Chapter 6 – Cost Estimating

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References

(a) NAVSEA 2005 Cost Estimating Handbook

(b) NAVSEAINST 7300.14B, Classification of Cost Estimates for Ships

(c) NAVSEAINST 4710.7A (cancelled), Standard Cost Estimating Form for Private Sector Overhaul and Repair Availabilities

(d) Joint Fleet Maintenance Manual (JFMM)

Tables

Chapter 6 – Cost Estimating

6.1 Introduction

The purpose of this chapter is to provide SUPSHIP personnel with background information regarding the preparation of government cost estimates. This chapter supplements the Federal Acquisition Regulation which establishes the requirements for an independent Government cost estimate to be used in the evaluation of bids and proposals. Cost estimates form the basis for major program acquisition decisions and for management decisions by Fleet, NAVSEA, and Program Office customers in the planning, programming, and budgeting of new construction, repair, and modernization work. Additionally, contracting activities require cost estimates for new procurements prior to issuing a solicitation, for modifications to a contract after award, for resolution of entitled claims, and to close out contracts that have been terminated.

6.2 Types of Estimates

There are six occasions when estimates may be required in conjunction with ship construction and repair contracts. These include:

1. Pre-Contract Award
2. Preliminary Cost
3. Contract Cost
4. Post-Contract Award
5. Predicted End Cost (PEC)/ Estimate at Completion (EAC)
6. Costs for Contract Modifications

6.2.1 Pre-Contract Award Estimating

For new ship acquisition programs, the NAVSEA Cost Engineering and Industrial Analysis Group (NAVSEA 05C) is responsible for developing cost estimates and for supporting both the Program Manager (PM) and the NAVSEA Contracts Directorate (NAVSEA 02) in proposal evaluation. Reference (a), the NAVSEA 2005 Cost Estimating Handbook, provides an explanation of the overall process of developing cost estimates for major acquisition programs.

Pre-award estimating can be associated with either competitive or non-competitive procurements. Estimating non-competitive procurements is less complex because the identity of the contractor is known prior to award. Estimating for competitive awards is more complex because of the uncertainties associated with contractor labor rates, capabilities, and

other cost factors. In both cases, the general approach to preparing labor hour and material estimates is the same.

Estimating total costs for a “first of a kind” major construction program are based on Cost Engineering principles that include detailed cost risk analysis. NAVSEA utilizes an analysis process that examines the finite elements of a program to identify all key cost risk factors, such as those associated with the complexity of the design, availability, demand for material (steel, aluminum) and equipment in the international market place, integration of state of the art technology into system operations, and workload in potential bidder’s facilities. Included also is an analysis of the overall experience of the shipbuilding industry in constructing emerging naval architectural innovations.

6.2.1.1 Cost Risk Analysis

Cost Risk Analysis is performed by NAVSEA 05C Cost Engineers to quantify the uncertainty and variability (risks) associated with major acquisition (ACAT 1) programs. The results of this detailed analysis:

- enable informed investment decisions based on levels of confidence and the probability of success
- support program margin and shortfall assessment
- identify the variables that account for significant risk in the project
- assist in determining the cost risk that the Navy decision authority is willing to accept

6.2.2 Preliminary Cost Estimating

The preliminary cost estimate is the estimate that is prepared in advance of a contract award. It may be developed by the government or solicited from a contractor. It is prepared in terms of labor and material quantities required, without reference to labor rates. Contingencies for growth and other uncertainties are not considered in the estimate. The rates to be applied to the labor estimate are dependent on the competitive environment. In the case of non-competitive procurements, the rate used is that applicable to the contractor who will do the work. In the case of competitive procurements, a composite rate must be determined based on a prorated average for the anticipated solicitation area.

6.2.3 Contract Cost Estimate

Prior to award of a contract, the Contracting Officer must be satisfied that the contract price is fair and reasonable. An integral part of this process is comparing and analyzing the contractor's price to an independent estimate prepared by the Government. This estimate is referred to as the Independent Government Estimate for the contract or the "Contract Cost Estimate". It is determined by applying the appropriate composite rate, adjusted to reflect current market conditions, to the preliminary labor estimates and current material prices to

required material quantities. The sum of the labor and material estimates is the Contract Cost Estimate. The original Contract Cost Estimate is retained as a part of the contract file.

6.2.4 Post-Contract Award

After contract award, the Contract Cost Estimate is adjusted to reflect the successful contractor's current labor rates. The contracting officer will determine the current Other Direct Labor Factor (ODLF) applicable to the contractor and apply it to the contractor's current Forward Pricing Rates to determine the labor rate to be used in establishing the Final Cost Estimate. This labor rate, in lieu of the competitive composite rate, is applied to the Preliminary Cost Estimate to calculate the Final Cost Estimate. The difference between the Final Cost Estimate and the contract award price represents the potential profit or loss of the contractor that should be maintained throughout the performance period, as stated in the Doctrine of Equitable Adjustment. A contractor that "buys-in" to a contract (submits a bid lower than his estimated cost or with little or no profit in order to win the bid) should not be allowed to recover the loss through excessive prices in contract modifications after award. Likewise, the Government must not attempt to reduce the contractor's potential profit by allowing insufficient consideration for changes after award.

6.2.5 Estimate at Completion (EAC)/Predicted End Cost (PEC)

The Estimate at Completion (EAC) is the estimated cost to complete all work for a new construction contract or project. Although EACs are routinely generated by the contractor (see Chapter 7, Earned Value Management System), SUPSHIPs evaluate these estimates and will, when appropriate, develop independent EACs for the program office and NAVSEA headquarters.

The Predicted End Cost (PEC) is the estimated cost of all work in a ship repair availability. The PEC equals the Award Price or Base Cost plus the estimated cost of other items that are not covered by the Award Price/Base Cost. Other items may include fees, growth, new work, Government-Furnished Material (GFM), messing and berthing, and boat repairs. Advance planning funds or funds that are provided to other activities should not be included in the estimate. The PEC does not establish financial obligations on customers, but rather is the Government's estimate of what the repair project is most likely to cost.

6.2.6 Contract Modifications

Estimates for contract modifications can vary widely in their level of detail and accuracy based on the intended purpose. A Program Manager or Type Commander may simply need a rough order of magnitude (ROM) estimate in order to make a decision on a contract modification, while a more accurate estimate would typically be required for a Technical Advisory Report (TAR) associated with a contract modification. In general, the level of detail required for a contract modification estimate is dictated by the requirements of the ACO to ensure the government is paying a fair and reasonable price for the contract modification.

6.3 Classification of Estimates

The following sections address the classifications that are commonly used for estimating costs for ship repair work and those that are used for new construction, conversion, major modernization and Service Life Extension Programs (SLEP).

6.3.1 Classification of Ship Repair Cost Estimates

6.3.1.1 Class A – Detailed Cost Estimate

A Class A estimate is an extensive cost estimate based on detailed engineering drawings, material lists, and man-hours by required skills and trades. The level of detail addressed in a Class A estimate should be to the maximum extent feasible. It is comparable to a fixed-price offer developed by a naval shipyard or a manufacturing estimate prepared in private industry. Variance is not expected to exceed 10 percent.

6.3.1.2 Class C – Budget Quality Estimate

Class C estimates are generally considered to be the best cost estimate attainable for new construction and modernization/repair. It is the recommended cost estimate developed by a field activity for use in budget submissions. They are normally prepared prior to award of a contract. Variance is not expected to exceed 15 percent.

6.3.1.3 Class D – Feasibility Estimate

Class D estimates are required prior to completion of the design or preparation of detailed specifications, reflecting the uncertainty associated with having incomplete information available for estimating purposes. It is usually exploratory in nature and is prepared to perform trade-offs and cost analysis. Variance is not expected to exceed 20 percent.

6.3.1.4 Class F – “Ballpark” Estimate

Class F estimates are known as "ballpark" estimates. This is a quick cost estimate prepared in the absence of design and cost information and is based on gross approximations. It is calculated by escalating previous costs to current dollars, using empirical costs for similar work, and adding factors for expected changes in design, processes, procedures, and other economic considerations. They may be acceptable when higher-level estimates are not possible due to insufficient time or incomplete information. Variance is not expected to exceed 40 percent.

6.3.1.5 Class X – Directed or Modified Estimate

A Class X estimate is an estimate provided by other Government activities or as directed by higher levels of authority. It is generally a total cost restriction without a developed design, engineering, or a detailed cost estimate. A directed estimate is also a modification of any previous cost estimate, Classes A through F, to conform to budget reductions or restrictions on cost which is not based on a change in the scope of work required.

6.3.2 Classification of New Construction Cost Estimates

See reference (b), NAVSEAINST 7300.14B, Classification of Cost Estimates for Ships for additional information regarding this topic.

6.3.2.1 Class C – Budget Quality Estimate

This is the highest quality cost estimate attainable in the planning, programming, and budgetary process for a new construction ship. A Class C estimate is the recommended classification of cost to be used for budget submittals to Congress, NAVCOMPT, and OSD/OMB for the current budget year.

6.3.2.2 Class D – Budget Quality Estimate (Conversion/Modernization/SLEP)

For a conversion, major modernization, or SLEP cost estimate to conform to this classification, the detailed scope of work requirements shall include the description and weights of equipment or systems to be removed, relocated, or added, as well as a list of proposed ship alterations (SHIPALTs), GFM, and an adequately defined repair package. Because of the uncertainties related to this type of work, the Class C estimate is not used until after contract award.

6.3.2.3 Class F – Feasibility Design (“Ball Park”) Estimate

Class F estimates are those costs prepared by using design information resulting from ship feasibility studies. The ship feasibility study produces at least a rough, one digit SWBS (Ship Work Breakdown Structure) group of weights, and only general guidance with respect to major electronics and weapons equipment. Costs that fit this classification also involve those derived by inflating to current dollars a previous cost for a similar ship and making gross adjustments for expected changes in design, program requirements, or program cost factors.

6.4 Standard Estimating for Ship Repair and Modernization

The standard estimating procedures was established by reference (c), NAVSEAINST 4710.7A (cancelled), Standard Cost Estimating Form for Private Sector Overhaul and Repair Availabilities. These procedures were established in order to ensure a common basis and consistent application of SUPSHIP estimating methodology for ship repair and modernization. The requirements of reference (a) are not applicable to estimates for ship construction, but they do provide insight into considerations for developing Government estimates.

Reference (d), the Joint Fleet Maintenance Manual (JFMM), Volume VII, Chapter 5, provides detailed information and procedures concerning preparation of estimates for ship repair and modernization work.

6.4.1 Average Contractor

In a competitive procurement, the identity of the contractor cannot be determined until after contract award. Therefore, some assumptions must be made about the contractor in order to define the estimating environment. For estimating purposes, the assumption is made that an average contractor under average conditions will perform the work. This assumption, however, also leads to problems since it is difficult to define an "average" contractor, i.e., one that possesses average facilities, equipment, tools, workforce, etc. To address this problem, NAVSEA directed that estimates for competitive procurements be prepared on Appendix 6-A (excerpt from NAVSEAINST 4710.7A). This instruction, together with the "average contractor" and "average condition" assumptions, defines the framework for standard estimating for competitively awarded availabilities. To ensure the validity of estimates, labor rates applied to labor estimates must be consistent. This requirement derives from the basic accounting requirement that estimating systems be consistent with applicable accounting systems.

6.4.2 Elements of Standard Estimating

Appendix 6-A supports estimating for 13 labor elements and an additional element for quality assurance personnel. An update to this form is used for repair planning via the Master Spec Catalog (MSC) and includes two additional direct labor elements: firewatches and supervisors. Although these labor elements can be categorized as the “hard-core” direct labor elements, they may not correspond exactly with a contractor’s labor categories. Table 6-1 shows general descriptions of labor categories that may be found in any shipyard. The titles in the formal contractor chart of accounts will vary from contractor to contractor; however, the work performed by personnel in those labor categories is always charged as direct labor. For this reason, these labor elements are defined as "hard-core" labor elements in discussions regarding estimating systems. In standard estimating, the hard-core labor elements are the only labor elements estimated by the estimator. All other labor required to perform the work being estimated is considered to be overhead labor or "other direct labor." Neither overhead nor other direct labor is estimated by the estimator. These two elements, "overhead" and "other direct labor," are accounted for by applying factors for overhead and other direct labor to the total hard-core labor estimate.

6.4.3 Standard Estimating Example

Contractors are required to estimate work requirements using a method or system consistent with their accounting system. It has been shown through audits of contractors' accounting systems that the hard-core labor elements identified in Appendix 6-A are always charged as direct labor. It is also true that all contractors have other direct labor elements in their chart of accounts that must be considered in estimating work to be performed. Table 6-1 shows two sample charts of accounts for contractor direct labor. In these two samples, an asterisk denotes those direct labor elements that are comparable to the standard estimating hard-core labor elements. Although the determination of which labor categories are hard-core is a matter of judgment, any contractor labor category judged to be comparable to a labor category listed in Table 6-2, is designated as a hard-core labor element. The remaining

labor categories are included in the term "other direct labor." The factors to be applied to Government estimates are based on an actual audit of the contractor's accounting system. For example, based on past accounting data for all direct labor charges in a contractor's accounting system, other direct labor requirements are computed as a percentage of the direct labor charges covered by the hard-core direct labor elements. For example, if a Government estimate of 100 man-hours was comparable to 140 man-hours in the contractor's estimating system, the other direct labor factor would be computed to be 40 percent of the hard-core charges. The key to achieving equity in estimating for a particular estimating system is to determine the appropriate factors to be applied to the Government estimate. The fundamental principle in standard estimating is to estimate only those direct labor elements necessary to complete the task requirements, such as those listed in Appendix 6-A. Those labor elements that are not included in the hard-core estimate (i.e., overhead and other direct labor) are considered in the contractor's Forward Pricing Rate. For this reason, it would be improper to estimate the cost of supervision, scheduling, material handling, fire watches, or any other labor factor that is already included in the contractor's Forward Pricing Rate.

Table 6-1: Sample Contractor Charts of Accounts for Direct Labor

Contractor A		Contractor B	
*Machinist	Mechanical	* Inside Machinist	Estimating
*Shipfitter	Marine Engineering	* Outside Machinist	Purchasing
* Chipper and Burner	Program Planning	*Pipe Covering	Contract
* Crane Service	Program Management	*Pipefitting	Planning
*Welder	Financial Analysis	*Sheetmetal	Temporary Services
* Carpenter	Graphic Services	*Electrical	Material Support
*Painter	Technical Illustrators	* Carpentry	Laboratory Services
* Installation and Testing	Plant Protection and	*Paint	Industrial Engineer
*Pipefitting and Covering	Firewatches	*Laborer and Sandblaster	Progressing
*Sheetmetal Worker		*Welding	Clerical Support
*Quality Assurance		*Cleaning Services	Program Management
Material Handler		* Staging	Accident Prevention
Procurement Personnel		*Shipfitting	Production Support
Change Control		*Mold Loft	Material Receipt
Cost Estimator		*Nondestructive Testing	Scheduling
Secretary and File Clerk		* Inspection	Production Control
Naval Architecture		Technical Support	Material
Electrical Engineering		Drafting	Firewatches

***Hard-core labor elements**

Table 6-1: Standard Cost Estimating Form Labor Categories

Shipfitter	Pipefitter
Sheetmetal	Insulation/Lagger
Welder/Burner	Carpenter/Shipwright
Inside Machinist	Electronics/Ordnance
Outside Machinist	Painter/Sandblaster
Boilermaker	Rigger/Laborer
Electrician	Quality Assurance and NDT

6.5 Estimating Environment

6.5.1 Environment Defined

An estimating environment includes both the estimating system and the collection of facilities, tools, equipment, materials, labor, skills, procedures, environment, and other factors that may impact the cost of performance. Knowledge of the estimating environment is one of the fundamental prerequisites for effective estimating. In a Naval Shipyard, this requirement is met as a natural consequence of the way business is conducted in that facility. In the private sector, the estimator may be estimating for work that will be awarded competitively to a contractor whose identity is not known. Where contracts are sole-sourced, the estimator does have the opportunity to adjust the estimating to match the contractor's estimating environment.

6.5.2 Cost Accounting Standards

Most contractors will prepare cost estimates using an estimating system consistent with the contractor's accounting system. For large commercial contractors subject to Cost Accounting Standards (CAS), the contractor is required to use an estimating system consistent with the methods used for recording or accounting for costs and to submit a formal CAS Board Disclosure Statement showing the chart of accounts used for all direct and indirect costs and the methods used to account for those costs.

Small contractors and other contractors not subject to CAS are required to use an accounting system which meets generally acceptable accounting standards. The Defense Contract Audit Agency (DCAA) periodically audits contractor's records to determine whether or not their actual practices of estimating costs are consistent with the accounting system.

In the case of corporations and other businesses that operate two or more companies or operating geographically separated facilities, the estimating systems used in all locations will generally fall under the same accounting system. The charts of accounts used to identify direct and indirect cost centers and accounting practices are essentially the same at all locations; however, estimates from one of the contractors may not be valid in any of the other company contractors, since estimating is a function of more than the accounting system. The facilities, tools, and equipment available to the workforce may vary widely from one location to another. If one site uses a state-of-the-art end-prep machine to machine piping joints for welding and another uses a hand grinding tool, the estimates of labor hours required may vary by as much as 400 percent for the exact same scope of work. Likewise, the use of precise numerically controlled machine tools is more efficient than the use of manually operated machine tools. Generally speaking, the use of new, modern facilities improves performance when compared to performance in older, obsolete facilities. In a contractor's accounting system, however, the cost of new, modern facilities and state-of-the-art machinery and tooling will increase the indirect cost factors used to determine the billing rate applied to direct labor hours. No two contractors have the same collection of facilities, tools, or equipment available for performance. Therefore, there may be differences in estimates among contractors owned by the same company.

6.5.3 Other Factors Affecting the Contractor’s Estimating Environment

Contractor estimating is a function of the labor skills available, the experience of the work-force and the workload. Highly skilled employees can perform more efficiently than unskilled employees, but at a higher wage rate. A contractor workforce experienced in construction or modernization of a particular ship class benefits from the learning experience and can perform more efficiently on subsequent ships of the same class. Other considerations, such as the maritime market and level of work backlog, also play an important role in estimating for competitive procurements. For example, market conditions may dictate a contractor estimate that can be significantly at variance with the estimate of actual costs. If the market is saturated, i.e., all contractors are at capacity or are operating with a significant backlog of work, a contractor does not need additional work. The addition of more work under these conditions may be very disruptive to ongoing work and the disruptive effects would have to be considered in estimating the costs of more work. Under these conditions, contractors may also seek higher profits to compensate for the added disruption. Therefore, any precise estimate of total costs based on work scope and labor rates would be overridden by an increase to account for the market being at full capacity. Conversely, when there is not enough work to keep all contractors busy, the marketplace becomes more competitive. Under this condition, contractor management will normally undercut well-conceived estimates in order to remain competitive. A basic principle of estimating is that an estimate prepared for any one contractor will not be valid for any other contractor. The estimator must know the estimating environment that is used and estimates must be prepared to reflect the total environment of where the work is to be performed.

6.6 Cost Estimating Methods, Standardization, Standards, and Techniques

6.6.1 Variables

A number of estimating methods and techniques have evolved which are applicable only under particular conditions. Cost estimates must take into consideration the current estimating environment, market conditions, weather, and any other factors that influence the labor hours and material costs associated with a cost estimate. In preparing detailed cost estimates for work activities, the estimator shall always use the best information available. Where standards are available and applicable, they should be used. Where the estimator lacks experience or knowledge of the work being estimated, it is essential that other sources of information be examined. These sources include the following:

- Master Specification Catalog
- other estimators who have longer service or experience
- engineered labor standards prepared by naval or private contractors
- material catalogs from industry vendors
- contract files for similar work packages
- personal records made from past jobs or negotiations
- other Government agencies that have performed similar work
- personal observations made during job execution
- "Rules of Thumb"
- historical data

6.6.2 Standardization of Cost Estimates

Estimates should be standardized to the maximum extent possible. When estimating work items to be used in a competitive environment, previous estimates used for the same item should be modified only after a careful justification and then only to reflect changes in scope or changes in the estimating system. When a previously used work item is tailored to meet a new work item, the previously used estimate should also be tailored to meet the new requirements.

For ship repair and modernization work, estimators should utilize the proven Standard Work Templates (SWT) found in the Navy Maintenance Database (NMD)/Master Specification Catalog whenever possible. The estimator should use an applicable Class Standard Work Template if possible to prepare a work item addressing an authorized Ship Work Line Item Number (SWLIN). If an applicable Class Standard Work Template is unavailable, an applicable SWT should be tailored to the SWLIN item requirements. If an SWT is unavailable, a Local Work Template (LWT) should be tailored to the SWLIN requirements. As a last resort, the planner should develop an original work item, using current standard phraseology and applicable Category II NAVSEA Standard Items (SI).

6.6.2.1 Estimating Standards

Estimating standards are established by relating labor and material costs to specific characteristics of products or services delivered. The use of estimating standards is designed to save time in estimating and is particularly effective in estimating the costs of recurring work. Estimating standards are used to estimate the cost of a single material item required for the work in question or the cost of a single labor operation (e.g., welding rods per ton of steel, labor hours per linear foot of weld, gallons of paint per square feet, or surface area, etc.). More complex estimating standards may also be used to estimate the costs of groups of materials or components, or broader classes of labor operations. Estimating standards must be consistent with the estimating system used to develop estimates. Standards derived from industry-wide statistics are generally applicable industry-wide. Standards that include contractor-specific procedures are applicable only in that contractor's estimating system. The use of such standards is limited to the environment where the standard was developed. When estimating for changes where the contractor is known, any approved engineering standards applicable at the contractor's plant should be used by both the contractor and the Government in developing estimates for the work. Large numbers of Engineered Standards and other standards have been developed by both naval and private contractors. Many of these standards contain basic charts and tables that depict labor and material allowances for various work elements. These allowances are then modified by unique factors to reflect skill levels of workers, facilities, tools available, etc. Some of these standards can be adapted for use in any contractor's facility, provided appropriate factors are used to modify the standard allowances.

6.6.3 Detailed Estimating Techniques

Inherent in the concept of detailed estimating is a requirement that the estimator know how the work being estimated is to be accomplished. The "how" of work accomplishment often varies from one contractor to another and it may also vary with time, workload, and other considerations. The method of accomplishing the work must be consistent with the applicable estimating system. Detailed estimating requires that an estimate for hard-core labor and material for each activity of work required be developed and added to obtain the total hard-core item estimate. This type of estimate can be referred to as a detailed estimate because the work required is broken down into as many detailed activities as needed to facilitate the estimating. A detailed estimate is built from the bottom up, starting with the

lowest element of work required and building on it until the total job is estimated; the greater the level of detail, the greater the possible refinement.

6.6.4 Use of Historical Data

When historical data has established a standard allowance in labor and material for a work item, that standard shall normally be used when estimating that work item. The estimated cost will change, however, because labor rates and the price of materials change with time. The labor-hours and material quantities should remain constant, except for changes in work scope, the estimating system, or the estimating environment. The use of such historical standards should be validated with each use to ensure that new technology and work practices have been properly considered and that they are representative of the actual cost elements being estimated. When collecting and analyzing cost data, care should be used to distinguish between estimated costs and return or actual reported costs. When using return costs in historical files, an effort should be made to make adjustments to eliminate the excess costs that can be attributed to inefficiencies or other factors that are unique to the availability and the way the work package was executed. Use of return cost data in historical files without appropriate adjustment causes inefficiencies in performance to be extrapolated needlessly into future cost estimates. For this reason, historical files based on estimated costs are generally preferred over files based on return cost. Historical files can incorporate both estimated and return cost, but any return cost used should be properly adjusted.

6.6.4.1 Return Cost Statistics

It is easy to accept a running average of historical return costs as the best estimate of future costs for the same or similar requirements, although this practice may not always give the best results. This estimating technique may easily incorporate prior inefficiencies that have persisted unchecked. Worse yet, historical files based on return costs run an even greater risk of perpetuating erroneous estimates because of inaccuracies in reporting those costs and a lack of consistency in execution. The actual cost of performance of a job is a function of time as much as it is the hard-core cost elements of labor and material. Collecting actual cost data in a contractor cost accounting system is a requirement for all ship repair contractors and naval shipyards, but the data collected does not always reflect the actual work accomplished. This can happen when workers erroneously charge labor to the wrong job order number or to the wrong contract. In private sector availabilities executed under fixed price contracts, return costs reported on departure reports are usually based on a prorated share of the contract price plus the negotiated costs of applicable contract modifications. The basis for the pro-ration is the Government estimate of each work item. Thus, a return cost based on a substantial buy-in by a contractor could be significantly different from return costs from a sole source negotiation or at a time when the market is saturated. For these and other reasons, return costs should be used with care in developing standard estimates for future work.

6.6.4.2 Estimated Cost Statistics

The best estimate of future costs is the statistical mean of a number of independent estimates for the same requirements. Even in the case of standard estimates derived from independent estimates, the standard shall be reviewed periodically to challenge its validity in all cost elements estimated.

6.6.4.3 Adjustment to Historical Cost Data

When collecting completion cost data for historical files, costs for acceleration, delay, and disruption should be subtracted before entering the cost figures into the files. These costs are unique to a specific availability and should not be extrapolated for use in future availabilities.

6.6.5 General Estimating Methods

Shipyards responding to Navy procurements prepare estimates in different ways. Four of the most common methods of estimating are round table, comparison, detailed estimating, and parametric cost estimating/"rules of thumb"/cost estimate relationships.

6.6.5.1 Round Table Estimating

Representatives of shipyard departments such as engineering, production, and material purchasing, may develop a cost estimate based on experience, knowledge of the work required, and knowledge of market conditions. These estimates are usually completed with no detailed drawings or bills of material and with limited information concerning the work specifications. Standard costs are usually available for a major portion of the work. This type of estimating is speedy and inexpensive.

6.6.5.2 Comparison Estimating

With comparison estimating, department representatives and a cost estimator compare previously accomplished work elements to the work being considered. A new estimate is developed from the known costs of these similar work elements. This method is often used when requirements for the new work are very similar to those of a known work element and the new estimate needs few changes.

6.6.5.3 Detailed Estimating

In a thorough, detailed analysis of each element of the required work, detailed estimating produces requirements for labor, tooling, material, and additional capital items. The application of labor rates, material prices, and overhead to the calculated requirements translates the estimate into dollars. This type of estimating provides complete calculations, records, and quotations available for future use.

6.6.5.4 Parametric Cost Estimating

Parametric cost estimating is broadly defined as a technique employing one or more Cost Estimating Relationships (CERs) for the estimating of costs associated with work to be performed. In this sense, CERs represent the relationships between the cost of materials, labor, or services and the products delivered or work performed. Simple CERs can be derived arithmetically from historical data. For example, examine the cost of quality assurance in performing machine shop work. If historical records show that the costs of quality assurance over the last six months of operations amount to 10 percent of the total effort expended in the direct labor pool, then it would be safe to use a CER which projects the cost of quality assurance as 10 percent of the total effort required in operations over the next six months, unless some changes are anticipated which may impact the overall cost of performance. It is difficult to use sophisticated CERs in ship repair estimating because of the non-recurring nature of most ship repair work. CERs are more useful in estimating manufacturing and construction costs as opposed to repair, overhaul, or modernization costs. This does not mean, however, that simple CERs cannot be used effectively. They are used frequently, but they are generally referred to as "Rules of Thumb." Experienced estimators who have observed and recorded the results of prior estimates and adjusted them for changing conditions have developed many "Rules of Thumb" over the years. "Rules of Thumb" allow for estimates to be made on the basis of such concepts as cost per pound or hours per foot or unit. As with all CERs, "Rules of Thumb" are subject to change; therefore, should be used in an informed manner. When changes occur in technology, procedures, or other areas of cost affecting a CER, it should be modified to reflect the impact.

The first step in developing a CER is to determine its need and usefulness. Applications for CERs can be readily identified through logical reasoning and hypothesizing about the factors affecting the costs of performance. Once a need has been identified, the next step in developing the CER is determining what will be estimated and how it will be estimated. If labor hours are the desired items to be estimated, which categories of labor will be included? Is there a fixed ratio of one category to another? Which labor categories are to be excluded? The next step is to determine which factors will be used to estimate or drive the CER. All significant factors that cause costs to be incurred should be considered, including specific material quantities and prices, applicable procedures or processes, and environmental costs. Of these factors, isolate those that make the most significant cost contribution. The number of factors selected should be the smallest number possible to make the CER understandable and effective in producing the required estimates. Next, obtain historical data on both the cost variable being estimated and all the driving factors selected for use in the CER. The data collected must be consistent with the CER parameters isolated for analysis and must be extensive enough to represent a broad sampling of the costs expected under conditions when the CER would apply. After that, the data must be analyzed to determine the relationships that exist and the usefulness of those relationships in determining a CER. Then the relationship that best describes the data used is selected. The CER is quantified for use by providing a description of the CER, the independent variable or variables that are used, and the method to predict the cost of the dependent variable.

CERs may be presented in many forms, such as graphs, tables, or charts. They may be based on relationships from simple straight-line (one-to-one correspondence) to complex multivariable non-linear relationships. CERs, like most tools used in estimating, must be tempered by good judgment and with consideration of current conditions. New processes, technology, or other factors may make CERs obsolete. It is necessary, therefore, that estimators have some knowledge of the factors involved in CER development and employ CERs appropriately.

6.7 Estimating for Contract Modifications

6.7.1 Contractor Modifications

For contract modifications, including Master Agreement Job Order modifications, and for non-competitive procurements, estimates must include allowances for known conditions in the estimating environment. The scope of the modification estimate must include:

- consideration of additions and deletions required by the change
- impact on completed work by the change
- current status of materials made obsolete by the change

The cost estimate must consider the means of performing the work, the completion date, and other factors impacting performance such as delay, disruption, or acceleration. These cost elements must be identified, quantified, and included in any cost estimate. In considering the means of performance, due consideration must be given to the contractor's normal operating procedures. The estimate should be prepared based on the methods, procedures, facilities, equipment, and employees available to the contractor. In such a sole source environment, it is unfair to the contractor to negotiate changes on any basis other than those that impact on the costs of performance by the contractor. Estimates for changes must be prepared based on the way the contractor would perform the work, considering current workload as well as contractor inefficiencies and disruptions that may result from the change. The estimate must also consider the timing of the work to be done. Change work authorized early in an availability is generally less disruptive, and therefore less costly, than change work authorized later in the availability.

6.7.2 Acceleration

Acceleration should be considered in developing estimates for contract modifications that increase the scope of work. Simply defined, acceleration is a speeding up of the work in an attempt to complete performance earlier than otherwise anticipated. Acceleration consists of such items as increased manning, added shift work, overtime, rescheduling of workforce, new hires, additional subcontracting, etc. Acceleration, when required, must be considered in any estimate for changed work in a job order. Acceleration costs will nearly always be incurred when significant growth or new work is added to a work package that is to be completed in the original contract performance period. A contract is also "accelerated" if the

original performance period is decreased without an accompanying decrease in the scope of work. When acceleration is required, it must be identified in the contract modification (scope of work) and estimated as any other work element is estimated.

6.7.3 Disruption

Disruption costs should also be considered in developing cost estimates for contract modifications. It is the cost of the man-hours, materials, and other costs that are expended to offset inefficiencies experienced as a result of Government-caused or contractor-caused changes, or other departures from the original schedule that includes the effect of changed work on unchanged work. It is also the process by which the above inefficiencies in the performance of contract work are created. Disruption, when it can be identified, must be quantified and accounted for in the contract modification estimate. As with most estimating, quantifying disruption is an inexact process and there are few official guidelines available for assistance. The real requirements to be kept in mind are that it must be considered in determining the scope of work and, if present, the contractor must be compensated for disruption attributable to the change. Disruption attributable to the contractor's past performance, without regard to the change, must not be considered.

6.7.4 Delay

When a contract change affects the completion of the contract, a contractor may request additional compensation for this delay. Delay can also be an element of the contractor's cost estimate when other Government action or inaction causes a delay to the contractor's efforts. Delay is defined as that period of time a contractor is required to perform beyond the planned delivery or completion date, due to contractually remediable Government action or inaction (e.g., changes, stop work orders, suspension, or late or defective GFM). Delay must also be considered whenever any time-oriented event affects the length of, or causes, a suspension in scheduled contract work. As with any other cost element, it must be identified, quantified, and accounted for in the cost estimate. Delay attributable solely to the contractor's execution of the job order is not considered in any estimate for a contract modification.

Appendix 6-A: Standard Cost Estimate

STANDARD COST ESTIMATE *(Previous edition obsolete)* *(NAVSEAINST 4710.7A)*
NAVSEA 4710/7 (REV. 6-81)
S/N 0116-LF-047-1035 ☐ ORIGINAL ☐ AMENDMENT ☐ REVISION **PART I**

SURVEYOR	ORIG. CODE					

TRADE

WORK ITEM PARAGRAPH/ CATEGORY STD ITEMS	SHIPFITTERS	SHEETMETAL	WELDERS BURNERS	INSIDE MACHINIST	OUTSIDE MACHINIST	BOILERMAKER	ELECTRICIAN	PIPEFITTER	INSULATOR LAGGER	CARPENTER SHIPWEIGHT	ELEX/ ORDANCE	PAINTERS SANDBLASTERS	RIGGER LABORER	QA/ NDT	MAN HR/DAY	CFM MAT'L
CHECKPOINTS REPORTS																
SUB TOTALS																

NOTES

1. EST WORKING DAYS REQ'D
2. ARE ALLOWANCE CHANGES INVOLVED? ☐ YES ☐ NO
3. LIST ITEM, SWLIN OR JCN NOS. THAT INTERFACE WITH THIS ITEM
4. REMARKS

LABOR TOTAL	$	HR. DAY	$
CFM MAT'L			$
SUB CONTRACTOR			$
MFR. REP			$
TOTAL EST CONTRACTOR			$

EST GROWTH	MD/MHR	MD/MHR	MAT'L	TOTAL
		$	$	$

GFM (NSA)	$
SHIP/HULL NO	

5. JSN/SWLIN

TITLE			
DATE	COAR NO	ITEM NO	MOD NO

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APPENDIX A (reverse side)

STANDARD COST ESTIMATE
NAVSEA 4710/7 (REV. 6-81)
S/N 0116-LF-047-1035

PART II

REPORTS REQUIRED

PARAGRAPH	TYPE OF REPORT (BRIEF)	REPORT DUE

CONTRACTOR FURNISHED MATERIAL ESTIMATE

PARA.	MATERIAL DESCRIPTION	QUANTITY	UNIT COST	TOTAL
			TOTAL $	

SUB CONTRACTOR ESTIMATE

PARA.	SERVICE	MD/MHR	$/MD/MHR	MATL	TOTAL
				TOTAL $	

TITLE	COAR NO.	ITEM NO	MOD NO

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Appendix 6-B: Acronyms

ACAT	Acquisition Category
ACO	Administrative Contracting Officer
CAS	Cost Accounting Standards
CER	Cost Estimating Relationship
DCAA	Defense Contract Audit Agency
EAC	Estimate at Completion
GFM	Government Furnished Material
JFMM	Joint Fleet Maintenance Manual
LWT	Local Work Template
MSC	Master Specification Catalog
NAVCOMPT	Navy Comptroller
NAVSEA	Naval Sea Systems Command
NAVSEAINST	Naval Sea Systems Command Instruction
NMD	Navy Maintenance Database
ODLF	Other Direct Labor Factor
OMB	Office of Management and Budget
OSD	Office of the Secretary of Defense
PEC	Predicted End Cost
ROM	Rough Order of Magnitude
ShipAlts	Ship Alterations
SI	Standard Item
SLEP	Service Life Extension Program

SWBS	Ship Work Breakdown Structure
SWLIN	Ship Work Line Item
SWT	Standard Work Template
TAR	Technical Advisory Report