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U.S. NAVY SHIP UPGRADE CONSTRUCTION COST MODEL

FINAL REPORT

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1. INTRODUCTION

This ship upgrade construction cost model was developed for the Navy Center for Cost Analysis (NCA) under T.I. No. 5E369 of NAVSEA Contract No. N00024-88-C-4216. The model provides a method for estimating the shipyard construction contract costs associated with major upgrades of U.S. Naval vessels including surface combatant, auxiliary and amphibious type ships. These major upgrades are considered to be forward fit upgrades to follow ships of a class being built in the same shipyard as the earlier ships. The model is based on return cost data provided by NCA for U.S. Naval surface combatants, auxiliary and amphibious ships. It is consistent with previous lead ship construction models developed for NCA. As with the previous models, it uses input parameters that are known early in the ship program development process.

Previous models developed for NCA address lead ship construction costs [References (1) to (7)], follow ship or follow yard construction costs [Reference (8)] or major backfit modernization costs [Reference (9) and (10)]. None of these models addresses the concept of a major forward fit upgrade to a ship class during its construction cycle. This upgrade model is the first attempt to develop a method for assessing the shipyard construction contract costs of the lead ship in a major upgrade program. The model builds upon modeling approaches and data from previous models, and incorporates features that allow the user to evaluate the impact of a major upgrade and, from this, develop an estimate of the total ship construction cost for the lead upgrade ship.

This model is considered a useful addition to the suite of models available to NCA. Major upgrades are a potential cost effective method to improve the overall capability of a class of ships, without incurring the total nonrecurring costs for a lead ship of a new class, or losing the total learning curve savings inherent in a follow ship construction program. This model will

allow NCA to estimate a major upgrade and to compare its costs to that of an equivalent lead ship, using the cost estimating relationships (CER's) in the lead ship construction model.

2. MAJOR UPGRADE PROGRAM SHIPYARD COSTS

Major upgrade programs are commonly used by the Navy to significantly improve the capabilities of a class of ships during the construction cycle for the class. The Navy continuously identifies changes, modifications or replacements to the existing class systems or equipment. Some of these are considered necessary to correct problems, while others allow the class to improve its mission or operating performance. Some of these changes are made as individual ship alterations to the ships, which are installed on the ships during periodic shipyard repair or maintenance availabilities. Frequently, however, the Navy establishes a class upgrade program, where a number of changes are grouped together and a ship of the class is designated as the lead ship to receive the upgrade. This ship and all subsequent ships of the class are built to the upgrade design as a forward fit. Often, under an upgrade program, backfit designs of key upgrade elements are also developed for existing ships in the class.

The shipyard costs associated with the lead ship of an upgrade program are a mixture of lead and follow ship factors. The ship itself is a follow ship in the series, and, for the portions of the ship that have not changed, the construction costs are those of a follow ship, including savings due to learning and class buys of equipment. For the portions of the ship that have totally changed, the construction costs are those of a lead ship, with little or no learning, and lead ship material cost factors.

Shipyard design and integration costs include normal recurring design, planning and management costs that are necessary to support the construction of the ship in series. Added to these are design and integration costs associated with modifying the class design to include the upgrade changes. In addition, there are program costs associated with the upgrade program, which include the class changes, both forward fit and backfit, as well as design, planning, management and other direct support to the Navy. The Navy will also use the upgrade program

as a vehicle to implement new initiatives, and the cost of these are also incorporated into the overall shipyard costs.

A good example of an upgrade program is the ongoing Flight IIA Program for the DDG 51 Class AEGIS equipped guided missile destroyers. The DDG 79 is the lead upgrade ship for the Flight IIA Program. Current plans are to build the last 16 ships of the class to the Flight IIA design. Modifications to the ship are shown in Figure 2-1 and include adding organic Lamps MK III helicopter capability, a general purpose armed helicopter, dual helicopter facility with RAST, evolved Sea Sparrow missile capability, Kingfisher mine countermeasures system, the additional six VLS cells, five blast hardened bulkheads, and appropriate hull, mechanical and electrical items. In addition, the fiber optics IVCS and DMS systems and the non-CFC air conditioning refrigeration plants are being modified. Finally, the CIWS, HARPOON, TACTAS (AN/SQR 19), at sea missile handling equipment, and the CPS Zone 4 are being deleted. As can be seen, the modifications to the ship directly impact a variety of systems on the ship and have resultant ship impacts on the ship's arrangements, structure and distributive systems, while at the same time, retaining much of the current DDG 51 Class ship's characteristics

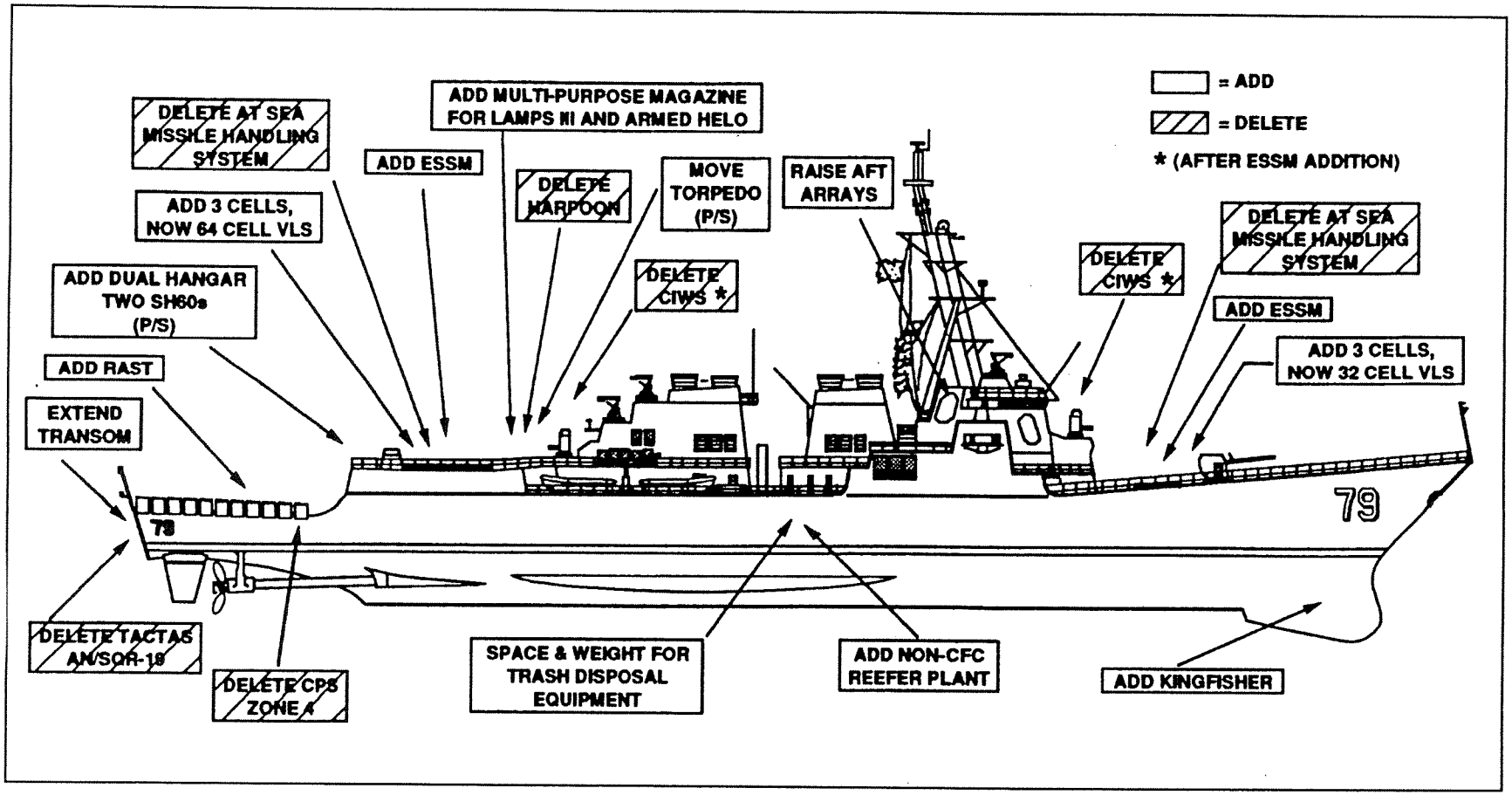


FIGURE 2-1

FLIGHT IIA MODIFICATIONS

3. MODELING APPROACH

This upgrade model provides a method for estimating the various factors associated with a major upgrade program. The model builds upon the existing lead ship construction cost models [Reference (1) to (5)] developed for NCA, and provides methods for modifying the cost groups to suit the lead upgrade ship. These include use of learning curve factors from Reference (8), and follow ship design factors from References (6) and (7). The model also relies on the most recent cost data for the lead ships from Reference (1), and in particular an excellent set of FFG 7 Class lead and follow ship production and pre-production costs for the ships built at BIW. These costs are provided as Appendix A.

The model is subdivided to estimate costs for U.S. Navy surface combatants, auxiliary and amphibious type ships as is done in the lead ship construction models. The same assumptions and groupings of ships used in the current model apply to the upgrade model.

3.1 Assumptions

The upgrade model assumes a number of aspects of the upgrade process. The first is that the Navy has established an upgrade program in a formal sense, including program costs for the shipyard to support the Navy initiatives. The model assumes that the program is essentially a forward fit design and construction effort, although some programmatic costs may be associated with developing backfit designs for specific upgrade changes the Navy would like to install on existing ships within the class.

The model also assumes that there will be major changes to the ship; however, the changes will not be significant enough to warrant new class construction or conversion programs, nor will they be so minor as to be a merely modified repeat design of the previous ship in the

class. These changes will require significant new design costs to modify the design to suit the required changes. Changes to the ship can include reconfiguration of the portions of the ship, such as adding a hangar on the DDG 51 Flight IIA. They can also include installation of major new equipment or systems, such as changing from GMLS to the vertical launch system on the CG 52 of the CG 47 Class ships. These changes have both direct system impact, and indirect ship impact on arrangements, structure and distributive systems (HVAC, electrical system, piping systems).

The model assumes that the lead upgrade ship is a follow ship in a series of ships built at one shipyard. This assumption reduces the nonrecurring costs for the ship and allows for learning to occur for the portions of the ship that are not affected by the change. Even if multiple yards are building the ship, the lead upgrade ship will typically be the nth ship built in one of the yards building the class. In the unlikely event that a new shipyard is given the contract to build the lead upgrade ship, production costs (nominally SWBS Groups 100-700, and part of SWBS Group 900) will be more those of a lead ship than a lead upgrade ship, and the lead ship model should be used for these costs.

3.2 Approach

The upgrade model allows for lead ship labor and material cost factors to be modified to suit the lead upgrade ship characteristics and to then estimate the lead upgrade ship's shipyard construction contract costs. In order to accomplish this, the model contains labor and material cost groups for estimating lead ship costs; labor and material learning curve slope factors to adjust the lead ship cost production costs to a follow ship cost; variability within each learning curve factor to adjust it to reflect the changes due to the upgrade; and methods for estimating the recurring and nonrecurring program, engineering, integration and shipyard services costs

associated with the upgrade program. The model also allows all dollar costs to be adjusted to reflect inflation using NCA's inflation escalation factors, Reference (11).

In order to provide sufficient detail for the upgrade model, the two digit SWBS based cost groups used in earlier lead ship construction cost models, References (2) to (5), are used instead of the one digit SWBS cost groups used in current lead ship construction cost model, Reference (1). These cost groups are shown in Table 3-1, and a cross reference of the three digit SWBS groups comprising the two digit cost groups is contained in Appendix B. The two digit cost groups are calibrated to the CER's in the current new construction cost model in order to reflect the most recent cost data. This also allows direct comparison of an equivalent lead ship cost with that of the lead ship construction cost model.

The rationale for this approach is that, even though the current lead ship construction model provides an excellent database of historical return costs based on shipyard cost performance reports (CPR's) and a good lead ship cost estimating capability, limitations in the data only allowed the use of one digit cost groups. These one digit cost groups are not sufficiently detailed to estimate potential system level changes that are typical of a major upgrade. The two digit cost groups, however, were developed for NCA in concert with shipyard cost estimators to reflect logical groupings of three digit SWBS weight and cost data into manageable cost estimating groups. They have proven to be a successful cost estimating tool for NCA. These two digit groups provide a sufficient level of detail to differentiate between different types of shipyard activity, such as installation of major electrical power generation equipment versus installing the cable and the electrical distribution system, while not requiring detailed information that may not be available to NCA for use in developing the cost estimate. In addition, the two digit cost groups use the same type of ship characteristics, i.e., weight, that are used in the current lead ship model, and the two digit cost groups fold directly into the one digit cost groups for summary and comparative purposes.

TABLE 3-1

TWO DIGIT COST MODEL

GROUP	GROUP TITLE	GROUP	GROUP TITLE
1	Hull Structure (Total)	5	Auxiliary Systems
1A	Structural Envelope/ Subdivisions	5A	Environmental Systems
1B	Superstructure	5B	Fluid Systems
1C	Foundations	5C	Maneuvering Systems
1D	Structural Attachments	5D	Equipment Handling Systems
2	Propulsion Plant	6	Outfit and Furnishings
2A	Propulsion Energy Systems	6A	Hull Fittings
2B	Propulsion Transmission Systems	6B	Non-Structural Subdivisions
2C	Propulsion Gases (Intake and Exhaust) Systems	6C 6D	Preservation Ship Support
2D	Propulsion Service Systems	6E	Habitability
3	Electric Plant	7	Armament
3A	Electrical Power Generation		
3B	Electrical Power Distribution		
4	Command and Surveillance	8	Integration/Engineering
4A	Vehicle Command		
4B	Weapons Command	9	Ship Assembly and Support Services

The major limitation of the older models is that their CER's have become obsolete. In the current model, NCA requested that CPR data be used versus the internal shipyard return cost data that were used in previous models. This provided NCA with a better measure of the actual shipyard costs to the government, and expanded the breadth of ship and shipyard cost data in the model. The current model also contains recent CPR return cost data for ships such as the DDG 51, LHD 1, AOE 6 and others that were not in the previous models. In addition, the older models represent material dollar costs in earlier year dollars. This new data set caused the CER's in the current model to differ from those of the earlier models.

In order to overcome this limitation, the upgrade model calibrates the two digit costs groups to the current lead ship construction model one digit CER's. This calibration is performed by a direct comparison of the costs of representative ships at the one digit level using both the current CER's and the two digit cost groups summed to equivalent one digit levels. The differences between the two are then used to adjust the two digit cost group factors within individual one digit groups to reflect the current CER's. Both labor man-hour factors (in man-hours/long ton) and material dollars (in CY1993 dollars/ long ton) are adjusted in this manner. This was considered a compromise appropriate to the level of accuracy required for this model.

3.3 Production Costs

In Appendix A, BIW differentiates between production and preproduction costs, where production costs represent the costs of construction related activities, and preproduction costs represent the recurring and nonrecurring type costs associated with design, integration, program and certain shipyard services. The upgrade model uses the same convention as a way to differentiate between construction-like activities under SWBS Groups 100-700 and part of 900, and design or program support type activities covered under SWBS Groups 800 and part of 900.

Comparison of CPR data on the FFG 7 Class [Reference (1)] and the data shown in Appendix A indicates that for the FFG 7, all of SWBS Groups 100-700 and approximately 60 percent of Group 900 are production-like costs, whereas, all of SWBS Group 800 and the remaining 40 percent of Group 900 are preproduction-like costs. This breakdown is used for differentiating between the production and preproduction costs in the upgrade model.

Lead ship production costs are estimated using the two digit SWBS group weights as the independent variables. This is multiplied by the representative adjusted cost group factors in the same manner as in the lead ship construction model.

In order to adjust the production costs to reflect the lead upgrade ship, the model contains learning curve slope factors for each two digit cost group for both labor and material costs. The learning curve factor is the percentage which a lead ship cost is multiplied by in order to adjust it to reflect the lead upgrade ship. It is a function of the slope of the learning curve for the shipyard, and the number of the upgrade ship in series in the yard. The learning curve factors were derived from shipyard input and other data contained in the follow ship and follow yard construction cost model, Reference (8). The learning curve factor is derived from the following equation:

$$LCF_\alpha = \frac{FS_\alpha}{LS_\alpha} = n^{\left[\frac{\log SL}{\log 2}\right]_\alpha} n-1^{\left[\frac{\log SL}{\log 2}+1\right]_\alpha}$$

where,

LCF is the learning curve factor.

FS is the follow ship cost.

LS is the lead ship cost.

α is the cost element under construction.

n is the number of ships built in the yard.

SL is the learning curve slope.

This study showed that for a series of ships being built with little or no change, and in a single shipyard, the learning curve slope for labor ranges from approximately 88 percent to 93 percent. Under these same conditions the learning curve slope for material costs is approximately 97 percent. By contrast, a lead ship slope would be 100 percent. These results are consistent with a similar in house NCA study, Reference (12), which provides an extensive assessment of the learning curve slopes for a wide range of ships. These range of slopes are used in this upgrade model.

The upgrade model also allows the individual production cost group learning curve factor percentages to be adjusted to reflect the changes due to the upgrade. These percentages can range from the baseline slope group percentage, if the systems within the group are unchanged, to a lead ship percentage of 100 percent, if the systems within the group are completely changed. If the systems within a cost group are partially changed, an intermediary slope can be used, which the model converts into an intermediary learning curve factor. In each case the selected cost group learning curve factor is then multiplied by the lead ship group cost to derive an estimate of the lead upgrade ship group cost.

As a simple example, if an upgrade program were only to replace an existing deckhouse with a completely new deckhouse on the eighth ship in a frigate class, a slope of 100 percent, with an associated learning curve factor of 1.00, would be applied to cost group 1B and lead ship costs for group 1B would be used. For the other production cost groups, the lead ship labor costs

would be multiplied by 0.69, which represents the learning curve factor for the eighth ship built in a yard with a slope of 92 percent, and the material costs would be multiplied by 0.88, which represents the learning curve factor for the eighth ship built at a yard with a slope of 97 percent. The cumulative costs would represent the total cost of the lead upgrade ship.

In summary, lead upgrade production labor costs are derived by multiplying the individual calibrated two digit cost group labor man-hours/ton factors by the associated group weights to derive lead ship group man-hour estimates. These are then multiplied by the associated modified group learning curve factors to derive lead upgrade ship group man-hour estimates. These estimates are then multiplied by the selected production man-hour rates to derive group labor dollar estimates. The labor man-hour and dollar estimates are then summed to derive a total ship production labor man-hour and dollar estimate. Material costs are derived in a similar manner, using material two digit cost group $/ton factors, group weights, and modified group learning curve factors. A total production cost estimate is derived by summing the labor and material costs.

3.4 Preproduction Costs

The upgrade model provides a method for adjusting lead ship recurring and nonrecurring preproduction costs, including program, design and integration, and similar shipyard services costs, to reflect the upgrade ship. In this case, the model superimposes the upgrade program and other nonrecurring costs onto the normal recurring costs for the ship in series. The program, design and integration costs are covered under SWBS group 800, and the shipyard services under SWBS group 900.

Both the old and current lead ship construction cost models use single, one digit level cost groups for SWBS Groups 800 and 900. As such, there is no need to calibrate these costs,

since the CER's from the current lead ship construction cost model can be used directly in the upgrade model. This is, in fact, what is done in the upgrade model. Unfortunately, the current lead ship construction model only has material cost CER's at the total ship level. To estimate the preproduction material costs, the upgrade model relies on the relationship between design man-hour dollar costs and related material dollar costs derived in the detail design cost estimating model [Reference (6)]. This study indicated that the design related material costs are on the order of 12 percent of the associated labor dollars. This percentage is used to estimate all preproduction material costs in the upgrade model.

The upgrade model subdivides the SWBS Group 900 costs between production and preproduction costs, using the percentages noted above. The model then subdivides the SWBS Group 800 and preproduction SWBS Group 900 costs between recurring and nonrecurring costs. A split of 10 percent/90 percent between recurring and nonrecurring costs, respectively, is used. This split is based on consideration of the data for follow ships shown in Appendix A, and the follow ship design costs discussed in the detail design cost model [Reference (6)]. The 10 percent recurring costs are used in the upgrade model as the baseline preproduction costs for the lead upgrade ship.

The upgrade model modifies the lead ship preproduction costs by adjusting the 90 percent nonrecurring portion of these costs to reflect the lead upgrade ship. These nonrecurring costs are divided into program related costs and other design and shipyard services costs.

Analysis of the FFG 7 data in Appendix A indicates that for an upgrade program, a threshold general program cost on the order of 20 percent of the lead ship preproduction costs occurs as part of a major upgrade program, even if the changes to the ship are minimal. This percentage is used in the upgrade model to reflect the program portion of the nonrecurring costs.

The remaining 70 percent of the lead ship preproduction costs are adjusted linearly based on the aggregate production costs learning curve factor, under the assumption that these are design and other related costs that are dependent upon the degree of change of the lead upgrade ship from its immediate predecessor. In this case, these costs would be zero if no change occurred on the ship, or 70 percent if the ship were totally changed, or was a new lead ship. The model automatically calculates the aggregate production costs learning curve factor and adjusts these preproduction costs accordingly. This can, however, be overridden and the user can use other percentages if so desired.

Figure 3-1 indicates the relationship used in the upgrade model to estimate the total preproduction labor costs, as discussed above. As noted, the estimated total percentage of lead ship costs represented by the lead upgrade ship is multiplied by the lead ship labor CER to estimate lead upgrade ship preproduction man-hours. This is then multiplied by the selected preproduction labor man-hour rate to derive a total preproduction labor dollar estimate. The labor dollar estimate is then multiplied by 12 percent to estimate a total preproduction material dollar estimate. The two estimates are combined to derive a total preproduction cost estimate.

3.5 Model Limitations

The upgrade model is a first effort at developing a model to estimate upgrade costs. The model itself has certain limitations that must be recognized. The first is the rote method by which the old two digit production cost groups are calibrated to the current one digit model. Although comparisons of the total ship production costs are favorable between the upgrade model and the lead ship model, it is not expected that the two digit cost groups will be exactly representative of the current costs for the groups. Inaccuracies due to escalation, the calibration method, and changing technologies will introduce some error in the individual two digit cost

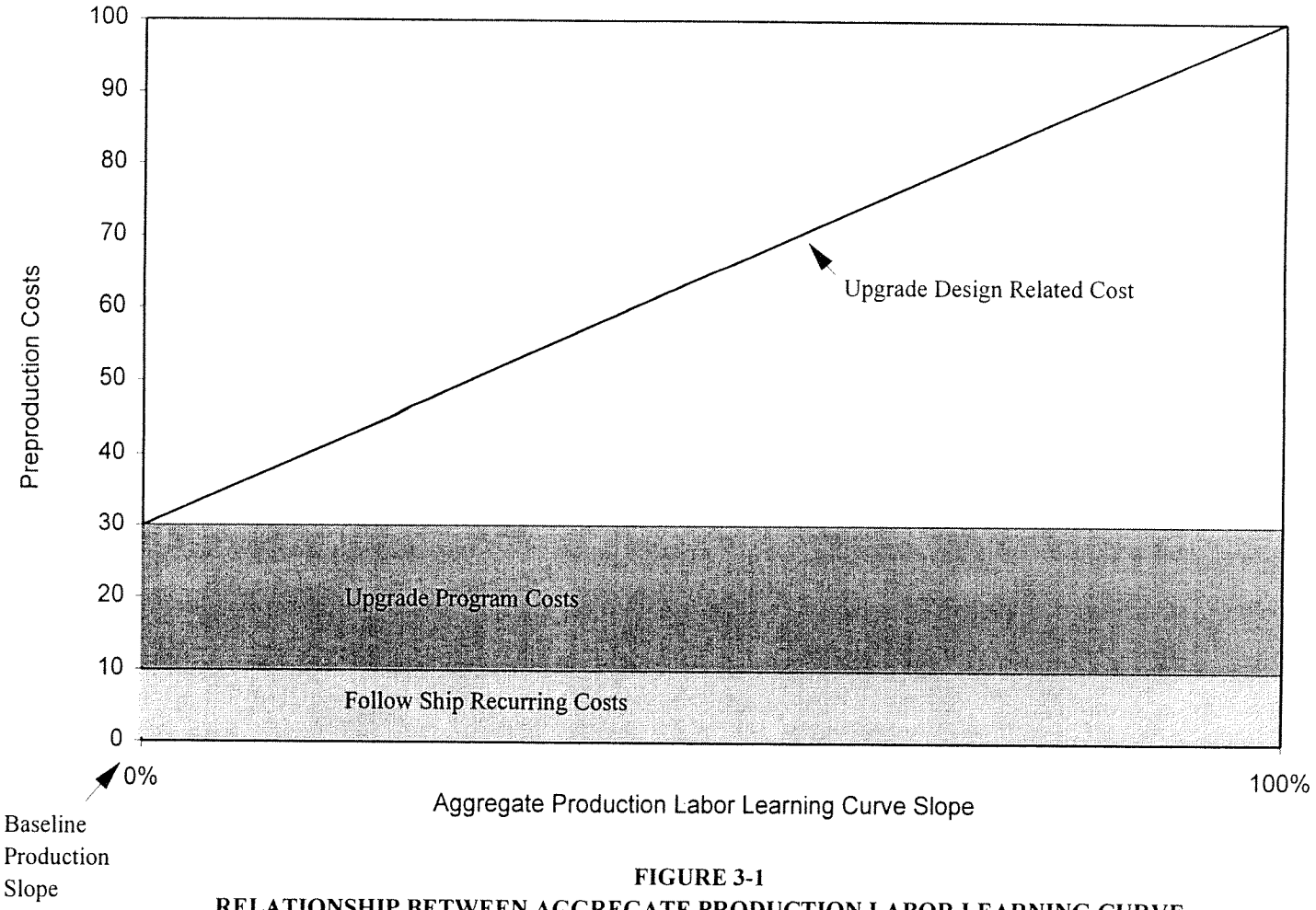


FIGURE 3-1
RELATIONSHIP BETWEEN AGGREGATE PRODUCTION LABOR LEARNING CURVE SLOPE AND PREPRODUCTION COSTS

groups. Since each individual group represents less than 3 percent of the total lead ship costs, small errors in any individual group will not significantly affect the final costs. The model should, however, only be used at the total ship level.

Although the preproduction costs are modeled using the lead ship CER's, the adjustments to these costs to reflect follow ship conditions are, because of data limitations, based on a single FFG 7 data set, which is then applied to all ship types. The factors for recurring costs, program costs, and the adjustment for change to the ship are all first cut estimates and could vary. Again, it is unlikely the variance will be so significant as to invalidate the estimate at the total ship level.

Ultimately, it would be advantageous to work with a shipyard cost estimator to assess each two digit labor and material cost group and modify them to reflect current values. It would also be advantageous to acquire data for a number of ships to use to develop CER's at the two digit level based on multiple data points. Additional data would also be useful to verify the assumptions made concerning the adjustments to the preproduction costs. However, even given the limitations, it is believed that this upgrade model provides a good tool for estimating major ship upgrades. It is also believed that the basic data and modeling approach can be directly correlated to prior models developed and successfully used by NCA.

4. MODEL DESCRIPTION

The upgrade model was developed in spreadsheet format using LOTUS 123. The easiest method for discussing the model is to provide an overview of the spreadsheets and then a detailed description of each spreadsheet page.

The upgrade model provides a method for estimating upgrade costs for surface combatant, amphibious and auxiliary type ships. The model uses representative ships from the lead ship construction cost model to perform cost group calibrations. The representative ships were selected to reflect ships whose actual costs are close to the modeled costs, and who are preferably in the mid-range of the CER's. The current lead ship construction model should be consulted for descriptions of the ships' characteristics and the lead ship model's data and CER's. The ships selected were as follows:

Surface Combatant	FFG 7
Amphibious Type	AD 41
Auxiliary Type	AOR 7

The FFG 7 represents a ship at the low range of surface combatants; however, it is the best ship in the database with regard to completeness of the data and the "closeness" of the data to the model results. Table 5-1 in Section 5 provides a summary of the return cost data versus modeled estimates for the FFG 7 for SWBS Groups 100-700, 100-700 and 900, and 100-900. The FFG 7 was also used since the data set shown in Appendix A includes the lead ship, follow ship, and class upgrade data that is used as a foundation of the modeling approach.

Although the AD 41 is not an amphibious ship by Navy classification, it has been used in the lead ship construction models as an analogue for an amphibious type ship, since it is a

complex auxiliary and its cost parameters fit best in the amphibious model. The AD 41 was selected as the baseline ship since it is a mid-range ship with available two digit data, and the data correlates well with the lead ship model CER's. Table 5-1 summarizes the return cost data versus modeled estimates for the AD 41 for the SWBS noted above.

The AOR 7 was selected as the baseline auxiliary ship since it is a mid-range ship with available two digit data and the data correlates well with the lead ship model CER's. Similarly, Table 5-1 summarizes the cost information for the AOR 7 for the SWBS groups noted.

In the following sections, the upgrade model will be described using the spreadsheets contained in the LOTUS program. The narrative will focus on the FFG 7 and the surface combatant model, and any major differences with the other ship types will be noted. Apendix C provides summaries of the results of all the lead ship estimates cited in this report. Included are the estimates for the FFG 7, AD 41 and AOR 7. These can be used in comparing the spreadsheets discussed in this section.

4.1 Baseline Data Calibration

Table 4-1 shows the LOTUS data reference sheet used in the upgrade model to calibrate the old two digit cost group data for the FFG 7 to the current lead ship cost model CER's. Column 1 identifies the two digit cost groups. Column 2 presents the two digit weight breakdown used in the lead ship models.

The calibrations of labor man-hours for production costs (SWBS Groups 100-700 and the production portion of 900) are shown in Columns 3 through 6. Column 3 presents the return labor man-hours cited in the old lead ship model, and Column 4 presents the same data in a man-hour/long ton format. Column 5 identifies the calibration factors that the two digit cost groups

are multiplied by to calibrate them to the existing model. The calibration factor is a ratio of the current lead ship model one digit estimate to the equivalent summation to the old two digit data. This factor is multiplied by each two digit man-hour /long ton number in Column 4 to develop the adjusted man-hour/long ton cost presented in Column 6. The adjusted labor costs derived in Column 6 are used as input to the upgrade model.

The calibrations of material dollars for production costs (SWBS Groups 100-700 and the production portion of 900) are shown in Columns 7 through 13. Column 7 presents the return material 1977 dollars cited in the old lead ship model, and Column 8 presents the same data in a 1977 dollars/long ton format. Column 9 provides the inflation factor used to adjust the 1977 dollars to 1993 dollars. The inflation factor used is from Reference (11). Column 10 identifies the calibration factor that the two digit cost groups are multiplied by to calibrate them to the existing model. Since the current lead ship model only has material cost CER's at the total ship level, the calibration factor is a ratio of the current lead ship model total ship material cost estimate to the equivalent summation of the old two digit data. Each two digit cost group in Column 8 is multiplied by the inflation factor in Column 9 and the calibration factor in Column 10 to derive a value for the material costs in 1993 dollars/long ton shown in Column 11. The model will automatically inflate the costs in Column 11 to future year dollars using inflation factors from Reference (11). Column 12 shows the inflation factor used and Column 13 the resultant two digit material cost in future year dollars/long ton. The costs derived in Column 13 are used as input to the upgrade cost model.

The values used for labor man-hours for preproduction costs (SWBS Groups 800 and the preproduction portion of 900) are presented in Columns 3 through 6. Columns 3 and 4 show the

TABLE 4-1
DATA REFERENCE SHEET

SURFACE COMBATANTS

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED	1993	INFLATED	1994
	L TONS	KMHRS	MHRS/TON	ADJ FCTR[2]	MHRS/TON	$K 1977	$/TON 1977	INFL FCTR[3]	ADJ FCTR[2]	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	928.5	271.1	292.0		318.6	576.6	621.0	0.3892		1,638.9	1.0000	1,638.9
1B	105.0	51.2	488.0		532.5	302.4	2,880.0	0.3892		7,600.5	1.0000	7,600.5
1C	138.0	46.8	339.0		369.9	180.5	1,308.0	0.3892		3,451.9	1.0000	3,451.9
1D	63.5	12.3	194.0		211.7	490.3	7,721.0	0.3892		20,376.3	1.0000	20,376.3
SUBTOTAL/ AVERAGE	1,235.0	381.5	308.9	1.09	337.0	1,549.8	1,254.9	0.3892	1.03	3,311.7	1.0000	3,311.7
2A	128.5	59.8	465.0		498.0	5,706.3	44,407.0	0.3892		117,193.4	1.0000	117,193.4
2B	82.0	23.2	283.5		303.6	1,755.5	21,408.0	0.3892		56,497.3	1.0000	56,497.3
2C	29.0	9.1	315.5		337.9	452.3	15,597.5	0.3892		41,163.0	1.0000	41,163.0
2D	40.0	17.3	432.0		462.7	3,215.4	80,386.0	0.3892		212,144.7	1.0000	212,144.7
SUBTOTAL/ AVERAGE	279.5	109.4	391.5	1.07	419.3	11,129.5	39,819.4	0.3892	1.03	105,086.4	1.0000	105,086.4
3A	98.0	21.3	217.0		281.8	2,755.0	28,112.0	0.3892		74,189.7	1.0000	74,189.7
3B	97.0	162.7	1,677.5		2,178.7	2,045.0	21,082.0	0.3892		55,637.0	1.0000	55,637.0
SUBTOTAL/ AVERAGE	195.0	184.0	943.5	1.30	1,225.4	4,799.9	24,615.0	0.3892	1.03	64,960.9	1.0000	64,960.9
4A	34.5	28.3	820.0		1,235.2	914.3	26,500.0	0.3892		69,935.5	1.0000	69,935.5
4B	81.5	59.1	725.0		1,092.1	1,008.6	12,376.0	0.3892		32,661.2	1.0000	32,661.2
SUBTOTAL/ AVERAGE	116.0	87.4	753.3	1.51	1,134.7	1,922.9	16,576.7	0.3892	1.03	43,747.1	1.0000	43,747.1
5A	109.0	129.7	1,190.0		1,590.2	1,678.7	15,401.0	0.3892		40,644.4	1.0000	40,644.4
5B	241.0	191.6	795.0		1,062.3	5,136.7	21,314.0	0.3892		56,249.3	1.0000	56,249.3
5C	46.0	7.2	156.0		208.5	548.5	11,924.0	0.3892		31,468.3	1.0000	31,468.3
5D	51.0	14.3	280.0		374.2	436.1	8,550.0	0.3892		22,564.1	1.0000	22,564.1
SUBTOTAL/ AVERAGE	447.0	342.8	766.8	1.34	1,024.7	7,799.9	17,449.5	0.3892	1.03	46,050.6	1.0000	46,050.6
6A	27.0	22.5	833.0		859.2	327.7	12,136.0	0.3892		32,027.8	1.0000	32,027.8
6B	66.0	96.0	1,454.5		1,500.2	443.6	6,721.0	0.3892		17,737.2	1.0000	17,737.2
6C	95.0	145.0	1,526.0		1,574.0	445.4	4,688.0	0.3892		12,372.0	1.0000	12,372.0
6D	73.5	51.0	694.0		715.8	316.8	4,310.0	0.3892		11,374.4	1.0000	11,374.4
6E	52.5	42.0	800.0		825.1	810.8	15,443.0	0.3892		40,755.2	1.0000	40,755.2
SUBTOTAL/ AVERAGE	314.0	356.5	1,135.2	1.03	1,170.9	2,344.2	7,465.5	0.3892	1.03	19,702.0	1.0000	19,702.0
7	93.0	25.6	275.0	1.29	355.4	250.4	2,692.0	0.3892	1.03	7,104.4	1.0000	7,104.4
TOTAL GR 1-7	2,679.5	1,487.1	555.0	1.19	657.9	29,796.6 (1977)	11,120.2 (1977)					
						76,558.5 (1993)	28,572.0 (1993)	0.3892	1.03	29,347.1	1.0000	29,347.1

	WEIGHT	CER[4]		ADJ	ADJUSTED	MATERIAL COSTS					$/TON
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR[5]	% LAB $	$/TON 1993	INFL FCTR	1994
GROUP 8	2,679.5	3,163.8	1,180.7	100%	1,180.7	1,180.7	35.0	12%	4,959.1	1.0000	4,959.1

GROUP 9												
	WEIGHT	CER[4]		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL[6]	MHRS/TON	1977	1977	FCTR[3]	FCTR[2]	1993	1994	1994
PROD	2,679.5	795.9	297.0	60%	178.2	1,025.8	382.8	0.3892	1.03	1,010.3	1.0000	1,010.3

	MATERIAL COSTS					$/TON
	MHRS/TON	$/MHR[5]	% LABOR	$/TON 1993	INFL FCTR	1994
PREPROD	118.8	35.0	12%	499.0	1.0000	499.0

1 - Based on FFG 7 data in Reference (2) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and FFG 7 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1977 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (5)
6 - Per Reference (6)

FFGCOM SHIP TYPE: FFG 7 MODEL USER: Eric Midboe

estimated total labor man-hours, and man-hours per ton, using the current lead ship CER's for groups 800 and 900. Column 5 indicates the split of man-hours between production and pre-production costs. Column 6 presents the resultant preproduction labor costs in man-hours/long ton that is used as input to the upgrade cost model.

The values used for material dollars for preproduction costs (SWBS Groups 800 and the preproduction portion of 900) are presented in Columns 7 through 13. Since the current lead ship model only provides CER's for material costs at the total ship level, the upgrade model uses an estimated relationship between preproduction labor dollars and material dollars to estimate the preproduction material dollars. Column 7 is unused. Column 8 provides the labor man-hour/long ton costs shown in Column 6. This is multiplied by an estimated labor rate of $35 per man-hour, shown in Column 9, to estimate the labor dollars in 1993 dollars. This is then multiplied by a factor of 0.12, shown in Column 10, to estimate the material dollars in 1993 dollars/long ton, which is shown in Column 11. Columns 12 and 13 show the inflation to future year dollars as discussed previously. The material costs shown in Column 13 are used as input to the upgrade model.

Appendix C provides the same information shown in Table 4-1 for the amphibious ships and auxiliary ships, respectively. The method for adjusting the data is the same for all ships, the only difference being the ship specific data used and the base year for inflating the material dollars.

4.2 Data Entry Sheet

Table 4-2 shows the data entry sheet for the upgrade model for surface combatant type ships. On the top of the sheet are spaces to input some general information about the estimate. These include the ship type, the file number, the modeler's name, the data source, the initial

TABLE 4-2
DATA ENTRY SHEET

SURFACE COMBATANTS

SHIP TYPE: FFG 7 FILE NAME: FFGCOM
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 01/31/95 DATA SOURCE:
REV #: 1

MAJOR UPGRADE (1-YES, 2-NO):	1	ENTER THE BASELINE LABOR "SLOPE"[1]:	99
THE NUMBER OF SHIPS BUILT IN THE YAR	1	ENTER THE BASELINE MAT'L "SLOPE"[1]:	100

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[1]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	928.5	100	1.00	100	1.00	35.0	1	
1B	SUPERSTRUCTURE	105.0	100	1.00	100	1.00	35.0	1	
1C	FOUNDATIONS	138.0	100	1.00	100	1.00	35.0	1	
1D	STRUCTURAL ATTACHMENTS	63.5	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	HULL STRUCTURE	1,235.0	100	1.00	100	1.00	35.0	1	
					0				
2A	PROPULSION ENERGY SYSTEMS	128.5	100	1.00	100	1.00	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	82.0	100	1.00	100	1.00	35.0	1	
2C	PROPULSION GASES SYSTEMS	29.0	100	1.00	100	1.00	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	40.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	PROPULSION PLANT	279.5	100	1.00	100	1.00	35.0	1	
3A	ELECTRICAL POWER GENERATION	98.0	100	1.00	100	1.00	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	97.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	ELECTRIC PLANT	195.0	100	1.00	100	1.00	35.0	1	
4A	VEHICLE COMMAND	34.5	100	1.00	100	1.00	35.0	1	
4B	WEAPONS COMMAND	81.5	100	1.00	100	1.00	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	116.0	100	1.00	100	1.00	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	109.0	100	1.00	100	1.00	35.0	1	
5B	FLUID SYSTEMS	241.0	100	1.00	100	1.00	35.0	1	
5C	MANEUVERING SYSTEMS	46.0	100	1.00	100	1.00	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	51.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	447.0	100	1.00	100	1.00	35.0	1	
		0.0							
6A	HULL FITTINGS	27.0	100	1.00	100	1.00	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	66.0	100	1.00	100	1.00	35.0	1	
6C	PRESERVATION	95.0	100	1.00	100	1.00	35.0	1	
6D	SHIP SUPPORT	73.5	100	1.00	100	1.00	35.0	1	
6E	HABITABILITY	52.5	100	1.00	100	1.00	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	314.0	100	1.00	100	1.00	35.0	1	
7	ARMAMENT	93.0	100	1.00	100	1.00	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	2,679.5	100.00	1.00	100	1.00	35.0	1	

		WEIGHT L TONS	% OF LEAD SHIP GR 8[7]		MHR RATE[4]		
8	INTEGRATION/ENGINEERING						
	RECURRING	2,679.5	10.00		35.0		
	NON-RECURRING	2,679.5	90.00		35.0		

		WEIGHT	LABOR		MAT		MHR		
9	SHIP ASSEMBLY AND SUPPORT SERVICES	L TONS	"SLOPE"[2]		"SLOPE"[3]		RATE[4]		
	PRODUCTION:	2,679.5	100		100		35.0		
	PREPROD.:		% OF LEAD SHIP GR 9[5]						
	RECURRING	2,679.5			10.00		35.0		
	NON-RECURRING	2,679.5			90.00		35.0		

NOTES:

[1] - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

[2] - Use cost and weight groups per Reference (2)

[3] - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

[4] - Use fully burdened rate

[5] - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

[6] - Use inflation factor per Reference (3)

[7] - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

entry date, and the revision number of the estimate. Also included is general information that the model will use in its calculations. These include the following:

Estimate Year:	This is the anticipated first year of production of the lead upgrade ship
Major Upgrade:	This determines whether the model exercises the 20 percent program cost factors for the preproduction costs. A "yes" input exercises the program costs.
The Number of Ships Built in the Yard:	This is the number the lead upgrade ship will be in series in the lead upgrade ship shipyard.
Enter the Baseline Labor and Material "Slope":	This is the baseline labor slope for the unchanged ship in series at the shipyard. Typically the labor slope will be between 88 and 93 percent. The model will automatically input a material cost slope of 97 percent in the detailed spreadsheet.

The columnar portion of the spreadsheet allows the modeler to input ship specific information and to adjust factors to reflect the upgrade characteristics.

For cost groups 1 through 7, Columns 1 and 2 provide the cost group numbers and titles. Column 3 allows entry of the two digit weight breakdown for the ship, using the three digit to two digit relationships shown in Appendix B. Column 4 allows adjustment of the baseline labor slope based on an assessment of the degree of change within the two digit cost group. This will range from the baseline slope for an unchanged group, to a lead ship slope of 100 percent for a fully changed group. The model develops the labor cost factor shown in Column 5 for each cost group based on the adjusted slope in Column 4. Column 6 allows adjustment of the baseline material slope based on an assessment of the degree of change within the two digit cost group. This will also be based on an assessment of the degree of change within the two digit cost group,

and will range from the baseline slope to a slope of 100 percent. Column 8 allows input for a labor rate for each cost two digit cost group. Column 9 shows the future year inflation factor based on the estimate year input and Reference (11). This, too, can be adjusted if better information is available. Column 10 allows the model used to identify any notes that are appropriate to the estimate.

For costs groups 8 and 9, Column 1 and 2 provide the cost group heading and title. Column 2 also shows the subdivision of nonrecurring and recurring costs in group 8, and the subdivision of first production and preproduction in group 9, followed by the further subdivision of nonrecurring and recurring costs in group 9. Column 3 provides the total ship lightship weight. For the production portion of group 9, Columns 4 through 9 allow the modeler to adjust the labor and material baseline slopes in a manner similar to that discussed above. For the preproduction costs of groups 8 and 9, Columns 4 through 6 show the breakdown of the percent lead ship preproduction labor costs assigned to nonrecurring and recurring costs. The model automatically applies the baseline factor of 10 percent to recurring costs when the estimate is for an upgrade program. The model also automatically applies the program factor of 20 percent, plus an adjustment to account for the aggregate slope for cost group 1-7 to the nonrecurring costs. Both the recurring and nonrecurring cost percentages can be adjusted if better information is available. Column 7 is unused. Column 8 allows input of a labor man-hour rate for the two groups. Column 9 shows the future year inflation factor. This input can be adjusted if better information is available.

Appendix C provides the same information shown in Table 4-4 for the amphibious and auxiliaries ships. The method for inputting the data is the same for all ship types.

4.3 Estimate Summary Sheets

Tables 4-3 and 4-4 provide summaries of the model results for the surface combatant model. Table 4-3 provides summaries for cost groups 1A through 7. Table 4-4 provides summaries for groups 8 and 9, and overall summaries.

Table 4-3 summarizes the information used to estimate the lead upgrade ship group 1-7 costs. Columns 1, 2, 4, 6 and 9 carry over pertinent information from the data entry sheet. Columns 3 and 8 carry over the adjusted labor and material factors from the data calibration sheet. Column 5 summarizes the estimated labor man-hours. Columns 7 and 10 summarize the estimated labor and material dollars, respectively. Column 11 summarizes the estimated total dollars.

Table 4-4 summarizes the information used to estimate the lead upgrade ship groups 8 and 9 costs. Columns 1, 2, 4 and 6 carry over pertinent information from the data entry sheet. Column 3 carries over the lead ship man-hour estimate based on the current lead ship model CER. For group 8, Column 5 summarizes the estimated labor man-hours. Columns 7 and 8 summarize the estimated labor and material dollars, respectively. Column 9 summarizes the estimated total dollars.

For group 9, Columns 1, 2, 4, 5, 7, 9 and 10 carry over pertinent information from the data entry sheet. Column 3 carries over the lead ship man-hour estimate based on the current lead ship model CER. Column 6 summarizes the estimated labor man-hours. Columns 8 and 11 summarize the estimated labor and material dollars, respectively. Column 12 summarizes the estimated total dollars.

TABLE 4-3
SHIP MAJOR UPGRADE MODEL
ESTIMATE SUMMARY SHEET
(GROUPS 1A-7)

SURFACE COMBATANTS

08/18/95
PAGE 2

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	928.5	318.6	1.00	295.85	35.0	10355	1,638.9	1.00	1,521.7	11,876.3
1B	105.0	532.5	1.00	55.91	35.0	1957	7,600.5	1.00	798.1	2,755.0
1C	138.0	369.9	1.00	51.05	35.0	1787	3,451.9	1.00	476.4	2,263.1
1D	63.5	211.7	1.00	13.44	35.0	470	20,376.3	1.00	1,293.9	1,764.4
SUBTOTAL	1,235.0	337.0	1.00	416.25	35.0	14569	3,311.7	1.00	4,090.0	18,658.8
2A	128.5	498.0	1.00	64.00	35.0	2240	117,193.4	1.00	15,059.4	17,299.3
2B	82.0	303.6	1.00	24.90	35.0	871	56,497.3	1.00	4,632.8	5,504.2
2C	29.0	337.9	1.00	9.80	35.0	343	41,163.0	1.00	1,193.7	1,536.7
2D	40.0	462.7	1.00	18.51	35.0	648	212,144.7	1.00	8,485.8	9,133.6
SUBTOTAL	279.5	419.3	1.00	117.20	35.0	4102	105,086.4	1.00	29,371.7	33,473.8
3A	98.0	281.8	1.00	27.62	35.0	967	74,189.7	1.00	7,270.6	8,237.3
3B	97.0	2,178.7	1.00	211.33	35.0	7397	55,637.0	1.00	5,396.8	12,793.4
SUBTOTAL	195.0	1,225.4	1.00	238.95	35.0	8363	64,960.9	1.00	12,667.4	21,030.6
4A	34.5	1,235.2	1.00	42.62	35.0	1492	69,935.5	1.00	2,412.8	3,904.3
4B	81.5	1,092.1	1.00	89.01	35.0	3115	32,661.2	1.00	2,661.9	5,777.2
SUBTOTAL	116.0	1,134.7	1.00	131.62	35.0	4607	43,747.1	1.00	5,074.7	9,681.5
5A	109.0	1,590.2	1.00	173.33	35.0	6067	40,644.4	1.00	4,430.2	10,496.8
5B	241.0	1,062.3	1.00	256.03	35.0	8961	56,249.3	1.00	13,556.1	22,517.0
5C	46.0	208.5	1.00	9.59	35.0	336	31,468.3	1.00	1,447.5	1,783.2
5D	51.0	374.2	1.00	19.08	35.0	668	22,564.1	1.00	1,150.8	1,818.6
SUBTOTAL	447.0	1,024.7	1.00	458.03	35.0	16031	46,050.6	1.00	20,584.6	36,615.6
6A	27.0	859.2	1.00	23.20	35.0	812	32,027.8	1.00	864.8	1,676.7
6B	66.0	1,500.2	1.00	99.01	35.0	3466	17,737.2	1.00	1,170.7	4,636.2
6C	95.0	1,574.0	1.00	149.53	35.0	5233	12,372.0	1.00	1,175.3	6,408.8
6D	73.5	715.8	1.00	52.61	35.0	1841	11,374.4	1.00	836.0	2,677.5
6E	52.5	825.1	1.00	43.32	35.0	1516	40,755.2	1.00	2,139.7	3,655.9
SUBTOTAL	314.0	1,170.9	1.00	367.67	35.0	12869	19,702.0	1.00	6,186.4	19,054.9
7	93.0	355.4	1.00	33.05	35.0	1157	7,104.4	1.00	660.7	1,817.5
TOTAL 1-7	2,679.5	657.9	1.00	1,762.8	35.0	61697	29,347.1	1.00	78,635.4	140,332.6

FFGCOM

SHIP TYPE: FFG 7

MODEL USER: Eric Midboe

TABLE 4-4
SHIP MAJOR UPGRADE MODEL
ESTIMATE SUMMARY SHEET
(GROUPS 8-9, OVERALL SUMMARY)

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	2,679.5	3,163.8						
NON - RECURRING			10.0	316.4	35.0	11,073.2	1,328.8	12,402.0
RECURRING			90.0	2,847.4	35.0	99,658.6	11,959.0	111,617.6
TOTAL	2,679.5	3,163.8	100.0	3,163.8	35.0	110,731.8	13,287.8	124,019.6

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (5)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	MATERIAL COSTS LCF	MATERIAL COSTS $K	TOTAL $K
				LCF							
PRODUCTION	2,679.5	795.9	60%	1.00	477.5	35.0	16,714.1	1,010.3	1.00	2,707.1	19,421.3
PREPRODUCTION	2,679.5	795.9	40%	% TOTAL						$K[3]	
NON - RECURRING				10.0	31.8	35.0	1,114.3	---	---	133.7	1,248.0
RECURRING				90.0	286.5	35.0	10,028.5	---	---	1,203.4	11,231.9
TOTAL	2,679.5	---	---	---	795.9	35.0	27,856.9	---	---	4,044.3	31,901.2

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (5)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	2,679.5	1,762.8	61,697.2	78,635.4	140,332.6
8	2,679.5	3,163.8	110,731.8	13,287.8	124,019.6
9	2,679.5	795.9	27,856.9	4,044.3	31,901.2
TOTAL	2,679.5	5,722.5	200,285.9	95,967.5	296,253.4

FFGCOM SHIP TYPE: FFG 7 MODEL USER: Eric Midboe

For the summary table, Column 1 shows the cost groups summarized; Column 2 indicates the total lightship weight; Columns 3 and 4 provide labor costs in man-hours and dollars, respectively, and Column 5 summarizes the material costs in dollars. Total material and labor costs in dollars are summarized in Column 6.

Appendix C summarizes the same information shown in Tables 4-3 and 4-4 for the amphibious and auxiliary ships, respectively. The methods used to estimate these costs are the same for all three ship types.

4.4 Lead Ship Costs Comparison Sheets

The upgrade model allows for a quick comparison of the upgrade model results with those of the current lead ship construction model. This comparison is useful as a check on the lead ship estimate used in the upgrade model. This lead ship estimate is the foundation from which all adjustments are made. Given the somewhat crude calibration and estimating techniques used in the upgrade model, this comparison is useful to check how accurately the upgrade model models the ship being estimated. The comparison also adds confidence in the upgrade model by directly relating it to the lead ship model, which is based on a larger database of ships. The results of these comparisons will be discussed in the Section 5 of this report.

Table 4-5 shows the lead ship comparison spreadsheet for the FFG 7, which was used to derive the surface combatant type upgrade model. Column 1 provides the list of one digit cost groups and cost group summaries. Column 2 provides the corresponding lightship weight estimates. Columns 3 and 4 provide comparisons of labor costs in man-hours, where Column 3 presents the results using the current lead ship model CER's, and Column 4 presents the summaries of the upgrade model two digit cost groups, assuming lead ship conditions (i.e., ship number 1, with a slope of 100 percent). Columns 5 and 6 provide the same comparisons for

TABLE 4-5
LEAD SHIP COST COMPARISON

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	1235.0	416.3	416.3		4090.0
200	279.5	117.2	117.2		29371.7
300	195.0	239.0	239.0		12667.4
400	116.0	131.6	131.6		5074.7
500	447.0	458.0	458.0		20584.6
600	314.0	367.7	367.7		6186.4
700	93.0	33.1	33.1		660.7
TOTAL 1 - 7	2679.5	1762.8	1762.8		78635.4
900	REF. TO 1-7	795.9	795.9		4044.3
TOTAL 1 - 7, 9	2679.5	2558.7	2558.7		82679.7
800	REF. TO 1-7	3163.8	3163.8		13287.8
TOTAL 1 - 9	2679.5	5722.5	5722.5		95967.5
CER 1 - 7	2679.5	1507.1	1762.8		78635.4
CER 1 - 7, 9	2679.5	2606.8	2558.7		82679.7
CER 1 - 9	2679.5	5762.5	5722.5	81667.6	95967.5

1 - From Reference 4
2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

FFGCOM SHIP TYPE: FFG 7 MODEL USER: Eric Midboe

material costs in 1993 dollars. Note that Column 5 presents material costs at the total ship level only.

Appendix C shows the lead ship comparison spreadsheets for the AD 41 and AOR 7.

5. MODEL RESULTS

This section describes the results of analyses performed to determine how well the upgrade model predicts costs. Two types of analysis were performed. The first was to compare lead ship costs for a variety of ships as predicted by the lead ship model and the upgrade model. The second was to use the upgrade model to estimate the follow ship and upgrade costs for the FFG 7 class and compare the results with actual return costs for the class.

5.1 Lead Ship Results

5.1.1 General

The upgrade model uses an estimate of the lead ship costs as a baseline from which adjustments are made to represent the lead upgrade ship conditions and, from this, costs. It is important that the upgrade model and the lead ship model provide similar estimates for the lead ship in order to relate the lead ship costs estimated by the upgrade model to the lead ship model. Since the two models develop the lead ship cost estimates differently, a comparison between the two provides an indication of the strengths and weaknesses of the two approaches.

Table 5-1 provides a summary of the lead ship costs for ships in the lead ship model where two digit weight breakdowns were available. Full summaries of the comparisons are provided in Appendix C. In Table 5-1, the "CER" Columns present the cost estimates derived from the lead ship model by summing the one digit cost groups. The "Upgrade" Columns present the cost estimates derived from the upgrade model by summing the two digit cost groups. The "Actual" Columns represent return cost data from the ships in question. In certain instances the actual return costs are modified to include estimates and these are highlighted in the notes. Comparisons are made for two ships of each type and results are provided for the following cost group summaries: Labor Cost Groups 1-7; 1-7 and 9; and 1-9; and Material Cost Groups 1-9.

Labor costs are in KMHRS and material costs are in $M(93).

The overall comparisons indicate that, with some exceptions, the lead ship and upgrade models compare favorably and are within the estimating accuracy of the models. Labor cost comparisons are generally better at the total ship level than the group 1-7 level, which is consistent with the findings of the lead ship model. Material cost comparisons are generally less favorable than the labor cost comparisons, which is also understandable since the material cost calibration was from the total ship level to the two digit cost group level, whereas the labor cost calibration was from the one digit cost group to the two digit cost group. In addition, material dollars were escalated using escalation factors that also added uncertainty to the final estimate.

Comparisons between actual return costs and the two models show, in general, that the models are comparable in their predictive capabilities. Since the lead ship model CER's were derived from multiple data points of individual ship return costs, it is not surprising that there are differences between the CER's and individual ship return costs. Similarly, the upgrade model is calibrated to the lead ship model CER's and not the specific return cost data, resulting in similar differences between predicted and actual costs. Overall, given the rough calibration process that was used to calibrate the two digit upgrade cost groups to the one digit lead ship CER, the upgrade model compares favorably with the lead ship model for all the ship types, and, except for a problem noted in section 5.13 with the low end amphibious ships, for the range of ships within each ship type. The two models typically estimated the lead ship costs within the accuracy of the models, with variances between the two models on the same order of magnitude as between the data and the CER's within the lead ship model. Also, as shown in the lead ship cost comparison sheets in Appendix C, the variance between the two models is on the same order of magnitude as that between the summation of the lead ship one digit groups and the summary construction (CER 1-7), production (CER 1-7, 9) and total ship (CER 1-9) CER's in the lead ship model.

TABLE 5-1

SUMMARY OF
COMPARISON OF LEAD SHIP COST ESTIMATES BETWEEN LEAD SHIP AND UPGRADE MODELS

SHIP TYPE	LABOR COSTS (KMHRS)					
	GROUPS 1-7			GROUPS 1-7, 9		
	CER'S	UPGR	ACTUAL	CER'S	UPGR	ACTUAL
Surface Combatants						
FFG7	1763	1763	1611	2559	2559	2577
CG 51	4335	4233	3233	6179	6078	5897
Amphibious Ships						
AD 41	4506	4506	4452	5852	5852	5202
LST 1182	1181	1836	1229	1194	2301	1979
Auxiliary Ships						
AOR 7	2465	2465	2397	2861	2861	3147
AO 180	1399	1611	1741	1705	1868	2491

TABLE 5-1 (CONTINUED)

SUMMARY OF COMPARISON OF LEAD SHIP COST ESTIMATES BETWEEN LEAD SHIP AND UPGRADE MODELS

SHIP TYPE	LABOR COSTS (KMHRS) GROUPS 1-9			MATERIAL COSTS ($M (93)) GROUPS 1-9		
	CER'S	UPGR	ACTUAL	CER'S	UPGR	ACTUAL
Surface Combatants						
FFG7	5723	5723	5718	81.7	96.0	81.2
CG51	14505	14404	14226[2]	231.6	215.0	252[1]
Amphibious Ships						
AD 41	8386	8386	7835[2]	254.5	266.9	NA[3]
LST 1182	1306	3174	2092[2]	52.0	99.2	49.9
Auxiliary Ships						
AOR 7	5414	5414	5699[2]	102.0	113.1	99.4
AO 180	3984	3521	4769[2,4]	72.1	72.8	88.5

Notes:

(1) Material Costs are for CG 47.

(2) Based on estimate adding actual group 1-7, 9 costs to CER value for Group 8.

(3) For comparison LSD 41 material costs are $214M and the CER predicts $212M.

(4) Note Group 8 costs for auxiliary ships based on single return cost data point. Note dual CER for Group 8.

5.1.2 Surface Combatant Ships

The comparison of surface combatant ship estimates indicates that the upgrade model and the lead ship model compare well for both labor and material costs. Since the FFG 7 and CG 51 are the two extremes of the ship sizes in the models, it is assumed that the upgrade model provides a good approximation of the lead ship costs for all sizes of surface combatant. It is noted that both the upgrade model and lead ship model over-predict the labor costs for groups 1-7 due to the influence of the DDG 51 costs in developing the CER's. This is smoothed out with the addition of groups 8 and 9, resulting in very good correlation at the production and total ship level.

The lead ship model predicts surface combatant material costs better than the upgrade model; however, the upgrade model is within 20 percent of the return cost values. In addition, for the two ships estimated, material costs are over-predicted for the FFG 7 and under-predicted for the CG 47. Given this, the 20 percent accuracy should be considered adequate until further development of the two digit material cost group factors can be made using actual material cost data.

The model user may consider adjusting the material cost estimate for the lead upgrade ship to reflect either the lead ship model data or material costs provided by NAVSEA, after consideration is given to which cost groups have been modified by the upgrade being estimated. The degree of adjustment will depend on whether the upgrade has significantly changed material costs for key cost drivers, such as propulsion units. Also, since the model over- and under-predicts material costs for the ships noted, the adjustment should be made with caution and be based on reliable costs for ships that are very similar to that being estimated.

5.1.3 Amphibious Ships

The comparison of the amphibious ship estimates indicates a limitation of the technique used to calibrate the two digit cost groups to the one digit CER. Although the lead ship model and upgrade model cost estimates for the AD 41 compare favorably for both labor and material costs, the estimates for the LST 1182 costs do not. The LST 1182 is at the low end of the range of amphibious ships, and in the lead ship model a number of the one digit CER's approach or go below zero. These include groups 3, 6, 7, 8 and 9. Negative one digit CER's are acceptable in the lead ship model, since they accurately represent the trend lines and, at a total ship level, satisfactorily estimate the total contract costs of the ships in question.

Calibrating the two digit cost groups in the upgrade model to a single mid-range lead ship one digit CER results in positive values for each cost group, even at the low end, and consequently, over-predicts costs at the low end. The resultant differences between the upgrade model and the lead ship model are consistent for construction, production and total ship costs for both labor and material.

Interestingly, the difference between the actual costs and both the upgrade and lead ship models indicates another trend. For both construction labor costs and total ship material costs the actual costs are consistent with the lead ship model and are over-predicted by a factor of two by the upgrade model. However, for production and total labor costs, the lead ship model under-predicts the actual costs and the upgrade model over-predicts these costs. This indicates that at the low end of the range of amphibious ships, the lead ship model is generally more accurate; however, it also indicates variability within the data.

With regard to the material costs, it is noted that the lead ship model CER for material costs is based on only three data points and does not intersect at zero. If the CER were forced through the zero intersect, the CER would estimate a material cost on the order of $90M for the

LST 1182, which is consistent with the upgrade model's estimate of $99M. As more lead ship amphibious material cost data becomes available and the lead ship material cost CER is refined, it is not unreasonable to expect that the CER may approximate the upgrade model results.

Overall, it is recommended that the upgrade model not be used in the range where the lead ship model one digit CER's predict negative values. At ranges where the lead ship one digit CER's approach zero, the upgrade model should be used with caution, and generally, the lead ship model should be considered a more accurate and defensible model.

5.1.4 Auxiliary Ships

The comparison between the lead ship model and the upgrade model for auxiliary ships indicates that the two models compare fairly well for both labor and material costs for both ships. Both models compare reasonably well with both the actual costs for both construction and production costs for the two ships investigated as well as with the actual costs for total labor costs and material costs for the AOR 7.

Neither model accurately estimates the "actual" costs for the total labor costs for the AO 180; however, in the case of the AO 180, the "actual" costs for group 8 are based on the CER, which, in itself, is derived from a limited data set for auxiliary ships. Until additional data is obtained, the lead ship group 8 costs estimates for auxiliary type ships will contain inherent error.

Further, neither model accurately estimates the actual material costs for the AO 180. Review of the lead ship model and data indicates that the individual data point for the AO 180 material costs is higher than the CER, but that the CER, in general, is a satisfactory estimator for auxiliary ships.

5.2 Upgrade Estimate Comparison

Comprehensive return cost data for an upgrade program is limited; however, a good example exists from BIW for the shipyard labor costs for the lead and follow ships of the FFG 7 Class. This data, provided in Appendix A, shows production and preproduction costs incurred by the shipyard for all the ships of the class. Using this, it is possible to assess the ability of the upgrade model to estimate both follow ship labor costs and major upgrade labor costs.

The second flight of the FFG 7 program was used for this assessment. The second flight was selected since it occurred in the middle of the construction cycle and the data for the modifications made was available. In the second flight, the design of the FFG 34 was modified to incorporate the upgrade elements shown in Table 5-2. The resultant ship, the FFG 36, is considered the lead upgrade ship for the second flight.

TABLE 5-2

FFG 34 FLIGHT II UPGRADE ELEMENTS

Item	Major Cost Group Affected
Modified equipment foundations	Group 1C: Foundations
Fire control system changes (add CIWS)	Group 4B: Weapons Command
Changes to firemain, sewage system, and distilling plant	Group 5B: Fluid Systems
Integration of TACTAS and RAST systems, Boat Room, and helicopter handling	Group 5D: Equipment Handling Systems
Increased accommodations	Group 6B: Non-Structural Subdivisions

TABLE 5-2, CONT'D. FFG 34 FLIGHT II UPGRADE ELEMENTS	
Changes to deck coverings	Group 6C: Preservation
Increased accommodations and sewage system modifications	Group 6E: Habitability
CIWS stowage, changes to Control Station and Magazine, and changes to small arms andequipment	Group 7: Armament

Two analyses were made. The first was to estimate the production and preproduction costs for the FFG 34, assuming a learning curve of 92 percent, no major upgrade program, no major changes to the ship, and that the ship was the 12th ship of the class built at BIW. The second was to estimate the production and preproduction costs for the FFG 36, assuming a baseline learning curve slope of 92 percent, a major upgrade program, major changes to the ship, and that the ship was the 13th ship of the class built at BIW. For the purposes of this estimate, it was assumed that any two digit cost group that was significantly modified would receive a learning curve slope of 96 percent.

In order to compare the results of these two analyses with the BIW costs, it was necessary to factor out the non-BIW lead ship group 8 design costs. This was done by subtracting the 2168 thousand man-hours of detail design agent costs quoted in the lead ship model from the lead ship group 8 costs, and a proportional value from the follow ship and lead upgrade ship estimates.

Table 5-3 summarizes the upgrade model results for the lead ship and for the two analyses. Full model results for these ships are provided in Appendix D. As can be seen, the

model estimates the production costs very well for all three ships, with the model predicting within 6 percent of the actual costs. The model estimates the preproduction costs very well for the FFG 34 -- with the model predicting within 4 percent of the actual costs. It also satisfactorily estimates the upgrade costs, predicting within 18 percent of the actual costs. Finally, the model estimates total cost very well, predicting within 5 percent of the actual costs.

The overall quality of the results is reassuring, given the assumption made that the modified two digit cost groups were given a learning curve slope of 96 percent. This indicates that an acceptable cost estimate can be made without fine tuning the individual two digit learning curve slopes, as long as a reasonable decision is made concerning which cost groups have experienced significant change. The option exists to use other learning curve slopes to fine tune the estimate; however, until more examples can be analyzed, it is unclear whether the fine tuning is warranted.

The model does not estimate upgrade preproduction costs as well as it estimates other costs. This is understandable since the upgrade preproduction costs are not purely a function of the learning curve, but include recurring costs, programmatic costs and nonrecurring design related costs. The interaction and overlap of these three components is not well documented, and the actual costs are driven by factors, such as contract deliverable requirements, that are dependent on policy decisions and not necessarily by physical changes to the ship . The fact that the model was able to approximate the relative value of the preproduction costs for the follow ship and the lead upgrade ship is very reassuring.

Preproduction costs are a relatively smaller component of total costs than production costs for both a follow ship and a lead upgrade ship. For this reason, the error introduced by uncertainty in preproduction estimates at the total ship level is relatively small. The upgrade model satisfactorily estimates costs for the FFG 7 program, in part, because this data set was used to develop many of the assumptions used in the model, including the recurring and program

cost factors and the breakdown of group 9 costs between production and preproduction. Although it is assumed that these cost factors are typical of the shipbuilding industry for the U.S. Navy, confirmation of these for all the ship types will require further validation between actual and estimated costs for other ships.

TABLE 5-3

RESULTS OF FFG 7 CLASS FOLLOW SHIP AND MAJOR UPGRADE COST ESTIMATE ASSESSMENT

SHIP	PRODUCTION LABOR		PREPRODUCTION LABOR		TOTAL LABOR		SLOPE (BASELINE) UPGRADE
	ACTUAL	MODEL	ACTUAL	MODEL	ACTUAL	MODEL	
FFC 7	2175	2240	1375	1314	3550	3554	100
FFC 34	1387	1469	136	139	1523	1608	92
FFC 36	1596	1603	718	587	2314	2190	92/96

6. CONCLUSIONS AND RECOMMENDATIONS

This upgrade model is a first effort at estimating the shipyard construction contract costs for the lead ship of an upgrade program. The upgrade program is assumed to be a forward fit modification to a follow ship of a class undergoing construction in a shipyard. The model assumes that the upgrade is a designated upgrade in a program sense and that the changes will significantly modify the ship.

The model attempts to account for the major cost drivers in an upgrade program, including lead and follow ship costs, changes to the ship, learning curve effects, and recurring and nonrecurring costs. The model estimates both labor and material costs using the two digit cost groups developed for previous lead ship construction cost models developed for NCA. These two digit cost groups are calibrated to the one digit cost groups contained in the current lead ship construction cost model. The basic approach is to develop a lead ship cost estimate using the two digit cost groups, and then to adjust individual cost groups for unmodified parts of the ship to reflect follow ship conditions, and to adjust individual cost groups for modified parts of the ship to reflect the upgrade changes

The model is considered an adjunct to the current suite of models that NCA uses to estimate lead ship, follow ship, detail design and modernization costs. The upgrade model builds upon these other models, uses data from these other models, and is compatible with these other models. The two digit cost groups used in the model can be folded directly into the one digit cost groups contained in the current models. In addition, the upgrade model provides a direct comparison of the lead ship costs between the lead ship model and the upgrade model for a notional lead ship of the class being upgraded. This allows the modeler to assess the adequacy of the upgrade model's lead ship estimate.

In general, analyses of the upgrade model, the various lead ship comparisons, and the FFG 7 follow ship and lead upgrade ship comparisons indicate that the upgrade model is a good first effort in estimating the various cost factors inherent for a follow ship and lead upgrade ship of a class. The model appears to be useful for all the ship types, with the exception of the low end of the amphibious ship types. It provides a good method for estimating follow ship and lead upgrade ship production costs, which are primarily driven by learning curve. Its ability to assess preproduction costs is less certain, since the model bases these on the FFG 7 experience for all ship types, and these costs are dependent on factors other than physical changes to the ship. However, preproduction costs are a relatively smaller component than production costs of both follow ship and lead upgrade ship costs, and at the total shipyard construction contract cost level, the upgrade model appears to be a good estimating tool.

Development and testing of the upgrade model highlighted some issues with the lead ship model that need to be addressed when the model is updated in the future. The first is the issue of the small amphibious ships, where a number of CER's approach or go below zero. This is an issue that was of concern in developing the CER's and may be a shortcoming in the lead ship model. The issue may be one of a lack of data at the low end of the amphibious ship range an attempt to categorize all ships of this type in one set of CER's. Consideration should be given to adding more data as it becomes available; to differentiating between large and small amphibious ships, and to developing separate CER's for each group.

The second issue relates to the limitation inherent in the fact that material costs are estimated only at the total ship level in the lead ship model. Although acceptable at the macro level, it does limit NCA's ability to assess more detailed material cost issues, such as upgrade costs or use of commercial off the shelf (COTS) equipment. The two digit groupings used in the upgrade model provide an adequate level of detail to begin to address these types of issues. The upgrade model used a rough calibration method to update these cost groups. Consideration should be given to improving the accuracy of these two digit cost groups by conducting a

rigorous assessment of the shipyard material costs for some of the recent ships in the model. Consideration should also be given to conducting sensitivity analyses of these revised cost groups to determine the impact of using ruggedized or militarized commercial equipment and fully commercial equipment.

The third issue relates to the inherent problems of the scarcity of data in the lead ship model, in particular for lead ship costs for group 8. Since this group represents up to 50 percent of the lead shipyard construction cost contract, errors in estimating these costs can significantly affect the accuracy of the estimate produced. Unfortunately, this problem is an issue of the limited lead ship data available. Consideration should be given to the following:

- Updating the lead ship model as additional data is identified
- Attempting to break group 8 cost down into its constituent parts
- Developing a better understanding of these parts
- Possibly developing more detailed CER's for these parts

With regard to the upgrade model, although it appears to be a good first effort in estimating upgrade costs, a number of issues should be addressed as the model is exercised and in its future development. The first is the need to improve the accuracy of the two digit cost groups used; the second is to convert them from factors based on a single data point to CER's based on multiple data points. The first can be accomplished by working with shipyard cost estimators to refine the cost factors for each group based on experience, which is how these groups were developed in the early models. The second can be accomplished if shipyards could provide data on recent ships at the two digit cost group level. This is also how the early two digit CER's were developed. It would, however, require the services of a number of yards to develop multiple data points for a each ship type. In both cases, the estimates would not necessarily be tied directly to CPR data, unless carefully coordinated.

Another issue is the need to develop additional upgrade return cost data to refine the assumptions made and cost factors used in the model, and to test the capability of the model to accurately predict upgrade costs for all ship types. Data from class upgrades, such as the LSD 49 cargo variant upgrade to the LSD 41 Class dock landing ships, should be evaluated to determine if the cost factors are similar to the FFG 7 Class experience and if the upgrade model can adequately predict the upgrade costs. This, too, will require the services of a shipyard to define the return costs at a two digit group breakdown.

A further recommendation is to conduct sensitivity analyses of the model. Representative ships should be used as baselines and parameters such as learning curve slope, weight, labor and material cost factor, ship number, and others should be systematically varied to determine the resultant impact on the cost estimate. From this, critical cost drivers can be identified and highlighted.

The final recommendation is that NCA exercise the model and catalog the problems experienced. The model requires the user to make a number of assumptions regarding baseline learning curve slopes, changes to cost groups, and the like. The experience of the user will be invaluable in determining the inherent weaknesses in the model, which can be addressed in future revisions.

APPENDIX A

FFG 7 CLASS LEAD AND FOLLOW SHIP DATA FROM BIW

BATH IRON WORKS CORPORATION
FFG PROGRAM
MANHOURS AT COMPLETION

(IN 000's)

	PRODUTION	PREPRODUCTION	TOTAL
FFG 7	2.175	1.375	3.550
FFG 8	1.787	833	2.620
FFG 11	1.700	261	1.961
FFG 13	1.639	150	1.789
FFG 15	1.535	138	1.673
FFG 16	1.491	148	1.639
FFG 21	1.492	540	2.032
FFG 24	1.448	153	1.601
FFG 26	1.404	170	1.574
FFG 29	1.429	158	1.587
FFG 32	1.370	146	1.516
FFG 34	1.387	136	1.523
FFG 36	1.596	718	2.314
FFG 39	1.570	179	1.749
FFG 42	1.570	154	1.724
FFG 45	1.546	149	1.695
FFG 47	1.577	146	1.723
FFG 49	1.567	140	1.707
FFG 50	1.696	649	2.345
FFG 53	1.607	140	1.747
FFG 55	1.603	138	1.741
FFG 56	1.610	127	1.737
FFG 58	1.686	157	1.843
FFG 59	1.794	219	2.013

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	7230.0	1280.2	1280.2		22805.3
200	447.0	167.9	167.9		23458.6
300	429.0	421.0	421.0		22742.9
400	53.0	73.5	73.5		4531.5
500	2007.0	1143.7	1143.7		71941.2
600	2699.0	1400.7	1400.7		101120.6
700	99.0	18.9	18.9		1456.4
TOTAL 1 - 7	12964.0	4505.8	4505.8		248056.6
900	REF. TO 1-7	1346.2	1346.2		8234.1
TOTAL 1 - 7, 9	12964.0	5852.1	5852.1		256290.7
800	REF. TO 1-7	2534.0	2534.0		10643.0
TOTAL 1 - 9	12964.0	8386.1	8386.1		266933.7
CER 1 - 7	12964.0	4124.0	4505.8		248056.6
CER 1 - 7, 9	12964.0	5301.9	5852.1		256290.7
CER 1 - 9	12964.0	7835.9	8386.1	254504.8	266933.7

1 - From Reference 4
2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

AD41f SHIP TYPE: AD41 MODEL USER: Eric Midboe

DATA ENTRY SHEET

08/18/95
PAGE 1

AMPHIBIOUS SHIPS

SHIP TYPE: LST1182 FILE NAME: LST1182f
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 03/22/95 DATA SOURCE: _____
REV #: _____

MAJOR UPGRADE (1-YES, 2-NO):	1	ENTER THE BASELINE LABOR "SLOPE"[1]:	99
THE NUMBER OF SHIPS BUILT IN THE YAR	1	ENTER THE BASELINE MAT'L "SLOPE"[1]:	100

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[3]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	2,122.0	100	1.00	100	1.00	35.0	1	
1B	SUPERSTRUCTURE	98.0	100	1.00	100	1.00	35.0	1	
1C	FOUNDATIONS	126.0	100	1.00	100	1.00	35.0	1	
1D	STRUCTURAL ATTACHMENTS	361.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	HULL STRUCTURE	2,707.0	100	1.00	100	1.00	35.0	1	
					0				
2A	PROPULSION ENERGY SYSTEMS	165.0	100	1.00	100	1.00	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	87.0	100	1.00	100	1.00	35.0	1	
2C	PROPULSION GASES SYSTEMS	39.0	100	1.00	100	1.00	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	57.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	PROPULSION PLANT	348.0	100	1.00	100	1.00	35.0	1	
3A	ELECTRICAL POWER GENERATION	70.0	100	1.00	100	1.00	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	66.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	ELECTRIC PLANT	136.0	100	1.00	100	1.00	35.0	1	
4A	VEHICLE COMMAND	50.0	100	1.00	100	1.00	35.0	1	
4B	WEAPONS COMMAND	27.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	77.0	100	1.00	100	1.00	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	132.0	100	1.00	100	1.00	35.0	1	
5B	FLUID SYSTEMS	284.0	100	1.00	100	1.00	35.0	1	
5C	MANEUVERING SYSTEMS	50.0	100	1.00	100	1.00	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	284.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	750.0	100	1.00	100	1.00	35.0	1	
6A	HULL FITTINGS	85.0	100	1.00	100	1.00	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	87.0	100	1.00	100	1.00	35.0	1	
6C	PRESERVATION	88.0	100	1.00	100	1.00	35.0	1	
6D	SHIP SUPPORT	50.0	100	1.00	100	1.00	35.0	1	
6E	HABITABILITY	69.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	379.0	100	1.00	100	1.00	35.0	1	
7	ARMAMENT	71.0	100	1.00	100	1.00	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	4,468.0	100.00	1.00	100	1.00	35.0	1	

		WEIGHT L TONS					MHR RATE[4]		
8	INTEGRATION/ENGINEERING		% OF LEAD SHIP GR 8[7]						
	RECURRING	4,468.0			10.00		35.0		
	NON-RECURRING	4,468.0			90.00		35.0		
		WEIGHT	LABOR		MAT		MHR		
9	SHIP ASSEMBLY AND SUPPORT SERVICES	L TONS	"SLOPE"[2]		"SLOPE"[3]		RATE[4]		
	PRODUCTION:	4,468.0	100		100		35.0		
	PREPROD.:		% OF LEAD SHIP GR 9[5]						
	RECURRING	4,468.0			10.00		35.0		
	NON-RECURRING	4,468.0			90.00		35.0		

NOTES:

1 - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

2 - Use cost and weight groups per Reference (2)

3 - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

4 - Use fully burdened rate

5 - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

6 - Use inflation factor per Reference (3)

7 - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	2,122.0	156.4	1.00	331.79	35.0	11613	2,557.4	1.00	5,426.7	17,039.3
1B	98.0	179.7	1.00	17.61	35.0	616	2,196.8	1.00	215.3	831.6
1C	126.0	952.9	1.00	120.06	35.0	4202	4,088.9	1.00	515.2	4,717.5
1D	361.0	264.1	1.00	95.35	35.0	3337	18,118.4	1.00	6,540.8	9,877.9
SUBTOTAL	2,707.0	177.1	1.00	564.81	35.0	19768	3,154.3	1.00	12,697.9	32,466.4
2A	165.0	217.7	1.00	35.92	35.0	1257	50,586.1	1.00	8,346.7	9,604.0
2B	87.0	133.9	1.00	11.65	35.0	408	26,034.0	1.00	2,265.0	2,672.8
2C	39.0	619.7	1.00	24.17	35.0	846	87,618.7	1.00	3,417.1	4,263.0
2D	57.0	2,686.7	1.00	153.14	35.0	5360	104,631.5	1.00	5,964.0	11,323.9
SUBTOTAL	348.0	375.6	1.00	224.88	35.0	7871	52,480.1	1.00	19,992.8	27,863.7
3A	70.0	18.8	1.00	1.31	35.0	46	75,913.7	1.00	5,314.0	5,359.9
3B	66.0	1,483.3	1.00	97.90	35.0	3426	41,076.7	1.00	2,711.1	6,137.4
SUBTOTAL	136.0	981.4	1.00	99.21	35.0	3472	53,013.9	1.00	8,025.0	11,497.4
4A	50.0	1,807.4	1.00	90.37	35.0	3163	112,109.2	1.00	5,605.5	8,768.4
4B	27.0	569.5	1.00	15.38	35.0	538	33,761.0	1.00	911.5	1,449.7
SUBTOTAL	77.0	1,387.0	1.00	105.75	35.0	3701	85,500.4	1.00	6,517.0	10,218.1
5A	132.0	1,128.2	1.00	148.93	35.0	5212	44,835.1	1.00	5,918.2	11,130.7
5B	284.0	1,173.6	1.00	333.30	35.0	11666	52,977.8	1.00	15,045.7	26,711.3
5C	50.0	143.5	1.00	7.18	35.0	251	22,588.7	1.00	1,129.4	1,380.6
5D	284.0	73.7	1.00	20.93	35.0	733	24,389.9	1.00	6,926.7	7,659.4
SUBTOTAL	750.0	569.8	1.00	510.34	35.0	17862	35,845.1	1.00	29,020.1	46,882.0
6A	85.0	1,812.9	1.00	154.09	35.0	5393	27,845.6	1.00	2,366.9	7,760.2
6B	87.0	271.8	1.00	23.64	35.0	828	36,541.1	1.00	3,179.1	4,006.6
6C	88.0	1,307.6	1.00	115.07	35.0	4027	27,970.2	1.00	2,461.4	6,488.7
6D	50.0	116.7	1.00	5.83	35.0	204	16,476.8	1.00	823.8	1,028.0
6E	69.0	282.0	1.00	19.46	35.0	681	105,888.0	1.00	7,306.3	7,987.4
SUBTOTAL	379.0	519.0	1.00	318.10	35.0	11134	37,466.0	1.00	16,137.4	27,271.0
7	71.0	190.9	1.00	13.55	35.0	474	14,710.6	1.00	1,044.5	1,518.7
TOTAL 1-7	4,468.0	347.6	1.00	1,836.6	35.0	64282	19,134.3	1.00	93,434.7	157,717.2

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	4,468.0	112.7						
NON - RECURRING			10.0	11.3	35.0	394.4	47.3	441.7
RECURRING			90.0	101.4	35.0	3,549.4	425.9	3,975.4
TOTAL	4,468.0	112.7	100.0	112.7	35.0	3,943.8	473.3	4,417.1

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (8)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	MATERIAL COSTS LCF	MATERIAL COSTS $K	TOTAL $K
PRODUCTION	4,468.0	12.4	60%	LCF 1.00	7.4	35.0	259.9	460.7	1.00	2,058.4	2,318.3
PREPRODUCTION	4,468.0	12.4	40%	% TOTAL						$K[3]	
NON - RECURRING				10.0	0.5	35.0	17.3	---	---	2.1	19.4
RECURRING				90.0	4.5	35.0	155.9	---	---	18.7	174.7
TOTAL	4,468.0	---	---	---	12.4	35.0	433.2	---	---	2,079.2	2,512.3

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (8)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	4,468.0	1,836.6	64,282.4	93,434.7	157,717.2
8	4,468.0	112.7	3,943.8	473.3	4,417.1
9	4,468.0	12.4	433.2	2,079.2	2,512.3
TOTAL	4,468.0	1,961.7	68,659.4	95,987.2	164,646.6

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED	1993	INFLATED	1994
	L TONS	KMHRS	MHRS/TON	ADJ FCTR[2]	MHRS/TON	$K 1980	$/TON 1980	INFL FCTR[3]	ADJ FCTR[2]	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	6,075.0	950.1	156.4		156.4	4,532.7	746.1	0.5179		2,557.4	1.0000	2,557.4
1B	745.0	133.9	179.7		179.7	477.5	640.9	0.5179		2,196.8	1.0000	2,196.8
1C	128.0	122.0	953.1		952.9	152.7	1,193.0	0.5179		4,088.9	1.0000	4,088.9
1D	282.0	74.5	264.2		264.1	1,490.7	5,286.2	0.5179		18,118.4	1.0000	18,118.4
SUBTOTAL/ AVERAGE	7,230.0	1,280.5	177.1	1.00	177.1	6,653.6	920.3	0.5179	1.78	3,154.3	1.0000	3,154.3
2A	323.0	74.9	231.9		217.7	4,767.1	14,758.8	0.5179		50,586.1	1.0000	50,586.1
2B	68.0	9.7	142.6		133.9	516.5	7,595.6	0.5179		26,034.0	1.0000	26,034.0
2C	30.0	19.8	660.0		619.7	766.9	25,563.3	0.5179		87,618.7	1.0000	87,618.7
2D	26.0	74.4	2,861.5		2,686.7	793.7	30,526.9	0.5179		104,631.5	1.0000	104,631.5
SUBTOTAL/ AVERAGE	447.0	178.8	400.0	0.94	375.6	6,844.2	15,311.4	0.5179	1.78	52,480.1	1.0000	52,480.1
3A	147.0	2.3	15.6		18.8	3,255.8	22,148.3	0.5179		75,913.7	1.0000	75,913.7
3B	282.0	348.7	1,236.5		1,483.3	3,379.6	11,984.4	0.5179		41,076.7	1.0000	41,076.7
SUBTOTAL/ AVERAGE	429.0	351.0	818.2	1.20	981.4	6,635.4	15,467.1	0.5179	1.78	53,013.9	1.0000	53,013.9
4A	35.0	64.8	1,851.4		1,807.4	1,144.8	32,708.6	0.5179		112,109.2	1.0000	112,109.2
4B	18.0	10.5	583.3		569.5	177.3	9,850.0	0.5179		33,761.0	1.0000	33,761.0
SUBTOTAL/ AVERAGE	53.0	75.3	1,420.8	0.98	1,387.0	1,322.1	24,945.3	0.5179	1.78	85,500.4	1.0000	85,500.4
5A	388.0	627.7	1,617.8		1,128.2	5,075.4	13,080.9	0.5179		44,835.1	1.0000	44,835.1
5B	530.0	891.9	1,682.8		1,173.6	8,192.0	15,456.6	0.5179		52,977.8	1.0000	52,977.8
5C	52.0	10.7	205.8		143.5	342.7	6,590.4	0.5179		22,588.7	1.0000	22,588.7
5D	1,037.0	109.6	105.7		73.7	7,379.2	7,115.9	0.5179		24,389.9	1.0000	24,389.9
SUBTOTAL/ AVERAGE	2,007.0	1,639.9	817.1	0.70	569.8	20,989.3	10,458.0	0.5179	1.78	35,845.1	1.0000	35,845.1
6A	29.0	34.1	1,175.9		1,812.9	235.6	8,124.1	0.5179		27,845.6	1.0000	27,845.6
6B	527.0	92.9	176.3		271.8	5,618.4	10,661.1	0.5179		36,541.1	1.0000	36,541.1
6C	744.0	631.0	848.1		1,307.6	6,071.4	8,160.5	0.5179		27,970.2	1.0000	27,970.2
6D	983.0	74.4	75.7		116.7	4,725.5	4,807.2	0.5179		16,476.8	1.0000	16,476.8
6E	416.0	76.1	182.9		282.0	12,851.7	30,893.5	0.5179		105,888.0	1.0000	105,888.0
SUBTOTAL/ AVERAGE	2,699.0	908.5	336.6	1.54	519.0	29,502.6	10,930.9	0.5179	1.78	37,466.0	1.0000	37,466.0
7	99.0	17.7	178.8	1.07	190.9	424.9	4,291.9	0.5179	1.78	14,710.6	1.0000	14,710.6
TOTAL GR 1-7	12,964.0	4,451.7	343.4	1.01	347.6	72,372.1 (1980)	5,582.5 (1980)					
						139,741.5 (1993)	10,779.2 (1993)	0.5179	1.78	19,134.3	1.0000	19,134.3

	WEIGHT	CER[4]		ADJ	ADJUSTED	MATERIAL COSTS					$/TON
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR[5]	% LAB $	$/TON 1993	INFL FCTR	1994
GROUP 8	12,964.0	2,534.0	195.5	100%	195.5	195.5	35.0	12%	821.0	1.0000	821.0

GROUP 9

	WEIGHT	CER[4]		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL[6]	MHRS/TON	1980	1980	FCTR[3]	FCTR[2]	1993	1994	1994
PROD	12,964.0	1,346.2	103.8	60%	62.3	1,742.5	134.4	0.5179	1.78	460.7	1.0000	460.7

	MATERIAL COSTS					$/TON
	MHRS/TON	$/MHR[5]	% LABOR	$/TON 1993	INFL FCTR	1994
PREPROD	41.5	35.0	12%	174.5	1.0000	174.5

1 - Based on AD41 data in Reference (7) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and AD 41 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1977 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (8)
6 - Per Reference (6)

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	2707.0	542.9	564.8		12697.9
200	348.0	163.7	224.9		19992.8
300	136.0	-144.2	99.2		8025.0
400	77.0	84.4	105.7		6517.0
500	750.0	575.5	510.3		29020.1
600	379.0	-51.6	318.1		16137.4
700	71.0	10.4	13.6		1044.5
TOTAL 1 - 7	4468.0	1181.1	1836.6		93434.7
900	REF. TO 1-7	12.4	464.0		2079.2
TOTAL 1 - 7, 9	4468.0	1193.5	2300.6		95513.9
800	REF. TO 1-7	112.7	873.3		3668.1
TOTAL 1 - 9	4468.0	1306.1	3174.0		99182.0
CER 1 - 7	4468.0	1099.4	1836.6		93434.7
CER 1 - 7, 9	4468.0	841.5	2300.6		95513.9
CER 1 - 9	4468.0	954.2	3174.0	51960.1	99182.0

1 - From Reference 4

2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

DATA ENTRY SHEET

AUXILIARY SHIPS

SHIP TYPE: AOR7 FILE NAME: AOR7f
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 03/22/95 DATA SOURCE: _____
REV #: _____

MAJOR UPGRADE (1-YES, 2-NO):	1	ENTER THE BASELINE LABOR "SLOPE"[1]:	99
THE NUMBER OF SHIPS BUILT IN THE YAR	1	ENTER THE BASELINE MAT'L "SLOPE"[1]:	100

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[1]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	6,696.0	100	1.00	100	1.00	35.0	1	
1B	SUPERSTRUCTURE	927.0	100	1.00	100	1.00	35.0	1	
1C	FOUNDATIONS	180.0	100	1.00	100	1.00	35.0	1	
1D	STRUCTURAL ATTACHMENTS	380.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	HULL STRUCTURE	8,183.0	100	1.00	100	1.00	35.0	1	
					0				
2A	PROPULSION ENERGY SYSTEMS	606.0	100	1.00	100	1.00	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	240.0	100	1.00	100	1.00	35.0	1	
2C	PROPULSION GASES SYSTEMS	39.0	100	1.00	100	1.00	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	86.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	PROPULSION PLANT	971.0	100	1.00	100	1.00	35.0	1	
3A	ELECTRICAL POWER GENERATION	125.0	100	1.00	100	1.00	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	198.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	ELECTRIC PLANT	323.0	100	1.00	100	1.00	35.0	1	
4A	VEHICLE COMMAND	78.0	100	1.00	100	1.00	35.0	1	
4B	WEAPONS COMMAND	24.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	102.0	100	1.00	100	1.00	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	329.0	100	1.00	100	1.00	35.0	1	
5B	FLUID SYSTEMS	702.0	100	1.00	100	1.00	35.0	1	
5C	MANEUVERING SYSTEMS	111.0	100	1.00	100	1.00	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	918.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	2,060.0	100	1.00	100	1.00	35.0	1	
6A	HULL FITTINGS	55.0	100	1.00	100	1.00	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	338.0	100	1.00	100	1.00	35.0	1	
6C	PRESERVATION	361.0	100	1.00	100	1.00	35.0	1	
6D	SHIP SUPPORT	206.0	100	1.00	100	1.00	35.0	1	
6E	HABITABILITY	103.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	1,063.0	100	1.00	100	1.00	35.0	1	
7	ARMAMENT	42.0	100	1.00	100	1.00	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	12,744.0	100.00	1.00	100	1.00	35.0	1	

		WEIGHT L TONS	% OF LEAD SHIP GR 8[7]		MHR RATE[4]		
8	INTEGRATION/ENGINEERING						
	RECURRING	12,744.0	10.00		35.0		
	NON-RECURRING	12,744.0	90.00		35.0		

		WEIGHT L TONS	LABOR "SLOPE"[2]		MAT "SLOPE"[3]		MHR RATE[4]		
9	SHIP ASSEMBLY AND SUPPORT SERVICES								
	PRODUCTION:	12,744.0	100		100		35.0		
	PREPROD.:		% OF LEAD SHIP GR 9[5]						
	RECURRING	12,744.0			10.00		35.0		
	NON-RECURRING	12,744.0			90.00		35.0		

NOTES:

1 - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

2 - Use cost and weight groups per Reference (2)

3 - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

4 - Use fully burdened rate

5 - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

6 - Use inflation factor per Reference (3)

7 - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	6,696.0	83.4	1.00	558.40	35.0	19544	1,305.2	1.00	8,739.4	28,283.5
1B	927.0	105.0	1.00	97.31	35.0	3406	1,142.2	1.00	1,058.8	4,464.5
1C	180.0	424.0	1.00	76.33	35.0	2671	1,508.0	1.00	271.4	2,942.8
1D	380.0	168.0	1.00	63.85	35.0	2235	4,734.8	1.00	1,799.2	4,034.1
SUBTOTAL	8,183.0	97.3	1.00	795.89	35.0	27856	1,450.4	1.00	11,868.9	39,725.0
2A	606.0	111.2	1.00	67.38	35.0	2358	21,379.2	1.00	12,955.8	15,314.0
2B	240.0	47.1	1.00	11.30	35.0	396	9,816.9	1.00	2,356.1	2,751.7
2C	39.0	278.4	1.00	10.86	35.0	380	39,223.9	1.00	1,529.7	1,909.7
2D	86.0	521.4	1.00	44.84	35.0	1570	28,022.8	1.00	2,410.0	3,979.5
SUBTOTAL	971.0	138.4	1.00	134.38	35.0	4703	19,826.5	1.00	19,251.6	23,954.9
3A	125.0	14.2	1.00	1.77	35.0	62	39,797.1	1.00	4,974.6	5,036.7
3B	198.0	747.5	1.00	148.01	35.0	5181	31,737.0	1.00	6,283.9	11,464.4
SUBTOTAL	323.0	463.7	1.00	149.79	35.0	5243	34,856.2	1.00	11,258.6	16,501.1
4A	78.0	775.9	1.00	60.52	35.0	2118	21,429.0	1.00	1,671.5	3,789.6
4B	24.0	694.5	1.00	16.67	35.0	583	9,128.6	1.00	219.1	802.5
SUBTOTAL	102.0	756.7	1.00	77.19	35.0	2702	18,534.8	1.00	1,890.5	4,592.1
5A	329.0	753.8	1.00	248.01	35.0	8680	16,411.7	1.00	5,399.4	14,079.7
5B	702.0	806.0	1.00	565.79	35.0	19803	23,138.9	1.00	16,243.5	36,046.1
5C	111.0	260.3	1.00	28.89	35.0	1011	15,503.6	1.00	1,720.9	2,732.0
5D	918.0	38.4	1.00	35.25	35.0	1234	19,081.8	1.00	17,517.1	18,751.0
SUBTOTAL	2,060.0	426.2	1.00	877.94	35.0	30728	19,845.1	1.00	40,880.9	71,608.8
6A	55.0	551.5	1.00	30.33	35.0	1062	17,431.8	1.00	958.7	2,020.4
6B	338.0	235.6	1.00	79.63	35.0	2787	7,966.4	1.00	2,692.6	5,479.6
6C	361.0	767.5	1.00	277.07	35.0	9697	8,718.3	1.00	3,147.3	12,844.7
6D	206.0	134.8	1.00	27.76	35.0	972	4,740.7	1.00	976.6	1,948.2
6E	103.0	106.5	1.00	10.97	35.0	384	64,177.0	1.00	6,610.2	6,994.1
SUBTOTAL	1,063.0	400.5	1.00	425.76	35.0	14902	13,532.9	1.00	14,385.5	29,287.1
7	42.0	103.7	1.00	4.36	35.0	152	6,924.4	1.00	290.8	443.3
TOTAL 1-7	12,744.0	193.4	1.00	2,465.3	35.0	86285	7,833.2	1.00	99,826.8	186,112.3

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	12,744.0	2,552.9						
NON - RECURRING			10.0	255.3	35.0	8,935.1	1,072.2	10,007.3
RECURRING			90.0	2,297.6	35.0	80,415.8	9,649.9	90,065.7
TOTAL	12,744.0	2,552.9	100.0	2,552.9	35.0	89,350.9	10,722.1	100,073.1

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (8)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	MATERIAL COSTS LCF	MATERIAL COSTS $K	TOTAL $K
				LCF							
PRODUCTION	12,744.0	395.8	60%	1.00	237.5	35.0	8,311.4	148.7	1.00	1,895.2	10,206.6
										$K[3]	
PREPRODUCTION	12,744.0	395.8	40%	% TOTAL							
NON - RECURRING				10.0	15.8	35.0	554.1	---	---	66.5	620.6
RECURRING				90.0	142.5	35.0	4,986.8	---	---	598.4	5,585.2
TOTAL	12,744.0	---	---	---	395.8	35.0	13,852.3	---	---	2,560.1	16,412.4

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (8)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	**12,744.0**	**2,465.3**	**86,285.5**	**99,826.8**	**186,112.3**
8	**12,744.0**	**2,552.9**	**89,350.9**	**10,722.1**	**100,073.1**
9	**12,744.0**	**395.8**	**13,852.3**	**2,560.1**	**16,412.4**
TOTAL	**12,744.0**	**5,414.0**	**189,488.7**	**113,109.1**	**302,597.8**

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED 1993		INFLATED 1994	
	L TONS	KMHRS	MHRS/TON	ADJ FCTR[2]	MHRS/TON	$K 1980	$/TON 1980	INFL FCTR[3]	ADJ FCTR[2]	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	6,696.0	676.0	101.0		83.4	4,507.6	673.2	0.5179		1,305.2	1.0000	1,305.2
1B	927.0	117.8	127.1		105.0	546.1	589.1	0.5179		1,142.2	1.0000	1,142.2
1C	180.0	92.4	513.3		424.0	140.0	777.8	0.5179		1,508.0	1.0000	1,508.0
1D	380.0	77.3	203.4		168.0	928.0	2,442.1	0.5179		4,734.8	1.0000	4,734.8
SUBTOTAL/ AVERAGE	8,183.0	963.5	117.7	0.83	97.3	6,121.7	748.1	0.5179	1.00	1,450.4	1.0000	1,450.4
2A	606.0	90.6	149.5		111.2	6,682.3	11,026.9	0.5179		21,379.2	1.0000	21,379.2
2B	240.0	15.2	63.3		47.1	1,215.2	5,063.3	0.5179		9,816.9	1.0000	9,816.9
2C	39.0	14.6	374.4		278.4	789.0	20,230.8	0.5179		39,223.9	1.0000	39,223.9
2D	86.0	60.3	701.2		521.4	1,243.0	14,453.5	0.5179		28,022.8	1.0000	28,022.8
SUBTOTAL/ AVERAGE	971.0	180.7	186.1	0.74	138.4	9,929.5	10,226.1	0.5179	1.00	19,826.5	1.0000	19,826.5
3A	125.0	1.7	13.6		14.2	2,565.8	20,526.4	0.5179		39,797.1	1.0000	39,797.1
3B	198.0	141.9	716.7		747.5	3,241.1	16,369.2	0.5179		31,737.0	1.0000	31,737.0
SUBTOTAL/ AVERAGE	323.0	143.6	444.6	1.04	463.7	5,806.9	17,978.0	0.5179	1.00	34,856.2	1.0000	34,856.2
4A	78.0	57.0	730.8		775.9	862.1	11,052.6	0.5179		21,429.0	1.0000	21,429.0
4B	24.0	15.7	654.2		694.5	113.0	4,708.3	0.5179		9,128.6	1.0000	9,128.6
SUBTOTAL/ AVERAGE	102.0	72.7	712.7	1.06	756.7	975.1	9,559.8	0.5179	1.00	18,534.8	1.0000	18,534.8
5A	329.0	202.6	615.8		753.8	2,784.9	8,464.7	0.5179		16,411.7	1.0000	16,411.7
5B	702.0	462.2	658.4		806.0	8,378.0	11,934.5	0.5179		23,138.9	1.0000	23,138.9
5C	111.0	23.6	212.6		260.3	887.6	7,996.4	0.5179		15,503.6	1.0000	15,503.6
5D	918.0	28.8	31.4		38.4	9,034.9	9,841.9	0.5179		19,081.8	1.0000	19,081.8
SUBTOTAL/ AVERAGE	2,060.0	717.2	348.2	1.22	426.2	21,085.4	10,235.6	0.5179	1.00	19,845.1	1.0000	19,845.1
6A	55.0	22.4	407.3		551.5	494.5	8,990.9	0.5179		17,431.8	1.0000	17,431.8
6B	338.0	58.8	174.0		235.6	1,388.8	4,108.9	0.5179		7,966.4	1.0000	7,966.4
6C	361.0	204.6	566.8		767.5	1,623.3	4,496.7	0.5179		8,718.3	1.0000	8,718.3
6D	206.0	20.5	99.5		134.8	503.7	2,445.1	0.5179		4,740.7	1.0000	4,740.7
6E	103.0	8.1	78.6		106.5	3,409.4	33,101.0	0.5179		64,177.0	1.0000	64,177.0
SUBTOTAL/ AVERAGE	1,063.0	314.4	295.8	1.35	400.5	7,419.7	6,980.0	0.5179	1.00	13,532.9	1.0000	13,532.9
7	42.0	5.0	119.0	0.87	103.7	150.0	3,571.4	0.5179	1.00	6,924.4	1.0000	6,924.4
TOTAL GR 1-7	12,744.0	2,397.1	188.1	1.03	193.4	51,488.3 (1980)	4,040.2 (1980)					
						99,417.5 (1993)	7,801.1 (1993)	0.5179	1.00	7,833.2	1.0000	7,833.2

	WEIGHT	CER[4]		ADJ	ADJUSTED	MATERIAL COSTS					
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR[5]	% LAB $	$/TON 1993	INFL FCTR	$/TON 1994
GROUP 8	12,744.0	2,552.9	200.3	100%	200.3	200.3	35.0	12%	841.3	1.0000	841.3

GROUP 9												
	WEIGHT	CER[4]		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL[6]	MHRS/TON	1980	1980	FCTR[3]	FCTR[2]	1993	1994	1994
PROD	12,744.0	395.8	31.1	60%	18.6	977.5	76.7	0.5179	1.00	148.7	1.0000	148.7

	MATERIAL COSTS					
	MHRS/TON	$/MHR[5]	% LABOR	$/TON 1993	INFL FCTR	$/TON 1994
PREPROD	12,744.0	395.8	31.1	40%	12.4	12.4	35.0	12%	52.2	1.0000	52.2

1 - Based on AOR 7 data in Reference (7) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and AOR 7 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1980 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (8)
6 - Per Reference (6)

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	8183.0	795.9	795.9		11868.9
200	971.0	134.4	134.4		19251.6
300	323.0	149.8	149.8		11258.6
400	102.0	77.2	77.2		1890.5
500	2060.0	877.9	877.9		40880.9
600	1063.0	425.8	425.8		14385.5
700	42.0	4.4	4.4		290.8
TOTAL 1 - 7	12744.0	2465.3	2465.3		99826.8
900	REF. TO 1-7	395.8	395.8		2560.1
TOTAL 1 - 7, 9	12744.0	2861.1	2861.1		102386.9
800	REF. TO 1-7	2552.9	2552.9		10722.1
TOTAL 1 - 9	12744.0	5414.0	5414.0		113109.1
CER 1 - 7	12744.0	2446.7	2465.3		99826.8
CER 1 - 7, 9	12744.0	2921.7	2861.1		102386.9
CER 1 - 9	12744.0	5474.5	5414.0	101978.4	113109.1

1 - From Reference 4
2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

AOR7f SHIP TYPE: AOR7 MODEL USER: Eric Midboe

DATA ENTRY SHEET

AUXILIARY SHIPS

SHIP TYPE: AO180 FILE NAME: AO180f
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 03/22/95 DATA SOURCE:
REV #:

MAJOR UPGRADE (1-YES, 2-NO):	1	ENTER THE BASELINE LABOR "SLOPE"[1]:	99
THE NUMBER OF SHIPS BUILT IN THE YAR	1	ENTER THE BASELINE MAT'L "SLOPE"[1]:	100

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[1]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	4,286.0	100	1.00	100	1.00	35.0	1	
1B	SUPERSTRUCTURE	864.0	100	1.00	100	1.00	35.0	1	
1C	FOUNDATIONS	144.0	100	1.00	100	1.00	35.0	1	
1D	STRUCTURAL ATTACHMENTS	278.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	HULL STRUCTURE	5,572.0	100	1.00	100	1.00	35.0	1	
					0				
2A	PROPULSION ENERGY SYSTEMS	430.0	100	1.00	100	1.00	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	121.0	100	1.00	100	1.00	35.0	1	
2C	PROPULSION GASES SYSTEMS	32.0	100	1.00	100	1.00	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	63.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	PROPULSION PLANT	646.0	100	1.00	100	1.00	35.0	1	
3A	ELECTRICAL POWER GENERATION	127.0	100	1.00	100	1.00	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	140.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	ELECTRIC PLANT	267.0	100	1.00	100	1.00	35.0	1	
4A	VEHICLE COMMAND	39.0	100	1.00	100	1.00	35.0	1	
4B	WEAPONS COMMAND	9.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	48.0	100	1.00	100	1.00	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	89.0	100	1.00	100	1.00	35.0	1	
5B	FLUID SYSTEMS	597.0	100	1.00	100	1.00	35.0	1	
5C	MANEUVERING SYSTEMS	76.0	100	1.00	100	1.00	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	383.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	1,145.0	100	1.00	100	1.00	35.0	1	
6A	HULL FITTINGS	31.0	100	1.00	100	1.00	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	155.0	100	1.00	100	1.00	35.0	1	
6C	PRESERVATION	207.0	100	1.00	100	1.00	35.0	1	
6D	SHIP SUPPORT	99.0	100	1.00	100	1.00	35.0	1	
6E	HABITABILITY	66.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	558.0	100	1.00	100	1.00	35.0	1	
7	ARMAMENT	16.0	100	1.00	100	1.00	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	8,252.0	100.00	1.00	100	1.00	35.0	1	

		WEIGHT L TONS					MHR RATE[4]		
8	INTEGRATION/ENGINEERING		% OF LEAD SHIP GR 8[7]						
	RECURRING	8,252.0			10.00		35.0		
	NON-RECURRING	8,252.0			90.00		35.0		

		WEIGHT	LABOR		MAT		MHR		
9	SHIP ASSEMBLY AND SUPPORT SERVICES	L TONS	"SLOPE"[2]		"SLOPE"[3]		RATE[4]		
	PRODUCTION:	8,252.0	100		100		35.0		
	PREPROD.:		% OF LEAD SHIP GR 9[5]						
	RECURRING	8,252.0			10.00		35.0		
	NON-RECURRING	8,252.0			90.00		35.0		

NOTES:

1 - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

2 - Use cost and weight groups per Reference (2)

3 - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

4 - Use fully burdened rate

5 - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

6 - Use inflation factor per Reference (3)

7 - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	4,286.0	83.4	1.00	357.42	35.0	12510	1,305.2	1.00	5,594.0	18,103.8
1B	864.0	105.0	1.00	90.69	35.0	3174	1,142.2	1.00	986.8	4,161.1
1C	144.0	424.0	1.00	61.06	35.0	2137	1,508.0	1.00	217.1	2,354.3
1D	278.0	168.0	1.00	46.71	35.0	1635	4,734.8	1.00	1,316.3	2,951.2
SUBTOTAL	5,572.0	97.3	1.00	555.89	35.0	19456	1,450.4	1.00	8,114.2	27,570.4
2A	430.0	111.2	1.00	47.81	35.0	1673	21,379.2	1.00	9,193.1	10,866.4
2B	121.0	47.1	1.00	5.70	35.0	199	9,816.9	1.00	1,187.8	1,387.3
2C	32.0	278.4	1.00	8.91	35.0	312	39,223.9	1.00	1,255.2	1,567.0
2D	63.0	521.4	1.00	32.85	35.0	1150	28,022.8	1.00	1,765.4	2,915.2
SUBTOTAL	646.0	138.4	1.00	95.27	35.0	3334	19,826.5	1.00	13,401.5	16,735.8
3A	127.0	14.2	1.00	1.80	35.0	63	39,797.1	1.00	5,054.2	5,117.3
3B	140.0	747.5	1.00	104.66	35.0	3663	31,737.0	1.00	4,443.2	8,106.2
SUBTOTAL	267.0	463.7	1.00	106.46	35.0	3726	34,856.2	1.00	9,497.4	13,223.5
4A	39.0	775.9	1.00	30.26	35.0	1059	21,429.0	1.00	835.7	1,894.8
4B	9.0	694.5	1.00	6.25	35.0	219	9,128.6	1.00	82.2	300.9
SUBTOTAL	48.0	756.7	1.00	36.51	35.0	1278	18,534.8	1.00	917.9	2,195.7
5A	89.0	753.8	1.00	67.09	35.0	2348	16,411.7	1.00	1,460.6	3,808.8
5B	597.0	806.0	1.00	481.16	35.0	16841	23,138.9	1.00	13,813.9	30,654.6
5C	76.0	260.3	1.00	19.78	35.0	692	15,503.6	1.00	1,178.3	1,870.6
5D	383.0	38.4	1.00	14.71	35.0	515	19,081.8	1.00	7,308.3	7,823.1
SUBTOTAL	1,145.0	426.2	1.00	582.74	35.0	20396	19,845.1	1.00	23,761.1	44,157.1
6A	31.0	551.5	1.00	17.10	35.0	598	17,431.8	1.00	540.4	1,138.8
6B	155.0	235.6	1.00	36.52	35.0	1278	7,966.4	1.00	1,234.8	2,512.8
6C	207.0	767.5	1.00	158.87	35.0	5561	8,718.3	1.00	1,804.7	7,365.3
6D	99.0	134.8	1.00	13.34	35.0	467	4,740.7	1.00	469.3	936.3
6E	66.0	106.5	1.00	7.03	35.0	246	64,177.0	1.00	4,235.7	4,481.7
SUBTOTAL	558.0	400.5	1.00	232.86	35.0	8150	13,532.9	1.00	8,284.9	16,434.9
7	16.0	103.7	1.00	1.66	35.0	58	6,924.4	1.00	110.8	168.9
TOTAL 1-7	8,252.0	193.4	1.00	1,611.4	35.0	56398	7,833.2	1.00	64,087.9	120,486.3

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	8,252.0	2,278.9						
NON - RECURRING			10.0	227.9	35.0	7,976.1	957.1	8,933.2
RECURRING			90.0	2,051.0	35.0	71,784.5	8,614.1	80,398.6
TOTAL	8,252.0	2,278.9	100.0	2,278.9	35.0	79,760.5	9,571.3	89,331.8

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (8)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	MATERIAL COSTS LCF	MATERIAL COSTS $K	TOTAL $K
PRODUCTION	8,252.0	305.9	60%	LCF 1.00	183.6	35.0	6,424.7	148.7	1.00	1,227.2	7,651.9
PREPRODUCTION	8,252.0	305.9	40%	% TOTAL						$K[3]	
NON - RECURRING				10.0	12.2	35.0	428.3	---	---	51.4	479.7
RECURRING				90.0	110.1	35.0	3,854.8	---	---	462.6	4,317.4
TOTAL	8,252.0	---	---	---	305.9	35.0	10,707.9	---	---	1,741.2	12,449.1

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (8)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	8,252.0	1,611.4	56,398.4	64,087.9	120,486.3
8	8,252.0	2,278.9	79,760.5	9,571.3	89,331.8
9	8,252.0	305.9	10,707.9	1,741.2	12,449.1
TOTAL	8,252.0	4,196.2	146,866.8	75,400.3	222,267.1

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED	1993	INFLATED	1994
	L TONS	KMHRS	MHRS/TON	ADJ FCTR[2]	MHRS/TON	$K 1980	$/TON 1980	INFL FCTR[3]	ADJ FCTR[2]	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	6,696.0	676.0	101.0		83.4	4,507.6	673.2	0.5179		1,305.2	1.0000	1,305.2
1B	927.0	117.8	127.1		105.0	546.1	589.1	0.5179		1,142.2	1.0000	1,142.2
1C	180.0	92.4	513.3		424.0	140.0	777.8	0.5179		1,508.0	1.0000	1,508.0
1D	380.0	77.3	203.4		168.0	928.0	2,442.1	0.5179		4,734.8	1.0000	4,734.8
SUBTOTAL/ AVERAGE	8,183.0	963.5	117.7	0.83	97.3	6,121.7	748.1	0.5179	1.00	1,450.4	1.0000	1,450.4
2A	606.0	90.6	149.5		111.2	6,682.3	11,026.9	0.5179		21,379.2	1.0000	21,379.2
2B	240.0	15.2	63.3		47.1	1,215.2	5,063.3	0.5179		9,816.9	1.0000	9,816.9
2C	39.0	14.6	374.4		278.4	789.0	20,230.8	0.5179		39,223.9	1.0000	39,223.9
2D	86.0	60.3	701.2		521.4	1,243.0	14,453.5	0.5179		28,022.8	1.0000	28,022.8
SUBTOTAL/ AVERAGE	971.0	180.7	186.1	0.74	138.4	9,929.5	10,226.1	0.5179	1.00	19,826.5	1.0000	19,826.5
3A	125.0	1.7	13.6		14.2	2,565.8	20,526.4	0.5179		39,797.1	1.0000	39,797.1
3B	198.0	141.9	716.7		747.5	3,241.1	16,369.2	0.5179		31,737.0	1.0000	31,737.0
SUBTOTAL/ AVERAGE	323.0	143.6	444.6	1.04	463.7	5,806.9	17,978.0	0.5179	1.00	34,856.2	1.0000	34,856.2
4A	78.0	57.0	730.8		775.9	862.1	11,052.6	0.5179		21,429.0	1.0000	21,429.0
4B	24.0	15.7	654.2		694.5	113.0	4,708.3	0.5179		9,128.6	1.0000	9,128.6
SUBTOTAL/ AVERAGE	102.0	72.7	712.7	1.06	756.7	975.1	9,559.8	0.5179	1.00	18,534.8	1.0000	18,534.8
5A	329.0	202.6	615.8		753.8	2,784.9	8,464.7	0.5179		16,411.7	1.0000	16,411.7
5B	702.0	462.2	658.4		806.0	8,378.0	11,934.5	0.5179		23,138.9	1.0000	23,138.9
5C	111.0	23.6	212.6		260.3	887.6	7,996.4	0.5179		15,503.6	1.0000	15,503.6
5D	918.0	28.8	31.4		38.4	9,034.9	9,841.9	0.5179		19,081.8	1.0000	19,081.8
SUBTOTAL/ AVERAGE	2,060.0	717.2	348.2	1.22	426.2	21,085.4	10,235.6	0.5179	1.00	19,845.1	1.0000	19,845.1
6A	55.0	22.4	407.3		551.5	494.5	8,990.9	0.5179		17,431.8	1.0000	17,431.8
6B	338.0	58.8	174.0		235.6	1,388.8	4,108.9	0.5179		7,966.4	1.0000	7,966.4
6C	361.0	204.6	566.8		767.5	1,623.3	4,496.7	0.5179		8,718.3	1.0000	8,718.3
6D	206.0	20.5	99.5		134.8	503.7	2,445.1	0.5179		4,740.7	1.0000	4,740.7
6E	103.0	8.1	78.6		106.5	3,409.4	33,101.0	0.5179		64,177.0	1.0000	64,177.0
SUBTOTAL/ AVERAGE	1,063.0	314.4	295.8	1.35	400.5	7,419.7	6,980.0	0.5179	1.00	13,532.9	1.0000	13,532.9
7	42.0	5.0	119.0	0.87	103.7	150.0	3,571.4	0.5179	1.00	6,924.4	1.0000	6,924.4
TOTAL GR 1-7	12,744.0	2,397.1	188.1	1.03	193.4	51,488.3 (1980)	4,040.2 (1980)					
						99,417.5 (1993)	7,801.1 (1993)	0.5179	1.00	7,833.2	1.0000	7,833.2

	WEIGHT	CER[4]		ADJ	ADJUSTED	MATERIAL COSTS					$/TON
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR[5]	% LAB $	$/TON 1993	INFL FCTR	1994
GROUP 8	12,744.0	2,552.9	200.3	100%	200.3	200.3	35.0	12%	841.3	1.0000	841.3

GROUP 9												
	WEIGHT	CER[4]		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL[6]	MHRS/TON	1980	1980	FCTR[3]	FCTR[2]	1993	1994	1994
PROD	12,744.0	395.8	31.1	60%	18.6	977.5	76.7	0.5179	1.00	148.7	1.0000	148.7
						MATERIAL COSTS						$/TON
						MHRS/TON	$/MHR[5]	% LABOR	$/TON 1993	INFL FCTR		1994
PREPROD	12,744.0	395.8	31.1	40%	12.4	12.4	35.0	12%	52.2	1.0000		52.2

1 - Based on AOR 7 data in Reference (7) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and AOR 7 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1980 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (8)
6 - Per Reference (6)

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	5572.0	563.5	555.9		8114.2
200	646.0	98.3	95.3		13401.5
300	267.0	118.7	106.5		9497.4
400	48.0	26.3	36.5		917.9
500	1145.0	389.3	582.7		23761.1
600	558.0	200.0	232.9		8284.9
700	16.0	2.7	1.7		110.8
TOTAL 1 - 7	8252.0	1398.8	1611.4		64087.9
900	REF. TO 1-7	305.9	256.3		1741.2
TOTAL 1 - 7, 9	8252.0	1704.7	1867.7		65829.0
800	REF. TO 1-7	2278.9	1653.0		6942.8
TOTAL 1 - 9	8252.0	3983.6	3520.7		72771.8
CER 1 - 7	8252.0	1498.9	1611.4		64087.9
CER 1 - 7, 9	8252.0	1884.0	1867.7		65829.0
CER 1 - 9	8252.0	4162.9	3520.7	72120.0	72771.8

1 - From Reference 4
2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

APPENDIX D

FFG 7 CLASS FOLLOW SHIP AND MAJOR UPGRADE ESTIMATE RESULTS

DATA ENTRY SHEET

SURFACE COMBATANTS

SHIP TYPE: FFG 7 FILE NAME: FFGCOM
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 01/31/95 DATA SOURCE:
REV #: 1

MAJOR UPGRADE (1-YES, 2-NO):	1	ENTER THE BASELINE LABOR "SLOPE"[1]:	99
THE NUMBER OF SHIPS BUILT IN THE YAR	1	ENTER THE BASELINE MAT'L "SLOPE"[1]:	100

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[1]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	928.5	100	1.00	100	1.00	35.0	1	
1B	SUPERSTRUCTURE	105.0	100	1.00	100	1.00	35.0	1	
1C	FOUNDATIONS	138.0	100	1.00	100	1.00	35.0	1	
1D	STRUCTURAL ATTACHMENTS	63.5	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	HULL STRUCTURE	1,235.0	100	1.00	100	1.00	35.0	1	
					0				
2A	PROPULSION ENERGY SYSTEMS	128.5	100	1.00	100	1.00	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	82.0	100	1.00	100	1.00	35.0	1	
2C	PROPULSION GASES SYSTEMS	29.0	100	1.00	100	1.00	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	40.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	PROPULSION PLANT	279.5	100	1.00	100	1.00	35.0	1	
3A	ELECTRICAL POWER GENERATION	98.0	100	1.00	100	1.00	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	97.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	ELECTRIC PLANT	195.0	100	1.00	100	1.00	35.0	1	
4A	VEHICLE COMMAND	34.5	100	1.00	100	1.00	35.0	1	
4B	WEAPONS COMMAND	81.5	100	1.00	100	1.00	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	116.0	100	1.00	100	1.00	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	109.0	100	1.00	100	1.00	35.0	1	
5B	FLUID SYSTEMS	241.0	100	1.00	100	1.00	35.0	1	
5C	MANEUVERING SYSTEMS	46.0	100	1.00	100	1.00	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	51.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	447.0	100	1.00	100	1.00	35.0	1	
		0.0							
6A	HULL FITTINGS	27.0	100	1.00	100	1.00	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	66.0	100	1.00	100	1.00	35.0	1	
6C	PRESERVATION	95.0	100	1.00	100	1.00	35.0	1	
6D	SHIP SUPPORT	73.5	100	1.00	100	1.00	35.0	1	
6E	HABITABILITY	52.5	100	1.00	100	1.00	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	314.0	100	1.00	100	1.00	35.0	1	
7	ARMAMENT	93.0	100	1.00	100	1.00	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	2,679.5	100.00	1.00	100	1.00	35.0	1	

8	INTEGRATION/ENGINEERING	WEIGHT L TONS	% OF LEAD SHIP GR 8[7]		MHR RATE[4]	
	RECURRING	2,679.5	10.00		35.0	
	NON-RECURRING	2,679.5	90.00		35.0	

9	SHIP ASSEMBLY AND SUPPORT SERVICES	WEIGHT L TONS	LABOR "SLOPE"[2]	MAT "SLOPE"[3]	MHR RATE[4]	
	PRODUCTION:	2,679.5	100	100	35.0	
	PREPROD.:		% OF LEAD SHIP GR 9[5]			
	RECURRING	2,679.5		10.00	35.0	
	NON-RECURRING	2,679.5		90.00	35.0	

NOTES:

1 - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

2 - Use cost and weight groups per Reference (2)

3 - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

4 - Use fully burdened rate

5 - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

6 - Use inflation factor per Reference (3)

7 - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	928.5	318.6	1.00	295.85	35.0	10355	1,638.9	1.00	1,521.7	11,876.3
1B	105.0	532.5	1.00	55.91	35.0	1957	7,600.5	1.00	798.1	2,755.0
1C	138.0	369.9	1.00	51.05	35.0	1787	3,451.9	1.00	476.4	2,263.1
1D	63.5	211.7	1.00	13.44	35.0	470	20,376.3	1.00	1,293.9	1,764.4
SUBTOTAL	1,235.0	337.0	1.00	416.25	35.0	14569	3,311.7	1.00	4,090.0	18,658.8
2A	128.5	498.0	1.00	64.00	35.0	2240	117,193.4	1.00	15,059.4	17,299.3
2B	82.0	303.6	1.00	24.90	35.0	871	56,497.3	1.00	4,632.8	5,504.2
2C	29.0	337.9	1.00	9.80	35.0	343	41,163.0	1.00	1,193.7	1,536.7
2D	40.0	462.7	1.00	18.51	35.0	648	212,144.7	1.00	8,485.8	9,133.6
SUBTOTAL	279.5	419.3	1.00	117.20	35.0	4102	105,086.4	1.00	29,371.7	33,473.8
3A	98.0	281.8	1.00	27.62	35.0	967	74,189.7	1.00	7,270.6	8,237.3
3B	97.0	2,178.7	1.00	211.33	35.0	7397	55,637.0	1.00	5,396.8	12,793.4
SUBTOTAL	195.0	1,225.4	1.00	238.95	35.0	8363	64,960.9	1.00	12,667.4	21,030.6
4A	34.5	1,235.2	1.00	42.62	35.0	1492	69,935.5	1.00	2,412.8	3,904.3
4B	81.5	1,092.1	1.00	89.01	35.0	3115	32,661.2	1.00	2,661.9	5,777.2
SUBTOTAL	116.0	1,134.7	1.00	131.62	35.0	4607	43,747.1	1.00	5,074.7	9,681.5
5A	109.0	1,590.2	1.00	173.33	35.0	6067	40,644.4	1.00	4,430.2	10,496.8
5B	241.0	1,062.3	1.00	256.03	35.0	8961	56,249.3	1.00	13,556.1	22,517.0
5C	46.0	208.5	1.00	9.59	35.0	336	31,468.3	1.00	1,447.5	1,783.2
5D	51.0	374.2	1.00	19.08	35.0	668	22,564.1	1.00	1,150.8	1,818.6
SUBTOTAL	447.0	1,024.7	1.00	458.03	35.0	16031	46,050.6	1.00	20,584.6	36,615.6
6A	27.0	859.2	1.00	23.20	35.0	812	32,027.8	1.00	864.8	1,676.7
6B	66.0	1,500.2	1.00	99.01	35.0	3466	17,737.2	1.00	1,170.7	4,636.2
6C	95.0	1,574.0	1.00	149.53	35.0	5233	12,372.0	1.00	1,175.3	6,408.8
6D	73.5	715.8	1.00	52.61	35.0	1841	11,374.4	1.00	836.0	2,677.5
6E	52.5	825.1	1.00	43.32	35.0	1516	40,755.2	1.00	2,139.7	3,655.9
SUBTOTAL	314.0	1,170.9	1.00	367.67	35.0	12869	19,702.0	1.00	6,186.4	19,054.9
7	93.0	355.4	1.00	33.05	35.0	1157	7,104.4	1.00	660.7	1,817.5
TOTAL 1-7	2,679.5	657.9	1.00	1,762.8	35.0	61697	29,347.1	1.00	78,635.4	140,332.6

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	2,679.5	3,163.8						
NON - RECURRING			10.0	316.4	35.0	11,073.2	1,328.8	12,402.0
RECURRING			90.0	2,847.4	35.0	99,658.6	11,959.0	111,617.6
TOTAL	2,679.5	3,163.8	100.0	3,163.8	35.0	110,731.8	13,287.8	124,019.6

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (5)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	MATERIAL COSTS LCF	MATERIAL COSTS $K	TOTAL $K
				LCF							
PRODUCTION	2,679.5	795.9	60%	1.00	477.5	35.0	16,714.1	1,010.3	1.00	2,707.1	19,421.3
PREPRODUCTION	2,679.5	795.9	40%	% TOTAL						$K[3]	
NON - RECURRING				10.0	31.8	35.0	1,114.3	---	---	133.7	1,248.0
RECURRING				90.0	286.5	35.0	10,028.5	---	---	1,203.4	11,231.9
TOTAL	2,679.5	---	---	---	795.9	35.0	27,856.9	---	---	4,044.3	31,901.2

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (5)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	2,679.5	1,762.8	61,697.2	78,635.4	140,332.6
8	2,679.5	3,163.8	110,731.8	13,287.8	124,019.6
9	2,679.5	795.9	27,856.9	4,044.3	31,901.2
TOTAL	2,679.5	5,722.5	200,285.9	95,967.5	296,253.4

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED 1993		INFLATED 1994	
	L TONS	KMHRS	MHRS/TON	ADJ FCTR[2]	MHRS/TON	$K 1977	$/TON 1977	INFL FCTR[3]	ADJ FCTR[2]	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	928.5	271.1	292.0		318.6	576.6	621.0	0.3892		1,638.9	1.0000	1,638.9
1B	105.0	51.2	488.0		532.5	302.4	2,880.0	0.3892		7,600.5	1.0000	7,600.5
1C	138.0	46.8	339.0		369.9	180.5	1,308.0	0.3892		3,451.9	1.0000	3,451.9
1D	63.5	12.3	194.0		211.7	490.3	7,721.0	0.3892		20,376.3	1.0000	20,376.3
SUBTOTAL/ AVERAGE	1,235.0	381.5	308.9	1.09	337.0	1,549.8	1,254.9	0.3892	1.03	3,311.7	1.0000	3,311.7
2A	128.5	59.8	465.0		498.0	5,706.3	44,407.0	0.3892		117,193.4	1.0000	117,193.4
2B	82.0	23.2	283.5		303.6	1,755.5	21,408.0	0.3892		56,497.3	1.0000	56,497.3
2C	29.0	9.1	315.5		337.9	452.3	15,597.5	0.3892		41,163.0	1.0000	41,163.0
2D	40.0	17.3	432.0		462.7	3,215.4	80,386.0	0.3892		212,144.7	1.0000	212,144.7
SUBTOTAL/ AVERAGE	279.5	109.4	391.5	1.07	419.3	11,129.5	39,819.4	0.3892	1.03	105,086.4	1.0000	105,086.4
3A	98.0	21.3	217.0		281.8	2,755.0	28,112.0	0.3892		74,189.7	1.0000	74,189.7
3B	97.0	162.7	1,677.5		2,178.7	2,045.0	21,082.0	0.3892		55,637.0	1.0000	55,637.0
SUBTOTAL/ AVERAGE	195.0	184.0	943.5	1.30	1,225.4	4,799.9	24,615.0	0.3892	1.03	64,960.9	1.0000	64,960.9
4A	34.5	28.3	820.0		1,235.2	914.3	26,500.0	0.3892		69,935.5	1.0000	69,935.5
4B	81.5	59.1	725.0		1,092.1	1,008.6	12,376.0	0.3892		32,661.2	1.0000	32,661.2
SUBTOTAL/ AVERAGE	116.0	87.4	753.3	1.51	1,134.7	1,922.9	16,576.7	0.3892	1.03	43,747.1	1.0000	43,747.1
5A	109.0	129.7	1,190.0		1,590.2	1,678.7	15,401.0	0.3892		40,644.4	1.0000	40,644.4
5B	241.0	191.6	795.0		1,062.3	5,136.7	21,314.0	0.3892		56,249.3	1.0000	56,249.3
5C	46.0	7.2	156.0		208.5	548.5	11,924.0	0.3892		31,468.3	1.0000	31,468.3
5D	51.0	14.3	280.0		374.2	436.1	8,550.0	0.3892		22,564.1	1.0000	22,564.1
SUBTOTAL/ AVERAGE	447.0	342.8	766.8	1.34	1,024.7	7,799.9	17,449.5	0.3892	1.03	46,050.6	1.0000	46,050.6
6A	27.0	22.5	833.0		859.2	327.7	12,136.0	0.3892		32,027.8	1.0000	32,027.8
6B	66.0	96.0	1,454.5		1,500.2	443.6	6,721.0	0.3892		17,737.2	1.0000	17,737.2
6C	95.0	145.0	1,526.0		1,574.0	445.4	4,688.0	0.3892		12,372.0	1.0000	12,372.0
6D	73.5	51.0	694.0		715.8	316.8	4,310.0	0.3892		11,374.4	1.0000	11,374.4
6E	52.5	42.0	800.0		825.1	810.8	15,443.0	0.3892		40,755.2	1.0000	40,755.2
SUBTOTAL/ AVERAGE	314.0	356.5	1,135.2	1.03	1,170.9	2,344.2	7,465.5	0.3892	1.03	19,702.0	1.0000	19,702.0
7	93.0	25.6	275.0	1.29	355.4	250.4	2,692.0	0.3892	1.03	7,104.4	1.0000	7,104.4
TOTAL GR 1-7	2,679.5	1,487.1	555.0	1.19	657.9	29,796.6 (1977)	11,120.2 (1977)					
						76,558.5 (1993)	28,572.0 (1993)	0.3892	1.03	29,347.1	1.0000	29,347.1

	WEIGHT	CER[4]		ADJ	ADJUSTED	MATERIAL COSTS					$/TON
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR[5]	% LAB $	$/TON 1993	INFL FCTR	1994
GROUP 8	2,679.5	3,163.8	1,180.7	100%	1,180.7	1,180.7	35.0	12%	4,959.1	1.0000	4,959.1

GROUP 9												
	WEIGHT	CER[4]		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL[6]	MHRS/TON	1977	1977	FCTR[3]	FCTR[2]	1993	1994	1994
PROD	2,679.5	795.9	297.0	60%	178.2	1,025.8	382.8	0.3892	1.03	1,010.3	1.0000	1,010.3
						MHRS/TON	$/MHR[5]	% LABOR	$/TON 1993	INFL FCTR	$/TON 1994	
PREPROD	2,679.5	795.9	297.0	40%	118.8	118.8	35.0	12%	499.0	1.0000	499.0	

1 - Based on FFG 7 data in Reference (2) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and FFG 7 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1977 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (5)
6 - Per Reference (6)

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	1235.0	416.3	416.3		4090.0
200	279.5	117.2	117.2		29371.7
300	195.0	239.0	239.0		12667.4
400	116.0	131.6	131.6		5074.7
500	447.0	458.0	458.0		20584.6
600	314.0	367.7	367.7		6186.4
700	93.0	33.1	33.1		660.7
TOTAL 1 - 7	2679.5	1762.8	1762.8		78635.4
900	REF. TO 1-7	795.9	795.9		4044.3
TOTAL 1 - 7, 9	2679.5	2558.7	2558.7		82679.7
800	REF. TO 1-7	3163.8	3163.8		13287.8
TOTAL 1 - 9	2679.5	5722.5	5722.5		95967.5
CER 1 - 7	2679.5	1507.1	1762.8		78635.4
CER 1 - 7, 9	2679.5	2606.8	2558.7		82679.7
CER 1 - 9	2679.5	5762.5	5722.5	81667.6	95967.5

1 - From Reference 4
2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

FFGCOM SHIP TYPE: FFG 7 MODEL USER: Eric Midboe

DATA ENTRY SHEET

08/18/95
PAGE 1

SURFACE COMBATANTS

SHIP TYPE: FFG34 FILE NAME: FFG34f
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 03/22/95 DATA SOURCE:
REV #: 0

MAJOR UPGRADE (1-YES, 2-NO):	2	ENTER THE BASELINE LABOR "SLOPE"[1]:	92
THE NUMBER OF SHIPS BUILT IN THE YAR	12	ENTER THE BASELINE MAT'L "SLOPE"[1]:	97

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[1]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	928.5	92	0.66	97	0.86	35.0	1	
1B	SUPERSTRUCTURE	105.0	92	0.66	97	0.86	35.0	1	
1C	FOUNDATIONS	138.0	92	0.66	97	0.86	35.0	1	
1D	STRUCTURAL ATTACHMENTS	63.5	92	0.66	97	0.86	35.0	1	
SUBTOTAL	HULL STRUCTURE	1,235.0	92	0.66	97	0.86	35.0	1	
2A	PROPULSION ENERGY SYSTEMS	128.5	92	0.66	97	0.86	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	82.0	92	0.66	97	0.86	35.0	1	
2C	PROPULSION GASES SYSTEMS	29.0	92	0.66	97	0.86	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	40.0	92	0.66	97	0.86	35.0	1	
SUBTOTAL	PROPULSION PLANT	279.5	92	0.66	97	0.86	35.0	1	
3A	ELECTRICAL POWER GENERATION	98.0	92	0.66	97	0.86	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	97.0	92	0.66	97	0.86	35.0	1	
					0				
SUBTOTAL	ELECTRIC PLANT	195.0	92	0.66	97	0.86	35.0	1	
4A	VEHICLE COMMAND	34.5	92	0.66	97	0.86	35.0	1	
4B	WEAPONS COMMAND	81.5	92	0.66	97	0.86	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	116.0	92	0.66	97	0.86	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	109.0	92	0.66	97	0.86	35.0	1	
5B	FLUID SYSTEMS	241.0	92	0.66	97	0.86	35.0	1	
5C	MANEUVERING SYSTEMS	46.0	92	0.66	97	0.86	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	51.0	92	0.66	97	0.86	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	447.0	92	0.66	97	0.86	35.0	1	
		0.0							
6A	HULL FITTINGS	27.0	92	0.66	97	0.86	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	66.0	92	0.66	97	0.86	35.0	1	
6C	PRESERVATION	95.0	92	0.66	97	0.86	35.0	1	
6D	SHIP SUPPORT	73.5	92	0.66	97	0.86	35.0	1	
6E	HABITABILITY	52.5	92	0.66	97	0.86	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	314.0	92	0.66	97	0.86	35.0	1	
7	ARMAMENT	93.0	92	0.66	97	0.86	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	2,679.5	92.00	0.66	97	0.86	35.0	1	
		WEIGHT					MHR		
8	INTEGRATION/ENGINEERING	L TONS	% OF LEAD SHIP GR 8[7]				RATE[4]		
	RECURRING	2,679.5			10.00		35.0		
	NON-RECURRING	2,679.5			0.00		35.0		
		WEIGHT	LABOR		MAT		MHR		
9	SHIP ASSEMBLY AND SUPPORT SERVICES	L TONS	"SLOPE"[2]		"SLOPE"[3]		RATE[4]		
	PRODUCTION:	2,679.5	92		97		35.0		
	PREPROD.:		% OF LEAD SHIP GR 9[3]						
	RECURRING	2,679.5			10.00		35.0		
	NON-RECURRING	2,679.5			0.00		35.0		

NOTES:

1 - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

2 - Use cost and weight groups per Reference (2)

3 - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

4 - Use fully burdened rate

5 - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

6 - Use inflation factor per Reference (3)

7 - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	928.5	318.6	0.66	194.01	35.0	6790	1,638.9	0.86	1,306.8	8,097.2
1B	105.0	532.5	0.66	36.67	35.0	1283	7,600.5	0.86	685.4	1,968.7
1C	138.0	369.9	0.66	33.48	35.0	1172	3,451.9	0.86	409.1	1,580.8
1D	63.5	211.7	0.66	8.82	35.0	309	20,376.3	0.86	1,111.2	1,419.7
SUBTOTAL	1,235.0	337.0	0.66	272.97	35.0	9554	3,311.7	0.86	3,512.4	13,066.3
2A	128.5	498.0	0.66	41.97	35.0	1469	117,193.4	0.86	12,932.6	14,401.5
2B	82.0	303.6	0.66	16.33	35.0	571	56,497.3	0.86	3,978.5	4,550.0
2C	29.0	337.9	0.66	6.43	35.0	225	41,163.0	0.86	1,025.1	1,250.1
2D	40.0	462.7	0.66	12.14	35.0	425	212,144.7	0.86	7,287.4	7,712.2
SUBTOTAL	279.5	419.3	0.66	76.86	35.0	2690	105,086.4	0.86	25,223.6	27,913.7
3A	98.0	281.8	0.66	18.11	35.0	634	74,189.7	0.86	6,243.8	6,877.7
3B	97.0	2,178.7	0.66	138.59	35.0	4851	55,637.0	0.86	4,634.6	9,485.2
SUBTOTAL	195.0	1,225.4	0.66	156.70	35.0	5484	64,960.9	0.86	10,878.4	16,362.9
4A	34.5	1,235.2	0.66	27.95	35.0	978	69,935.5	0.86	2,072.0	3,050.2
4B	81.5	1,092.1	0.66	58.37	35.0	2043	32,661.2	0.86	2,286.0	4,328.9
SUBTOTAL	116.0	1,134.7	0.66	86.32	35.0	3021	43,747.1	0.86	4,358.0	7,379.1
5A	109.0	1,590.2	0.66	113.67	35.0	3978	40,644.4	0.86	3,804.6	7,782.9
5B	241.0	1,062.3	0.66	167.90	35.0	5876	56,249.3	0.86	11,641.6	17,518.0
5C	46.0	208.5	0.66	6.29	35.0	220	31,468.3	0.86	1,243.1	1,463.2
5D	51.0	374.2	0.66	12.51	35.0	438	22,564.1	0.86	988.3	1,426.2
SUBTOTAL	447.0	1,024.7	0.66	300.37	35.0	10513	46,050.6	0.86	17,677.6	28,190.4
6A	27.0	859.2	0.66	15.21	35.0	532	32,027.8	0.86	742.6	1,275.1
6B	66.0	1,500.2	0.66	64.93	35.0	2273	17,737.2	0.86	1,005.3	3,278.0
6C	95.0	1,574.0	0.66	98.06	35.0	3432	12,372.0	0.86	1,009.4	4,441.4
6D	73.5	715.8	0.66	34.50	35.0	1208	11,374.4	0.86	718.0	1,925.5
6E	52.5	825.1	0.66	28.41	35.0	994	40,755.2	0.86	1,837.5	2,831.8
SUBTOTAL	314.0	1,170.9	0.66	241.11	35.0	8439	19,702.0	0.86	5,312.7	13,751.7
7	93.0	355.4	0.66	21.67	35.0	759	7,104.4	0.86	567.4	1,326.0
TOTAL 1-7	2,679.5	657.9	0.66	1,156.0	35.0	40460	29,347.1	0.86	67,530.1	107,990.1

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	2,679.5	3,163.8						
NON - RECURRING			10.0	316.4	35.0	11,073.2	1,328.8	12,402.0
RECURRING			0.0	0.0	35.0	0.0	0.0	0.0
TOTAL	2,679.5	3,163.8	10.0	316.4	35.0	11,073.2	1,328.8	12,402.0

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (5)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	MATERIAL COSTS LCF	MATERIAL COSTS $K	TOTAL $K
				LCF							
PRODUCTION	2,679.5	795.9	60%	0.66	313.2	35.0	10,960.8	1,010.3	0.86	2,324.8	13,285.7
										$K[3]	
PREPRODUCTION	2,679.5	795.9	40%	% TOTAL							
NON - RECURRING				10.0	31.8	35.0	1,114.3	---	---	133.7	1,248.0
RECURRING				0.0	0.0	35.0	0.0	---	---	0.0	0.0
TOTAL	2,679.5	---	---	---	345.0	35.0	12,075.1	---	---	2,458.5	14,533.7

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (5)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	**2,679.5**	**1,156.0**	**40,460.0**	**67,530.1**	**107,990.1**
8	**2,679.5**	**316.4**	**11,073.2**	**1,328.8**	**12,402.0**
9	**2,679.5**	**345.0**	**12,075.1**	**2,458.5**	**14,533.7**
TOTAL	**2,679.5**	**1,817.4**	**63,608.3**	**71,317.5**	**134,925.7**

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED	1993	INFLATED	1994
	L TONS	KMHRS	MHRS/TON	ADJ FCTR2	MHRS/TON	$K 1977	$/TON 1977	INFL FCTR3	ADJ FCTR2	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	928.5	271.1	292.0		318.6	576.6	621.0	0.3892		1,638.9	1.0000	1,638.9
1B	105.0	51.2	488.0		532.5	302.4	2,880.0	0.3892		7,600.5	1.0000	7,600.5
1C	138.0	46.8	339.0		369.9	180.5	1,308.0	0.3892		3,451.9	1.0000	3,451.9
1D	63.5	12.3	194.0		211.7	490.3	7,721.0	0.3892		20,376.3	1.0000	20,376.3
SUBTOTAL/ AVERAGE	1,235.0	381.5	308.9	1.09	337.0	1,549.8	1,254.9	0.3892	1.03	3,311.7	1.0000	3,311.7
2A	128.5	59.8	465.0		498.0	5,706.3	44,407.0	0.3892		117,193.4	1.0000	117,193.4
2B	82.0	23.2	283.5		303.6	1,755.5	21,408.0	0.3892		56,497.3	1.0000	56,497.3
2C	29.0	9.1	315.5		337.9	452.3	15,597.5	0.3892		41,163.0	1.0000	41,163.0
2D	40.0	17.3	432.0		462.7	3,215.4	80,386.0	0.3892		212,144.7	1.0000	212,144.7
SUBTOTAL/ AVERAGE	279.5	109.4	391.5	1.07	419.3	11,129.5	39,819.4	0.3892	1.03	105,086.4	1.0000	105,086.4
3A	98.0	21.3	217.0		281.8	2,755.0	28,112.0	0.3892		74,189.7	1.0000	74,189.7
3B	97.0	162.7	1,677.5		2,178.7	2,045.0	21,082.0	0.3892		55,637.0	1.0000	55,637.0
SUBTOTAL/ AVERAGE	195.0	184.0	943.5	1.30	1,225.4	4,799.9	24,615.0	0.3892	1.03	64,960.9	1.0000	64,960.9
4A	34.5	28.3	820.0		1,235.2	914.3	26,500.0	0.3892		69,935.5	1.0000	69,935.5
4B	81.5	59.1	725.0		1,092.1	1,008.6	12,376.0	0.3892		32,661.2	1.0000	32,661.2
SUBTOTAL/ AVERAGE	116.0	87.4	753.3	1.51	1,134.7	1,922.9	16,576.7	0.3892	1.03	43,747.1	1.0000	43,747.1
5A	109.0	129.7	1,190.0		1,590.2	1,678.7	15,401.0	0.3892		40,644.4	1.0000	40,644.4
5B	241.0	191.6	795.0		1,062.3	5,136.7	21,314.0	0.3892		56,249.3	1.0000	56,249.3
5C	46.0	7.2	156.0		208.5	548.5	11,924.0	0.3892		31,468.3	1.0000	31,468.3
5D	51.0	14.3	280.0		374.2	436.1	8,550.0	0.3892		22,564.1	1.0000	22,564.1
SUBTOTAL/ AVERAGE	447.0	342.8	766.8	1.34	1,024.7	7,799.9	17,449.5	0.3892	1.03	46,050.6	1.0000	46,050.6
6A	27.0	22.5	833.0		859.2	327.7	12,136.0	0.3892		32,027.8	1.0000	32,027.8
6B	66.0	96.0	1,454.5		1,500.2	443.6	6,721.0	0.3892		17,737.2	1.0000	17,737.2
6C	95.0	145.0	1,526.0		1,574.0	445.4	4,688.0	0.3892		12,372.0	1.0000	12,372.0
6D	73.5	51.0	694.0		715.8	316.8	4,310.0	0.3892		11,374.4	1.0000	11,374.4
6E	52.5	42.0	800.0		825.1	810.8	15,443.0	0.3892		40,755.2	1.0000	40,755.2
SUBTOTAL/ AVERAGE	314.0	356.5	1,135.2	1.03	1,170.9	2,344.2	7,465.5	0.3892	1.03	19,702.0	1.0000	19,702.0
7	93.0	25.6	275.0	1.29	355.4	250.4	2,692.0	0.3892	1.03	7,104.4	1.0000	7,104.4
TOTAL GR 1-7	2,679.5	1,487.1	555.0	1.19	657.9	29,796.6 (1977)	11,120.2 (1977)					
						76,558.5 (1993)	28,572.0 (1993)	0.3892	1.03	29,347.1	1.0000	29,347.1

	WEIGHT	CER4		ADJ	ADJUSTED	MATERIAL COSTS					$/TON
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR5	% LAB $	$/TON 1993	INFL FCTR	1994
GROUP 8	2,679.5	3,163.8	1,180.7	100%	1,180.7	1,180.7	35.0	12%	4,959.1	1.0000	4,959.1

GROUP 9												
	WEIGHT	CER4		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL6	MHRS/TON	1977	1977	FCTR3	FCTR2	1993	1994	1994
PROD	2,679.5	795.9	297.0	60%	178.2	1,025.8	382.8	0.3892	1.03	1,010.3	1.0000	1,010.3

		MATERIAL COSTS					$/TON
		MHRS/TON	$/MHR5	% LABOR	$/TON 1993	INFL FCTR	1994
PREPROD	2,679.5	795.9	297.0	40%	118.8	118.8	35.0	12%	499.0	1.0000	499.0

1 - Based on FFG 7 data in Reference (2) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and FFG 7 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1977 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (5)
6 - Per Reference (6)

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	1235.0	416.3	416.3		4090.0
200	279.5	117.2	117.2		29371.7
300	195.0	239.0	239.0		12667.4
400	116.0	131.6	131.6		5074.7
500	447.0	458.0	458.0		20584.6
600	314.0	367.7	367.7		6186.4
700	93.0	33.1	33.1		660.7
TOTAL 1 - 7	2679.5	1762.8	1762.8		78635.4
900	REF. TO 1-7	795.9	795.9		4044.3
TOTAL 1 - 7, 9	2679.5	2558.7	2558.7		82679.7
800	REF. TO 1-7	3163.8	3163.8		13287.8
TOTAL 1 - 9	2679.5	5722.5	5722.5		95967.5
CER 1 - 7	2679.5	1507.1	1762.8		78635.4
CER 1 - 7, 9	2679.5	2606.8	2558.7		82679.7
CER 1 - 9	2679.5	5762.5	5722.5	81667.6	95967.5

1 - From Reference 4
2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

DATA ENTRY SHEET

SURFACE COMBATANTS

SHIP TYPE: FFG36 FILE NAME: FFG36f
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 03/22/95 DATA SOURCE:
REV #: 0

MAJOR UPGRADE (1-YES, 2-NO):	1	ENTER THE BASELINE LABOR "SLOPE"[1]:	92
THE NUMBER OF SHIPS BUILT IN THE YAR	13	ENTER THE BASELINE MAT'L "SLOPE"[1]:	97

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[1]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	928.5	92	0.65	97	0.86	35.0	1	
1B	SUPERSTRUCTURE	105.0	92	0.65	97	0.86	35.0	1	
1C	FOUNDATIONS	138.0	96	0.81	97	0.86	35.0	1	
1D	STRUCTURAL ATTACHMENTS	63.5	92	0.65	97	0.86	35.0	1	
SUBTOTAL	HULL STRUCTURE	1,235.0	92	0.67	97	0.86	35.0	1	
2A	PROPULSION ENERGY SYSTEMS	128.5	92	0.65	97	0.86	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	82.0	92	0.65	97	0.86	35.0	1	
2C	PROPULSION GASES SYSTEMS	29.0	92	0.65	97	0.86	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	40.0	92	0.65	97	0.86	35.0	1	
SUBTOTAL	PROPULSION PLANT	279.5	92	0.65	97	0.86	35.0	1	
3A	ELECTRICAL POWER GENERATION	98.0	92	0.65	97	0.86	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	97.0	92	0.65	97	0.86	35.0	1	
					0				
SUBTOTAL	ELECTRIC PLANT	195.0	92	0.65	97	0.86	35.0	1	
4A	VEHICLE COMMAND	34.5	92	0.65	97	0.86	35.0	1	
4B	WEAPONS COMMAND	81.5	96	0.81	100	1.00	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	116.0	95	0.76	99	0.96	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	109.0	96	0.81	97	0.86	35.0	1	
5B	FLUID SYSTEMS	241.0	96	0.81	100	1.00	35.0	1	
5C	MANEUVERING SYSTEMS	46.0	93	0.69	97	0.86	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	51.0	96	0.81	97	0.86	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	447.0	96	0.80	99	0.93	35.0	1	
		0.0							
6A	HULL FITTINGS	27.0	92	0.65	97	0.86	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	66.0	96	0.81	97	0.86	35.0	1	
6C	PRESERVATION	95.0	96	0.81	97	0.86	35.0	1	
6D	SHIP SUPPORT	73.5	92	0.65	97	0.86	35.0	1	
6E	HABITABILITY	52.5	96	0.81	97	0.86	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	314.0	95	0.76	97	0.86	35.0	1	
7	ARMAMENT	93.0	96	0.81	97	0.86	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	2,679.5	93.40	0.71	97	0.87	35.0	1	
8	INTEGRATION/ENGINEERING	WEIGHT L TONS	% OF LEAD SHIP GR 8[7]				MHR RATE[4]		
	RECURRING	2,679.5			10.00		35.0		
	NON-RECURRING	2,679.5			32.26		35.0		
9	SHIP ASSEMBLY AND SUPPORT SERVICES	WEIGHT L TONS	LABOR "SLOPE"[2]		MAT "SLOPE"[3]		MHR RATE[4]		
	PRODUCTION:	2,679.5	92		97		35.0		
	PREPROD.:		% OF LEAD SHIP GR 9[5]						
	RECURRING	2,679.5			10.00		35.0		
	NON-RECURRING	2,679.5			32.26		35.0		

NOTES:

1 - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

2 - Use cost and weight groups per Reference (2)

3 - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

4 - Use fully burdened rate

5 - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

6 - Use inflation factor per Reference (3)

7 - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	928.5	318.6	0.65	192.07	35.0	6723	1,638.9	0.86	1,302.0	8,024.6
1B	105.0	532.5	0.65	36.30	35.0	1271	7,600.5	0.86	682.8	1,953.4
1C	138.0	369.9	0.81	41.40	35.0	1449	3,451.9	0.86	407.6	1,856.7
1D	63.5	211.7	0.65	8.73	35.0	305	20,376.3	0.86	1,107.1	1,412.6
SUBTOTAL	1,235.0	337.0	0.67	278.50	35.0	9748	3,311.7	0.86	3,499.5	13,247.2
2A	128.5	498.0	0.65	41.55	35.0	1454	117,193.4	0.86	12,885.3	14,339.5
2B	82.0	303.6	0.65	16.16	35.0	566	56,497.3	0.86	3,964.0	4,529.7
2C	29.0	337.9	0.65	6.36	35.0	223	41,163.0	0.86	1,021.4	1,244.1
2D	40.0	462.7	0.65	12.02	35.0	421	212,144.7	0.86	7,260.7	7,681.3
SUBTOTAL	279.5	419.3	0.65	76.09	35.0	2663	105,086.4	0.86	25,131.3	27,794.6
3A	98.0	281.8	0.65	17.93	35.0	628	74,189.7	0.86	6,220.9	6,848.6
3B	97.0	2,178.7	0.65	137.20	35.0	4802	55,637.0	0.86	4,617.7	9,419.8
SUBTOTAL	195.0	1,225.4	0.65	155.13	35.0	5430	64,960.9	0.86	10,838.6	16,268.3
4A	34.5	1,235.2	0.65	27.67	35.0	968	69,935.5	0.86	2,064.4	3,032.8
4B	81.5	1,092.1	0.81	72.19	35.0	2527	32,661.2	1.00	2,661.9	5,188.5
SUBTOTAL	116.0	1,134.7	0.76	99.86	35.0	3495	43,747.1	0.96	4,726.3	8,221.3
5A	109.0	1,590.2	0.81	140.58	35.0	4920	40,644.4	0.86	3,790.7	8,710.9
5B	241.0	1,062.3	0.81	207.65	35.0	7268	56,249.3	1.00	13,556.1	20,823.8
5C	46.0	208.5	0.69	6.59	35.0	231	31,468.3	0.86	1,238.6	1,469.2
5D	51.0	374.2	0.81	15.48	35.0	542	22,564.1	0.86	984.6	1,526.3
SUBTOTAL	447.0	1,024.7	0.80	370.29	35.0	12960	46,050.6	0.93	19,569.9	32,530.2
6A	27.0	859.2	0.65	15.06	35.0	527	32,027.8	0.86	739.9	1,267.0
6B	66.0	1,500.2	0.81	80.31	35.0	2811	17,737.2	0.86	1,001.7	3,812.3
6C	95.0	1,574.0	0.81	121.27	35.0	4245	12,372.0	0.86	1,005.7	5,250.2
6D	73.5	715.8	0.65	34.16	35.0	1196	11,374.4	0.86	715.3	1,910.8
6E	52.5	825.1	0.81	35.13	35.0	1230	40,755.2	0.86	1,830.8	3,060.5
SUBTOTAL	314.0	1,170.9	0.76	285.93	35.0	10008	19,702.0	0.86	5,293.3	15,300.9
7	93.0	355.4	0.81	26.81	35.0	938	7,104.4	0.86	565.3	1,503.5
TOTAL 1-7	2,679.5	657.9	0.71	1,292.6	35.0	45242	29,347.1	0.87	69,624.4	114,866.0

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	2,679.5	3,163.8						
NON - RECURRING			10.0	316.4	35.0	11,073.2	1,328.8	12,402.0
RECURRING			32.3	1,020.6	35.0	35,720.8	4,286.5	40,007.3
TOTAL	2,679.5	3,163.8	42.3	1,337.0	35.0	46,793.9	5,615.3	52,409.2

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (5)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	MATERIAL COSTS LCF	MATERIAL COSTS $K	TOTAL $K
				LCF							
PRODUCTION	2,679.5	795.9	60%	0.65	310.0	35.0	10,851.4	1,010.3	0.86	2,316.3	13,167.7
PREPRODUCTION	2,679.5	795.9	40%	% TOTAL						$K[3]	
NON - RECURRING				10.0	31.8	35.0	1,114.3	---	---	133.7	1,248.0
RECURRING				32.3	102.7	35.0	3,594.5	---	---	431.3	4,025.9
TOTAL	2,679.5	---	---	---	444.6	35.0	15,560.2	---	---	2,881.4	18,441.5

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (5)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	**2,679.5**	**1,292.6**	**45,241.7**	**69,624.4**	**114,866.0**
8	**2,679.5**	**1,337.0**	**46,793.9**	**5,615.3**	**52,409.2**
9	**2,679.5**	**444.6**	**15,560.2**	**2,881.4**	**18,441.5**
TOTAL	**2,679.5**	**3,074.2**	**107,595.8**	**78,121.0**	**185,716.8**

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED	1993	INFLATED	1994
	L TONS	KMHRS	MHRS/TON	ADJ FCTR[2]	MHRS/TON	$K 1977	$/TON 1977	INFL FCTR[3]	ADJ FCTR[2]	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	928.5	271.1	292.0		318.6	576.6	621.0	0.3892		1,638.9	1.0000	1,638.9
1B	105.0	51.2	488.0		532.5	302.4	2,880.0	0.3892		7,600.5	1.0000	7,600.5
1C	138.0	46.8	339.0		369.9	180.5	1,308.0	0.3892		3,451.9	1.0000	3,451.9
1D	63.5	12.3	194.0		211.7	490.3	7,721.0	0.3892		20,376.3	1.0000	20,376.3
SUBTOTAL/ AVERAGE	1,235.0	381.5	308.9	1.09	337.0	1,549.8	1,254.9	0.3892	1.03	3,311.7	1.0000	3,311.7
2A	128.5	59.8	465.0		498.0	5,706.3	44,407.0	0.3892		117,193.4	1.0000	117,193.4
2B	82.0	23.2	283.5		303.6	1,755.5	21,408.0	0.3892		56,497.3	1.0000	56,497.3
2C	29.0	9.1	315.5		337.9	452.3	15,597.5	0.3892		41,163.0	1.0000	41,163.0
2D	40.0	17.3	432.0		462.7	3,215.4	80,386.0	0.3892		212,144.7	1.0000	212,144.7
SUBTOTAL/ AVERAGE	279.5	109.4	391.5	1.07	419.3	11,129.5	39,819.4	0.3892	1.03	105,086.4	1.0000	105,086.4
3A	98.0	21.3	217.0		281.8	2,755.0	28,112.0	0.3892		74,189.7	1.0000	74,189.7
3B	97.0	162.7	1,677.5		2,178.7	2,045.0	21,082.0	0.3892		55,637.0	1.0000	55,637.0
SUBTOTAL/ AVERAGE	195.0	184.0	943.5	1.30	1,225.4	4,799.9	24,615.0	0.3892	1.03	64,960.9	1.0000	64,960.9
4A	34.5	28.3	820.0		1,235.2	914.3	26,500.0	0.3892		69,935.5	1.0000	69,935.5
4B	81.5	59.1	725.0		1,092.1	1,008.6	12,376.0	0.3892		32,661.2	1.0000	32,661.2
SUBTOTAL/ AVERAGE	116.0	87.4	753.3	1.51	1,134.7	1,922.9	16,576.7	0.3892	1.03	43,747.1	1.0000	43,747.1
5A	109.0	129.7	1,190.0		1,590.2	1,678.7	15,401.0	0.3892		40,644.4	1.0000	40,644.4
5B	241.0	191.6	795.0		1,062.3	5,136.7	21,314.0	0.3892		56,249.3	1.0000	56,249.3
5C	46.0	7.2	156.0		208.5	548.5	11,924.0	0.3892		31,468.3	1.0000	31,468.3
5D	51.0	14.3	280.0		374.2	436.1	8,550.0	0.3892		22,564.1	1.0000	22,564.1
SUBTOTAL/ AVERAGE	447.0	342.8	766.8	1.34	1,024.7	7,799.9	17,449.5	0.3892	1.03	46,050.6	1.0000	46,050.6
6A	27.0	22.5	833.0		859.2	327.7	12,136.0	0.3892		32,027.8	1.0000	32,027.8
6B	66.0	96.0	1,454.5		1,500.2	443.6	6,721.0	0.3892		17,737.2	1.0000	17,737.2
6C	95.0	145.0	1,526.0		1,574.0	445.4	4,688.0	0.3892		12,372.0	1.0000	12,372.0
6D	73.5	51.0	694.0		715.8	316.8	4,310.0	0.3892		11,374.4	1.0000	11,374.4
6E	52.5	42.0	800.0		825.1	810.8	15,443.0	0.3892		40,755.2	1.0000	40,755.2
SUBTOTAL/ AVERAGE	314.0	356.5	1,135.2	1.03	1,170.9	2,344.2	7,465.5	0.3892	1.03	19,702.0	1.0000	19,702.0
7	93.0	25.6	275.0	1.29	355.4	250.4	2,692.0	0.3892	1.03	7,104.4	1.0000	7,104.4
TOTAL GR 1-7	2,679.5	1,487.1	555.0	1.19	657.9	29,796.6 (1977)	11,120.2 (1977)					
						76,558.5 (1993)	28,572.0 (1993)	0.3892	1.03	29,347.1	1.0000	29,347.1

	WEIGHT	CER[4]		ADJ	ADJUSTED	MATERIAL COSTS					$/TON
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR[5]	% LAB $	$/TON 1993	INFL FCTR	1994
GROUP 8	2,679.5	3,163.8	1,180.7	100%	1,180.7	1,180.7	35.0	12%	4,959.1	1.0000	4,959.1

GROUP 9												
	WEIGHT	CER[4]		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL[6]	MHRS/TON	1977	1977	FCTR[3]	FCTR[2]	1993	1994	1994
PROD	2,679.5	795.9	297.0	60%	178.2	1,025.8	382.8	0.3892	1.03	1,010.3	1.0000	1,010.3
						MATERIAL COSTS						$/TON
						MHRS/TON	$/MHR[5]	% LABOR	$/TON 1993	INFL FCTR		1994
PREPROD	2,679.5	795.9	297.0	40%	118.8	118.8	35.0	12%	499.0	1.0000		499.0

1 - Based on FFG 7 data in Reference (2) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and FFG 7 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1977 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (5)
6 - Per Reference (6)

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	1235.0	416.3	416.3		4090.0
200	279.5	117.2	117.2		29371.7
300	195.0	239.0	239.0		12667.4
400	116.0	131.6	131.6		5074.7
500	447.0	458.0	458.0		20584.6
600	314.0	367.7	367.7		6186.4
700	93.0	33.1	33.1		660.7
TOTAL 1 - 7	2679.5	1762.8	1762.8		78635.4
900	REF. TO 1-7	795.9	795.9		4044.3
TOTAL 1 - 7, 9	2679.5	2558.7	2558.7		82679.7
800	REF. TO 1-7	3163.8	3163.8		13287.8
TOTAL 1 - 9	2679.5	5722.5	5722.5		95967.5
CER 1 - 7	2679.5	1507.1	1762.8		78635.4
CER 1 - 7, 9	2679.5	2606.8	2558.7		82679.7
CER 1 - 9	2679.5	5762.5	5722.5	81667.6	95967.5

1 - From Reference 4
2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

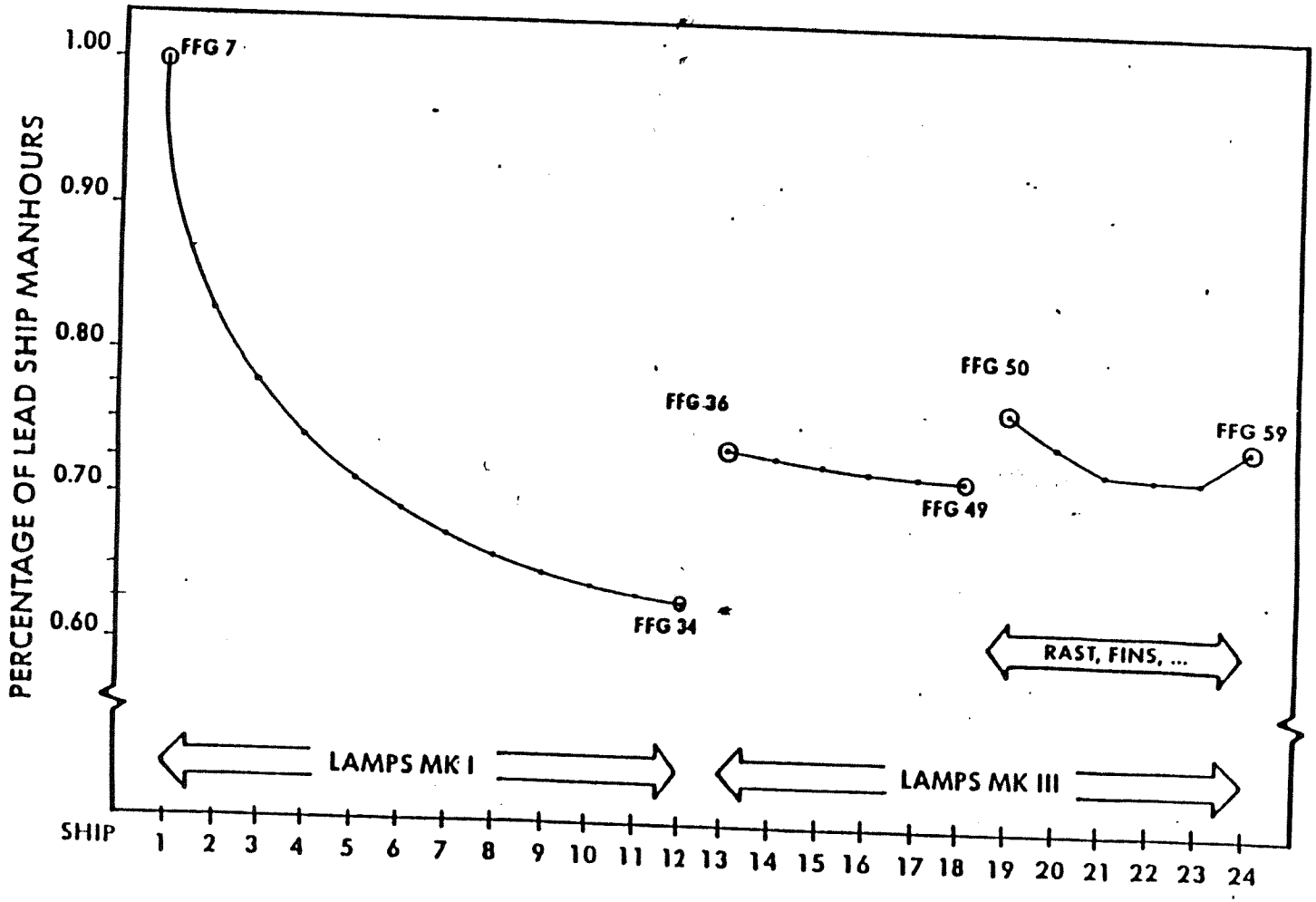
FFG36f SHIP TYPE: FFG36 MODEL USER: Eric Midboe

AUGUST
1992

FFG 7 CLASS

BIW

PRODUCTION MANHOUR PERFORMANCE



APPENDIX B

TWO DIGIT COST GROUPS SWBS BREAKDOWN

Appendix B
Two-Digit SWBS Distribution

The basic two-digit structure has been somewhat modified to take into account special systems costs and areas where the cost estimators data would not fit into the two-digit structure. These are outlined below.

SWBS 197 - Welding

This is apportioned between 1A, 1B, 1C, and 1D by the same percentage that the two-digit weight is of the total Group 1 weight.

SWBS 252 - Propulsion Control System

This is estimated separately from Group 2D because of the variety of automation systems that may be found on auxiliaries and amphibious vessels.

SWBS 475 - Degaussing

Degaussing is estimated separately from the rest of Group 4A because it is not found on all auxiliaries and its cost factor is different than that for the rest of Group 4A.

SWBS 639 - Radiation Shielding

This is not found in large quantitites on all auxilairies and has a higher cost factor. It is estimated as a function of weight.

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 1A

SWBS NO.	DESCRIPTION	WEIGHT
111	SHELL PLATING, SURF. SHIP AND SUBMARINE PRESS. HULL	
113	INNER BOTTOM	
114	SHELL APPENDAGES	
115	STANCHIONS	
116	LONGIT. FRAMING, SURF. SHIP AND SUBMARINE PRESS. HULL	
117	TRANSV. FRAMING, SURF. SHIP AND SUBMARINE PRESS. HULL	
121	LONGITUDINAL STRUCTURAL BULKHEADS	
122	TRANSVERSE STRUCTURAL BULKHEADS	
123	TRUNKS AND ENCLOSURES	
124	BULKHEADS IN TORPEDO PROTECTION SYSTEM	
131	MAIN DECK	
132	2ND DECK	
133	3RD DECK	
134	4TH DECK	
135	5TH DECK AND DECKS BELOW	
136	01 HULL DECK	
137	02 HULL DECK	
141	1ST PLATFORM	
142	2ND PLATFORM	
143	3RD PLATFORM	
144	4TH PLATFORM	
145	5TH PLATFORM	
149	FLATS	
166	SPONSONS	
197	WELDING (1A PERCENTAGE OF 197)	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 1B

SWBS NO.	DESCRIPTION	WEIGHT
151	DECKHOUSE STRUCTURE TO FIRST LEVEL	
152	1ST DECKHOUSE LEVEL	
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	
164	BALLISTIC PLATING	
197	WELDING (1B PERCENTAGE OF 197)	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 1C

SWBS NO.	DESCRIPTION	WEIGHT
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	
189	COMBAT SYSTEM ALIGNMENT	
197	WELDING (IC PERCENTAGE OF 197)	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 1D

SWBS NO.	DESCRIPTION	WEIGHT
161	STRUCTURAL CASTINGS, FORGINGS, AND EQUIV. WELDMENTS	
162	STACKS AND MACKS (COMBINED STACK AND MAST)	
163	SEA CHESTS	
165	SONAR DOMES	
167	HULL STRUCTURAL CLOSURES	
168	DECKHOUSE STRUCTURAL CLOSURES	
169	SPECIAL PURPOSE CLOSURES AND STRUCTURES	
171	MASTS, TOWERS, TETRAPODS	
172	KINGPOSTS AND SUPPORT FRAMES	
179	SERVICE PLATFORMS	
197	WELDING (1D PERCENTAGE OF 197)	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 2A

SWBS NO.	DESCRIPTION	WEIGHT
221	PROPULSION BOILERS	
222	GAS GENERATORS	
223	MAIN PROPULSION BATTERIES	
224	MAIN PROPULSION FUEL CELLS	
231	PROPULSION STEAM TURBINES	
232	PROPULSION STEAM ENGINES	
233	PROPULSION INTERNAL COMBUSTION ENGINES	
234	PROPULSION GAS TURBINES	
235	ELECTRIC PROPULSION	
236	SELF-CONTAINED PROPULSION SYSTEMS	
237	AUXILIARY PROPULSION DEVICES	
241	PROPULSION REDUCTION GEARS	
242	PROPULSION CLUTCHES AND COUPLINGS	
253	MAIN STEAM PIPING SYSTEM	
254	CONDENSERS AND AIR EJECTORS	
255	FEED AND CONDENSATE SYSTEM	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 2B

SWBS NO.	DESCRIPTION	WEIGHT
243	PROPULSION SHAFTING	
244	PROPULSION SHAFT BEARINGS	
245	PROPULSORS	
246	PROPULSOR SHROUDS AND DUCTS	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 2C

SWBS NO.	DESCRIPTION	WEIGHT
251	COMBUSTION AIR SYSTEM	
259	UPTAKES (INNER CASING)	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 2D

SWBS NO.	DESCRIPTION	WEIGHT
256	CIRCULATING AND COOLING SEA WATER SYSTEM	
258	H.P. STEAM DRAIN SYSTEM	
261	FUEL SERVICE SYSTEM	
262	MAIN PROPULSION LUBE OIL SYSTEM	
264	LUBE OIL FILL, TRANSFER, AND PURIFICATION	
252	PROPULSION CONTROL SYSTEM	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 3A

SWBS NO.	DESCRIPTION	WEIGHT
311	SHIP SERVICE POWER GENERATION	
312	EMERGENCY GENERATORS	
314	POWER CONVERSION EQUIPMENT	
342	DIESEL SUPPORT SYSTEMS	
343	TURBINE SUPPORT SYSTEMS	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 3B

SWBS NO.	DESCRIPTION	WEIGHT
313	BATTERIES AND SERVICE FACILITIES	
321	SHIP SERVICE POWER CABLE	
322	EMERGENCY POWER CABLE SYSTEM	
323	CASUALTY POWER CABLE SYSTEM	
324	SWITCHGEAR AND PANELS	
331	LIGHTING DISTRIBUTION	
332	LIGHTING FIXTURES	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 4A

SWBS NO.	DESCRIPTION	WEIGHT
421	NON-ELECTRICAL/ELECTRONIC NAVIGATION AIDS	
422	ELECTRICAL NAVIGATION AIDS (INCL NAVIG. LIGHTS)	
423	ELECTRONIC NAVIGATION SYSTEMS, RADIO	
424	ELECTRONIC NAVIGATION SYSTEMS, ACOUSTICAL	
426	ELECTRICAL NAVIGATION SYSTEMS	
427	INERTIAL NAVIGATION SYSTEMS	
428	NAVIGATION CONTROL MONITORING	
431	SWITCHBOARDS FOR I.C. SYSTEMS	
432	TELEPHONE SYSTEMS	
433	ANNOUNCING SYSTEMS	
434	ENTERTAINMENT AND TRAINING SYSTEMS	
435	VOICE TUBES AND MESSAGE PASSING SYSTEMS	
436	ALARM, SAFETY, AND WARNING SYSTEMS	
437	INDICATING, ORDER, AND METERING SYSTEMS	
438	INTEGRATED CONTROL SYSTEMS	
443	VISUAL AND AUDIBLE SYSTEMS	
473	TORPEDO DECOYS	
474	DECOYS (OTHER)	
476	MINE COUNTERMEASURES	
491	ELECTRONIC TEST, CHECKOUT, AND MONITORING EQUIPMENT	
492	FLIGHT CONTROL AND INSTRUMENT LANDING SYSTEMS	
493	NON COMBAT DATA PROCESSING SYSTEMS	
494	METEOROLOGICAL SYSTEMS	
495	SPECIAL PURPOSE INTELLIGENCE SYSTEMS	
475	DEGAUSSING	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 4B

SWBS NO.	DESCRIPTION	WEIGHT
411	DATA DISPLAY GROUP	
412	DATA PROCESSING GROUP	
413	DIGITAL DATA SWITCHBOARDS	
414	INTERFACE EQUIPMENT	
415	DIGITAL DATA COMMUNICATIONS	
417	COMMAND AND CONTROL ANALOG SWITCHBOARDS	
441	RADIO SYSTEMS	
442	UNDERWATER SYSTEMS	
444	TELEMETRY SYSTEMS	
445	TTY AND FACSIMILE SYSTEMS	
446	SECURITY EQUIPMENT SYSTEMS	
451	SURFACE SEARCH RADAR	
452	AIR SEARCH RADAR (2D)	
453	AIR SEARCH RADAR (3D)	
454	AIRCRAFT CONTROL APPROACH RADAR	
455	IDENTIFICATION SYSTEMS (IFF)	
456	MULTIPLE MODE RADAR	
459	SPACE VEHICLE ELECTRONIC TRACKING	
461	ACTIVE SONAR	
462	PASSIVE SONAR	
463	MULTIPLE MODE SONAR	
464	CLASSIFICATION SONAR	
465	BATHYTHERMOGRAPH	
471	ACTIVE ECM (INCL COMBINATION ACTIVE/PASSIVE)	
472	PASSIVE ECM	
481	GUN FIRE CONTROL SYSTEMS	
482	MISSILE FIRE CONTROL SYSTEMS	
483	UNDERWATER FIRE CONTROL SYSTEMS	
484	INTEGRATED FIRE CONTROL SYSTEMS	
489	WEAPON SYSTEMS SWITCHBOARDS	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 5A

SWBS NO.	DESCRIPTION	WEIGHT
511	COMPARTMENT HEATING SYSTEM	
512	VENTILATION SYSTEM	
513	MACHINERY SPACE VENTILATION SYSTEM	
514	AIR CONDITIONING SYSTEM	
517	AUXILIARY BOILERS AND OTHER HEAT SOURCES	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 5B

SWBS NO.	DESCRIPTION	WEIGHT
521	FIREMAIN AND FLUSHING (SEA WATER) SYSTEM	
522	SPRINKLER SYSTEM	
523	WASHDOWN SYSTEM	
524	AUXILIARY SEA WATER SYSTEM	
526	SCUPPERS AND DECK DRAINS	
557	FIREMAIN ACTUATED SERVICES - OTHER	
528	PLUMBING DRAINAGE	
529	DRAINAGE AND BALLASTING SYSTEM	
531	DISTILLING PLANT	
532	COOLING WATER	
533	POTABLE WATER	
534	AUX. STEAM AND DRAINS WITHIN MACHINERY BOX	
535	AUX. STEAM AND DRAINS OUTSIDE MACHINERY BOX	
536	AUXILIARY FRESH WATER COOLING	
541	SHIP FUEL AND FUEL COMPENSATING SYSTEM	
542	AVIATION AND GENERAL PURPOSE FUELS	
543	AVIATION AND GENERAL PURPOSE LUBRICATING OIL	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 5B (Continued)

SWBS NO.	DESCRIPTION	WEIGHT
544	LIQUID CARGO	
545	TANK HEATING	
549	SPECIAL FUEL AND LUBRICANTS, HANDLING AND STOWAGE	
551	COMPRESSED AIR SYSTEMS	
552	COMPRESSED GASES	
553	O_2N_2 SYSTEM	
554	LP BLOW	
555	FIRE EXTINGUISHING SYSTEMS	
556	HYDRAULIC FLUID SYSTEM	
557	LIQUID GASES, CARGO	
558	SPECIAL PIPING SYSTEMS	
565	TRIM AND HEEL SYSTEMS (SURFACE SHIPS)	
593	ENVIRONMENTAL POLLUTION CONTROL SYSTEMS	
594	SUBMARINE RESCUE, SALVAGE, AND SURVIVAL SYSTEMS	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 5C

SWBS NO.	DESCRIPTION	WEIGHT
561	STEERING AND DIVING CONTROL SYSTEMS	
562	RUDDER	
565	TRIM AND HEEL SYSTEMS	
568	MANEUVERING SYSTEMS	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 5D

SWBS NO.	DESCRIPTION	WEIGHT
571	REPLENISHMENT-AT-SEA SYSTEMS	
572	SHIP STORES AND EQUIPMENT HANDLING SYSTEMS	
573	CARGO HANDLING SYSTEMS	
770	CARGO MUNITIONS	
772	CARGO MUNITIONS HANDLING	
773	CARGO MUNITIONS STOWAGE	
574	VERTICAL REPLENISHMENT SYSTEMS	
581	ANCHOR HANDLING AND STOWAGE SYSTEMS	
582	MOORING AND TOWING SYSTEMS	
583	BOATS, BOAT HANDLING AND STOWAGE SYSTEMS	
584	MECHANICALLY OPERATED DOOR, GATE, RAMP, TURNTABLE SYSTEM	
585	ELEVATING AND RETRACTING GEAR	
588	AIRCRAFT HANDLING, SERVICING AND STOWAGE	
589	MISCELLANEOUS MECHANICAL HANDLING SYSTEMS	
592	SWIMMER AND DIVER SUPPORT AND PROTECTION SYSTEMS	
595	TOWING, LAUNCHING AND HANDLING FOR UNDERWATER SYSTEMS	
596	HANDLING SYSTEMS FOR DIVER AND SUBMERSIBLE VEHICLES	
597	SALVAGE SUPPORT SYSTEMS	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 6A

SWBS NO.	DESCRIPTION	WEIGHT
605	RODENT AND VERMIN PROOFING	
611	HULL FITTINGS	
612	RAILS, STANCHIONS, AND LIFELINES	
613	RIGGING AND CANVAS	
625	AIRPORTS, FIXED PORTLIGHTS, AND WINDOWS	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 6B

SWBS NO.	DESCRIPTION	WEIGHT
621	NON-STRUCTURAL BULKHEADS	
622	FLOOR PLATES AND GRATINGS	
623	LADDERS	
624	NON-STRUCTURAL CLOSURES	
637	SHEATHING	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 6C

SWBS NO.	DESCRIPTION	WEIGHT
602	HULL DESIGNATING AND MARKING	
603	DRAFT MARKS	
604	LOCKS, KEYS, AND TAGS	
631	PAINTING	
632	ZINC COATING	
633	CATHODIC PROTECTION	
634	DECK COVERING	
635	HULL INSULATION	
636	HULL DAMPING	
639	RADIATION SHIELDING	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 6D

SWBS NO.	DESCRIPTION	WEIGHT
654	UTILITY SPACES	
655	LAUNDRY SPACES	
656	TRASH DISPOSAL SPACES	
664	DAMAGE CONTROL STATIONS	
665	WORKSHOPS, LABS, TEST AREAS (INCLUDING PORTABLE TOOLS, EQUIPMENT)	
671	LOCKERS AND SPECIAL STOWAGE	
672	STOREROOMS AND ISSUE ROOMS	
673	CARGO STOWAGE	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 6E

SWBS NO.	DESCRIPTION	WEIGHT
638	REFRIGERATED SPACES	
641	OFFICER BERTHING AND MESSING SPACES	
642	NONCOMMISSIONED OFFICER BERTHING AND MESSING SPACES	
643	ENLISTED PERSONNEL BERTHING AND MESSING SPACES	
644	SANITARY SPACES AND FIXTURES	
645	LEISURE AND COMMUNITY SPACES	
651	COMMISSARY SPACES	
652	MEDICAL SPACES	
653	DENTAL SPACES	
661	OFFICES	
662	MACHINERY CONTROL CENTERS FURNISHINGS	
663	ELECTRONICS CONTROL CENTERS FURNISHINGS	

APPENDIX B
TWO-DIGIT SWBS DISTRIBUTION

COST GROUP: 7

SWBS NO.	DESCRIPTION	WEIGHT
701	GENERAL ARRANGEMENT - WEAPONRY SYSTEMS	
711	GUNS	
712	AMMUNITION HANDLING	
713	AMMUNITION STOWAGE	
721	LAUNCHING DEVICES (MISSILES AND ROCKETS)	
722	MISSILE, ROCKET, AND GUIDANCE CAPSULE HANDLING SYSTEM	
723	MISSILE AND ROCKET STOWAGE	
724	MISSILE HYDRAULICS	
725	MISSILE GAS	
726	MISSILE COMPENSATING	
727	MISSILE LAUNCHER CONTROL	
728	MISSILE HEATING, COOLING, TEMPERATURE CONTROL	
729	MISSILE MONITORING, TEST AND ALIGNMENT	
731	MINE LAUNCHING DEVICES	
732	MINE HANDLING	
733	MINE STOWAGE	
741	DEPTH CHARGE LAUNCHING DEVICES	
742	DEPTH CHARGE HANDLING	
743	DEPTH CHARGE STOWAGE	
751	TORPEDO TUBES	
752	TORPEDO HANDLING	
753	TORPEDO STOWAGE	
754	SUBMARINE TORPEDO EJECTION	
761	SMALL ARMS AND PYROTECHNIC LAUNCHING DEVICES	
762	SMALL ARMS AND PYROTECHNIC HANDLING	
763	SMALL ARMS AND PYROTECHNIC STOWAGE	
782	AIRCRAFT RELATED WEAPONS HANDLING	
783	AIRCRAFT RELATED WEAPONS STOWAGE	
792	SPECIAL WEAPONS HANDLING	
793	SPECIAL WEAPONS STOWAGE	
797	MISCELLANEOUS ORDNANCE SPACES	

APPENDIX C

FFG 7, CG 51, AD 41, LST 1182, AOR 7, AO 180 SUMMARIES

DATA ENTRY SHEET

SURFACE COMBATANTS

SHIP TYPE: FFG 7 FILE NAME: FFGCOM
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 01/31/95 DATA SOURCE:
REV #: 1

MAJOR UPGRADE (1-YES, 2-NO):	1	ENTER THE BASELINE LABOR "SLOPE"[1]:	99
THE NUMBER OF SHIPS BUILT IN THE YAR	1	ENTER THE BASELINE MAT'L "SLOPE"[1]:	100

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[1]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	928.5	100	1.00	100	1.00	35.0	1	
1B	SUPERSTRUCTURE	105.0	100	1.00	100	1.00	35.0	1	
1C	FOUNDATIONS	138.0	100	1.00	100	1.00	35.0	1	
1D	STRUCTURAL ATTACHMENTS	63.5	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	HULL STRUCTURE	1,235.0	100	1.00	100	1.00	35.0	1	
					0				
2A	PROPULSION ENERGY SYSTEMS	128.5	100	1.00	100	1.00	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	82.0	100	1.00	100	1.00	35.0	1	
2C	PROPULSION GASES SYSTEMS	29.0	100	1.00	100	1.00	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	40.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	PROPULSION PLANT	279.5	100	1.00	100	1.00	35.0	1	
3A	ELECTRICAL POWER GENERATION	98.0	100	1.00	100	1.00	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	97.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	ELECTRIC PLANT	195.0	100	1.00	100	1.00	35.0	1	
4A	VEHICLE COMMAND	34.5	100	1.00	100	1.00	35.0	1	
4B	WEAPONS COMMAND	81.5	100	1.00	100	1.00	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	116.0	100	1.00	100	1.00	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	109.0	100	1.00	100	1.00	35.0	1	
5B	FLUID SYSTEMS	241.0	100	1.00	100	1.00	35.0	1	
5C	MANEUVERING SYSTEMS	46.0	100	1.00	100	1.00	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	51.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	447.0	100	1.00	100	1.00	35.0	1	
		0.0							
6A	HULL FITTINGS	27.0	100	1.00	100	1.00	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	66.0	100	1.00	100	1.00	35.0	1	
6C	PRESERVATION	95.0	100	1.00	100	1.00	35.0	1	
6D	SHIP SUPPORT	73.5	100	1.00	100	1.00	35.0	1	
6E	HABITABILITY	52.5	100	1.00	100	1.00	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	314.0	100	1.00	100	1.00	35.0	1	
7	ARMAMENT	93.0	100	1.00	100	1.00	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	2,679.5	100.00	1.00	100	1.00	35.0	1	
8	INTEGRATION/ENGINEERING	WEIGHT L TONS	% OF LEAD SHIP GR 8[7]				MHR RATE[4]		
	RECURRING	2,679.5			10.00		35.0		
	NON-RECURRING	2,679.5			90.00		35.0		
9	SHIP ASSEMBLY AND SUPPORT SERVICES	WEIGHT L TONS	LABOR "SLOPE"[2]		MAT "SLOPE"[3]		MHR RATE[4]		
	PRODUCTION:	2,679.5	100		100		35.0		
	PREPROD.:		% OF LEAD SHIP GR 9[5]						
	RECURRING	2,679.5			10.00		35.0		
	NON-RECURRING	2,679.5			90.00		35.0		

NOTES:

1 - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

2 - Use cost and weight groups per Reference (2)

3 - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

4 - Use fully burdened rate

5 - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

6 - Use inflation factor per Reference (3)

7 - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	928.5	318.6	1.00	295.85	35.0	10355	1,638.9	1.00	1,521.7	11,876.3
1B	105.0	532.5	1.00	55.91	35.0	1957	7,600.5	1.00	798.1	2,755.0
1C	138.0	369.9	1.00	51.05	35.0	1787	3,451.9	1.00	476.4	2,263.1
1D	63.5	211.7	1.00	13.44	35.0	470	20,376.3	1.00	1,293.9	1,764.4
SUBTOTAL	1,235.0	337.0	1.00	416.25	35.0	14569	3,311.7	1.00	4,090.0	18,658.8
2A	128.5	498.0	1.00	64.00	35.0	2240	117,193.4	1.00	15,059.4	17,299.3
2B	82.0	303.6	1.00	24.90	35.0	871	56,497.3	1.00	4,632.8	5,504.2
2C	29.0	337.9	1.00	9.80	35.0	343	41,163.0	1.00	1,193.7	1,536.7
2D	40.0	462.7	1.00	18.51	35.0	648	212,144.7	1.00	8,485.8	9,133.6
SUBTOTAL	279.5	419.3	1.00	117.20	35.0	4102	105,086.4	1.00	29,371.7	33,473.8
3A	98.0	281.8	1.00	27.62	35.0	967	74,189.7	1.00	7,270.6	8,237.3
3B	97.0	2,178.7	1.00	211.33	35.0	7397	55,637.0	1.00	5,396.8	12,793.4
SUBTOTAL	195.0	1,225.4	1.00	238.95	35.0	8363	64,960.9	1.00	12,667.4	21,030.6
4A	34.5	1,235.2	1.00	42.62	35.0	1492	69,935.5	1.00	2,412.8	3,904.3
4B	81.5	1,092.1	1.00	89.01	35.0	3115	32,661.2	1.00	2,661.9	5,777.2
SUBTOTAL	116.0	1,134.7	1.00	131.62	35.0	4607	43,747.1	1.00	5,074.7	9,681.5
5A	109.0	1,590.2	1.00	173.33	35.0	6067	40,644.4	1.00	4,430.2	10,496.8
5B	241.0	1,062.3	1.00	256.03	35.0	8961	56,249.3	1.00	13,556.1	22,517.0
5C	46.0	208.5	1.00	9.59	35.0	336	31,468.3	1.00	1,447.5	1,783.2
5D	51.0	374.2	1.00	19.08	35.0	668	22,564.1	1.00	1,150.8	1,818.6
SUBTOTAL	447.0	1,024.7	1.00	458.03	35.0	16031	46,050.6	1.00	20,584.6	36,615.6
6A	27.0	859.2	1.00	23.20	35.0	812	32,027.8	1.00	864.8	1,676.7
6B	66.0	1,500.2	1.00	99.01	35.0	3466	17,737.2	1.00	1,170.7	4,636.2
6C	95.0	1,574.0	1.00	149.53	35.0	5233	12,372.0	1.00	1,175.3	6,408.8
6D	73.5	715.8	1.00	52.61	35.0	1841	11,374.4	1.00	836.0	2,677.5
6E	52.5	825.1	1.00	43.32	35.0	1516	40,755.2	1.00	2,139.7	3,655.9
SUBTOTAL	314.0	1,170.9	1.00	367.67	35.0	12869	19,702.0	1.00	6,186.4	19,054.9
7	93.0	355.4	1.00	33.05	35.0	1157	7,104.4	1.00	660.7	1,817.5
TOTAL 1-7	2,679.5	657.9	1.00	1,762.8	35.0	61697	29,347.1	1.00	78,635.4	140,332.6

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	2,679.5	3,163.8						
NON - RECURRING			10.0	316.4	35.0	11,073.2	1,328.8	12,402.0
RECURRING			90.0	2,847.4	35.0	99,658.6	11,959.0	111,617.6
TOTAL	2,679.5	3,163.8	100.0	3,163.8	35.0	110,731.8	13,287.8	124,019.6

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (5)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	MATERIAL COSTS LCF	MATERIAL COSTS $K	TOTAL $K
				LCF							
PRODUCTION	2,679.5	795.9	60%	1.00	477.5	35.0	16,714.1	1,010.3	1.00	2,707.1	19,421.3
PREPRODUCTION	2,679.5	795.9	40%	% TOTAL						$K[3]	
NON - RECURRING				10.0	31.8	35.0	1,114.3	---	---	133.7	1,248.0
RECURRING				90.0	286.5	35.0	10,028.5	---	---	1,203.4	11,231.9
TOTAL	2,679.5	---	---	---	795.9	35.0	27,856.9	---	---	4,044.3	31,901.2

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (5)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	2,679.5	1,762.8	61,697.2	78,635.4	140,332.6
8	2,679.5	3,163.8	110,731.8	13,287.8	124,019.6
9	2,679.5	795.9	27,856.9	4,044.3	31,901.2
TOTAL	2,679.5	5,722.5	200,285.9	95,967.5	296,253.4

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED	1993	INFLATED	1994
	L TONS	KMHRS	MHRS/TON	ADJ FCTR[2]	MHRS/TON	$K 1977	$/TON 1977	INFL FCTR[3]	ADJ FCTR[2]	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	928.5	271.1	292.0		318.6	576.6	621.0	0.3892		1,638.9	1.0000	1,638.9
1B	105.0	51.2	488.0		532.5	302.4	2,880.0	0.3892		7,600.5	1.0000	7,600.5
1C	138.0	46.8	339.0		369.9	180.5	1,308.0	0.3892		3,451.9	1.0000	3,451.9
1D	63.5	12.3	194.0		211.7	490.3	7,721.0	0.3892		20,376.3	1.0000	20,376.3
SUBTOTAL/ AVERAGE	1,235.0	381.5	308.9	1.09	337.0	1,549.8	1,254.9	0.3892	1.03	3,311.7	1.0000	3,311.7
2A	128.5	59.8	465.0		498.0	5,706.3	44,407.0	0.3892		117,193.4	1.0000	117,193.4
2B	82.0	23.2	283.5		303.6	1,755.5	21,408.0	0.3892		56,497.3	1.0000	56,497.3
2C	29.0	9.1	315.5		337.9	452.3	15,597.5	0.3892		41,163.0	1.0000	41,163.0
2D	40.0	17.3	432.0		462.7	3,215.4	80,386.0	0.3892		212,144.7	1.0000	212,144.7
SUBTOTAL/ AVERAGE	279.5	109.4	391.5	1.07	419.3	11,129.5	39,819.4	0.3892	1.03	105,086.4	1.0000	105,086.4
3A	98.0	21.3	217.0		281.8	2,755.0	28,112.0	0.3892		74,189.7	1.0000	74,189.7
3B	97.0	162.7	1,677.5		2,178.7	2,045.0	21,082.0	0.3892		55,637.0	1.0000	55,637.0
SUBTOTAL/ AVERAGE	195.0	184.0	943.5	1.30	1,225.4	4,799.9	24,615.0	0.3892	1.03	64,960.9	1.0000	64,960.9
4A	34.5	28.3	820.0		1,235.2	914.3	26,500.0	0.3892		69,935.5	1.0000	69,935.5
4B	81.5	59.1	725.0		1,092.1	1,008.6	12,376.0	0.3892		32,661.2	1.0000	32,661.2
SUBTOTAL/ AVERAGE	116.0	87.4	753.3	1.51	1,134.7	1,922.9	16,576.7	0.3892	1.03	43,747.1	1.0000	43,747.1
5A	109.0	129.7	1,190.0		1,590.2	1,678.7	15,401.0	0.3892		40,644.4	1.0000	40,644.4
5B	241.0	191.6	795.0		1,062.3	5,136.7	21,314.0	0.3892		56,249.3	1.0000	56,249.3
5C	46.0	7.2	156.0		208.5	548.5	11,924.0	0.3892		31,468.3	1.0000	31,468.3
5D	51.0	14.3	280.0		374.2	436.1	8,550.0	0.3892		22,564.1	1.0000	22,564.1
SUBTOTAL/ AVERAGE	447.0	342.8	766.8	1.34	1,024.7	7,799.9	17,449.5	0.3892	1.03	46,050.6	1.0000	46,050.6
6A	27.0	22.5	833.0		859.2	327.7	12,136.0	0.3892		32,027.8	1.0000	32,027.8
6B	66.0	96.0	1,454.5		1,500.2	443.6	6,721.0	0.3892		17,737.2	1.0000	17,737.2
6C	95.0	145.0	1,526.0		1,574.0	445.4	4,688.0	0.3892		12,372.0	1.0000	12,372.0
6D	73.5	51.0	694.0		715.8	316.8	4,310.0	0.3892		11,374.4	1.0000	11,374.4
6E	52.5	42.0	800.0		825.1	810.8	15,443.0	0.3892		40,755.2	1.0000	40,755.2
SUBTOTAL/ AVERAGE	314.0	356.5	1,135.2	1.03	1,170.9	2,344.2	7,465.5	0.3892	1.03	19,702.0	1.0000	19,702.0
7	93.0	25.6	275.0	1.29	355.4	250.4	2,692.0	0.3892	1.03	7,104.4	1.0000	7,104.4
TOTAL GR 1-7	2,679.5	1,487.1	555.0	1.19	657.9	29,796.6 (1977)	11,120.2 (1977)					
						76,558.5 (1993)	28,572.0 (1993)	0.3892	1.03	29,347.1	1.0000	29,347.1

	WEIGHT	CER[4]		ADJ	ADJUSTED	MATERIAL COSTS					
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR[5]	% LAB $	$/TON 1993	INFL FCTR	$/TON 1994
GROUP 8	2,679.5	3,163.8	1,180.7	100%	1,180.7	1,180.7	35.0	12%	4,959.1	1.0000	4,959.1

GROUP 9												
	WEIGHT	CER[4]		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL[6]	MHRS/TON	1977	1977	FCTR[3]	FCTR[2]	1993	1994	1994
PROD	2,679.5	795.9	297.0	60%	178.2	1,025.8	382.8	0.3892	1.03	1,010.3	1.0000	1,010.3
						MHRS/TON	$/MHR[5]	% LABOR	$/TON 1993	INFL FCTR	$/TON 1994	
PREPROD	2,679.5	795.9	297.0	40%	118.8	118.8	35.0	12%	499.0	1.0000	499.0	

1 - Based on FFG 7 data in Reference (2) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and FFG 7 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1977 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (5)
6 - Per Reference (6)

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	1235.0	416.3	416.3		4090.0
200	279.5	117.2	117.2		29371.7
300	195.0	239.0	239.0		12667.4
400	116.0	131.6	131.6		5074.7
500	447.0	458.0	458.0		20584.6
600	314.0	367.7	367.7		6186.4
700	93.0	33.1	33.1		660.7
TOTAL 1 - 7	2679.5	1762.8	1762.8		78635.4
900	REF. TO 1-7	795.9	795.9		4044.3
TOTAL 1 - 7, 9	2679.5	2558.7	2558.7		82679.7
800	REF. TO 1-7	3163.8	3163.8		13287.8
TOTAL 1 - 9	2679.5	5722.5	5722.5		95967.5
CER 1 - 7	2679.5	1507.1	1762.8		78635.4
CER 1 - 7, 9	2679.5	2606.8	2558.7		82679.7
CER 1 - 9	2679.5	5762.5	5722.5	81667.6	95967.5

1 - From Reference 4
2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

FFGCOM SHIP TYPE: FFG 7 MODEL USER: Eric Midboe

DATA ENTRY SHEET

SURFACE COMBATANTS

SHIP TYPE: CG51 FILE NAME: CG51f
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 03/22/95 DATA SOURCE:
REV #:

MAJOR UPGRADE (1-YES, 2-NO):	1	ENTER THE BASELINE LABOR "SLOPE"[1]:	99
THE NUMBER OF SHIPS BUILT IN THE YAR	1	ENTER THE BASELINE MAT'L "SLOPE"[1]:	100

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[1]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	2,300.0	100	1.00	100	1.00	35.0	1	
1B	SUPERSTRUCTURE	435.0	100	1.00	100	1.00	35.0	1	
1C	FOUNDATIONS	434.0	100	1.00	100	1.00	35.0	1	
1D	STRUCTURAL ATTACHMENTS	273.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	HULL STRUCTURE	3,442.0	100	1.00	100	1.00	35.0	1	
					0				
2A	PROPULSION ENERGY SYSTEMS	233.0	100	1.00	100	1.00	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	314.0	100	1.00	100	1.00	35.0	1	
2C	PROPULSION GASES SYSTEMS	65.0	100	1.00	100	1.00	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	58.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	PROPULSION PLANT	670.0	100	1.00	100	1.00	35.0	1	
3A	ELECTRICAL POWER GENERATION	135.5	100	1.00	100	1.00	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	240.5	100	1.00	100	1.00	35.0	1	
SUBTOTAL	ELECTRIC PLANT	376.0	100	1.00	100	1.00	35.0	1	
4A	VEHICLE COMMAND	139.0	100	1.00	100	1.00	35.0	1	
4B	WEAPONS COMMAND	257.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	396.0	100	1.00	100	1.00	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	280.0	100	1.00	100	1.00	35.0	1	
5B	FLUID SYSTEMS	399.0	100	1.00	100	1.00	35.0	1	
5C	MANEUVERING SYSTEMS	73.0	100	1.00	100	1.00	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	180.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	932.0	100	1.00	100	1.00	35.0	1	
6A	HULL FITTINGS	15.0	100	1.00	100	1.00	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	88.0	100	1.00	100	1.00	35.0	1	
6C	PRESERVATION	231.0	100	1.00	100	1.00	35.0	1	
6D	SHIP SUPPORT	109.0	100	1.00	100	1.00	35.0	1	
6E	HABITABILITY	139.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	582.0	100	1.00	100	1.00	35.0	1	
7	ARMAMENT	346.0	100	1.00	100	1.00	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	6,744.0	100.00	1.00	100	1.00	35.0	1	
		WEIGHT					MHR		
8	INTEGRATION/ENGINEERING	L TONS	% OF LEAD SHIP GR 8[7]				RATE[4]		
	RECURRING	6,744.0			10.00		35.0		
	NON-RECURRING	6,744.0			90.00		35.0		
		WEIGHT	LABOR		MAT		MHR		
9	SHIP ASSEMBLY AND SUPPORT SERVICES	L TONS	"SLOPE"[2]		"SLOPE"[3]		RATE[4]		
	PRODUCTION:	6,744.0	100		100		35.0		
	PREPROD.:		% OF LEAD SHIP GR 9[5]						
	RECURRING	6,744.0			10.00		35.0		
	NON-RECURRING	6,744.0			90.00		35.0		

NOTES:

1 - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

2 - Use cost and weight groups per Reference (2)

3 - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

4 - Use fully burdened rate

5 - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

6 - Use inflation factor per Reference (3)

7 - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	2,300.0	318.6	1.00	732.85	35.0	25650	1,638.9	1.00	3,769.4	29,419.0
1B	435.0	532.5	1.00	231.64	35.0	8107	7,600.5	1.00	3,306.2	11,413.6
1C	434.0	369.9	1.00	160.54	35.0	5619	3,451.9	1.00	1,498.1	7,117.1
1D	273.0	211.7	1.00	57.79	35.0	2023	20,376.3	1.00	5,562.7	7,585.4
SUBTOTAL	3,442.0	337.0	1.00	1182.82	35.0	41399	3,311.7	1.00	14,136.5	55,535.2
2A	233.0	498.0	1.00	116.04	35.0	4061	117,193.4	1.00	27,306.1	31,367.5
2B	314.0	303.6	1.00	95.34	35.0	3337	56,497.3	1.00	17,740.2	21,077.2
2C	65.0	337.9	1.00	21.96	35.0	769	41,163.0	1.00	2,675.6	3,444.3
2D	58.0	462.7	1.00	26.84	35.0	939	212,144.7	1.00	12,304.4	13,243.7
SUBTOTAL	670.0	419.3	1.00	260.19	35.0	9106	105,086.4	1.00	60,026.2	69,132.7
3A	135.5	281.8	1.00	38.19	35.0	1337	74,189.7	1.00	10,052.7	11,389.3
3B	240.5	2,178.7	1.00	523.97	35.0	18339	55,637.0	1.00	13,380.7	31,719.6
SUBTOTAL	376.0	1,225.4	1.00	562.16	35.0	19676	64,960.9	1.00	23,433.4	43,108.9
4A	139.0	1,235.2	1.00	171.70	35.0	6009	69,935.5	1.00	9,721.0	15,730.4
4B	257.0	1,092.1	1.00	280.68	35.0	9824	32,661.2	1.00	8,393.9	18,217.6
SUBTOTAL	396.0	1,134.7	1.00	452.37	35.0	15833	43,747.1	1.00	18,115.0	33,948.1
5A	280.0	1,590.2	1.00	445.25	35.0	15584	40,644.4	1.00	11,380.4	26,964.2
5B	399.0	1,062.3	1.00	423.88	35.0	14836	56,249.3	1.00	22,443.5	37,279.1
5C	73.0	208.5	1.00	15.22	35.0	533	31,468.3	1.00	2,297.2	2,829.8
5D	180.0	374.2	1.00	67.35	35.0	2357	22,564.1	1.00	4,061.5	6,418.7
SUBTOTAL	932.0	1,024.7	1.00	951.69	35.0	33309	46,050.6	1.00	40,182.6	73,491.9
6A	15.0	859.2	1.00	12.89	35.0	451	32,027.8	1.00	480.4	931.5
6B	88.0	1,500.2	1.00	132.02	35.0	4621	17,737.2	1.00	1,560.9	6,181.6
6C	231.0	1,574.0	1.00	363.59	35.0	12726	12,372.0	1.00	2,857.9	15,583.5
6D	109.0	715.8	1.00	78.02	35.0	2731	11,374.4	1.00	1,239.8	3,970.6
6E	139.0	825.1	1.00	114.70	35.0	4014	40,755.2	1.00	5,665.0	9,679.3
SUBTOTAL	582.0	1,170.9	1.00	701.21	35.0	24542	19,702.0	1.00	11,804.0	36,346.5
7	346.0	355.4	1.00	122.96	35.0	4304	7,104.4	1.00	2,458.1	6,761.9
TOTAL 1-7	6,744.0	657.9	1.00	4,233.4	35.0	148169	29,347.1	1.00	170,155.8	318,325.1

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	6,744.0	8,325.7						
NON - RECURRING			10.0	832.6	35.0	29,139.9	3,496.8	32,636.7
RECURRING			90.0	7,493.1	35.0	262,258.9	31,471.1	293,730.0
TOTAL	6,744.0	8,325.7	100.0	8,325.7	35.0	291,398.8	34,967.9	326,366.7

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (5)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	LCF	$K	TOTAL $K
PRODUCTION	6,744.0	1,844.6	60%	LCF 1.00	1,106.7	35.0	38,735.6	1,010.3	1.00	6,813.6	45,549.2
PREPRODUCTION	6,744.0	1,844.6	40%	% TOTAL						$K[3]	
NON - RECURRING				10.0	73.8	35.0	2,582.4	---	---	309.9	2,892.3
RECURRING				90.0	664.0	35.0	23,241.4	---	---	2,789.0	26,030.3
TOTAL	6,744.0	---	---	---	1,844.6	35.0	64,559.3	---	---	9,912.4	74,471.7

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (5)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	**6,744.0**	**4,233.4**	**148,169.2**	**170,155.8**	**318,325.1**
8	**6,744.0**	**8,325.7**	**291,398.8**	**34,967.9**	**326,366.7**
9	**6,744.0**	**1,844.6**	**64,559.3**	**9,912.4**	**74,471.7**
TOTAL	**6,744.0**	**14,403.6**	**504,127.4**	**215,036.1**	**719,163.5**

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED	1993	INFLATED	1994
	L TONS	KMHRS	MHRS/TON	ADJ FCTR[2]	MHRS/TON	$K 1977	$/TON 1977	INFL FCTR[3]	ADJ FCTR[2]	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	928.5	271.1	292.0		318.6	576.6	621.0	0.3892		1,638.9	1.0000	1,638.9
1B	105.0	51.2	488.0		532.5	302.4	2,880.0	0.3892		7,600.5	1.0000	7,600.5
1C	138.0	46.8	339.0		369.9	180.5	1,308.0	0.3892		3,451.9	1.0000	3,451.9
1D	63.5	12.3	194.0		211.7	490.3	7,721.0	0.3892		20,376.3	1.0000	20,376.3
SUBTOTAL/ AVERAGE	1,235.0	381.5	308.9	1.09	337.0	1,549.8	1,254.9	0.3892	1.03	3,311.7	1.0000	3,311.7
2A	128.5	59.8	465.0		498.0	5,706.3	44,407.0	0.3892		117,193.4	1.0000	117,193.4
2B	82.0	23.2	283.5		303.6	1,755.5	21,408.0	0.3892		56,497.3	1.0000	56,497.3
2C	29.0	9.1	315.5		337.9	452.3	15,597.5	0.3892		41,163.0	1.0000	41,163.0
2D	40.0	17.3	432.0		462.7	3,215.4	80,386.0	0.3892		212,144.7	1.0000	212,144.7
SUBTOTAL/ AVERAGE	279.5	109.4	391.5	1.07	419.3	11,129.5	39,819.4	0.3892	1.03	105,086.4	1.0000	105,086.4
3A	98.0	21.3	217.0		281.8	2,755.0	28,112.0	0.3892		74,189.7	1.0000	74,189.7
3B	97.0	162.7	1,677.5		2,178.7	2,045.0	21,082.0	0.3892		55,637.0	1.0000	55,637.0
SUBTOTAL/ AVERAGE	195.0	184.0	943.5	1.30	1,225.4	4,799.9	24,615.0	0.3892	1.03	64,960.9	1.0000	64,960.9
4A	34.5	28.3	820.0		1,235.2	914.3	26,500.0	0.3892		69,935.5	1.0000	69,935.5
4B	81.5	59.1	725.0		1,092.1	1,008.6	12,376.0	0.3892		32,661.2	1.0000	32,661.2
SUBTOTAL/ AVERAGE	116.0	87.4	753.3	1.51	1,134.7	1,922.9	16,576.7	0.3892	1.03	43,747.1	1.0000	43,747.1
5A	109.0	129.7	1,190.0		1,590.2	1,678.7	15,401.0	0.3892		40,644.4	1.0000	40,644.4
5B	241.0	191.6	795.0		1,062.3	5,136.7	21,314.0	0.3892		56,249.3	1.0000	56,249.3
5C	46.0	7.2	156.0		208.5	548.5	11,924.0	0.3892		31,468.3	1.0000	31,468.3
5D	51.0	14.3	280.0		374.2	436.1	8,550.0	0.3892		22,564.1	1.0000	22,564.1
SUBTOTAL/ AVERAGE	447.0	342.8	766.8	1.34	1,024.7	7,799.9	17,449.5	0.3892	1.03	46,050.6	1.0000	46,050.6
6A	27.0	22.5	833.0		859.2	327.7	12,136.0	0.3892		32,027.8	1.0000	32,027.8
6B	66.0	96.0	1,454.5		1,500.2	443.6	6,721.0	0.3892		17,737.2	1.0000	17,737.2
6C	95.0	145.0	1,526.0		1,574.0	445.4	4,688.0	0.3892		12,372.0	1.0000	12,372.0
6D	73.5	51.0	694.0		715.8	316.8	4,310.0	0.3892		11,374.4	1.0000	11,374.4
6E	52.5	42.0	800.0		825.1	810.8	15,443.0	0.3892		40,755.2	1.0000	40,755.2
SUBTOTAL/ AVERAGE	314.0	356.5	1,135.2	1.03	1,170.9	2,344.2	7,465.5	0.3892	1.03	19,702.0	1.0000	19,702.0
7	93.0	25.6	275.0	1.29	355.4	250.4	2,692.0	0.3892	1.03	7,104.4	1.0000	7,104.4
TOTAL GR 1-7	2,679.5	1,487.1	555.0	1.19	657.9	29,796.6 (1977)	11,120.2 (1977)					
						76,558.5 (1993)	28,572.0 (1993)	0.3892	1.03	29,347.1	1.0000	29,347.1

	WEIGHT	CER[4]		ADJ	ADJUSTED	MATERIAL COSTS					$/TON
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR[5]	% LAB $	$/TON 1993	INFL FCTR	1994
GROUP 8	2,679.5	3,163.8	1,180.7	100%	1,180.7	1,180.7	35.0	12%	4,959.1	1.0000	4,959.1

GROUP 9												
	WEIGHT	CER[4]		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL[6]	MHRS/TON	1977	1977	FCTR[3]	FCTR[2]	1993	1994	1994
PROD	2,679.5	795.9	297.0	60%	178.2	1,025.8	382.8	0.3892	1.03	1,010.3	1.0000	1,010.3

	MATERIAL COSTS					$/TON
	MHRS/TON	$/MHR[5]	% LABOR	$/TON 1993	INFL FCTR	1994
PREPROD	118.8	35.0	12%	499.0	1.0000	499.0

1 - Based on FFG 7 data in Reference (2) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and FFG 7 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1977 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (5)
6 - Per Reference (6)

SWBS GROUP	WEIGHT	LABOR COSTS		MATERIAL COSTS	
		CER'S[1]	UPGRADE[2]	CER'S[1]	UPGRADE[2]
	LT	KMHRS	KMHRS	$K 1994	$K 1994
100	3442.0	1100.4	1182.8		14136.5
200	670.0	208.6	260.2		60026.2
300	376.0	718.6	562.2		23433.4
400	396.0	268.5	452.4		18115.0
500	932.0	1011.4	951.7		40182.6
600	582.0	916.5	701.2		11804.0
700	346.0	110.7	123.0		2458.1
TOTAL 1 - 7	6744.0	4334.8	4233.4		170155.8
900	REF. TO 1-7	1844.6	1844.6		9912.4
TOTAL 1 - 7, 9	6744.0	6179.4	6078.0		180068.2
800	REF. TO 1-7	8325.7	8325.7		34967.9
TOTAL 1 - 9	6744.0	14505.0	14403.6		215036.1
CER 1 - 7	6744.0	4226.2	4233.4		170155.8
CER 1 - 7, 9	6744.0	6236.4	6078.0		180068.2
CER 1 - 9	6744.0	14541.8	14403.6	231647.6	215036.1

1 - From Reference 4
2 - This comparison assumes no learning curve (slope and LCF equal 1 (Lead Ship))

CG51f SHIP TYPE: CG51 MODEL USER: Eric Midboe

DATA ENTRY SHEET

AMPHIBIOUS SHIPS

SHIP TYPE: AD41 FILE NAME: AD41f
ESTIMATE YEAR: 1994 MODEL USER: Eric Midboe
INITIAL ENTRY DATE: 03/22/95 DATA SOURCE:
REV #:

MAJOR UPGRADE (1-YES, 2-NO):	1	ENTER THE BASELINE LABOR "SLOPE"[1]:	99
THE NUMBER OF SHIPS BUILT IN THE YAR	1	ENTER THE BASELINE MAT'L "SLOPE"[1]:	100

ENTER WEIGHT DISTRIBUTION (IN LT) AND "SLOPE" (IN %) OF THE LEARNING CURVE HERE:

COST GROUP[2]	TITLE	WEIGHT L TONS[2]	LABOR "SLOPE"[1]	LABOR LCF	MAT'L "SLOPE"[3]	MAT'L LCF	MHR RATE[4,5]	INFL FCTR[5,6]	NOTES
1A	STRUCTURAL ENVELOPE/SUBDIVISIONS	6,075.0	100	1.00	100	1.00	35.0	1	
1B	SUPERSTRUCTURE	745.0	100	1.00	100	1.00	35.0	1	
1C	FOUNDATIONS	128.0	100	1.00	100	1.00	35.0	1	
1D	STRUCTURAL ATTACHMENTS	282.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	HULL STRUCTURE	7,230.0	100	1.00	100	1.00	35.0	1	
					0				
2A	PROPULSION ENERGY SYSTEMS	323.0	100	1.00	100	1.00	35.0	1	
2B	PROPULSION TRAIN SYSTEMS	68.0	100	1.00	100	1.00	35.0	1	
2C	PROPULSION GASES SYSTEMS	30.0	100	1.00	100	1.00	35.0	1	
2D	PROPULSION SERVICES SYSTEMS	26.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	PROPULSION PLANT	447.0	100	1.00	100	1.00	35.0	1	
3A	ELECTRICAL POWER GENERATION	147.0	100	1.00	100	1.00	35.0	1	
3B	ELECTRICAL POWER DISTRIBUTION	282.0	100	1.00	100	1.00	35.0	1	
					0				
SUBTOTAL	ELECTRIC PLANT	429.0	100	1.00	100	1.00	35.0	1	
4A	VEHICLE COMMAND	35.0	100	1.00	100	1.00	35.0	1	
4B	WEAPONS COMMAND	18.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	COMMAND AND SURVEILLANCE	53.0	100	1.00	100	1.00	35.0	1	
5A	ENVIRONMENTAL SYSTEMS	388.0	100	1.00	100	1.00	35.0	1	
5B	FLUID SYSTEMS	530.0	100	1.00	100	1.00	35.0	1	
5C	MANEUVERING SYSTEMS	52.0	100	1.00	100	1.00	35.0	1	
5D	EQUIPMENT HANDLING SYSTEMS	1,037.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	AUXILIARY SYSTEMS	2,007.0	100	1.00	100	1.00	35.0	1	
6A	HULL FITTINGS	29.0	100	1.00	100	1.00	35.0	1	
6B	NON-STRUCTURAL SUBDIVISIONS	527.0	100	1.00	100	1.00	35.0	1	
6C	PRESERVATION	744.0	100	1.00	100	1.00	35.0	1	
6D	SHIP SUPPORT	983.0	100	1.00	100	1.00	35.0	1	
6E	HABITABILITY	416.0	100	1.00	100	1.00	35.0	1	
SUBTOTAL	OUTFIT AND FURNISHINGS	2,699.0	100	1.00	100	1.00	35.0	1	
7	ARMAMENT	99.0	100	1.00	100	1.00	35.0	1	
TOTAL 1-7	SHIP CONSTRUCTION	12,964.0	100.00	1.00	100	1.00	35.0	1	

		WEIGHT L TONS	% OF LEAD SHIP GR 8[7]		MHR RATE[4]	
8	INTEGRATION/ENGINEERING					
	RECURRING	12,964.0	10.00		35.0	
	NON-RECURRING	12,964.0	90.00		35.0	

		WEIGHT L TONS	LABOR "SLOPE"[2]	MAT "SLOPE"[3]	MHR RATE[4]	
9	SHIP ASSEMBLY AND SUPPORT SERVICES					
	PRODUCTION:	12,964.0	100	100	35.0	
	PREPROD.:		% OF LEAD SHIP GR 9[5]			
	RECURRING	12,964.0	10.00		35.0	
	NON-RECURRING	12,964.0	90.00		35.0	

NOTES:

1 - Recommend: (Per Reference (1))
No Change: 88-93% (baseline slope)
Full Change: 100%
Moderate Change: 88-100% Depending on degree of change and baseline slope selected

2 - Use cost and weight groups per Reference (2)

3 - Recommend: (Per Reference (1))
No Change: 97% (baseline slope)
Full Change: 100%
Moderate Change: 97-100%

4 - Use fully burdened rate

5 - Model provides initial estimate automatically for individual groups. The user may modify them, but every time Data Entry is entered from the main menu they will change back to a copy of the Total 1-7 values.

6 - Use inflation factor per Reference (3)

7 - Model provides initial estimate automatically for non-recurring. The user may modify it, but every time Data Entry is entered from the main menu it will change back to the calculated formula.

COST GROUP	WEIGHT L TONS	LABOR COSTS ADJUSTED MHRS/TON	LCF	KMHRS	RATE $ / MHR 1994	$K 1994	MATERIAL COSTS ADJUSTED $/TON 1994	LCF	$K 1994	TOTAL LAB+MAT $K 1994
1A	6,075.0	156.4	1.00	949.87	35.0	33245	2,557.4	1.00	15,535.9	48,781.4
1B	745.0	179.7	1.00	133.87	35.0	4685	2,196.8	1.00	1,636.6	6,322.0
1C	128.0	952.9	1.00	121.97	35.0	4269	4,088.9	1.00	523.4	4,792.3
1D	282.0	264.1	1.00	74.48	35.0	2607	18,118.4	1.00	5,109.4	7,716.3
SUBTOTAL	7,230.0	177.1	1.00	1280.19	35.0	44807	3,154.3	1.00	22,805.3	67,612.0
2A	323.0	217.7	1.00	70.32	35.0	2461	50,586.1	1.00	16,339.3	18,800.6
2B	68.0	133.9	1.00	9.11	35.0	319	26,034.0	1.00	1,770.3	2,089.1
2C	30.0	619.7	1.00	18.59	35.0	651	87,618.7	1.00	2,628.6	3,279.2
2D	26.0	2,686.7	1.00	69.85	35.0	2445	104,631.5	1.00	2,720.4	5,165.3
SUBTOTAL	447.0	375.6	1.00	167.87	35.0	5876	52,480.1	1.00	23,458.6	29,334.2
3A	147.0	18.8	1.00	2.76	35.0	97	75,913.7	1.00	11,159.3	11,255.9
3B	282.0	1,483.3	1.00	418.28	35.0	14640	41,076.7	1.00	11,583.6	26,223.5
SUBTOTAL	429.0	981.4	1.00	421.04	35.0	14736	53,013.9	1.00	22,742.9	37,479.4
4A	35.0	1,807.4	1.00	63.26	35.0	2214	112,109.2	1.00	3,923.8	6,137.9
4B	18.0	569.5	1.00	10.25	35.0	359	33,761.0	1.00	607.7	966.5
SUBTOTAL	53.0	1,387.0	1.00	73.51	35.0	2573	85,500.4	1.00	4,531.5	7,104.3
5A	388.0	1,128.2	1.00	437.76	35.0	15321	44,835.1	1.00	17,396.0	32,717.5
5B	530.0	1,173.6	1.00	622.01	35.0	21770	52,977.8	1.00	28,078.2	49,848.6
5C	52.0	143.5	1.00	7.46	35.0	261	22,588.7	1.00	1,174.6	1,435.8
5D	1,037.0	73.7	1.00	76.43	35.0	2675	24,389.9	1.00	25,292.3	27,967.6
SUBTOTAL	2,007.0	569.8	1.00	1143.66	35.0	40028	35,845.1	1.00	71,941.2	111,969.4
6A	29.0	1,812.9	1.00	52.57	35.0	1840	27,845.6	1.00	807.5	2,647.6
6B	527.0	271.8	1.00	143.23	35.0	5013	36,541.1	1.00	19,257.2	24,270.1
6C	744.0	1,307.6	1.00	972.84	35.0	34049	27,970.2	1.00	20,809.8	54,859.2
6D	983.0	116.7	1.00	114.71	35.0	4015	16,476.8	1.00	16,196.7	20,211.4
6E	416.0	282.0	1.00	117.33	35.0	4106	105,888.0	1.00	44,049.4	48,155.8
SUBTOTAL	2,699.0	519.0	1.00	1400.67	35.0	49024	37,466.0	1.00	101,120.6	150,144.2
7	99.0	190.9	1.00	18.90	35.0	661	14,710.6	1.00	1,456.4	2,117.7
TOTAL 1-7	12,964.0	347.6	1.00	4,505.8	35.0	157705	19,134.3	1.00	248,056.6	405,761.2

GROUP 8 COSTS

TYPE	WEIGHT LONG TONS	CER[1]	% LEAD SHIP	LABOR COST KMHRS	RATE	$K	MAT'L COST $K	TOTAL LAB + MAT $K
	12,964.0	2,534.0						
NON - RECURRING			10.0	253.4	35.0	8,869.1	1,064.3	9,933.4
RECURRING			90.0	2,280.6	35.0	79,822.3	9,578.7	89,400.9
TOTAL	12,964.0	2,534.0	100.0	2,534.0	35.0	88,691.4	10,643.0	99,334.4

1 - Lead ship Group 8 costs per Reference (4) CER
2 - Assume material costs are 12% of labor costs per Reference (8)

GROUP 9 COSTS

TYPE	WEIGHT LONG TONS	CER[1] KMHRS	CER[1] % TOTAL	LABOR COSTS	KMHRS	RATE $/MHR	$K	MATERIAL COSTS $K/TON[2]	LCF	$K	TOTAL $K
				LCF							
PRODUCTION	12,964.0	1,346.2	60%	1.00	807.7	35.0	28,271.2	460.7	1.00	5,972.4	34,243.7
				% TOTAL						$K[3]	
PREPRODUCTION	12,964.0	1,346.2	40%								
NON - RECURRING				10.0	53.8	35.0	1,884.7	---	---	226.2	2,110.9
RECURRING				90.0	484.6	35.0	16,962.7	---	---	2,035.5	18,998.3
TOTAL	12,964.0	---	---	---	1,346.2	35.0	47,118.7	---	---	8,234.1	55,352.8

1 - Lead ship Group 9 costs per Reference (4) CER
2 - Production material rate per Reference Sheet
3 - Assume preproduction material costs are 12% of labor costs per Reference (8)

OVERALL SUMMARY

COST GROUP	WEIGHT LT	LABOR KMHRS	LABOR $K	MATERIAL $K	TOTAL $K
1-7	12,964.0	4,505.8	157,704.6	248,056.6	405,761.2
8	12,964.0	2,534.0	88,691.4	10,643.0	99,334.4
9	12,964.0	1,346.2	47,118.7	8,234.1	55,352.8
TOTAL	12,964.0	8,386.1	293,514.7	266,933.7	560,448.4

COST GROUP	WEIGHT	LABOR COSTS				MATERIAL COSTS						
		DATABASE		ADJUSTED		DATABASE			ADJUSTED	1993	INFLATED	1994
	L TONS	KMHRS	MHRS/TON	ADJ FCTR[2]	MHRS/TON	$K 1980	$/TON 1980	INFL FCTR[3]	ADJ FCTR[2]	$/TON 1993	INFL FCTR 1994	$/TON 1994
1A	6,075.0	950.1	156.4		156.4	4,532.7	746.1	0.5179		2,557.4	1.0000	2,557.4
1B	745.0	133.9	179.7		179.7	477.5	640.9	0.5179		2,196.8	1.0000	2,196.8
1C	128.0	122.0	953.1		952.9	152.7	1,193.0	0.5179		4,088.9	1.0000	4,088.9
1D	282.0	74.5	264.2		264.1	1,490.7	5,286.2	0.5179		18,118.4	1.0000	18,118.4
SUBTOTAL/ AVERAGE	7,230.0	1,280.5	177.1	1.00	177.1	6,653.6	920.3	0.5179	1.78	3,154.3	1.0000	3,154.3
2A	323.0	74.9	231.9		217.7	4,767.1	14,758.8	0.5179		50,586.1	1.0000	50,586.1
2B	68.0	9.7	142.6		133.9	516.5	7,595.6	0.5179		26,034.0	1.0000	26,034.0
2C	30.0	19.8	660.0		619.7	766.9	25,563.3	0.5179		87,618.7	1.0000	87,618.7
2D	26.0	74.4	2,861.5		2,686.7	793.7	30,526.9	0.5179		104,631.5	1.0000	104,631.5
SUBTOTAL/ AVERAGE	447.0	178.8	400.0	0.94	375.6	6,844.2	15,311.4	0.5179	1.78	52,480.1	1.0000	52,480.1
3A	147.0	2.3	15.6		18.8	3,255.8	22,148.3	0.5179		75,913.7	1.0000	75,913.7
3B	282.0	348.7	1,236.5		1,483.3	3,379.6	11,984.4	0.5179		41,076.7	1.0000	41,076.7
SUBTOTAL/ AVERAGE	429.0	351.0	818.2	1.20	981.4	6,635.4	15,467.1	0.5179	1.78	53,013.9	1.0000	53,013.9
4A	35.0	64.8	1,851.4		1,807.4	1,144.8	32,708.6	0.5179		112,109.2	1.0000	112,109.2
4B	18.0	10.5	583.3		569.5	177.3	9,850.0	0.5179		33,761.0	1.0000	33,761.0
SUBTOTAL/ AVERAGE	53.0	75.3	1,420.8	0.98	1,387.0	1,322.1	24,945.3	0.5179	1.78	85,500.4	1.0000	85,500.4
5A	388.0	627.7	1,617.8		1,128.2	5,075.4	13,080.9	0.5179		44,835.1	1.0000	44,835.1
5B	530.0	891.9	1,682.8		1,173.6	8,192.0	15,456.6	0.5179		52,977.8	1.0000	52,977.8
5C	52.0	10.7	205.8		143.5	342.7	6,590.4	0.5179		22,588.7	1.0000	22,588.7
5D	1,037.0	109.6	105.7		73.7	7,379.2	7,115.9	0.5179		24,389.9	1.0000	24,389.9
SUBTOTAL/ AVERAGE	2,007.0	1,639.9	817.1	0.70	569.8	20,989.3	10,458.0	0.5179	1.78	35,845.1	1.0000	35,845.1
6A	29.0	34.1	1,175.9		1,812.9	235.6	8,124.1	0.5179		27,845.6	1.0000	27,845.6
6B	527.0	92.9	176.3		271.8	5,618.4	10,661.1	0.5179		36,541.1	1.0000	36,541.1
6C	744.0	631.0	848.1		1,307.6	6,071.4	8,160.5	0.5179		27,970.2	1.0000	27,970.2
6D	983.0	74.4	75.7		116.7	4,725.5	4,807.2	0.5179		16,476.8	1.0000	16,476.8
6E	416.0	76.1	182.9		282.0	12,851.7	30,893.5	0.5179		105,888.0	1.0000	105,888.0
SUBTOTAL/ AVERAGE	2,699.0	908.5	336.6	1.54	519.0	29,502.6	10,930.9	0.5179	1.78	37,466.0	1.0000	37,466.0
7	99.0	17.7	178.8	1.07	190.9	424.9	4,291.9	0.5179	1.78	14,710.6	1.0000	14,710.6
TOTAL GR 1-7	12,964.0	4,451.7	343.4	1.01	347.6	72,372.1 (1980)	5,582.5 (1980)					
						139,741.5 (1993)	10,779.2 (1993)	0.5179	1.78	19,134.3	1.0000	19,134.3

	WEIGHT	CER[4]		ADJ	ADJUSTED	MATERIAL COSTS					$/TON
	L TONS	KMHRS	MHRS/TON	FCTR	MHRS/TON	MHRS/TON	$/MHR[5]	% LAB $	$/TON 1993	INFL FCTR	1994
GROUP 8	12,964.0	2,534.0	195.5	100%	195.5	195.5	35.0	12%	821.0	1.0000	821.0

GROUP 9												
	WEIGHT	CER[4]		%	ADJUSTED	$K	$/TON	INFL	ADJ	$/TON	INFL FCTR	$/TON
	L TONS	KMHRS	MHRS/TON	TOTAL[6]	MHRS/TON	1980	1980	FCTR[3]	FCTR[2]	1993	1994	1994
PROD	12,964.0	1,346.2	103.8	60%	62.3	1,742.5	134.4	0.5179	1.78	460.7	1.0000	460.7

	MATERIAL COSTS					$/TON
	MHRS/TON	$/MHR[5]	% LABOR	$/TON 1993	INFL FCTR	1994
PREPROD	41.5	35.0	12%	174.5	1.0000	174.5

1 - Based on AD41 data in Reference (7) calibrated to new construction CER's in Reference (4)
2 - Adjustment factor in percent difference between CER and AD 41 data. Two digit cost groups are multiplied by the adjustment factor.
3 - Inflation factor per Reference (3) from 1977 to 1993
4 - From Reference (4)
5 - Assume 12% Labor Dollars at $35/mhr per Reference (8)
6 - Per Reference (6)