERS, CALIBRATION OF
9803	PRODUCTION SUPPORT, INTEGRATED OVERHAUL MANAGEMENT CENTER
9804	VALVE HANDWHEELS
9805	TESTING, RELIEF VALVES
981	INSURANCE
982	TRIALS
9821	DISCREPANCY CORRECTIONS AND INSPECTION, PRE PEB/LOE
9822	DISCREPANCY CORRECTIONS, PEB/LOE
9823	DOCK AND SEA TRIALS
9824	DISCREPANCY CORRECTIONS, DOCK AND SEA TRIAL
9825	HULL VIBRATION SURVEY

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
983	DELIVERY
9831	GUARANTEE ENGINEER
984	OPEN AND INSPECT (CONVERSIONS ONLY)
985	FIRE AND FLOODING PROTECTION
986	TESTS AND INSPECTION
9861	PRE-OVERHAUL TESTS AND INSPECTION (POT&I)
9862	OIL AND WATER SAMPLE ANALYSIS
9863	QUALITY ASSURANCE SERVICES
987	WEIGHING AND RECORDING
988	CONTRACT DATA REQUIREMENTS (ADMINISTRATION)
989	FITTING-OUT
990	CONSTRUCTION SUPPORT
991	STAGING, SCAFFOLDING, AND CRIBBING
9911	STAGING FOR ROUTINE WORK
992	TEMPORARY UTILITIES AND SERVICES
9921	TEMPORARY UTILITIES AND SERVICES (PRORATABLE)
9922	TEMPORARY UTILITIES AND SERVICES (NON PRORATABLE)
9923	BILGE CLEANING AND GAS FREEING, MACHINERY SPACES
9924	TEMPORARY STEAM BARGE SERVICES
993	MATERIAL HANDLING AND REMOVAL
9931	SERVICES, CRANE AND RIGGING SY SUPPORT
9932	SERVICES, CRANE AND RIGGING SF SUPPORT
9933	CARE AND PRESERVATION
994	CLEANING SERVICES
9941	PREVENTIVE MAINTENANCE
995	MOLDS AND TEMPLATES, JIGS, FIXTURES, AND SPEC. TOOLS
996	LAUNCHING
997	DRYDOCKING
9971	DOCK AND UNDOCK SHIP
F00	LOADS (FULL LOAD CONDITION)
F10	SHIPS FORCE, AMPHIB. FORCE, TROOPS AND PASSENGERS
F11	SHIPS OFFICERS
F12	SHIPS NONCOMMISSIONED OFFICERS
F13	SHIPS ENLISTED MEN
F14	MARINES
F15	TROOPS
F16	AIR WING PERSONNEL
F19	OTHER PERSONNEL
F20	MISSION RELATED EXPENDABLES AND SYSTEMS
F21	SHIP AMMUNITION (FOR USE BY SHIP ON WHICH STOWED)
F22	ORDNANCE DELIVERY SYSTEMS AMMUNITION
F23	ORDNANCE DELIVERY SYSTEMS
F24	ORDNANCE REPAIR PARTS (SHIP AMMO)
F25	ORDNANCE REPAIR PARTS (ORDNANCE DELIVERY SYS. AMMO)

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
F26	ORDNANCE DELIVERY SYSTEMS SUPPORT EQUIPMENT
F29	SPECIAL MISSION RELATED SYSTEMS AND EXPENDABLES
F30	STORES
F31	PROVISIONS AND PERSONNEL STORES
F32	GENERAL STORES
F33	MARINES STORES (FOR SHIP'S COMPLEMENT)
F39	SPECIAL STORES
F40	FUELS AND LUBRICANTS
F41	DIESEL FUEL
F42	JP-5
F43	GASOLINE
F44	DISTILLATE FUEL
F45	NAVY STANDARD FUEL OIL (NSFO)
F46	LUBRICATING OIL
F49	SPECIAL FUELS AND LUBRICANTS
F50	LIQUIDS AND GASES (NON FUEL TYPE)
F51	SEA WATER
F52	FRESH WATER
F53	RESERVE FEED WATER
F54	HYDRAULIC FLUID
F55	SANITARY TANK LIQUID
F56	GAS (NON FUEL TYPE)
F59	MISCELLANEOUS LIQUIDS (NON FUEL TYPE)
F60	CARGO
F61	CARGO, ORDNANCE AND ORDNANCE DELIVERY SYSTEMS
F62	CARGO, STORES
F63	CARGO, FUELS AND LUBRICANTS
F64	CARGO, LIQUIDS (NON FUEL TYPE)
F65	CARGO, CRYOGENIC AND LIQUIFIED GAS
F66	CARGO, AMPHIBIOUS ASSAULT SYSTEMS
F67	CARGO, GASES
F69	CARGO, MISCELLANEOUS
F70	SEA WATER BALLAST (SUBMARINES)
F71	MAIN BALLAST WATER (SUBMARINES)
F72	VARIABLE BALLAST WATER (SUBMARINES)
F73	RESIDUAL WATER (SUBMARINES)
M00	MARGINS
M10	CONTRACTOR CONTROLLED MARGINS
M11	DESIGN AND BUILDING MARGIN
M12	BUILDING MARGIN (RESERVED)
M20	GOVERNMENT CONTROLLED MARGIN (SURFACE SHIP)
M21	PRELIMINARY DESIGN MARGIN (SURFACE SHIP)
M22	CONTRACT DESIGN MARGIN (SURFACE SHIP)
M23	CONTRACT MODIFICATION MARGIN (SURFACE SHIP)

EXPANDED SHIP WORK BREAKDOWN STRUCTURE
ESWBS TO TITLE INDEX

ESWBS	TITLE
M24	GEM MARGIN (SURFACE SHIP)
M25	FUTURE GROWTH MARGIN (SURFACE SHIP)
M26	SERVICE LIFE MARGIN (SURFACE SHIP)
M27	NUCLEAR MACHINERY MARGIN (SURFACE SHIP)
M30	GOVERNMENT CONTROLLED MARGIN STATUS (SUBMARINES)
M31	PRELIMINARY DESIGN MARGIN (SUBMARINE)
M32	CONTRACT DESIGN MARGIN (SUBMARINE)
M33	NAVSHIPS DEVELOPMENT MARGIN (SUBMARINE)
M34	NUCLEAR MACHINERY MARGIN (SUBMARINE)
M35	FUTURE GROWTH MARGIN (SUBMARINE)
M36	STABILITY LEAD STATUS (SUBMARINE)
M37	TRIMMING LEAD STATUS (SUBMARINE)
M40	BALLAST STATUS (SUBMARINE)
M41	LEAD, INTERNAL (SUBMARINE)
M42	LEAD, EXTERNAL (SUBMARINE)
M43	LEAD, MET (SUBMARINE)
M44	STEEL, INTERNAL (SUBMARINE)
M45	STEEL, EXTERNAL (SUBMARINE)
M46	STEEL, MBT (SUBMARINE)
M47	LEAD CORRECTION, MET (SUBMARINE)
M48	LEAD CORRECTION, OTHER THEN MET (SUBMARINE)

ANNEX C

NATO Ship Programmatic Cost Element Index

NATO Ship Programmatic Cost Element Index

(Note: This list is not considered to be an all-inclusive list of Programmatic Elements. It should be added to and amended as required when a project specific CWBS is developed.)

P00 Programmatic Cost

- P10 Budgeting Practices
  - P11 Contract Incentives
  - P12 Shipbuilder Profit
  - P13 Revenue Dependency
  - P14 Industrial Benefits
- P20 Escalation
- P30 Law and Government Regulations
  - P31 Taxes
  - P32 Tariffs
  - P33 Duties
  - P34 Data Rights
  - P35 Licensing Fees
  - P36 Royalties
  - P37 Social Security
- P40 Contingencies
  - P41 (ESWBS M00) Margins

P411 (ESWBS M10)	Contractor-Controlled Margins (either submarine or surface ship)
P4111 (ESWBS M11)	Design and Building Margin
P4112 (ESWBS M12)	Building Margin (only if separate from P4111)
P412 (ESWBS M20)	Government-Controlled Margins (surface ship)
P4121 (ESWBS M21)	Preliminary Design Margin
P4122 (ESWBS M22)	Contract Design Margin
P4123 (ESWBS M23)	Contract Modification Margin
P4124 (ESWBS M24)	Government Furnished Material Margin
P4125 (ESWBS M25)	Future Growth Margin
P4126 (ESWBS M26)	Service Life Margin
P4127 (ESWBS M27)	Nuclear Machinery Margin

	P413 (ESWBS M30)	Government Controlled Margins (submarine)
	P4131 (ESWBS M31)	Preliminary Design Margin
	P4132 (ESWBS M32)	Contract Design Margin
	P4133 (ESWBS M33)	Contract Modification Margin
	P4134 (ESWBS M34)	Nuclear Machinery Margin
	P4135 (ESWBS M35)	Future Growth Margin
	P4136 (ESWBS M36)	Stability Lead Status
	P4137 (ESWBS M37)	Trimming Lead Status
	P414 (ESWBS M40)	Ballast Status (submarine)
	P4141 (ESWBS M41)	Lead, Internal
	P4142 (ESWBS M42)	Lead, External
	P4143 (ESWBS M43)	Lead, MBT
	P4144 (ESWBS M44)	Steel, Internal
	P4145 (ESWBS M45)	Steel, External
	P4146 (ESWBS M46)	Steel, MBT
	P4147 (ESWBS M47)	Lead Correction, MBT
	P4148 (ESWBS M48)	Lead Correction, Other than MBT
P42	Contract Change Orders	
P43	Management Reserves	

P50 Government Support Activities
- P51 National Program Management Offices
- P52 Laboratories and Ranges
- P53 Arsenals and Depots
- P54 Other Field Activities
- P55 Other Government Agencies
- P56 Contractor Support

P60 NATO Program Management Office Activities

P70	(ESWBS F00) Shipboard Load-out Items	
P71	(ESWBS F10)	Ships Force, Amphibious Force, Troops & Passengers
	P711 (ESWBS F11)	Ships Officers
	P712 (ESWBS F12)	Ships Non-commissioned Officers
	P713 (ESWBS F13)	Ships Enlisted Men
	P714 (ESWBS F14)	Marines
	P715 (ESWBS F15)	Troops
	P716 (ESWBS F16)	Air Wing Personnel
	P719 (ESWBS F19)	Other Personnel

P72	(ESWBS F20)	Mission Related Expendables and Systems
	P721 (ESWBS F21)	Ship Ammunition (for use by ship on which stowed)
	P722 (ESWBS F22)	Ordnance Delivery System Ammunition
	P723 (ESWBS F23)	Ordnance Delivery Systems
	P724 (ESWBS F24)	Ordnance Repair Parts (Ship Ammo)
	P725 (ESWBS F25)	Ordnance Repair Parts (Ordnance Delivery Systems)
	P726 (ESWBS F26)	Ordnance Delivery Systems Support Equipment
	P729 (ESWBS F29)	Special Mission Related Systems and Expendables
P73	(ESWBS F30)	Stores
	P731 (ESWBS F31)	Provisions and Personnel Stores
	P732 (ESWBS F32)	General Stores
	P733 (ESWBS F33)	Marines Stores (for ship's compliment)
	P739 (ESWBS F39)	Special Stores
P74	(ESWBS F40)	Fuels and Lubricants
	P741 (ESWBS F41)	Diesel Oil
	P742 (ESWBS F42)	JP-5
	P743 (ESWBS F43)	Gasoline
	P744 (ESWBS F44)	Distillate Fuel
	P745 (ESWBS F45)	Navy Standard Fuel Oil
	P746 (ESWBS F46)	Lubricating Oil
	P749 (ESWBS F49)	Special Fuels and Lubricants
P75	(ESWBS F50)	Liquids and Gases
	P751 (ESWBS F51)	Sea Water
	P752 (ESWBS F52)	Fresh Water
	P753 (ESWBS F53)	Reserve Feed Water
	P754 (ESWBS F54)	Hydraulic Fluid
	P755 (ESWBS F55)	Sanitary Tank Liquid
	P756 (ESWBS F56)	Gas (non-fuel type)
	P759 (ESWBS F59)	Miscellaneous Liquids (non-fuel type)
P76	(ESWBS F60)	Cargo
	P761 (ESWBS F61)	Cargo, Ordnance and Ordnance Delivery Systems
	P762 (ESWBS F62)	Cargo, Stores
	P763 (ESWBS F63)	Cargo, Fuels and Lubricants
	P764 (ESWBS F64)	Cargo, Liquids (non-fuel type)

	P765 (ESWBS F65)	Cargo, Cryogenic and Liquified Gas
	P766 (ESWBS F66)	Cargo, Amphibious Assault Systems
	P767 (ESWBS F67)	Cargo, Gases
	P769 (ESWBS F69)	Cargo, Miscellaneous
P77	(ESWBS F70)	Sea-Water Ballast (submarines)
	P771 (ESWBS F71)	Main Ballast Water
	P772 (ESWBS F72)	Variable Ballast Water
	P773 (ESWBS F73)	Residual Water

P80 Disposal Costs

ANNEX D

Allocation of NATO Ship CWBS to LCC Composition

Allocation of NATO Ship CWBS to LCC Composition

CWBS from	to	Sailaway	Non-Sailaway Program Acquisition	Operations Support*	Remark
000	099		x	x	
100		x	x	x	
101					Note 1.
110	187	x		x	
190		x	x	x	
191	198	x		x	
199		x	x	x	
200		x	x	x	
201	202				Note 1.
210	264	x		x	
290		x	x	x	
298		x		x	
299		x	x	x	
300		x	x	x	
301	305				Note 1.
310	343	x		x	
390		x	x	x	
398		x		x	
399		x	x	x	
400		x	x	x	
401	409				Note 1.
410	489	x		x	
490		x	x	x	
491	498	x		x	
499		x	x	x	
500		x	x	x	

* Includes Load-out Items and Disposal.

CWBS from	to	Sailaway	Non-Sailaway Program Acquisition	Operations Support*	Remark
501	509				Note 1.
510	589	x		x	
590		x	x	x	
591	598	x		x	
599		x	x	x	
600		x	x	x	
601	605				Note 1.
610	673	x		x	
690		x	x	x	
698		x		x	
699		x	x	x	
700		x	x	x	
701	703				Note 1.
710	786	x		x	
790		x	x	x	
792	798	x		x	
799		x	x	x	
800		x	x	x	Note 2. Includes 801-897
801	802	x	x	x	Note 2.
803	804		x	x	
805	808	x	x	x	Note 2.
810	813	x		x	
820			x	x	
830		x	x	x	Note 2. Includes 831-839
831	832	x	x	x	Note 2.
833		x		x	
834	835	x	x	x	Note 2.
836			x	x	
837		x		x	

* Includes Load-out Items and Disposal.

CWBS from to	Sailaway	Non-Sailaway Program Acquisition	Operations Support*	Remark
838 - 842	x	x	x	Note 2. 840 includes 842-845
843	x		x	Note 2.
844	x	x	x	
845	x		x	
850 – 859		x	x	
880 – 881			x	Includes 891-897
890	x	x	x	
891 - 893		x	x	
894	x	x	x	Note 2.
895		x	x	
896 - 897	x	x	x	Note 2.
900	x		x	Includes 901-997
901 - 979	x			
980 - 997	x		x	
P00	x	x	x	Note 2. Includes P10-P733.
P10 - P37	x	x	x	Note 2.
P40	x	x		Includes P41-P43
P41 - P42	x			
P43	x	x		
P50		x	x	Includes P51-P56
P51		x	x	
P52 - P56		x	x	
P60		x	x	
P70 - P73			x	
P74	x		x	
P75 - P77			x	
P80			x	

* Includes Load-out Items and Disposal.

Notes:

1. Costs are not normally collected against these groups--these groups are normally used by specification writers to identify general requirements that pertain to a 1-digit family of ESWBS groups.

2. Cost collected against these CWBS elements must be individually examined. If they support the entire class, the costs should be allocated to "Non-Sailaway Program Acquisition" or "Operations Support," as applicable. If they support only a particular hull, the costs should be allocated to "Sailaway" or "Operations Support," as applicable.

ANNEX E

NATO Ship Operating and Support Cost Categories

NATO Alternate Operating and Support Cost Categories for Ships

Personnel (Direct Unit-Level Personnel: Officers, Enlisted, Civilian, Temporary Duty)

- Direct Operations Personnel
- Direct Maintenance Personnel
- Other Direct Support Personnel

Consumables

Unit-level consumption of Operating Material

- Energy (Petroleum, Oil, Lubricants (POL))
- Expendable Stores, Spare Parts, Equipage
- Training Munitions
- Other Operational Material (e.g., Organizational Maintenance)

Maintenance

Depot (Availability's)
Intermediate Maintenance Activities
Basic Overhaul
Component Repair

Sustaining Support

Replenishment Spares
Modifications & Refit Programs (e.g., Mid-life Modernization)

Software Maintenance & Modifications

Support Equipment
System Specific Training

NATO Alternate Operating and Support Cost Categories for Ships (cont'd)

Other Direct Costs

Engineering & Technical Services

Update Publications & Documentation

Second Destination Transportation

Leasing & Storage

Trainers & Simulators

Charter/Harbor Fees

Rents & Utilities

Operation of Helicopter (Personnel, Maintenance, POL)

Handling of Government Owned Stores

Other

Indirect Support

Personnel Acquisition and Training, Benefits & Administration

Training Facilities

Platform Land Based Test Sites (LBTS)

Payload LBTS(s)

Support Personnel (Navy: Bases, Depots, Medical, Transients, Patients, Students)

Support Installations (Base Operating Support, Depots, Medical Facilities)

General Training and Education

Navy Command (Headquarters, Personnel & Operations)

Transportation & Logistic Supply (Supply Ship, Ammo, POL)

BE Military Systems Operating and Support Cost Categories

EXPLOITATION COST

Cost of Use:
- Personnel costs
- Training costs manipulators
  - Instructor costs
  - Simulators
  - Training means
  - Training material
- Users documentation costs
- Infrastructure costs for the use of material
  - Building
    - Manipulation-and support costs
    - Periodical depreciation costs of old buildings
  - Work
    - Manipulation-and support costs
    - Periodical depreciation costs of old buildings
  - Ground
    - Manipulation-and support costs
    - Periodical depreciation costs of old buildings
- Consumption goods costs
  - Fuel costs
  - Munitions costs
  - Other consumption costs

Maintenance Costs:
- Maintenance personnel costs
- Maintenance personnel training costs
  - Instructors costs
  - Training means
  - Training material
- Spare parts costs
- Inventory costs
- Measurement-and testing equipment costs

BE Military Systems Operating and Support Cost Categories (cont'd)

- Tool cost
- Maintenance documentation costs
- Information documentation costs
- Infrastructure costs for the use of material
  - Building
    - Manipulation-and support costs
    - Periodical depreciation costs of old buildings
  - Work
    - Manipulation-and support costs
    - Periodical depreciation costs of old buildings
  - Ground
    - Manipulation-and support costs
    - Periodical depreciation costs of old buildings
  - Transportation costs
    - Material
    - Spare parts / Reparation tools
  - Maintenance outsourcing costs
  - Modification/Upgrading costs

FR Military Systems Operating and Support Cost Categories

In-Service Stage
- **Management**
- **Operation**
  - Personnel
  - Petroleum, Oil and Lubricants / Energy
  - Consumables
  - Means
  - Transportation
  - Staff support
  - Munitions
  - Others
- **Support**
  - Maintenance
    - Personnel
    - Petroleum, Oil and Lubricants / Energy
    - Consumables
    - Means
    - Transportation
    - Contractor assistance or sub-contract
  - Replenishment spares
    - Personnel
    - Transportation
    - Non repairable spares
    - Repairable spares
  - Software maintenance
    - Personnel
    - Means
    - Contractor assistance or sub-contract

FR Military Systems Operating and Support Categories (cont'd)

Ongoing Training

- Personnel
- Consumable
- Training means
- Allowances
- Contractor assistance

Infrastructure

- Personnel
- Energy
- Consumable
- Private contract

Technical follow-up

- Personnel
- Means
- Contractor assistance

NL Military Systems Operating and Support Cost Categories

EXPLOITATION

Operation

- Personnel
- Training
- Documentation
- Infrastructure/Facilities
- Consumables
- Others

Support (MILITARY SYSTEMS)*

- Personnel
- Training
- Facilities
- Spare/repair parts
- Test & support
- Documentation
- Infrastructure
- Packaging, handling, shipping and transportation

***Support (SHIPS)**

- Maintenance Personnel
- Spares
- Inventory
- Contractor
- Modification and Upgrading
- Integrated Logistics Support
- Maintenance Training

TU Military Systems Operating and Support Cost Categories

Operation
- Electric power
- Consumables
- Operational personnel
- Operational facilities
- Leasing

Support
- System equipment maintenance
- Support equipment maintenance
- Contractor services
- Inventory administration
- Replenishment spares & repair parts
- Repair material
- Transportation and packaging

UK Military Systems Operating and Support Cost Categories

Operation
- Crew
- Consumables
- Munitions (training & replenishment)
- Transport
- Spare

In-Service Support
- Support Management
- Upkeep - planned (preventative maintenance) including refits
- Upkeep - unplanned (corrective maintenance)
- Replenishment Spares
- Depot/Storage
- Training (ongoing provision)
- Transportation of equipment
- Overhaul
- Upgrade capability
- Post Design Support
- Contractor Logistic Support
- Support Equipment & Special Tooling & Test Equipment
- Technical data maintenance
- Spare

Attrition
- Loss of Capability
- Spare

Infrastructure Maintenance/Management
- Management of infrastructure (required as a result of equipment ownership)
- Maintenance of infrastructure (required as a result of equipment ownership)
- Spare

US Military Systems Operating and Support Cost Categories

Mission Personnel Pay and Allowances
- Operations
- Maintenance
- Other Mission Personnel

Unit Level Consumption
- Petroleum, Oil and Lubricants/Energy Consumption
- Consumable Material/Repair Parts
- Depot Level Reparable
- Training Munitions/Expendable Stores
- Other

Intermediate Maintenance (External to Unit)
- Maintenance
- Consumable Material/Repair Parts
- Other

Depot Maintenance
- Overhaul/Rework
- Other

Contractor Support
- Interim Contractor Support
- Contractor Logistics Support
- Other

Sustaining Support
- Support Equipment Replacement
- Modification Kit Procurement/Installation
- Other Recurring Investment
- Sustaining Engineering Support
- Software Maintenance / Support
- Simulator Operations
- Other

Indirect Support
- Personnel Support
- Installation Support

ANNEX F

NATO Elements of Manpower Cost

ANEP-41
Edition 4

NATO ELEMENTS OF MANPOWER COST (SHIPS)

Direct Personnel Cost Elements (Enlisted and Officer)

- Military Compensation
  - Basic Pay
  - Allowances
  - Incentive Pay
  - Retired Pay Accrual (Contributions to Military Retirement Fund)
  - Social Security (as applicable)
- Enlisted Bonus
- Reenlistment Bonus
- Special Pay
- Other Benefits
- Permanent Change of Station
  - Accession
  - Training
  - Operational
  - Rotational
- Separation Cost (Movement from last permanent duty station to point of separation)
- Non-Navy (Paid by outside agency)
  - Veteran's Benefits
    - Continuing Education
    - Medical Support

NATO ELEMENTS OF MANPOWER COST (SHIPS)

Indirect Personnel Cost Elements (Enlisted and Officer)

- Recruiting
- Training (General)
  - Basic Training
  - Locating (costs borne while member is in that temporary travel and training status)
  - Supporting
    - Base Operating and Support
    - Administrative Support
    - Medical Support
- Officer Acquisition
  - Preparatory Training
    - College Curriculum
    - Accession Program
- Training (Specialized)
- Individual's Account (non-force structure personnel)
  - Transients
  - Patients
  - Holdees
  - Students
  - Trainees
  - Cadets
- Base Support
  - Utility System Operations
  - Public Works Services
  - Base Administration
  - Supply Operations
  - Security and Transportation
  - Personnel Support
  - Bachelor Quarters Operations
  - Morale, Welfare and Recreation
  - Disability Compensation
  - Environmental and Hazardous Waste Management

Note: **Non-Navy** (Paid by other agency)
- Continuing Education
- Medical Support

ANNEX G

Cost Models

Cost Models

Acquisition Cost Models

MODEL	COUNTRY	DEFINITION
ACEIT	AUS, US	Automated Cost Estimating Integrated Tools: ACE - Automated Cost Estimator ACE RI$K - analyze risks and uncertainties AIM - ACE Information Manager CO$STAT -Cost Analysis Statistical Package ACDB - Automated Cost Database POST - Program Office Support Tool
ACM (combatants)	NL	Acquisition Cost Model for combatants
ACM (non-combatants	NL	Acquisition Cost Model for non-combatants
COCOMO II	US	Constructive Cost Model (For software)
DeSIs	NL	Decision Support Information system
GELI-MAKO-MAKOCS	GE	Detailed Production Estimate (Single or multiple nations)
SCOPE	GE	Ship Components Optimization and Performance Estimation
PACE	US	Project Analysis and Cost Estimation Model
PRICE H/S	US	Price Hardware/Software Estimating Tool

O&S Cost Models

MODEL	*COUNTRY*	*DEFINTION*
OSCAM	UK, US	Operating and Support Cost Analysis Model
SOS	GE	Ship Operating and Support
SALDO	NL	Life Cycle Cost model

Cost Model Descriptions

ACEIT - Automated Cost Estimating Integrated Tools is a US developed integrated tool suite of several software products for cost estimating and analysis. Core features include capability to store technical and (normalized) cost data, statistical package to facilitate CER development; and a spreadsheet that promotes structured, systematic model development, and built-in inflation rates, learning, time phasing, documentation, sensitivity/what-if, risk and other analysis capabilities. ACEIT integrates all the necessary cost estimating functions but allows you to enter the process at any level.

ACM - Acquisition cost model developed by NL with two variants, one for combatants and one for non-combatants.

COCOMO II – Constructive Cost Model II is a US developed model that allows one to estimate the cost, effort, and schedule when planning a new software development activity. It consists of three sub-models, each one offering increased fidelity the further along one is in the project planning and design process. Listed in increasing fidelity, these sub-models are called the Applications Composition, Early Design, and Post-architecture models.

DeSIs – Decision Support Information system is used for COEA-like calculations (NL developed model).

GELI-MAKO-MAKOCS - GELI/MAKO is a German ship cost model that utilizes a bottoms-up methodology to develop overall national program cost estimates. The MAKOCS module facilitates coverage of multinational aspects of a program. Because it employs a detailed bottoms-up methodology, the GELI/MAKO/MAKOCS model is most useful when the ship is well enough defined to accurately identify ship platform and payload components to the sixth level of the CWBS (3-digit breakdown of ESWBS).

OSCAM – OSCAM is an Operating and Support Cost Analysis Model jointly developed by the UK and US that provides rapid assessments of the O&S costs of high cost capital assets and their component systems. Using “System Dynamics” techniques, OSCAM represents the business processes that drive costs and their relationship to management policies in order to assess the impact of alternative maintenance strategies and operating policies on the cost and availability of these assets.

PRICE H - The Hardware Development Estimating Model (US developed) is used to estimate costs, resources, and schedules for hardware projects such as electronic, electromechanical, and structural assemblies. It can be used to estimate hardware projects of any scale, from the smallest individual component to the complex hardware assemblies of a complete aircraft, a ship or a space station. PRICE H can generate estimates even when using minimal known project data, so that many alternatives can be examined before designs and bills of material are finalized. The application accomplishes this by supplying internally generated, industry-average values wherever actual data is not yet specified.

PRICES - The Software Development Estimating Model (US developed) estimates the costs and schedules of software development projects. It is designed to handle all types of software from business systems and communications to command and control, avionics, and space systems. Price S can be used to estimate selected portions of a software project, or to comprehensively estimate the entire project, including all development, modification, and life-cycle costs. It also provides sizing applications that make it easier to determine the size of the project to be estimated. Price S delivers estimates even when using a minimum set of inputs by supplying industry-average values for actual input data that has not yet been specified

SALDO – Life Cycle Cost model for PLCC cost calculations (NL developed).

SCOPE - Ship Components Optimization and Performance Estimation (GE model) is a parametric cost model that utilizes ship characteristic data to estimate the cost of ship construction. SCOPE is applicable in the Pre-Feasibility, Feasibility, and Project Definition Phases when the platform and major system designs are not well defined.

SOS - Ship Operating and Support model (GE model) is used to estimate ownership costs and was applied in past NATO ship programs to derive total ship costs covering the In-Service phase. The model appears reasonable for use in estimating the operation and support costs of future NATO ship programs during all program phases, but may require revision to accommodate multinational requirements.

ANNEX H

Guidelines for the Preparation of the Cost Analysis Requirements and Assumptions (CARA) Document

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Foreword

ANEP-41 provides general guidance for the cost estimating and analysis of naval ships in a NATO collaborative setting. It provides discussion of the framework, terminology and definitions, and hierarchical cost structure for use in addressing the full life cycle cost of naval ships, including development, design, procurement, operating and support, and disposal. As an adjunct to ANEP-41, it is necessary to also have a general prescription as guidance to facilitate exercises in the collaborative costing process for NATO endeavours that establishes the Cost Analysis Requirements and Assumptions (CARA) to provide a practical and efficient approach for associated efforts by the participating nations.

CARA General Guidance

1. This document provides guidance on the preparation of the CARA document at the onset of the ship costing effort. Such efforts may consist of studies initiated within NATO or collaborative programs amongst the nations.
2. The CARA is to be prepared by the participating governmental technical, program or cost office(s) responsible for the particular study or project at hand. The CARA should include the common program agreed to by all the NATO participating nations as well as all unique program requirements of the participating nations.
3. The CARA will contain a program or project description along with the salient features and requirements of the ship program that affect its cost. The program description and requirements will be used as the basis for the development of the program acquisition and life cycle cost estimate or portion thereof as the parties agree.
4. Program requirements and assumptions as stated in the CARA will establish the basis of estimate for the associated cost estimates (acquisition and life cycle).
5. The CARA will include any associated definitions for cost terms or parameters beyond those already defined in ANEP-41 and provide understanding as to how they relate to the documented ANEP-41 life-cycle cost categories and work breakdown structure elements.
6. Each CARA should be sufficiently comprehensive to facilitate identification of any area(s) or issue(s) that could have a significant affect on life-cycle costs that therefore must be addressed in the cost analysis.
7. The CARA shall address all items in ANEP-41 figure 1 (whether or not reported), while at the same time remain as streamlined as practicable. The level of detail of the information presented in a CARA will vary depending

upon the maturity of the program. It is essential that any assumptions made in preparing a CARA for less mature programs be identified in the appropriate sections of the document.

8. CARAs should be regarded as "living" documents that are updated in preparation for the associated multinational, collaborative, NATO NG/6 or other required NATO organization reviews. The updates reflect any changes that have occurred, or new data that have become available, since the previous program or study review.
9. The analysts who will be responsible for estimating the costs (e.g., NATO Ship Costing Team or Working Group) should review the CARA before it is submitted. The purpose of this review is to ensure that the CARA is complete and that it contains all of the information that will be needed to prepare the cost estimates. The cost analysts should not prepare the CARA, however.
10. CARAs are divided into a number of sections, each focusing on a particular aspect of the program being assessed as outlined below.

CARA Outline

1) Purpose of the Cost Estimate:
   a) Name of Project
   b) Scope and extent
   c) Affected costs boundaries
2) Project Cycle
3) Ship Capabilities:
   a) Mission Needs
   b) Need for development and design
   c) Operational modus operandi, reference mission or variations thereof
4) Ships Characteristics:
   a) Physical and performance (length, breadth, ESWBS weights (light ship and full load), gross tonnage, propulsion type, structural and component materials, endurance, speed, etc)
   b) General Arrangements
   c) New design, repeat, modified
   d) Major equipment
   e) Design features/systems (speed, endurance, fuel consumption, etc.)
   f) Technologies
   g) Standards (Classification Societies, military, commercial, etc)
   h) Software development
5) Build Program
   a) Quantity of Ships
   b) Build Cycle

   c) Test and Production Facilities
6) Operational Profile (life cycle, sea time, etc)
   a) Operational Scenario
   b) Operational Support Facilities
   c) Sustainability Considerations
   d) Life Cycle Duration
7) Support Profile:
   a) Upkeep (Maintenance concept)
      i) Crew
      ii) Contractor
   b) Classification
   c) Common Support items
8) Manning (Scheme of Complement (SoC), training, etc)
   a) Rank, Number and Speciality
   b) Ship/Equipment specific training
9) Acquisition and Support Strategy:
   a) Industrial Scenario
   b) Government Furnished Equipment, Software, and Information
   c) Contract Conditions
   d) Multinational Scenario
10) Economic Conditions
11) Environmental Issues (including disposal, international laws, IMO, etc…)
12) Risk (Cost Estimating Uncertainty)

Detailed Description

1) Purpose of Estimate:
   a) Name of Project. Delineate the name of the project and sponsoring activity (e.g., NG/6, Multinational Collaborative affiliation, etc.). Provide the commonly used ship acronym and class of ship(s) as applicable.
   b) Scope and extent. Guidance on the scope of the project. Elaborate the project boundaries for purposes of costs incurred. Discuss analytical methods to be used in preparing the design data for use in the cost estimates, e.g., rough order of magnitude studies, comparative analyses, cost-benefit studies, affordability analyses, budgetary estimates, contract quality estimates, etc.
      i) Ship Design Study (early stage project or "what if" analyses, options analyses, etc)
      ii) Ship Design Collaborative Development (advanced stage effort with possible contract investment to produce design)
      iii) Ship Construction Collaborative Procurement (advance stage effort with possible investment to produce design and build ship(s))
   c) Affected costs boundaries
      i) Elements of the NATO Ship Hierarchy to be included
      ii)National participation and contribution
      iii) Industrial base
      iv) Infrastructure
      v) Fleet
      vi) Navy
      vii) Government
      viii)List all topics, items or issues that will not be part of the current costing (e.g., limitations of or exclusions to the cost estimate (if any)
2) Project Cycle
   a) Schedules for collaborative project (time durations for the project)
      i) Overall schedule (Development, Design, Construction, In-Service, Decommissioning)
      ii) Design schedule (length of respective PAPS phases)
      iii) Construction (start and delivery dates)
      iv) Major sub system schedules (including technology off-ramps or planned insertion dates)
      v) First of Class, ship or component prototypes
      vi) Testing schedule
      vii) Fleet introduction (initial operational capability)
   b) National participation and off-take schedules

3) Ship Capabilities:
   a) Mission Needs - purpose and role of the ship (coastal patrol, ocean going, wartime, peacetime, interoperability, etc)
   b) Need for development and design (of the ship itself and its components, systems, software, firmware, hardware, training requirements)
   c) Operational modus operandi (or variations thereof)
4) Ship Characteristics
   This section provides a physical and technical description of the hardware, software, operational requirements, and human characteristics of the ship and its systems. It addresses the ship and its major equipment (hardware/software) and WBS components of the ship and its subsystems. The discussion should identify which items are off-the-shelf and which items are not. The technical and risk issues associated with development and production of individual subsystems must be addressed. Further, it is imperative to describe any specific workmanship-related manufacturing or production techniques pertaining to the ship or its subsystems that will materially affect their acquisition or life cycle costs (for example, describe the design and construction process approach, technologies employed, cost inferences, etc). A separate discussion is provided for each major equipment (hardware and software) work breakdown structure (WBS) item. Physical design parameters should include performance, operational (including system design life), and material (weight and material composition) characteristics. The planned sequence of changes in weight, performance, or operational characteristics that are expected to occur or have historically occurred as the program progresses through the acquisition and operating phases should be noted here. These parameters should be reconciled with the system requirements in the NATO Staff Target (or other requirements document as applicable) to show that the system is being consistently and realistically defined. A tabular format is suggested.
   a) Physical parameters (Length, Breadth, Draft, ESWBS Weights, Gross Tonnage, structural and component materials, etc.). This set of paragraphs describes the general design parameters of the ship along with a technical discussion of the design evolutions, design changes, and the particulars of how the ship and its subsystems compares to its predecessor(s). Major structural and component material composition should be noted here.
   b) General Arrangements
      i) Hull form (mono-hull, swath, surface, submarine, stealth, etc)
      ii) Number of decks
      iii) Superstructure, sponsons, appendages, etc
      iv) Number of compartments by type (berthing, messing/galley, officer quarters, enlisted quarters, weapons stowage/magazines, machinery compartments, medical, command and control, etc).

v) Weapons and material handling routes, elevators
vi) Underway replenishment
vii) Aircraft Hangars, lifeboats, rafts, etc.
viii) Prime Movers and Energy Plants (Propulsion and Electrical Plant, Shafting and Bearings, Rudders, Machinery Control, etc.)
ix) Combat systems, weapons launchers, guns, etc.
x) Other, as applicable

c) New design, repeat, modified. Describe whether the ship is a derivative of a previous or existing ship design and how it differs as applicable. Delineate best representative predecessor ship(s) for comparison purposes.
d) Major equipment
   i) List
      (1) Contractor Furnished (shipbuilder or prime contractor)
      (2) Government Furnished
   ii) Commonality. Equipment that is analogous or interchangeable among sub-systems should be identified here. Commonality with subsystems of other ships or weapon systems, or with variants of the basic system, should be identified. Breakouts, by weight, of common and system-specific components should be provided, if applicable.
e) Design features and subsystems
   i) Functional and Performance Description. This paragraph identifies overall performance characteristics of the ship (speed, endurance, survivability, and the function(s) the various subsystems (e.g., propulsion, electric power, command and control, etc.) are to perform (provide separate subparagraph for each major or significant feature). In addition, it describes the associated performance characteristics (e.g., fuel type(s), fuel consumption(s), power rating(s), habitability, etc.) of the ship and its subsystems and lists any firmware to be developed for data processing equipment.
   ii) System Survivability. This paragraph discusses the survivability capabilities and features of the ship and its subsystems (provide separate subparagraph for each major or significant feature). It describes the environments (e.g., nuclear, chemical, biological, fire, etc.) in which the ship will be expected to operate, and identifies any unique materials incorporated in the ship design that contribute to its survivability.
   iii) System Safety. This paragraph references applicable documents (e.g., SOLAS, Naval Vessel, Shipping, Military, Environmental, etc.) and identifies any special or unique system safety considerations (e.g. "fail safe" design, automatic safety, explosive safety needs, etc.).

iv) Human Performance Engineering. This paragraph references applicable documents (military standards, human systems integration plans, etc.) and identifies any special or unique human performance and engineering characteristics (i.e., constraints on allocation of functions to personnel and associated communications, and personnel and equipment interactions). This paragraph should reference any applicable documents, which concern cost or address cost risks (also see Risk section).

v) Material, Processes, and Parts. This paragraph describes the principal materials and processes entailed in the development and fabrication of the ship. The discussion should identify the respective amount of each material to be used (e.g., aluminium, steel, etc.). It should also describe the basic design and construction processes and methods to be employed (e.g., integrated product and process development, extent of advanced construction techniques, military versus commercial practices, etc). In addition, any standard or commercial parts, or parts for which qualified products lists have been established, should be identified.

f) Technologies. This section describes the physical design parameters of the system along with a technical discussion of the technologies, design evolutions, design changes, and the particulars of how the ship and its subsystems compares to its predecessor(s). A separate discussion is provided for each equipment (hardware and software) work breakdown structure (WBS) item. Physical design parameters should include performance, operational (including design life), and material (weight and material composition) characteristics. The planned sequence of changes in performance or operational characteristics that are expected to occur or have historically occurred as the program progresses through the acquisition and operating phases should be noted here. These parameters should be reconciled with the system requirements in the NATO Staff Target (or other requirements document as applicable) to show that the system is being consistently and realistically defined. A tabular format is suggested.

g) Standards (Classification Societies, military, commercial, mixed, etc). This section describes the design, technical, construction, operational, environmental, shock resistance, habitability, or other standards applicable to the ship and its subsystems. A separate discussion is provided as needed for each standard invoked. A tabular format is suggested (to identify degree or extent of each).

h) Software development.
   i) Software Description. This paragraph describes the software resources associated with the system. It should distinguish among operational, application, and support software and identify which items must be developed and which can be acquired off-the-shelf (software reuse from the demonstration and validation phase in the engineering and manufacturing phase should be discussed). The paragraph applies to all systems that use computer and software resources. A form such as the US DD Form 2630 (definitions of the terms used in DD Form 2630 are attached) should be attached to the CARA submission providing more information on the factors that will influence software development and maintenance costs. However, the use of a form is optional if the same information can be provided in another format, such as a matrix or table. Additionally, this information should be tailored to satisfy specific software model requirements.
   ii) Software Sub-elements. This set of paragraphs (repeated for each of the software sub-elements) describes the design and intended uses of system software.
   iii) Commonality. This subparagraph identifies software that is analogous or interchangeable among sub-elements.
   iv) Programming Description. This subparagraph identifies programming requirements that will influence the development and cost of the software sub-element. The discussion should address the programming language and programming support environment (including standard tools and modern programming practices) and the compiler(s) and/or assembler(s) to be used.
   v) Host Computer Hardware Description. This subparagraph describes the host computer system on which the software sub-element will be operating. This host system should be readily identifiable in the WBS referred to above.
   vi) Design and Coding Constraints. This subparagraph describes the design and coding constraints under which the software will be developed (i.e., protocols, standards, etc).

5) Build Program
   a) Quantity of Ships. Delineate the quantity of ships to be acquired or studied for the exercise including the quantity by nation.
   b) Build Cycle. This section describes the master schedule for the system. Both hardware and software schedules should be discussed. A timeline chart showing the program major milestones by phase (e.g., software development, ship design reviews, ship design completion, ship construction start, builder's trials, and ship delivery along with significant test events, software drops, system light-off(s), decision milestone

reviews, initial deployment date, and final operational capability) should be provided. Specific element schedules, if known, should be presented with the descriptions of those elements. The schedule for design and building the ship must include a delineation of the supporting schedule for effort to be performed by each participating nation and the planned respective contractor(s) or government entity(s).

c) Test and Production Facilities. This paragraph describes the type and number of hardware and software test and production facilities (both contractor and Government owned) required during all phases of program acquisition. Separately identify those funded as part of the acquisition prime contract, those separately funded by the program office, and those provided by other activities -- such as a Government test organization or facility. Existing facilities that can be modified and/or utilized should be noted. The discussion should describe the size and design characteristics of the respective facilities, along with any land acquisition requirements. The impacts of hazardous, toxic, or radiological materials used or generated during system tests or production should be assessed.

6) Operational Profile (life cycle, sea time, etc).
   a) Operational Scenario. This paragraph defines, in quantitative terms, the operational scenario and availability goals for specific missions of the ship. It should identify the percentage of the systems expected to be operable both at the start of a mission and at unspecified (random) points in time. It defines the activity rates for the ship (e.g., number of operating hours per year (i.e., steaming hours underway and not underway), operating shifts per day, etc).
   b) Operational Support Facilities. This paragraph describes the type and number of hardware and software facilities required for system deployment, operation and support (including training, personnel, depot maintenance, etc). Existing facilities that can be modified and/or utilized should be noted. The discussion should describe the size and design characteristics of the respective facilities, along with any land acquisition requirements. The impacts of hazardous, toxic, or radiological materials consumed or generated by the system should be assessed.
   c) Sustainability Considerations. This paragraph describes the degree of autonomy, station keeping, own-ship supportability, replenishment approach, etc. envisioned for the ship.
   d) Life Cycle. Specify the life cycle duration of each ship and the class of ships (as applicable).
7) Support Profile. This section describes the Ship Maintenance Profile. It delineates the planned and scheduled maintenance cycles, unscheduled maintenance approach, periodic industrial availabilities, mid-life overhaul, mission upgrade plan, as applicable. The CARA should describe the

planned modernization concept for new design features and technology insertions as well as industrial process changes that are anticipated for the ships life cycle. The following items are to be specified:

a) Upkeep (Maintenance concept)
   i) Crew (identify work to be accomplished by ship's force)
   ii) Contractor (identify work to be accomplished by contractor)
b) Use of Classification Society (“Class”) versus other requirements
   i) Build to Class requirements (not maintained in Class post-build) versus Build and Maintain to Class
   ii) Maintain to pure Class rules versus pure Naval rules versus mixture of rules
   iii) Utilise Class Surveyors versus Naval Surveyors versus mixture
   iv) Understand the implications of Naval requirements over and above Class requirements
c) Common Support items (delineate approach and/or items that will be shared with other projects or programs such as logistics concepts, trainers, land based support sites or activities, shore based spares, depots, etc).

8) Manning (SoC), training, etc. This section describes the Ship's Manpower Requirements in terms of its crew complement based on workload, watch-standing, damage control and navy operational requirements. If available, the manpower estimate report should be cited in support of the manpower requirement. The ship's manning requirements should be specified by:
   a) Rank, Number and Speciality
   b) Ship/Equipment specific training
9) Acquisition and Support Strategy
   a) Industrial Scenario. This section describes the acquisition plan for the system. It addresses the number of prime sources (contractor or government entities) expected to compete during each acquisition phase. The specific supplier sources (contractors, subcontractors and/or government entities) involved in each phase should be identified, if known. If this information is source selection sensitive, special labeling of the overall CARA may be required.
   b) Government Furnished Equipment, Software, and Information. This paragraph identifies the subsystems, equipment, property, and information that will be furnished by the Government and included in the life cycle cost estimates for the ship project. Any Government-furnished commercial off-the-shelf (COTS) software should be addressed in the discussion. Where Government-furnished equipment or property is common to other weapon systems, the text should identify how the costs will be accounted for.
   c) Contracting Strategy and Contract Conditions. This paragraph describes the type of contracts to be awarded in each phase of the

program along with any particular conditions that are to be applied. It describes the assumed scenario with respect to the number of contracts planned for the prime(s) including each subsequent batch as applicable. The status of any existing contracts should be discussed.

d) Multinational Scenario. This section should detail the particular scenario or scenarios to be considered for the project or study. The level of participation and acquisition approach (e.g., work sharing, cost sharing, design development, component supply, ship construction capability, sourcing method to be employed, etc) assumed for each if of the participating nations should be identified and described.

10) Economic conditions. This section describes the assumed economic conditions for the period of performance of the project life. It specifies the agreed currency for comparison (e.g., Euro), year associated to the currency, the form of currency expression (constant, current, real, etc.), and units of currency to be shown (thousands, millions, etc.) It also delineates:
    a) Whether a competitive industrial scenario is anticipated
    b) The level of skills available for completion of the project,
    c) The currency exchange rates applicable for the estimate, etc.
    d) Whether (and what) government taxes to be included or not.
11) Environmental Issues (including disposal, international laws, IMO, etc)
    a) Environmental Impact Analysis. This paragraph identifies how environmental impact analysis requirements (including impacts on land, personnel, and facilities) will be accomplished for operational, depot, and training locations, and how the results will be incorporated into the program.
    b) Environmental Conditions. This subparagraph identifies the environmental conditions expected or assumed during development, production, transportation, storage, and operation of the subsystem. It also identifies any hazardous, toxic, or radiological materials that may be encountered or generated during the subsystem's development, manufacture, transportation, storage, operation, and disposal. The quantities of each hazardous material used or generated over the subsystem's lifetime should be estimated based on the most current operations and maintenance concepts. The discussion should also describe the evaluation methodology for environmentally acceptable alternatives as well as the rationale for selection of alternatives. Finally, the alternatives considered, and reasons for rejection, must be identified.
12) Risk. Risk should be discussed for three aspects: technical, schedule and cost. For each of these, the risk management approach should be delineated:
    a) Technical: the areas of significant risk with respect to technology availability or expected performance should be identified. Fallback

solutions should be addressed in the event the advanced technology solutions.

b) Schedule: Areas of significant schedule risk should be identified for both the ship and essential components for its initial delivery (e.g., the critical path items should be identified and discussed, including but not limited to the design products and long lead-time materials or components to be installed in the ship).

c) Cost: Areas of significant cost estimating uncertainty (uncertainty attributed to estimating errors) should be identified and quantified. The use of probability distributions or ranges of cost will quantify uncertainty. The probability distributions, and assumptions used in preparing all range estimates should be documented and provided. The presentation of this analysis should address cost uncertainty that is attributable to estimating errors, e.g., uncertainty inherent with estimating costs based on assumed values of independent variables that are:
   i) Outside database ranges, or
   ii) Attributed to other factors, such as performance and weight characteristics, new technology, manufacturing initiatives, inventory objectives, schedules, and the financial condition of the contractor.

CARA SOFTWARE GLOSSARY

The following section lists the software definitions taken from US DD Form 2630.

CATEGORY: Level of Difficulty For Designing, Producing, or Using Software.

System Software: Software designed for a specific computer system or family of computer systems to facilitate the operation and maintenance of the computer system and associated programs. For example: operating system, communications, computer system health and status, security and fault tolerance.(most expensive per line of code within a residence).

Application Software: Software specially produced for the functional use of a computer system. For example: target tracking, fire control, weapon assignment, navigation, and mission resource management (less expensive per line of code within a residence).

Support Software: Off-line software. For example: development and diagnostic tools, simulation and/or training, maintenance, site support, delivered test software, report generators least expensive per line of code within a residence).

CODE TYPE: Degree of software code design newness.

New Code: Newly developed software.

Modified Code: Pre-developed code that can be incorporated in the software component with a significant amount of effort but less effort than required for a newly developed code (i.e., 30 - 70 percent of code is modified).

Reused Code: Pre-developed code that can be incorporated in the software component with little or no change (i.e., approximately 10 per cent is modified).

SOURCE LINES OF CODE (SLOC):
Old Definition (Pre-1994): Source lines of code are physical source statements: one physical line equals one statement. The delimiter (or, more precisely, the terminator) for physical source statements is usually a special character or character pair such as [newline] or [carriage return]-[Line feed]. If "dead code" (i.e., code that is delivered with a package but is never referenced or used) is excluded, list the methods by which that is done. List all keywords and symbols that are excluded when they appear on lines of their own, such as

[begin], [end], [{], [}], and the like. If separate counts are made for different types of statements, such as format statements, declarations, executable statements, and the like, state the rules used for classifying them. List any other rules used in counting.

New Definition (After 1994): "Source line of code" denotes any compilable source instruction, including data declaration, type definitions, and assignments. It excludes comments, null/dummy statements, blank lines, continuation lines, prefaces, file boundary statements, and commercial off-the-shelf software (COTS).

INSTANTIATION: The process of representing an abstraction by a concrete example. For example, the instantiation of a generic procedure creates a new subprogram or package that can be used.

KSLOC: Thousands of source lines of code.

PROGRAM LIBRARY: An organized repository of reusable code.

RESIDENCE: The location where the software will be maintained and used.

Space: Software on an orbiting vehicle and suborbital probes (most expensive per line of code for any given category).

Air: Software on an aircraft or missile (less expensive per line of code for any given category).

Ground-Mobile: Ground-based software physically maintained and used on a ground-mobile platform.

Ground-Fixed: Ground-based software physically maintained and used at a fixed site.

TERMINAL SEMICOLONS: A statement terminated by a semicolon, including data declarations, and code used to instantiate a reusable component the first time it is instantiated. When multiple semicolons are used with a declaration statement, the terminating semicolon is used to define the termination of the source line of code. Comments, blank lines, and non-deliverable code are not included in the line count.

ANNEX I

Cost Estimate Input and Output Templates

ANNEX I

Contents

Cost Estimate Input Template I-3

Cost Estimate Input Template Forms I-6 through I-8

Form A Design Weights and Reference Data I-6

Form B Major Equipment List I-7

Form C Manpower I-8

Cost Estimate Output Template I-9

Cost Estimate Input Template

Enter ☑ for current stage of the Project

Mission Need Evaluation	
Pre-Feasibility	
Feasibility	
Project Definition	
Design & Development	
Production	
In-Service	

"X" denotes areas that generally must be filled in

Where "X" is denoted by major category element, information/data should be entered for all sub-elements

Where "X" is denoted at specific sub-element, information/data should be entered for given sub-element

Where not denoted by "X", information/data may be entered for elements/sub-elements as may be required for specific projects

1) Purpose of Estimate:	X
a) Name of Project	
b) Scope and extent	
i) Ship Design Study	
ii) Ship Design Collaborative Development	
iii) Ship Construction Collaborative Procurement	
c) Affected costs boundaries	
i) Elements of the NATO Ship Hierarchy to be included	
ii) National participation and contribution	
iii) Industrial base	
iv) Infrastructure	
v) Fleet	
vi) Navy	
vii) Government	
viii) Topics, items or issues that will not be part of the current costing	
2) Project Cycle	X
a) Schedules for collaborative project	
i) Overall schedule	
ii) Design schedule	
iii) Construction	
iv) Major sub system schedules	
v) First of Class, ship or component prototypes	
vi) Testing schedule	
vii) Fleet introduction	
b) National participation and off-take schedules	
3) Ship Capabilities:	X
a) Mission Needs	
b) Need for development and design	
c) Operational modus operandi	

Cost Estimate Input Template (cont'd)

	INFORMATION / DATA			
	Ship Design	Program Schedule & Acquisition Strategy	Economic	In-Service Support
4) Ship Characteristics	X			
a) Physical parameters				
i) Length				
ii) Breadth				
iii) Draft				
iv) ESWBS Weights **(See Form A, page I-6)**				
v) Gross Tonnage				
vi) Structural and component materials				
b) General Arrangements				
i) Hull form				
ii) Number of decks				
iii) Superstructure				
iv) Number of compartments by type				
v) Weapons and material handling				
vi) Underway replenishment				
vii) Aircraft Hangars, lifeboats, rafts				
viii) Prime Movers and Energy Plants				
ix) Combat systems				
x) Other, as applicable				
c) New design, repeat, modified				
d) Major equipment **(See Form B, page I-7)**				
i) List				
(1) Contractor Furnished (shipbuilder or prime contractor)				
(2) Government Furnished				
ii) Commonality				
e) Design features and sub-systems				
i) Functional and Performance Description				
ii) System Survivability				
iii) System Safety				
iv) Human Performance Engineering				
v) Material, Processes, and Parts				
f) Technologies				
g) Standards				
h) Software development.				
i) Software Description				
ii) Software Sub-elements				
iii) Commonality				
iv) Programming Description				
v) Host Computer Hardware Description				
vi) Design and Coding Constraints				

Cost Estimate Input Template (cont'd)

	INFORMATION / DATA			
	Ship Design	Program Schedule & Acquisition Strategy	Economic	In-Service Support
5) Build Program		X		
a) Quantity of Ships				
b) Build Cycle				
c) Test and Production Facilities				
6) Operational Profile				X
a) Operational Scenario				
i) Time Underway				
ii) Time not Underway				
b) Operational Support Facilities				
c) Sustainability Considerations				
d) Life Cycle				
7) Support Profile				X
a) Upkeep (Maintenance concept)				
i) Crew				
ii) Contractor				
b) Use of Classification Society ("Class") versus other requirements				
i) Build to Class requirements				
ii) Maintain to pure Class rules versus pure Naval rules versus mixture of rules				
iii) Utilize Class Surveyors versus Naval Surveyors versus mixture				
iv) Implications of Naval requirements over and above Class requirements				
c) Common Support items				
8) Manning (Scheme of Complement)				
a) Rank, Number and Specialty **(See Form C, page I-8)**	X			X
b) Ship/Equipment specific training (e.g., specialized skills and training)	X			X
c) Annual costs (Direct / Indirect) **(See Form C, page I-8)**			X	
9) Acquisition and Support Strategy		X		X
a) Industrial Scenario				
b) Government Furnished Equipment, Software, and Information				
c) Contracting Strategy and Contract Conditions				
d) Multinational Scenario				
10) Economic conditions			X	
a) Whether a competitive industrial scenario is anticipated				
b) The level of skills available for completion of the project				
c) The currency exchange rates applicable for the estimate (currency, date of currency for the estimate, and currency exchange rate(s) applicable)				
d) Whether (and what) government taxes to be included or not				
e) Principal cost factors (e.g., price of fuel, steel, inflation rate(s), etc.)				
11) Environmental Issues	X	X	X	X
a) Environmental Impact Analysis				
b) Environmental Conditions				
12) Risk	X	X	X	X
a) Technical				
b) Schedule				
c) Cost				
i) outside database ranges				
ii) attributed to other factors				

Cost Estimate Input Template (Form A) - Design Weights and Reference Data

ESWBS	Ship Design Weights [1] (Metric Tons)	Reference Data			
		Labor CER [2]	Material CER [2]	Material Quotations [3]	Analogous System(s) [4]
100 110 120 130 140 150 160 170 180 190					
200 210 220 230 240 250 260 290					
300 310 320 330 340 390					
400 410 420 430 440 450 460 470 480 490					
500 510 520 530 540 550 560 570 580 590					
600 610 620 630 640 650 660 670 690					
700 710 720 730 740 750 760 770 780 790 Margin					
800 900	Not Applicable			Not Applicable	Not Applicable

Notes:

1) Enter ship design weights from CARA, ship weight report, or as provided by naval architect design study
2) Enter data source or analogy for Cost Estimating Relationships (CER)
3) Enter source(s) of quote
4) Enter analogous ship(s) or sub-systems utilized

Cost Estimate Input Template (Form B) - Major Equipment List

Combat Systems	number [-]	Type	Manufacturer	CFE	GFE	Commonality

Navigation Systems	number [-]	Type	Manufacturer	CFE	GFE	Commonality

Communication Systems	number [-]	Type	Manufacturer	CFE	GFE	Commonality

Aviation Systems	number [-]	Type	Manufacturer	CFE	GFE	Commonality

Other Systems	number [-]	Type	Manufacturer	CFE	GFE	Commonality

Notes:
1) Enter data/ information from CARA, naval architect design study, or other applicable source(s)

Cost Estimate Input Template (Form C) - Manpower

Scheme of Compliment			Annual Costs (EURO)			Life Cycle Cost (EURO)
Rank	Number	Specialty	Direct	Indirect	Total	[-][2] Years

Notes:

1) Enter data/information from CARA, naval architect design study, or other applicable source(s)

2) Enter number of years for the life cycle

Cost Estimate Output Template

Cost Categories		Cost Domain: Linked Direct – Sail-Away	Linked Direct – Acquisition	Linked Direct – Life Cycle	Linked Indirect – Variable – Total Life Cycle	Linked Indirect – Fixed – Total Ownership Cost	Non-Linked – Whole Life
Hardware (by SWBS, ANNEX B)	100 Hull Structure						
	200 Propulsion Plant						
	300 Electric Plant						
	400 Command & Surveillance						
	500 Auxiliaries						
	600 Outfit & Furnishings						
	700 Armament						
Software (by SWBS, ANNEX B)	100 Hull Structure						
	200 Propulsion Plant						
	300 Electric Plant						
	400 Command & Surveillance						
	500 Auxiliaries						
	600 Outfit & Furnishings						
	700 Armament						
Design & Support (by SWBS, ANNEX B)	000 Guidance & Administration						
	800 Integration / Engineering						
	900 Assembly and Support Services						
Programmatics (by cost element, ANNEX C)	P10 Budgeting Practices						
	P20 Escalation						
	P30 Law & Government Regulations						
	P40 Contingencies						
	P50 Government Support Activities						
	P60 NATO Program Management Activities						
	P70 Shipboard Out-Load						
	P80 Disposal Costs						
O&S Costs (By cost category, ANNEX E)	Personnel						
	Consumables						
	Direct Maintenance						
	Sustaining Investment						
	Other Direct Costs						
	Indirect Costs						
GRAND TOTAL							