A COMPUTER MODEL TO ASSESS FINANCING PROVISIONS OF NAVAL FPIF SHIPBUILDING CONTRACTS.

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THESIS

A COMPUTER MODEL TO ASSESS FINANCING
PROVISIONS OF NAVAL FPIF SHIPBUILDING CONTRACTS

by

Stephen Robert Olson

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Continuation 20.

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A discussion of two applications of the model is included. Two escalation payment alternatives were evaluated for the CVN-70. Various thresholds for progress payments were studied for the FFG-7. From experience with these applications it was concluded that a detailed model of this type is necessary for evaluating FPIF contract provisions.

A Computer Model to Assess Financing

Provisions of Naval FPIF Shipbuilding Contracts

by

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Lieutenant, United States Navy
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ACKNOWLEDGEMENT

The author wishes to acknowledge the recommendations of LCDR Clyde Marshall, USN, in developing the simulation model. LCDR Marshall's advice on how best to simulate schedule overrun, the use of a cost element matrix, and his share line program subroutine, as well as numerous suggestions on the modeling approach, were incorporated into the FPIF contract financing simulation model described in this paper.

I. INTRODUCTION

A. PURPOSE

This paper has two purposes. The first is to present a simulation model to be used to assess the impact of alternative financing provisions on a USN Fixed Price Incentive Fee (FPIF) ship acquisition contract. The model can also be used to measure the effect of changes in actual contractor performance (cost growth and schedule overrun) or escalation index forecasts. The model, its implementation and potential application are discussed in Sections I through IV.

The second purpose is to discuss preliminary findings attained through the use of the model. This discussion will deal primarily with the impact of differing escalation payment methods being considered for use in the CVN-70 (Nuclear Aircraft Carrier) single ship procurement, and on a progress payment method under consideration for the FFG-7 Class (Guided Missile Frigate) multiship procurement. These subjects are presented in Section V.

B. THE FIXED PRICE INCENTIVE FEE (FPIF) CONTRACT

An FPIF contract is a contract form frequently used for major ship acquisition programs within the Naval Sea Systems Command. It is appropriate when technological risk is relatively low and there are few unresolved production uncertainties. The FPIF contract should only be used when a reasonable estimate of target cost, in constant dollars, can be made, and which both parties to the contract believe is valid and have a prudent expectation of achieving. The contract form recognizes that some uncertainty does exist, inherent in the extended construction period

of major ship acquisition contracts, and provides a method of sharing the risk between the government and the contractor. It may also provide an incentive to the contractor to control or reduce costs. The FPIF contract share line is the element that determines how risk will be shared by the contracting parties and is discussed in greater detail in section IV-E of this paper.

C. THE FPIF CONTRACT FINANCING SIMULATION MODEL

The author first became aware of the potential usefulness of an FPIF contract simulation model in Oct 1974 while on a familiarization tour at the office of the Nuclear Aircraft Carrier (CVN) Ship Acquisition Program Manager (SHAPM). At that time the SHAPM was faced with selecting a contract escalation clause that was both equitable to the contractor and in the best interests of the Navy. At issue was a new contract clause being proposed as the vehicle through which the Navy would reimburse the contractor for economic price changes. Proponents of this new clause claimed that it was superior to the old method in attempting to identify and reimburse actual price changes beyond the control of the contractor, and it was. Detractors claimed that it "gave" too much to the contractor and removed one of the Navy's few contract incentives for timely performance. It appeared that some of these claims could best be resolved by simulating a contract, with various cost and schedule performance profiles, to evaluate the dollar impact of the escalation clauses under consideration. A simulation model was constructed to do this, although limited in scope to answer the specific questions at hand.

The simulation presented in this paper is an extension of the original model with greatly increased flexibility to address a variety of questions that may arise in preparing and monitoring an FPIF contract.

In constructing the model, the author attempted to place himself in the position of the SHAPM and to provide a simulation that would best address those questions of interest to the SHAPM or higher levels. The independent variables in the simulation may be considered in two classes. The first consists of those variables over which the program manager can exercise some control prior to contract award, and include escalation and progress payment methods, frequency (timing) of payments, the share line, scheduled ship delivery dates, and learning curves. The second category refers to those variables over which the program manager has little, if any, control and include the actual cost and schedule performance of the contractor and the actual performance of the escalation indicies.

By using the simulation model to assess these variables, it is hoped that the program manager will achieve a greater insight on the impact of contract provisions, not only to the government, but to the contractor's cash flow, profitability, and level of risk in undertaking a Navy FPIF contract.

D. AN OVERVIEW OF THE MODEL

The FPIF contract financing simulation model is basically a cash flow model that generates and records the major cash streams that affect a contractor in the performance of an FPIF procurement contract. Progress

curves for Labor/Overhead and Material are either provided by the user or generated by the model. These progress curves are then assumed to typify the timing with which the contractor incurs (books) costs, and weekly booked costs are calculated over the life of the contract. These weekly costs also include adjustments for price level changes based on user supplied forecasts of the future performance of the escalation indices. Where there is a delay between the time the contractor books costs and and the time he actually experiences a cash flow, as in the biweekly salary of white-collar workers, this delay is accounted for. The model then makes progress payments and escalation payments to the contractor based on the method and frequency specified by the user. When all of these cash flows have been generated the model then has a record of all progress and escalation payments made to the contractor in addition to a record of the contractors net cash flow in each week of the contract. This weekly cash flow, when accumulated over the life of the contract, then provides a record of the contractor's net cumulative cash investment in the contract at the end of each week. By discounting the net investment over the life of the contract at the user-provided contractor cost of capital, the net present value (excluding capital investment) for the contract is determined.

E. APPLICATIONS OF THE MODEL

1. Questions of Interest

The following examples will give the user some idea of the types of questions that may be addressed by the model:

How will changing the progress payment thresholds affect cash flow and contractor exposure in the event of cost growth or schedule overrun?

How will changing the frequency of progress payments or escalation payments affect the contractor's cash flow?

What happens to the contractor if schedule delays or cost growth occur? When does the contractor start to lose money?

How effective are share lines in penalizing the contractor for cost growth? Is it unduly harsh in light of inflation?

What is the financial impact of the contractor's proposed learning? How does it compare with the government's estimate?

Given forecasts for escalation indices, what effects do different production/delivery schedules have on total program cost (including escalation payments)?

Does an escalation payment method really incentivize timely ship delivery?

What is the real value (profitability) of the contract, given that constant dollar profits are spread over the life of a contract?

What is the impact on total program costs if escalation indices do not change as forecasted?

The above list is not all inclusive. The model was designed to be flexible and capable of responding to a wide variety of questions regarding the FPIF contract. Once a full understanding of the model is achieved, the user may then explore those questions unique to the particular contract at hand.

F. DEFINITIONS

In researching the Navy's use of FPIF contract the author encountered some confusion due to a lack of uniform terminology. Because of this, the author's definitions of the more important terms, as used in this paper, are provided.

1. Base Costs

Base costs, as used in this paper, refer to all de-escalated (base year) costs incurred by the contractor. In determining contractor progress payment eligibility, base costs are calculated by subtracting escalation payments from total ("escalated") costs incurred.

2. Cost Growth

Cost growth refers to an increase in base costs not caused by price changes. Cost growth, in this context, is a change in the base cost due to forces which the contractor is expected to be able to control. It is assumed that when cost growth occurs it is due to poor contractor estimates, manhour/material inefficiencies, poor management, or some other contractor responsible cause. Whenever cost growth in base dollars occurs it is also subject to a proportionate price change.

3. Price Change

Price level changes reflect changes in costs (input prices) to the contractor over which he has no ability to control. In general, price changes are experienced throughout an industry and are not, over an extended period of time, unique to a particular contractor. Price changes are usually attributed to inflationary/deflationary forces in the national economy, although they may be unique to a particular sector or industry. It is price changes that escalation indices attempt to measure, and for which the government attempts to compensate the contractor under the escalation provisions of an FPIF contract.

4. Escalation

Escalation describes those payments made by the government in attempting to reimburse the contractor for price changes. Escalation payments may, or may not reimburse the contractor for all price changes

experienced, dependent on the accuracy of the escalation indices, or any inherent deficiencies or specific restrictions contained in the escalation payments clause itself.

5. Billing Price

The billing price is calculated whenever contractor progress payment eligibility is being determined and is the best estimate, during contract performance, of the final base price of the contract. It is determined by dividing base costs to date by measured progress to date. The share line is then applied against this cost to estimate contractor profit at completion. The sum of estimated cost plus profit is the billing price.

II. MODEL DESCRIPTION

The simulation is a deterministic (non-stochastic) model written in the FORTRAN (level G) programming language. The model acts as a "book-keeping" recorder over the life of the contract, generating progress curves, incurring contractor costs, as determined by inputs specified by the user.

Specific input requirements are identified in Section IV and the actual input sequence is provided in Appendix A.

A. OPTIONS

For each simulation run, the user must specify one of six possible OPTIONS, and may then select up to eight different variations (CASES) within the specified OPTION. The six OPTIONS are:

1. Learning Curves (OPTION 1)

The user may select up to eight different sets of Labor/Overhead and Material learning curves as CASES within the simulation run. A more detailed description of Learning Curves may be found in section IV-A.

2. Progress Curves (OPTION 2)

The user may input, or have the program generate, up to eight different sets of Labor/Overhead and Material forecasted progress curves. A more detailed description of progress curves may be found in section IV-B.

As CASES under this option, the user may also select up to eight different sets of contract terms, with or without changes in the progress curves. Contract terms, as used in this paper, refer to the following input variables:

Target Cost

Target Profit

Contract Ceiling

Allowance for Long Lead Time Material (See Section III-B-4)

Total Number of Months in the Contract (from Contract award through the contracted delivery date of the last ship constructed)

3. Escalation Index Forecasts (OPTION 3)

The user may select up to eight different sets of annual forecasts for a maximum of three different escalation indices that may be specified in the contract. The annual forecasts are assumed to apply to the fiscal, vice calender, year. Escalation indices are discussed in greater detail in Section IV-C.

4. Escalation Payment Methods (OPTION 4)

The simulation presently provides for two different escalation payment methods. Method I specifies that escalation payments will be in accordance with predetermined payment curves written into the procurement contract. Method II, commonly referred to as "Marshall's Method," does not call for payment curves. As written into the simulation, Method II may be modified so that seven different payment schemes may be selected under this method. For both methods, the frequency of payments may be changed as desired. A total of eight different escalation payment alternatives can be evaluated during one simulation run under this OPTION. A more detailed description of the payment methods and alternatives is provided in Section IV-D.

5. The Share Line (OPTION 5)

The user may select up to eight different share lines, with a maximum of five break-points in each share line, under this OPTION. A detailed discussion of share lines may be found in section IV-E.

6. Progress Payment Methods (OPTION 6)

The simulation presently provides for two different progress payment methods. However, by varying the payment thresholds and the frequency of payments for each method, a large number of alternatives may be generated. Up to eight different CASES may be evaluated under this OPTION. A detailed discussion of progress payment methods may be found in Section IV-F.

B. MODEL STRUCTURE

1. Approach

The model contains a main program and ten subroutines. The basic approach in programming was to use the main program to: (1) control input and output; (2) execute DO loops; (3) determine the appropriate subroutines and call them in the proper sequence; and (4) perform the basic bookkeeping in generating contractor costs. Heavy use was made of COMMON statements to link the main and subroutines. With the exception of the two escalation payment subroutines (ESCPA1 and ESCPA2) and the two progress payment subroutines (PROPA1 and PROPA2) every subroutine is called at least once during program execution. The ESCPA and PROPA subroutines are linked to the main program with COMMON statements but are only called if specified by the user. They were designed to permit complete removal from the program and to allow

additional payment methods to be programmed into the simulation. After a CASE is generated the program saves two values, total payments and net present value, it then checks to see if a detailed quarterly output has been requested, and prints it if appropriate, all data peculiar to that CASE is then lost, and the next CASE is executed. This approach, and the coordination of DO loops and CALLS, was chosen to minimize storage requirements and execution time.

2. Flow

Figure 1 is a simplified flow chart of the model. A glossary of the variables is contained in Appendix B. The basic sequence of events is:

1. All input data are read into the program. Care must be taken to ensure that all required data are provided in the proper sequence. There are no default values, and the program will either fail to execute or provide erroneous results if the correct sequence, as described in Appendix A, is not followed.

2. Learning curve weights (Labor/Overhead and Material) for each ship are generated and stored in variables LCWS and LCWT.

3. Learning curve weights are applied to individual ship progress curves and composite progress curves are then generated with all ships under the contract combined into two curves, one for Labor/Overhead and one for Material. The principle output variable, FPMI, contains monthly incremental progress curves for the baseline (on schedule) case. These curves will be printed if requested by the user.

4. Monthly escalation index values are generated and stored in variables BBLS and BLS. Subroutine BLSGEN is called only once during program execution. The tables of BLS index values will be printed if requested by the user.

5. Schedule overrun is simulated as appropriate. Variable FPMI is left unchanged, but used to generate a new variable FPM2, which contains monthly incremental progress for the schedule overrun condition.

6. Cost growth is simulated, as appropriate, by applying a percentage increase to the Labor/Overhead and/or Material base year target dollars. These revised dollar estimates are stored as FLC, FOC, FMC.

7. Bookkeeping variables for contractor cash investment (CI), "absorbed escalation" (ESCAB), and monthly booked costs (FTCM) are set to zero.

8. Variables for progress (FPM1), dollar estimates (FLC, FMC, FOC), information on the contractor cost element structure (IND, ICFT, ICFDP, PCEL), are used to generate monthly booked costs (FTCM - includes "escalation"), monthly "escalation" incurred (ESCAB), and weekly cash investment by the contractor (CI).

9. The program checks to see if a quarterly output is desired for the CASE being simulated. This is necessary since additional bookkeeping records are required if the quarterly output is desired.

10. The appropriate escalation payment subroutine is called and records are created for monthly and cumulative escalation payments earned (EPAY, CUME).

11. The appropriate progress payment subroutine is called and records are created for monthly and cumulative progress payments earned (PPAY, CUMB).

12. Subroutine WKPAY takes the earned escalation payments, adjusts them, and pays the contractor according to the payment frequency specified. These payments are subtracted from cash investment (CI) and "absorbed escalation" (ESCAB).

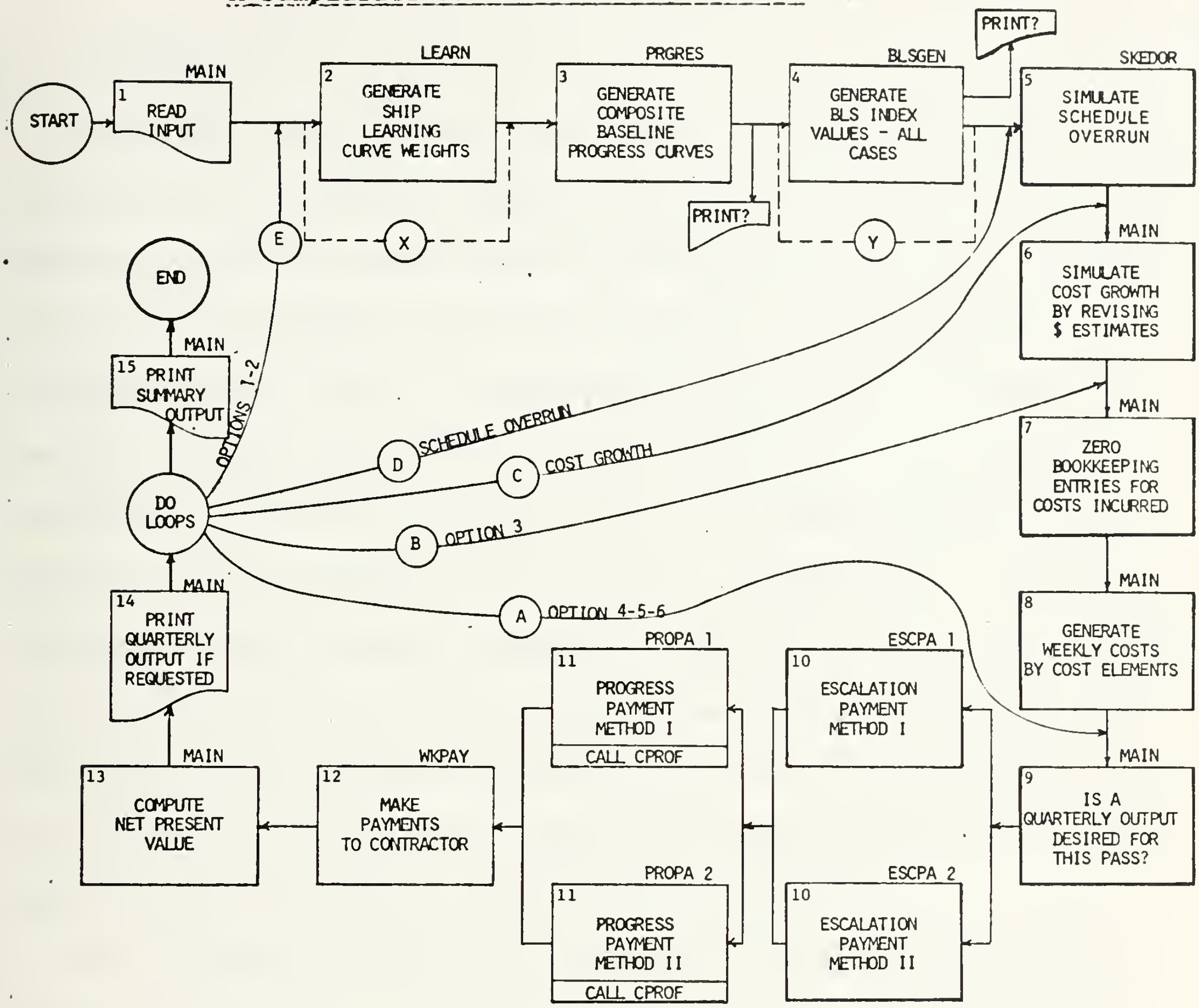
13. Subroutine WKPAY is called a second time and adjusts earned progress payments and pays the contractor according to the payment frequency specified. These payments are subtracted from cash investment (CI).

14. Net present value is computed using the contractor's cost of capital (CINT) and weekly cash investment (CI).

15. A quarterly output table is printed if requested.

16. The summary output is printed.

A Simplified Flow Chart of the Model



NOTES:

1. THE APPROPRIATE SUBROUTINE NAME IS INDICATED AT THE TOP OF EACH FLOWPOINT.

2. BY-PASS X IS IN EFFECT AFTER THE CASE 1 ITERATION, UNLESS OPTION 1 IS BEING EXECUTED.

3. BY-PASS Y IS IN EFFECT FOR ALL OPTIONS AFTER THE CASE 1 ITERATION.

4. DO-LOOPS ARE EXECUTED FOR OPTIONS AS INDICATED BELOW. THE FIRST LOOP INDICATES THAT IT IS FULLY EXECUTED FOR EACH PASS THROUGH THE NEXT (EXTERNAL) LOOP LISTED.

OPTIONS 1-2	C-D-E
OPTIONS 3	B-C-D
OPTIONS 4-5-6	A-C-D

Figure 1

C. ASSUMPTIONS

In general, the simulation assumes that the dynamic elements of shipbuilding and FPIF contract financing perform in a perfectly predictable manner, and that all elements that are measured during contract performance, such as escalation indices and progress, are determined with absolute accuracy. This is obviously not the case, but the assumptions are none-the-less rational and the most logical based on practical experience. If the user is fully aware of the modeling assumptions he should be able to compensate and temper his judgment of the simulation output and extract valuable information. The greatest value of the model is in comparing contract alternatives and evaluating their relative impact over a range of possible scenarios that could occur during the life of a contract. In this context, the model output should be quite valid and relatively unaffected by the modeling assumptions.

The following are the simplifying assumptions made in constructing the model:

1. Constant Dollars

It is assumed that target cost, target profit, contract ceiling, and allowances for long-lead time (unescalated) material are priced in base year dollars consistent with the base months specified for the escalation indices.

2. Allowance for Long Lead-Time Material

The Allowance for Long Lead Time Material permits the user to specify the dollar value of direct material that is fully priced at contract award and not subject to the escalation provisions of the basic contract. The simulation handles these costs in the same manner as the remaining direct material and assumes that the costs are incurred as described by the material progress curve. Price changes and escalation reimbursement, however, are not applied to these long-lead time costs.

3. Booked Costs

The Labor and Material progress curves are assumed to describe the timing with which costs are "booked," where "booked" costs establish contractor eligibility for progress payments. Since the Armed Services Procurement Regulation (ASPR) requires payment to establish progress payment eligibility for direct material costs, these costs are not considered booked until they are paid for by the contractor. All other costs are assumed "booked" at the end of the week, regardless of the contractor's action in paying for the costs incurred. Any delay between the time costs are "booked" and the time the contractor actually pays for these incurred costs (experiences cash flow) is accounted for in the cost element structure.

4. Simulated Progress and Costs Incurred

A direct relationship is assumed between the percentage of final base year costs incurred (booked) by the contractor and the percentage of physical progress measured during ship construction. This is true even when cost growth is simulated, since final cost refers to the

actual base costs incurred at contract completion, and implies a zero delay between the time the contractor begins to experience actual cost growth and the time it is detected by the contract administration agency.

5. Cash Flow

All costs incurred by the contractor are considered as cash flows. An argument may be made that charges such as depreciation are not cash flow, however it may also be argued that depreciation charges reflect capital investments or a "minimum" return of investment paid to stockholders and required for the contractor to remain in business. If viewed in this context, depreciation indirectly reflects a corporate cash flow.

6. Escalation Indices

It is assumed that the impact of price changes on the contractor is perfectly described by the escalation indices. This implies that price changes experienced by the contractor represent the average of all the industries whose inputs determine the particular index and, in the absence of any restrictions or inherent deficiencies in the contract escalation clause, the contractor will be fully reimbursed for all price changes experienced.

7. Cost Element Structure

It is assumed that the user has some estimate of how a particular contractor will incur costs, herein referred to as the cost element structure. The cost element structure is a matrix that accounts for all costs that the contractor will incur and has three criteria that define the costs elements. These criteria are:

a. Timing or Frequency of Disbursements

This accounts for the lag between the time that costs are booked and the time that the contractor actually disburses payments. The simulation will handle either periodic payments, as in biweekly pay to salaried employees, or fixed delays, such as payments made 30 days after billing. The user should note that the direct materials account should have a zero delay specified, since the Armed Services Procurement Regulation (ASPR) requires that the contractor have payment receipts to be eligible for reimbursement by the government.

b. Escalation Index

Each cost element is tied to an escalation index that is used to simulate price changes.

c. Labor-Overhead-Material

Each cost element is based on a combination of percentages of Labor, Overhead, and Material costs.

Determining the cost element structure for a particular contractor or contract may not be an easy task, but it is one of the key inputs in simulating contractor cash flow. The cost element structure may be as simple or complex as the user desires, but it is essential that 100 percent of the contractor's labor, overhead, and material costs be accounted for. A maximum of ten elements is permitted in the cost element structure. An example of a cost element matrix for a contractor is provided in figure 2.

A Cost Element Structure Example

COST ELEMENT	PAYMENT TYPE	DELAY/ PERIODICITY (WEEKS)	ESCALATION INDEX	% OF BASE COSTS LABOR	OVERHEAD	MATERIAL
White-Collar Labor	II	2	LAB	0.10	0.30	-
Blue Collar Labor	III	0	LAB	0.90	-	-
Direct Material	III	0	MAT	-	-	1.00
Indirect Material	I	4	LAB	0.00	0.35	-
Miscellaneous	I	4	LAB	0.00	0.10	-
Depreciation	III	0	NONE	-	0.25	-
Variable Name	ICFT	ICFDP	IND	PCEL	PCEL	PCEL

Payment Types:
I - Fixed Delay
II - Periodic (i.e., Monthly)
III - No Delay

Figure 2

8. Cost Elements and Escalation Payment Method II (Marshall's Method)

It is assumed that the contract administration agency monitors the monthly costs incurred for each cost element and that these costs, and the indicated escalation index, are used to calculate escalation payments when Method II is selected. This implies that if Method II is not restricted (see Section IV-D-3), "Absorbed Escalation" will always be 0.

9. Net Present Value (NPV) as an Indication of Profitability

The model makes the assumption that the contractor's motivation is based entirely on the monetary motivation and that cash flow and return on investment are the only criteria that determine his success and justification for remaining in business. Given this assumption, the net present value method of discounting cash flows provides a logical measure of the impact on the contractor of various contract provisions and the effects of different performance and economic outcomes.

NPV accounts for the cash investment required of the contractor and for the fact that his profit is spread out over the life of the contract. In using net present value as an indicator of profitability it is tactically implied, that the contractor's only investment is in the form of cash and all capital investments not specifically provided for within the target cost are disregarded. NPV generated by the model may therefore be viewed as the contractor's return on working capital over the life of the contract.

The contractor's cost-of-capital is normally used as the discount rate in calculating NPV. Since this rate is not normally available to the program manager, a reasonable estimate must be made and provided as an input to the model.

10. <u>Simulating Schedule Overrun</u>

The projected progress curves for a contract, with no adjustment for schedule overrun, are herein referred to as the baseline curves. The baseline curves typically have an "S" shape as described in Section IV-B and depicted in figure 4 (page 47). The tails of the "S" curve describe the gradual build-up and decline of effort during the beginning and end of ship construction. It is assumed that these gradual changes in the level-of-effort exist regardless of any schedule overrun experienced, and that the schedule overrun phenomena is best described by "strectching" the curve. Schedule overrun is therefore simulated by first determining that month during which the monthly incremental progress is the greatest. This normally occurs in the middle of the construction period. A new month, with this maximum incremental progress, is inserted into the progress curve adjacent to the previously determined month of greatest progress. This process is

repeated for the total number of months of schedule overrun being simulated, and the resultant curve is normalized to 100%. It should be noted that the baseline curves are used for each iteration of schedule overrun, as opposed to compounding the curve used in the preceding schedule overrun iteration.

11. Miscellaneous

a. Fiscal Year

The fiscal year starts 1 October of the preceding calender year and ends on 31 September. The four quarters of the fiscal year are: October - December, January - March, April - June, July - September.

b. Timing

The first and second months of each fiscal quarter contain four weeks, and the third month has five weeks.

D. DIMENSION RESTRICTIONS

The model is limited to a maximum of thirty ships in the contract being simulated, unless progress curves are provided as an input to the model and cover all ships in the contract. (Vice individual curves for each ship.) See section IV-B.

The maximum contract period that can be handled, from award through the contracted delivery date of the final ship, is ten years.

There is a maximum five year limit imposed on the sum of the following input parameters.

Maximum number of months of schedule overrun being simulated

\+ Maximum delay/periodicity in the cost element structure

\+ Maximum interval between escalation or progress payments

Up to three different escalation indices may be imposed on the model. Index number one is assumed to be the labor index, and index number two is assumed to be the direct material index, and will be so labeled if an escalation index output is requested.

E. A NOTE ON COMPILATION

If an IBM FORTRAN compiler is used to load the simulation, erroneous error messages will be printed for Hollerith field data statements located in the program. This is an internal IBM problem and the error messages should be ignored.

III. MODEL OUTPUT

A. PROGRESS TABLES

A progress table is printed if requested by the user. This table contains the baseline progress curves used by the simulation in incurring costs over the life of the contract, assuming the contractor experiences no schedule overrun. Each curve is determined by combining individual ship curves, in proportion to each ship's Labor/Overhead or Material learning curve weight. Six columns are printed as depicted in Table I. The first two columns contain the monthly incremental and cumulative curve profiles used to generate Labor and Overhead costs. The next two columns contain the monthly and cumulative curve profiles used to generate Material costs. The last two columns reflect the weighted progress curve profile used in determining contractor eligibility for progress payments. This curve is obtained by combining the Labor/Overhead and Material Curves in the proportions determined by the Labor/Material/Overhead breakdown of contractor costs.

If OPTIONS 1 or 2 are selected, and progress table output has been requested, the new progress table will be printed for each CASE.

These progress curves are not the curves used to determine escalation payments if Escalation Payment Method I is selected. Escalation payment curves, if required, must be provided by the user, and are not provided as an output from the model.

B. ESCALATION INDEX TABLES

Tables of monthly escalation index values (Table II) are printed if requested by the user. This table indicates the date and value of the

TABLE I

ALL CASES
****

PROGRESS CURVES
(NO SCHEDULE OVERRUN)

DATE	LABOR PROGRESS INCRE.	LABOR PROGRESS TO DATE	MATERIAL PROGRESS INCRE.	MATERIAL PROGRESS TO DATE	WEIGHTED TOTAL INCRE.	WEIGHTED TOTAL TO DATE
DEC 75	0.0	0.0	0.0	0.0	0.0	0.0
JAN 76	0.000	0.000	0.001	0.001	0.000	0.000
FEB 76	0.000	0.000	0.001	0.001	0.000	0.001
MAR 76	0.000	0.001	0.001	0.002	0.000	0.001
APR 76	0.000	0.001	0.001	0.003	0.001	0.002
MAY 76	0.000	0.001	0.001	0.003	0.001	0.002
JUN 76	0.000	0.002	0.001	0.004	0.001	0.003
JUL 76	0.001	0.002	0.001	0.005	0.001	0.003
AUG 76	0.001	0.003	0.001	0.006	0.001	0.004
SEP 76	0.001	0.003	0.001	0.006	0.001	0.005
OCT 76	0.001	0.004	0.001	0.007	0.001	0.005
NOV 76	0.001	0.005	0.001	0.008	0.001	0.006
DEC 76	0.001	0.006	0.001	0.008	0.001	0.007
JAN 77	0.001	0.006	0.005	0.013	0.002	0.009
FEB 77	0.001	0.007	0.005	0.017	0.002	0.012
MAR 77	0.001	0.008	0.005	0.022	0.002	0.014
APR 77	0.002	0.009	0.011	0.033	0.006	0.020
MAY 77	0.002	0.011	0.011	0.044	0.006	0.026
JUN 77	0.002	0.013	0.011	0.055	0.006	0.032
JUL 77	0.004	0.017	0.018	0.073	0.010	0.042
AUG 77	0.004	0.021	0.018	0.091	0.010	0.052
SEP 77	0.004	0.024	0.018	0.109	0.010	0.062
OCT 77	0.005	0.029	0.024	0.132	0.013	0.076
NOV 77	0.005	0.034	0.024	0.156	0.013	0.089
DEC 77	0.005	0.039	0.024	0.180	0.013	0.103
JAN 78	0.009	0.049	0.031	0.211	0.019	0.122
FEB 78	0.009	0.058	0.031	0.241	0.019	0.141
MAR 78	0.009	0.068	0.031	0.272	0.019	0.160
APR 78	0.014	0.082	0.032	0.304	0.022	0.182
MAY 78	0.014	0.096	0.032	0.337	0.022	0.204
JUN 78	0.014	0.110	0.032	0.369	0.022	0.226
JUL 78	0.020	0.130	0.039	0.408	0.028	0.255
AUG 78	0.020	0.150	0.039	0.447	0.028	0.283
SEP 78	0.020	0.170	0.039	0.485	0.028	0.312
OCT 78	0.028	0.197	0.041	0.527	0.034	0.346
NOV 78	0.028	0.225	0.041	0.568	0.034	0.379
DEC 78	0.028	0.253	0.041	0.609	0.034	0.413
JAN 79	0.035	0.288	0.041	0.649	0.038	0.451
FEB 79	0.035	0.323	0.041	0.690	0.038	0.488
MAR 79	0.035	0.358	0.041	0.731	0.038	0.526
APR 79	0.041	0.400	0.032	0.762	0.037	0.563
MAY 79	0.041	0.441	0.032	0.794	0.037	0.600
JUN 79	0.041	0.482	0.032	0.825	0.037	0.637
JUL 79	0.044	0.526	0.021	0.846	0.034	0.670
AUG 79	0.044	0.571	0.021	0.867	0.034	0.704
SEP 79	0.044	0.615	0.021	0.887	0.034	0.737
OCT 79	0.043	0.658	0.013	0.900	0.030	0.767
NOV 79	0.043	0.702	0.013	0.914	0.030	0.797
DEC 79	0.043	0.745	0.013	0.927	0.030	0.827

TABLE II

LABOR ESCALATION INDEX PROJECTIONS

****
ALL CASES
****
LAST ACTUAL: JAN 1975 (180.4)
****

FORECASTS OF PERCENT CHANGE DURING FISCAL YEAR

YEAR	75	76	77	78	79
%CHG	14.4	11.0	8.5	8.9	6.2

MONTHLY PROJECTIONS

CALENDER YEAR

MONTH	75	76	77	78	79	80	81	82	83
JAN		205.0	225.8	245.3	264.8	281.2	298.7	317.2	
FEB		206.8	227.3	247.0	266.1	282.6	300.2	318.8	
MAR		208.6	228.9	248.8	267.5	284.1	301.7	320.4	
APR		210.5	230.4	250.6	268.8	285.5	303.2	322.0	
MAY		212.3	232.0	252.4	270.2	286.9	304.7	323.6	
JUN		214.1	233.5	254.1	271.5	288.3	306.2	325.2	
JUL		215.9	235.1	255.9	272.8	289.8	307.7	326.8	
AUG		217.7	236.7	257.7	274.2	291.2	309.2	328.4	
SEP		219.5	238.2	259.4	275.5	292.6	310.8	330.0	
OCT		221.1	240.0	260.8	276.9	294.1	312.4	0.0	
NOV		222.7	241.7	262.1	278.4	295.6	314.0	******	
DEC	203.2	224.2	243.5	263.5	279.8	297.1	315.6	******	

last actual (reported) index value, the forecasts of future index performance by fiscal year, and the resultant monthly index values based on those forecasts. The annual forecasts are assumed to be linear rates of change over the fiscal year, as opposed to a percent change reflecting a monthly compounded rate. The table covers the period from contract award through the last year of contract performance for the maximum schedule overrun condition being simulated by the model. If the fiscal year forecasts do not cover the entire period being simulated, the last forecast is assumed for all succeeding years through contract completion.

Tables are printed for each index used by the model (maximum of three permitted) and they are printed for each CASE if OPTION 3 is selected.

C. THE SUMMARY OUTPUT

The summary output (Table III) is printed at the end of a simulation run and provides two indicators for each CASE and for each schedule overrun and cost growth situation simulated by the model. The "MONTH LATE" column indicates the number of months of schedule overrun. The "% GROWTH" column indicates the percentage of cost growth applied to the base year target cost. If the user specfied that cost growth was to be limited to Labor/Overhead or Material this is noted in the table heading, and the "% GROWTH" percentages are those applied to the base year Labor/Overhead or Material target costs as indicated. The two indicators for each CASE are:

1. "TOTAL PAYMENT"

"TOTAL PAYMENT" reflects the total dollar ($ millions) end-cost to the government and includes all payments made to the contractor under the provisions of the progress and escalation payment clauses of the contract.

TABLE III

THE SUMMARY OUTPUT

MONTH LATE *****	% GROWTH ******	CASE 1 ************ TOTAL PAYMENT *****	NPV @ %10 *****	CASE 2 ************ TOTAL PAYMENT *****	NPV @ %10 *****	CASE 3 ************ TOTAL PAYMENT *****	NPV @ %10 *****
0	0	333.0	19.0	333.0	20.8	333.0	19.7
0	10	357.8	13.8	357.8	16.7	357.8	15.7
0	20	373.8	2.3	373.8	5.3	373.8	5.3
0	30	377.4	-17.6	377.4	-14.6	377.4	-14.6
0	40	375.8	-40.9	375.8	-37.9	375.8	-37.9
3	0	335.5	18.5	335.5	20.4	335.5	19.3
3	10	360.5	13.3	360.5	16.3	360.5	15.3
3	20	376.7	2.0	376.7	5.1	376.7	5.1
3	30	380.2	-17.8	380.2	-14.7	380.2	-14.7
3	40	378.4	-41.2	378.4	-38.1	378.4	-38.1
6	0	337.9	18.0	337.9	20.0	337.9	18.8
6	10	363.2	12.9	363.2	16.0	363.2	14.9
6	20	379.7	1.6	379.7	4.9	379.7	4.9
6	30	383.0	-18.1	383.0	-14.9	383.0	-14.9
6	40	380.9	-41.4	380.9	-38.2	380.9	-38.2
9	0	340.3	17.5	340.3	19.6	340.3	18.4
9	10	365.9	12.4	365.9	15.7	365.9	14.6
9	20	382.6	1.3	382.6	4.7	382.6	4.7
9	30	385.9	-18.3	385.9	-15.0	385.9	-15.0
9	40	383.5	-41.6	383.5	-38.3	383.5	-38.3
12	0	342.8	17.0	342.8	19.2	342.8	17.9
12	10	368.5	12.0	368.5	15.3	368.5	14.2
12	20	385.5	1.0	385.5	4.5	385.5	4.5
12	30	388.8	-18.5	388.8	-15.0	388.8	-15.0
12	40	386.2	-41.8	386.2	-38.3	386.2	-38.3

2. "NPV AT XX%"

"NPV AT XX%" reflects the net present value to the contractor using the internal rate of return specified (XX) in the heading. Net present value is obtained by reducing the XX rate to a weekly compounded rate (i.e., $\sqrt[52]{1.0+XX}$) and compounding this rate over the life of the contract. The weekly compounded interest rate is divided into the contractor's corresponding weekly cash investment over the life of the contract and the sum of the resultant values is the net present value.

D. THE DETAILED QUARTERLY OUTPUT

Detailed quarterly outputs (Table IV) are printed on request and are unique for the CASE, schedule overrun, and cost growth situation identified in the heading of each table. Values listed are millions and are for the end of the fiscal quarter indicated. The six output columns are:

1. "% PROGRESS TO DATE"

"% Progress to Date" is the percentage of weighted (i.e., Labor/Overhead and Material) progress achieved by the contractor through the quarter indicated.

2. "TOTAL COSTS BOOKED"

"Total Costs Booked" includes all costs booked by the contractor through the quarter indicated. This cost includes any economic price level changes experienced by the contractor.

3. "PROGRESS/INTERIM PAYMENTS"

This column includes all payments made by the government under the provisions of the progress payments clause specified in the simulation. If Progress Payment Method I is selected this column will

include interim payments. The last value in this column reflects final contract settlement upon completion of construction of the last ship. There is no provision in the simulation for a guarantee witholding account following delivery of the last ship in the contract.

4. "TOTAL ESCALATION PAYMENTS"

This column shows all payments made by the government, to the contractor, under the provisions of the escalation payments clause specified in the simulation.

5. "CONTRACTOR CASH INVESTMENT"

Contractor cash investment reflects the net cash outlay by the contractor after accounting for all cash expenditures in performance of the contract, including economic price changes and cost element time delays, and all escalation and progress payments to the contractor. A negative sign means that payments by the government have exceeded contractor cash demands by the amount indicated. The last value in this column indicates the contractor's profit or loss, in base year dollars, at completion of the contract.

6. "CONTRACTOR ABSORBED ESCALATION"

The values in the contractor absorbed escalation column reflect the assumption that the contractor incurs price changes exactly as described by the escalation indices. This column then identifies the under or over payment of escalation due to inherent deficiencies or specific provisions of the escalation clause. A negative sign means that the government has provided greater reimbursements under the escalation provisions of the contract than the price changes experienced by the contractor.

TABLE IV

THE DETAILED QUARTERLY OUTPUT

CASE 6
****

MONTHS LATE: 0
COST GROWTH: 0 PERCENT

QTR ***	% PROGRESS TO DATE ********	TOTAL COSTS BOOKED *******	PROGRES /INTRIM PAYMENT *******	TOTAL ESCAL PAYMENT *******	KR CASH INVEST *******	KR ABSORB ESCAL *******
			FY 76 ******			
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.30	0.32	0.02	0.01	0.0
3	0.3	0.69	0.65	0.06	-0.03	-0.00
4	0.5	1.13	1.11	0.12	-0.02	-0.00
			FY 77 ******			
1	0.7	1.74	1.61	0.21	-0.08	-0.00
2	1.4	3.55	3.58	0.47	-0.02	-0.00
3	3.2	8.30	7.41	1.24	-0.35	-0.00
4	6.2	16.37	15.15	2.68	-0.10	-0.00
			FY 78 ******			
1	10.3	27.36	23.70	4.79	-1.13	-0.00
2	16.0	43.16	38.14	8.06	-0.66	-0.00
3	22.6	62.08	52.30	12.27	-2.49	-0.00
4	31.2	86.66	73.97	18.07	-1.79	-0.00
			FY 79 ******			
1	41.3	116.41	95.44	25.51	-4.54	-0.00
2	52.6	150.04	128.80	34.35	-7.36	-0.00
3	63.7	183.74	154.46	43.71	-14.43	-0.00
4	73.7	215.12	181.86	52.90	-15.63	-0.00
			FY 80 ******			
1	82.7	243.51	202.60	61.61	-20.71	-0.00
2	89.2	264.53	220.21	68.27	-21.51	-0.00
3	94.2	280.97	231.87	73.62	-24.52	-0.00
4	97.8	292.70	241.25	77.55	-25.03	-0.00
			FY 81 ******			
1	99.6	298.56	245.29	79.54	-26.27	-0.00
2	100.0	300.05	253.00	80.05	-33.00	-0.00

LAST SHIP DELIVERED: FEB 1981

IV. OPTION (INPUT) VARIABLES IN THE SIMULATION

A. LEARNING CURVES (OPTION 1)

1. Discussion

Learning curves are a commonly used management tool to describe a phenomenon that frequently occurs in the series production of goods.[1] The process described by a learning curve is generally that of increased efficiency in the application of labor manhours or material dollars with successive units of production. This increased efficiency can be attributed to many factors, with some of the most common being:[2]

a. Job Familiarization by workmen, which result from the repetition of manufacturing operations.

b. General improvement in tool coordination, shop organization, and engineering liaison.

c. Development of more efficiently produced subassemblies.

d. Development of more efficient parts-supply systems.

e. Development of more efficient tools.

f. Improvement of overall management.

The above list is not all-inclusive, indeed the learning process is not fully understood and its causes and significance will vary with each production process and set of circumstances. Nevertheless, learning curves are frequently generated to measure and forecast increased production efficiency. Such forecasts can have a major impact on estimates of overall program costs, and failure to attain the learning predicted can result in program cost growth of major proportions.

Learning curves are identifed by a "rate" and can be stated in two different frames of reference. In both cases the rate refers to

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[1]The RAND Corporation, Military Equipment Cost Analysis, 1971, p. 93

[2]ibid, p. 94.

units of output. There is an important distinction, however, in interpreting the rate specified and its frame of reference.

The first frame of reference is referred to as a Unit Learning Curve and is stated in the form:

$$y = ax^{s} \tag{1}$$

where

a = cost of the first unit of production

$s = \ln(u)/\ln(2.0)$

u = the specified rate (Unit Learning Curve)

x = the unit of production (i.e., 1,2,...)

y = the cost of the xth unit of production

The interpretation of the unit learning curve is that the rate indicates the amount by which the cost of the last unit produced will decrease when the total number of units produced is doubled. For example; if a 90% unit learning curve is specified and the first unit cost is $100, then one would expect the second unit to cost $90 (.9 x 100), the fourth unit to cost $81 (.9x90), the eighth unit to cost $73 (.9 x 81), etc.

The second frame of reference is the Cumulative Average Learning Curve and is stated in the form:

$$z = ax^{s} \tag{2}$$

where

a = cost of the first unit of production

$s = \ln(c)/\ln(2.0)$

c = the specified rate (Cumulative Average Learning Curve)

x = the unit of production (i.e., 1,2,...)

z = the average unit cost of x units of production

The interpretation of the cumulative average learning curve is that the rate indicates the amount by which the average cost of <u>all units produced</u> will decrease when the total number of units produced is doubled. For example; if a 90% cumulative average learning curve is specified and the first unit cost is $100.00, then one would expect the average cost of two units to be $90 each (i.e., the second unit would cost $80), etc.

A more detailed discussion of the differences between the two learning curve frames of reference is not within the scope of this paper. Suffice it to say that, although the differences between the two approaches may appear subtle, the distinction between them is extremely important. The appropriateness of either method can only be determined by the particular case at hand and a study of previous learning experienced in similar production situations. A more detailed discussion of learning curves may be found in reference (5).

2. <u>Learning Curves and Ship Acquistion Contracts</u>

In general, because ship procurements are in much smaller quantities than other DOD procurements such as aircraft, learning curves probably have a much smaller impact on total program costs than these large quantity buys. However, because the unit cost of a ship is so great, and the construction period so long, the implied learning curve can have a major impact on the payments to a contractor, and his cash flow position, over the life of a contract.

Contracts for the series production of ships generally permit the contractor to specify anticipated learning when a responding to a Request for Proposals (RFP), with learning for labor and material identified seperately. The learning curves may be specified explicitly, but usually the information is obtained by comparing estimates of labor

manhours and material dollars for each unit of construction. In determining the learning curve, production start-up and engineering/development costs should be separately identified, if possible, and not charged against the lead ship. The learning curve reflected by the contractor's anticipated unit costs is significant not only because it purports to reflect his labor requirements and material plans, but because it has a major impact on the timing of cash reimbursement by the government. This is true because progress on each ship, as measured during the construction period, is weighted by the "learning" specified in the contract, so that heavier weights applied to earlier ships provide the contractor with a greater proportion of cost and profit dollars earlier in the program. This may be fully justified. The incentive exists, however, for the contractor to overestimate anticipated learning simply to take advantage of the improved cash flow situation that will result if the contractor's learning forecasts are incorporated into the contract.

3. Program Application

Labor and Material learning curves as used in this simulation are assumed to apply to Labor and Material costs for succeeding units of production. For Labor, the distinction of costs as opposed to manhours is important, since it reflects an added degree of flexibility in using the program. This flexibility may be required where a contractor proposes to vary the overhead rate over time and exclusive of any changes already being compensated for by the escalation provisions of the contract. This situation can be imposed on the program by adjusting the unit Labor dollar costs, or learning curve.

Learning may be imposed by the program user by specifying integer weights for Labor and Material on each ship (CASE I only) or rates for the Unit Learning Curves. If the user desires to impose a cumulative average learning curve the resultant weights must be calculated by hand and provided for the CASE I Analysis. The program permits the user to specify the weights for CASE I and/or differing unit learning curve rates for suceeding cases if a learning curve comparison is desired and OPTION 1 is specified. If the user specifies that no learning curve is desired, the program assumes that the total Labor/Overhead and Material costs for each ship are identical.

An additional feature of the simulation permits the generation and reimbursement for engineering/development and production start-up costs related to the entire program and not charged to any of the ships in the contract. The simulation accomplishes this by reading in Labor and Material weights and generating these costs as though an additional ship were added to the program. This option is only expliciteley permitted when a unit learning curve is specified, although it can also be imposed in CASE I when all weights are provided. Input requirements are fully described in Appendix A.

B. PROGRESS CURVES (OPTION 2)

1. Discussion

Progress curves are used to estimate the schedule with which a contractor will perform work and incur costs under a contract. Curves for Labor/Overhead and Material are determined seperately. It is generally assumed that these curves have an "S" shape as depicted in

figure 4, with the material curve leading the labor curve by some period of time.

In responding to an RFP, a contractor will usually provide profiles of estimated progress curves for each ship under the contract, but unless specified by the contract payments section, forecasted curves are not included as part of the contract and have no impact on payments. Actual progress, as measured during construction, is the element used to determine eligibility for progress payments.

2. Program Application

One of the main objectives in preparing this simulation was to determine the impact on cash flow and the timing of payments of varying contract terms and conditions, and how they are affected by variations in contractor performance. Estimates of Labor and Material progress are therefore important elements in the simulation.

Where an RFP response is being evaluated, the user will probably want to use the contractor's progress profiles as inputs to the simulation. The simulation will accept these profiles in any combination of the following:

a. Monthly or Quarterly Values

b. Cumulative or Incremental Progress

c. Individual Progress for Each Ship or Total Progress for the Contract

In the pre-solicitation stage, it may be desireable to simulate an assortment of profiles to determine the funding impact of different schedules. The simulation will generate progress curves when desired

using a scheme developed within the Naval Sea Systems Command to obtain "rough" cuts at estimated progress curves. This method requires the user to specify 16 values (8 each for labor and material) for each ship of the contract and generates a reasonable approximation of total progress for the program. These values are used to generate an "S" shaped curve for each ship using a trapezoid approximation as depicted in figure .

The Trapezoid Approximation of Progress

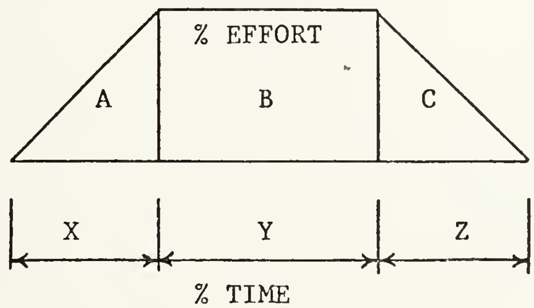
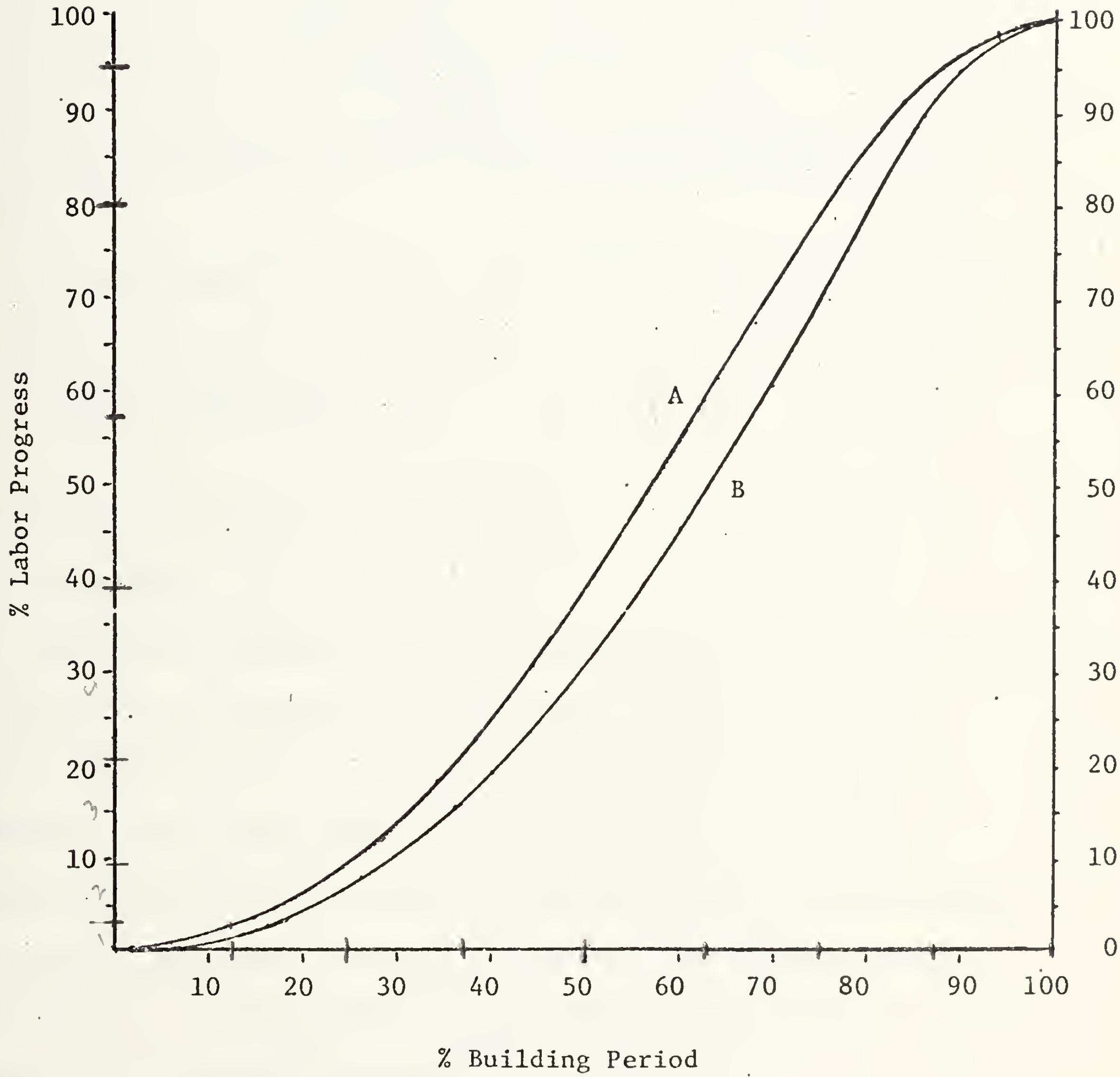


Figure 3

The X-Y-Z percentages indicate the proportion of time which the corresponding A-B-C percentages of total effort/dollars are expended for a ship. During periods X and Z this level of effort is assumed to be continuously increasing/decreasing at decreasing/increasing rates, respectively. During period Y, the level of effort is assumed to remain constant. The remaining two values required are the month of the contract that the effort begins, (where 1 is the month of contract award), and the total number of months covered by the curve for that ship. In the absence of any better guidelines, a good estimate for the labor distribution on a USN steel ship is:

Program Generated Progress Curves



% EFFORT

A

A	B	C
40	40	20
50	25	25
X	Y	Z

% PROGRESS

% EFFORT

B

A	B	C
30	40	30
50	25	25
X	Y	Z

% PROGRESS

Figure 4

% EFFORT

A	B	C
40	40	20
50	25	25
X	Y	Z

% PROGRESS

Plots of the resultant curve and a variation are depicted in figure 4.

The distribution of the material curve can only be determined by an analysis of the type of ship, number of ships purchased, make-or-buy plans, lead-time requirements, etc.

C. ESCALATION INDEX FORECASTS (OPTION 3)

1. Discussion

Escalation indices are used to measure price changes, and determine the size of the escalation payment made to the contractor. In general, an index measures input prices for a specific aggregate or "marketbasket" that approximates an industry's mix of input goods. The index value may then be compared with a base month, or the preceding month's value, to provide a measure a relative price change during the period covered. It is generally accepted that a valid index must reflect a balance of the following considerations:[3]

a. An index should have a sound theoretical basis, not significantly affected by changes in goods that are not appropriate for the contractor's marketbasket, yet broad enough to reasonably account for all price changes that the contractor experience.

[3] Logistics Management Institute, Wage Rate and Material Price Level Adjustment Provisions in DOD Procurement, 1968, pp. 19-22.

b. An index should be historically accurate, providing a reasonable correlation between past index measurements and price level changes experienced by the industry in the same time period.

c. An index should be statistically valid, having a large enough sample size and frequency of sampling.

d. The index should be relatively free from influence by individual firms. The weight of an individual contractor's input to the index should be as small as possible.

e. The influence of the index composition on labor/management relations should be minimized.

f. The administrative burden of maintaining the index should be minimal.

More detailed discussions on escalation indices and their application may be found in references (3), (4), (6), and (7).

The Naval Sea Systems Command uses two escalation indices to provide separate estimates of Labor and Material price changes experienced by the shipbuilding industry. Both of the indices are of the Laspeyres type, using fixed weights to determine the aggregate index, and are described below.

2. The Steel Vessel Index

The Bureau of Labor Statistics (BLS) Material Index for Steel Vessel Contracts is made up of three commodity subgroups of the Wholesale Price Index. These subgroups and their weightings are as follows:[4]

10-1	Iron and Steel	45%
11-4	General Purpose Machinery and Equipment	40%
11-7	Electrical Machinery and Equipment	15%

[4] Naval Ship Systems Command, NAVSHIPS Forecasts of BLS Material and Labor Indices for Estimating Shipbuilder's Contract Escalation for SCN Funds, 1974, p. 16.

A breakdown of the Subgroup 10-1 and it's weighting is as follows:

1011	Iron Ore	.792%
1012	Iron and Steel Scrap	5.587%
1013	Steel Mill Products	72.358%
1015	Foundry & Forge Shop Products	18.261%
1016	PIG Iron & Ferroalloys	3.002%

As can be seen above the steel mill products i.e., plates, sheets, bars etc., make up 72.4% of 10-1 and approximately 33% of the BLS Material Index.

3. <u>The Labor Index</u>

The BLS Labor Index (for Steel Vessel Contracts) consists of inputs from seventeen selected private shipyards in the country. The index is based on the straight time average hourly earnings as reported by the yards:[5]

The selected yards and their percentage of the work force in April 1974 are as follows:

	% of Total reported Employees
Bath Shipbuilding	2.8
G. D. Groton	16.9
Newport News	31.0
*American	1.1
*Dravo	1.4
Marinette	0.5
Avondale	10.5
Bethlehem (Texas)	2.6
Levingston	2.1
Litton	20.2
*Bethlehem (San Fran)	0.5
*Gunderson	0.7
*Lockheed	2.2
National Steel	3.9
*Todd (San Pedro)	2.0
*Todd (Seattle)	1.2
Williamette	0.5

*Yards with cost of living adjustments in their union agreements.

[5]ibid, p. 23.

4. Index Forecasts

The Cost Estimating and Analysis Division of the Naval Sea Systems Command (NAVSEA 01G) develops forecasts of escalation index performance for budgetary purposes.

Forecasts for the Material index are primarily determined by estimated of price changes for steel mill products and based on reviews of current literature, industry comments and predictions, steel mill labor contracts, etc.

Forecasts for the Labor index are based on union wage contract agreements, comments of AFL-CIO union leaders, comments of the shipbuilding industry's management, cost-of-living provisions in existing contracts, etc.

These forecasts are for budgeting purposes only, and are in no way identified with an actual contract or escalation clause.

5. Program Application;

The model permits the user to provide forecasts of future index performance for each escalation index. The forecasts must reflect the anticipated change of the index value over the fiscal year specified. The model assumes that this change is linear over the fiscal year, not based on a monthly compounding rate of change. The user may forecast out as many years as desired. If forecasts do not cover the full period being evaluated by the model, the last forecast provided for each index will be assumed for all subsequent years.

If OPTION THREE is selected, the user may provide up to eight different sets of escalation index forecasts for evaluation by the model.

D. ESCALATION PAYMENT METHODS (OPTION 4)

1. Discussion

In addition to the index forecasts discussed in OPTION 3, the amount of escalation payment also depends upon how the contract recognizes incurrence of expenditures over time. Two alternative methods are modelled depending upon whether the expenditures are estimated at the contract signing or whether the expenditures are measured as the contract progresses. The second method is more accurate. Accurate measurement and compensation of the price changes to the contractor should induce him to rely upon the escalation procedure rather than add "margins" to his cost estimate. It is usually assumed that a contractor is "risk averse." If so the margin he adds is more than the anticipated price change. Such a margin is inherent in a contract without escalation. The contract is then said to have "contingency pricing." It has been shown in references [1] and [6] that under the above assumptions the government and the contractor benefit from escalation provisions.

If OPTION 4 is selected, up to eight different variations (CASES) of the escalation payment methods described below may be evaluated, with the frequency of payments as specified by the user for each CASE.

2. Method I - The Contract Curve Method

The contract curve method was, until recently, the standard method used within the Naval Sea Systems Command to determine escalation payments in a ship acquisition contract. In this method, Labor and Material escalation curves are specified in the contract. These curves are usually quite similar to the anticipated progress curves for the contract, although there may be some modifications to account for material lead time, etc. Unless adjustment of these curves is specifically required due to government responsible delays, the curves remain fixed throughout the contract life, regardless of actual contractor progress performance. In addition to the escalation curves, a Labor/Material split is also specified in the contract, and this split, applied to Target Cost, determines the fixed amount of base year dollars to be apportioned by the Labor and Material curves on which escalation payments will be made. This method has no provisions for reimbursement of price changes associated with cost growth or schedule overrun.

Escalation payments are determined as follows:

LABOR

$$\mathrm{EPAY(LAB,M)} = \mathrm{TCOST} * \mathrm{PLESC} * \mathrm{KECM(LAB,M)} * \left(\frac{\mathrm{BLS(LAB,M)} - \mathrm{BLS(LAB,B)}}{\mathrm{BLS(LAB,B)}}\right) \tag{3}$$

MATERIAL

$$\mathrm{EPAY(MAT,M)} = \left((\mathrm{TCOST} * \mathrm{PMESC}) - \mathrm{ALLTM}\right) * \mathrm{KECM(MAT,M)} * \left(\frac{\mathrm{BLS(MAT,M)} - \mathrm{BLS(MAT,B)}}{\mathrm{BLS(MAT,B)}}\right) \tag{4}$$

Where:

EPAY(LAB/MAT,M) = The escalation payment in month M for LABor or MATerial, as appropriate.

TCOST = Target Cost ($).

PLESC = The proportion of TCOST to be escalated with the Labor escalation index.

PMESC = The proportion of TCOST to be escalated with the Material escalation index.

KECM(LAB/MAT,M) = The incremental percentage change in month M of the appropriate LABor or MATerial contract escalation curve.

BLS(LAB/MAT,M) = The actual escalation index value for month M for the appropriate LABor or MATerial index. "B" indicates the appropriate base month index value.

ALLTM = The allowance for long lead time material. (See section II-C-2).

3. Method II - Marshall's Method

Method II is the escalation reimbursement method proposed by LCDR Clyde Marshall, USN (formerly assigned to the Navy Material Command (NAVMAT 0233)). With this method, no escalation curves are specified in the contract, and the escalation is paid based on actual costs incurred. Since actual costs are used, there is no need for a contracted Labor/Material split. Payments are determined by first "de-escalating" all incurred costs to base year values using the appropriate escalation indices. The difference between actual costs incurred (i.e. - with all price changes), and the calculated base cost is then reimbursed as escalation. Payments are determined monthly in this manner as follows:

LABOR:

$$BCOST(LAB,M) = AC(LABIND,M) * \frac{BLS(LAB,B)}{BLS(LAB,M)} \quad (5)$$

$$EPAY(LAB,M) = AC(LABIND,M) - BCOST(LAB,M) \quad (6)$$

MATERIAL:

$$BCOST(MAT,M) = \left(\left(AC(MATIND,M) - CLLTM(M)\right) * \frac{BLS(MAT,B)}{BLS(MAT,M)}\right) + CLLTM(M) \quad (7)$$

$$EPAY(MAT,M) = AC(MATIND,M) - BCOST(MAT,M) \quad (8)$$

Where:

BCOST(LAB/MAT,M) = The calculated base costs for Labor/Material in month M. (See note 6)

AC(LABIND/MATIND,M) = The actual costs booked by the contractor, identified with either the LABor or MATerial Index, in month M.

BLS(LAB/MAT,M) = The actual escalation index values for LABor and MATerial in month M.

"B" indicates the base month index value.

CLLTM(M) = Actual costs incurred for long lead time material in month M.

EPAY(LAB/MAT,M) = The calculated escalation payment for incurred LABor or MATerial costs in month M.

As indicated above, Method II attempts to reimburse the contractor for all price changes experienced over the life of the contract. Calculation of payments is not affected if either cost growth or schedule overrun occur. This is consistent with the conceptual purpose of escalation payments to reduce the contractor's exposure to price changes over which he has no control, and thereby reduce contingency pricing by the contractor.

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[6] The calculated BCOST is the basis for progress payments. Base costs in escalation payment method I are determined by subtracting the escalation reimbursement from total costs incurred.

Because of the open-ended nature of Method II a number of suggestions were made to alter the payment provisions in the event of cost growth or schedule overrun. These contract provisions may be invoked in the simulation and are described below:

a. Share Line Alternative

This provision calls for the reduction of escalation payments in the same manner that the share line reduces contractor profit if cost growth occurs. If calculated base costs exceed target, the escalation payment to the contractor is reduced by the share, and the unreimbursed escalation is absorbed by the contractor. This calculated unreimbursed escalation portion is <u>not</u> added back into base costs, since this would mean using the share line twice to reduce the same costs and make the share line provision relatively meaningless.

b. Freezing the Index

This provision specifies that the escalation index value is frozen at the contracted month of delivery if schedule overrun occurs. The index value reported for the contracted delivery month is used for all subsequent escalation payment calculations, unless the actual month index value is less than the index in the contracted delivery month.

c. Ceasing Payments at Ceiling

This provision specifies that all escalation payments cease if calculated base costs exceed contract ceiling.

4. <u>Frequency of Payments</u>

Escalation payments may be made with any frequency specified by the program user. The longer the period between payments, the greater the effect on contractor cash flow.

E. THE SHARE LINE (OPTION 5)

1. Discussion

The share line is the element that distinguishes a cost incentivized contract from other contract forms. The share line specifies the proportion with which the government and the contractor will share cost growth, if it occurs, and provides the contractor with an additional profit if the base cost at contract completion is less than the target cost specified in the contract. It is an attempt by the government to incentivize cost control by the contractor, while at the same time recognizing that elements of cost uncertainty exist for which the government should share the risk.

The share line may consist of a single government-to-contractor share or be composed of multiple shares. When a multiple share line is used, each share is specified over a unique cost range. In concept, succesively steeper shares beyond target cost indicate decreasing anticipated risk in incurring additional cost growth. A graph of a representative share line is depicted in figure 5.

2. The Point of Total Assumption (PTA)

The share line depicted in figure 5 is an example of a multiple share line with three break points. The first share (before target cost) reflects the incentive of additional contractor profit if base costs are kept below target. The second break point occurs when base costs reflect a 10% cost growth situation. If that point is reached, the government will have paid out $18 more in base costs, while the contractor will have suffered a $2 loss in profit. The final share (80/20) continues until the Point of Total Assumption (PTA) is reached.

A Share Line Example

Target Cost (TC) = $200
Target Profit (TP) = $ 20
Ceiling Price (CP) = $260

Share (Government/Contractor)	Start (Lower Bound)	Break Point (Upper Bound)
70/30	None	TC
90/10	TC	1.10 * TC
80/20	1.10 * TC	PTA

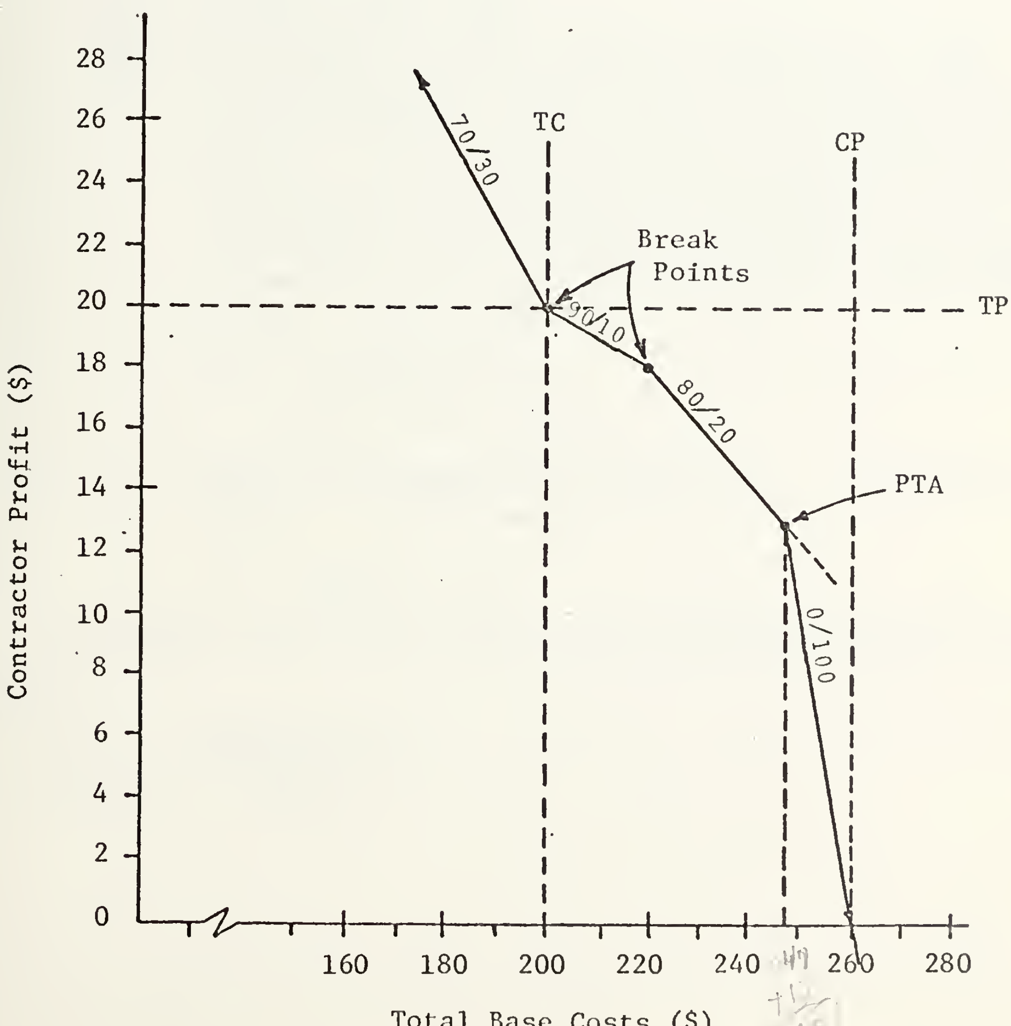

Figure 5

The Point of Total Assumption is determined by the share line and ceiling price, and is the point where:

$$\begin{array}{rl} & \text{Profit Earned by Contractor} \\ + & \underline{\text{Base Cost Payments by Government}} \\ = & \text{Ceiling Price} \end{array}$$

Beyond PTA, government sharing ceases and the contractor absorbs all cost growth incurred. Beyond the ceiling price, the contractor is losing money on the contract.

The Point of Total Assumption can be determined in the following manner: (the values indicated refer to the example in figure 5)

let:

- TC = Target Cost (200)
- TP = Target Profit (20)
- CP = Ceiling Price (260)
- GS = Government Portion on the last share line (.80)
- X = Total additional costs incurred by the government (beyond Target) at the lower bound of the final share line. This value is 0 if there is only one share. If there is more than one break point beyond TC, X is determined by multiplying the governments' share by the increment of cost covered by the share, and summing these values for each share (except the final) beyond target. In the example:

$$\begin{aligned} X &= (1.10*TC-TC)*0.9 \\ &= (.10*TC)*0.9 = 18 \end{aligned}$$

- Y = The lower bound for the final share. (TC if only one share) In the example:

$$Y = 1.10*TC = 220$$

The total base costs at PTA is then determined by the following equation:

$$BC_{PTA} = \frac{(CP-TC-TP-X)}{GS} + Y$$

In the example:

$$BC_{PTA} = \frac{(260-200-20-18)}{.08} + 220$$

$$= \frac{22}{.8} + 220 = 247.5$$

the break point at PTA is 1.2375*TC

Note that beyond PTA, the implied share line is 0/100. Further discussion on plotting share lines may be found in reference (2).

3. Program Application

If OPTION FIVE is selected, a total of eight different share lines, each with a maximum of five break points, may be evaluated by the simulation. Only one share is permitted before target cost. A share line is described by first specifying the number of break points and then identifying each break point (as a function of target cost) and the corresponding government or contractor share before that break point is reached. The break point for the last share must be at least as great as the Point of Total Assumption. The simulation automatically ceases all progress payments when the total exceeds the ceiling price.

F. PROGRESS PAYMENT METHODS (OPTION 6)

1. Discussion

As defined by the Armed Services Procurement Regulation, "the term progress payments...signifies payments made as work progresses under a contract, upon the basis of costs incurred, of percentage of completion accomplished, or a particular stage of completion."

Progress payments are essential in major ship acquisition contracts because they provide a means of periodically reimbursing the contractor for work performed pursuant to the contract. The alternative to progress

payments, where any reimbursement by the government is deferred until the contract is completed or a ship delivered, would be prohibitively expensive since the contractor might then be forced to obtain operating capital through commercial financing, with resultant interest costs passed on to the government. In contrast to the consideration of minimizing contractor needs for outside financing, there has been the requirement to avoid overpayment to the contractor, especially if cost growth is occuring, to ensure that the contractor is only paid for work performed pursuant to the contract and is provided the incentive to control costs and maintain his production schedule.

Progress payment methods used within the Naval Sea Systems Command have generally been structured to ensure that the contractor's operating capital needs are provided for, as long as the contractor is controlling costs as determined by the contracted target cost and measured progress. If cost growth is occurring, however, the contractor may find himself in an increasingly perilous cash flow position. This aspect of current progress payment methods emphasizes the significance of an accurate target cost, reasonable share line, and the importance of an equitable progress payment scheme. In their absence, the contractor can suffer undeserved cash flow problems that could seriously impair his ability to perform under the contract, embarass both the Navy and the contractor, and strain the Navy-contractor relationship in administering the contract.

One of the primary purposes of constructing the FPIF contract financing simulation model was to provide a means of evaluating these cash flow impacts on the contractor. The model also provides a means of measuring the NPV effects on the contractor when progress payment thresholds provide for periodic payment of profit to the contractor.

2. Method I - SECNAVINST 7810.11

The Secretary of the Navy Instruction 7810.11, provided as Appendix C in this paper, was promulagated on 15 March 1973 and cancelled 17 July 1975. The instruction contained the authorized progress payment method for FPIF shipbuilding contracts but, as indicated by its short life, was never used in a major ship acquisition contract and was poorly received by the shipbuilding industry. It was retained as a progress payment method in the model since it was only recently cancelled, and the author felt that it might still be of some future interest in analyzing different payment alternatives.

The method provided for progress payments based on measured progress and limited by a percentage of actual contractor costs incurred. In addition, perodic "interim payments" were paid to the contractor. These interim payments represented "a payment to the contractor for a significant milestone of accomplished performance." The method is fully described in Appendix C, however the model has no provision for a final settlement reserve and assumes that all payments due are paid upon delivery of the last ship in the contract.

3. Method II - SECNAVINST 7810.12

The Secretary of the Navy Instruction 7810.12, provided as Appendix D in this paper, was promulgated on 17 July 1975 and cancelled SECNAVINST 7810.11. The instruction contains the current authorized progress payment method for FPIF shipbuilding contracts.

The method provides for progress payments based on a percent of measured progress and limited by a percent of actual costs incurred by the contractor. These thresholds are changed upward after the fifty percent progress point is reached. The method also provides for a withholding account specified as a percentage of the estimated base cost and profit (billing price) at contract completion. This withholding, which is only required after the fifty percent progress point is reached, is subtracted from the percentage of progress calculated payment, not from the payment ceiling threshold determined by actual costs incurred. The method is fully described in Appendix D, however the model has no provision for interim liquidation of payments upon delivery of each ship and assumes the final payment is provided upon delivery of the last ship in the contract.

4. Program Application

The user specifies the frequency of payments for either method.

Method I may be invoked with progress and cost incurred thresholds as specified by the user. The user also specifies the number of interim payments and the appropriate cost and progress milestones for each payment.

Method II may be invoked with two distinct combinations of progress and cost incurred thresholds specified by the user. The user also specifies the transition point, as a percent of progress, from one set of thresholds to the other, and also specifies the amount of withholding, as a percent of the billing price, before and after the transition point.

If OPTION SIX is selected, a maximum of eight different progress payment schemes may be evaluated during a simulation run.

V. CONCLUSIONS

A. THE CONTRACT CURVE METHOD VS MARSHALL'S METHOD

The author used the model to study the effects of two different escalation payment methods on an aircraft carrier procurement contract. The two methods are identified as Method I and Method II in this paper and described in detail in section IV-D. The basic assumptions in this study were:

Single ship procurement (7 years)

Target Price $500 M

Ceiling $600 M

Simulated cost growth limited to Labor and Overhead only

Progress payments were made weekly using a modified version of Method II as described in section IV-F of this paper. Payments were based on 95 percent of progress and limited to 105 percent of cost incurred throughout the contract.

Share Line:	Percentage of Target Cost	Contractor Shares Below(before) Break Point
	100	0.15
	105	0.05
	115	0.10
	133	0.15

Escalation payments were made monthly

Where Method II was used as the escalation payment method, the escalation index values were frozen at the contracted delivery month when schedule overrun was being simulated, and escalation payments were reduced in accordance with the share line when cost growth was being simulated. The conclusions were:

1. Method I was extremely sensitive to the accuracy of the contract escalation curves.

Two sets of Labor and Material escalation curves were used in successive simulation runs using escalation payment Method I. These curves

are depicted in figures 6 and 7. Both sets of curves were developed within the Naval Sea Systems Command; the first set was prepared 14 June 1974; the second set was prepared 30 July 1974. The 30 July Labor/Overhead curve was displaced at the center approximately three months to the left of the 14 June curve, while the 30 July Material curve was displaced at the center approximately six months to the left of the 14 June curve. By running the simulation with one set of curves as the contract escalation curves and the other set simulating actual contract performance, it was possible to evaluate the sensitivity of escalation payment Method I to the accuracy of the contracted curves, using "Absorbed Escalation" as a measure of sensitivity.

When the 14 June curves were stipulated as the contract escalation curves, but actual performance followed the 30 July curves, the contractor was over compensated for escalation by $21M to $31M, depending on the accuracy of the Method I Labor/Material split. Assuming the contract completed on schedule and at "true" target cost, the overcompensation for escalation drove base costs $20M below target and the the contractor received the additional benefits that accrued from the share line below target, although no "real" savings on construction costs had been achieved. Significant schedule overrun and cost growth dampened this overpayment. This was because the contract escalation curves were not adjusted as schedule overrun occured and because escalation payment Method I is based on target cost only.

When the 30 July curves were stipulated as the contract escalation curves, but actual performance followed the 14 June curves, the contractor was undercompensated for escalation by $23M to $32M, depending on the accuracy of the Labor/Material split. This undercompensation resulted in an equivalent increase in charges against base costs and an apparent cost growth situation of some significance.

Alternative
Labor Escalation Curves
For a CVN Contract

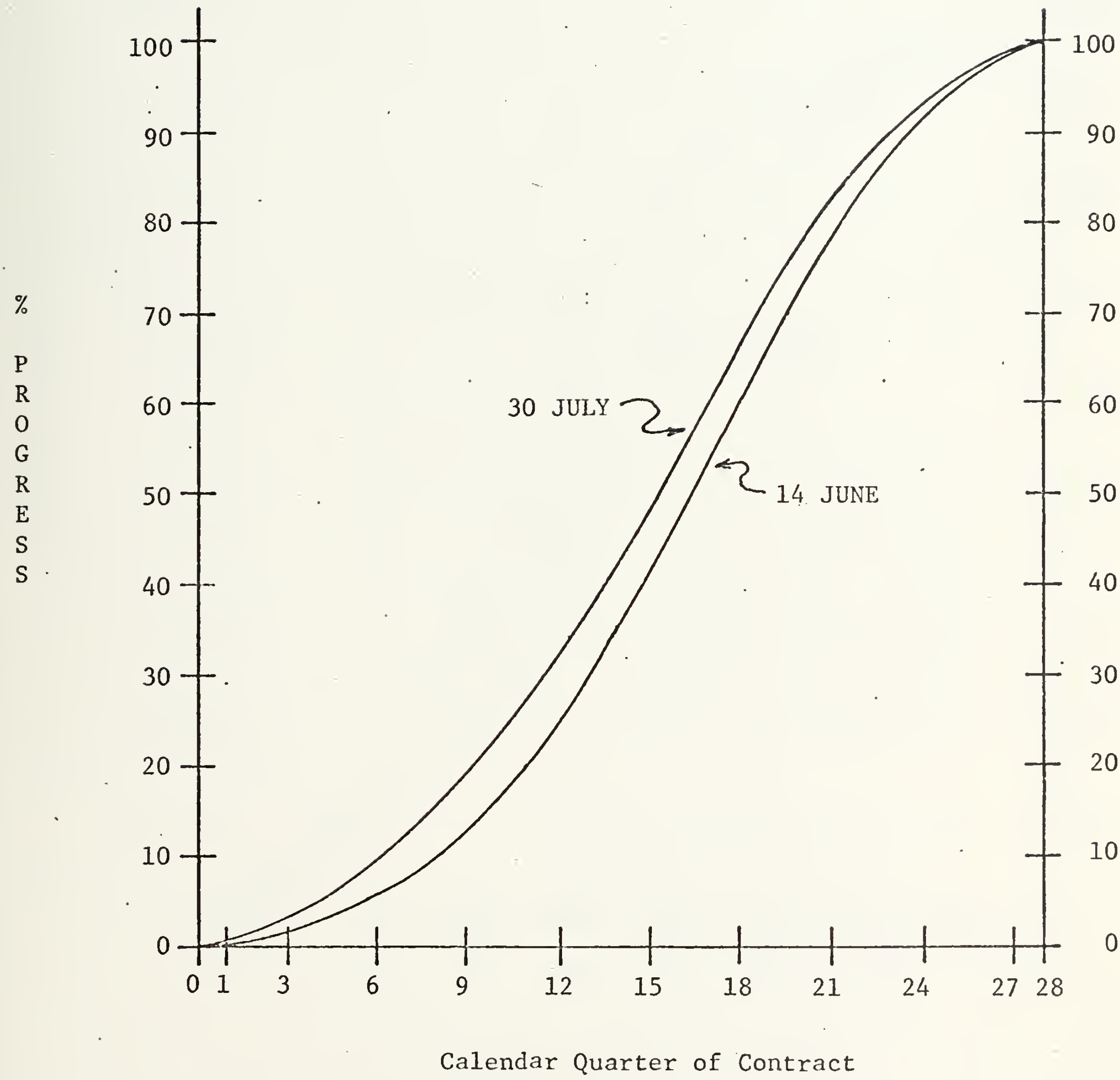

Figure 6

<u>Alternative</u>

<u>Material Escalation Curves</u>
<u>For a CVN Contract</u>

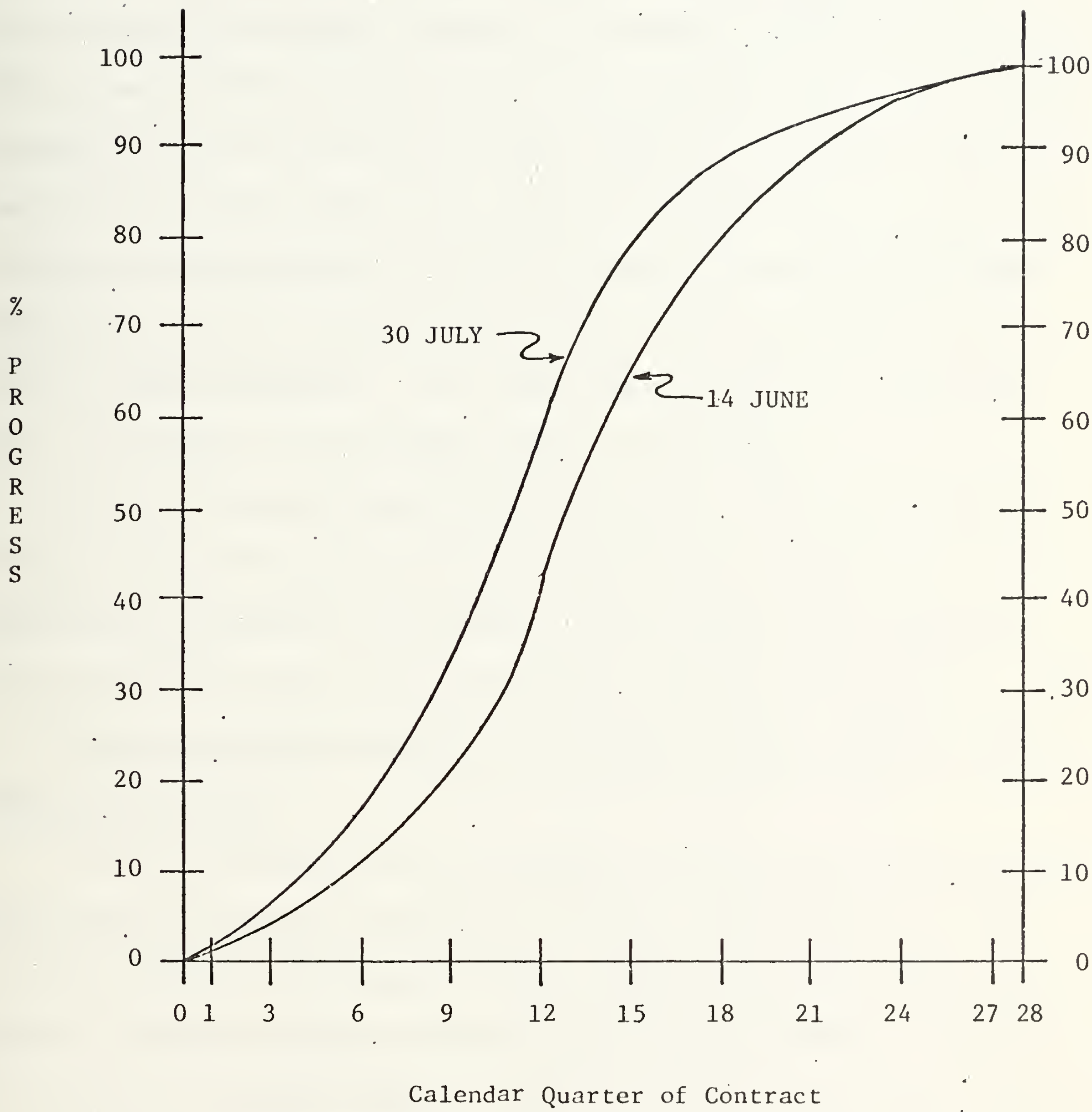

Figure 7

The confounding effect of inaccurate curves noted above did not have as severe an effect on the contractor's return (using NPV at 15% as an indicator) as might be expected. Throughout the range of mismatches, NPV fluctuated between $27.7M and $24.5M. This was because any over/under compensation for escalation had a direct effect on the charges against base costs and over-compensation automatically implied that the contractor experienced a delay between the time he actually incurred the escalation expense and the time he was reimbursed for it, while the reverse was true for under-compensation. The "time-value of money" thus tended to dampen the effects of inequitable escalation payments.

The major problem associated with contract curve inaccuracies was that the effects of the share line in controlling cost growth were significantly frustrated and payments to the contractor were made from the wrong "pot" of money. (i.e., escalation rather than base cost.)

2. Escalation payment Method I was sensitive to the accuracy of the Labor/Material split.

The cost element matrix of the model was structured so that there was an implied Labor/Material split of 53.5/45. The simulation was then run with different Labor/Material splits specified in escalation payment Method I, and with forecasts of escalation index performance as provided by the Naval Sea Systems Command. These forecasts had the Material index increasing at a significantly faster rate than the Labor Index. (Over a seven year period the Material index increased 264% vs 160% for the Labor Index).

The simulation was first run with a contracted split of 55/43, thus favoring Labor by approximately 2%, and resulted in undercompensation for escalation by at least $5M. This resulted in increased charges against the base costs even though no "real" cost growth was experienced.

The simulation was next run with a contracted split of 51/47, thus favoring Material by approximately 2%. This produced overcompensation for escalation by at least $3.5M.

3. Neither escalation payment method had a major effect on the contractor's NPV (at 15%) when simulating schedule overruns up to six months, unaccompanied by cost growth.

When six month schedule overruns were simulated with 20% cost growth in Labor and Overhead, NPV for Method I was reduced by approximately $4.5M (an 18% reduction), while NPV for Method II was reduced by approximately $3.5M (a 14% reduction).

In terms of total payments to the contractor (i.e., Progress Payments + Escalation Payments) and NPV to the contractor, the differences between the escalation payment methods were relatively insignificant up to the point where a six month schedule overrun was accompanied by 20% Labor and Overhead cost growth. Regardless of the delivery schedule, when Labor and Overhead cost growth exceeded 30% the methods diverged rapidly, due to the advanced position of Method I on the share line, caused by incurred price changes being charged against base costs.

4. Method I magnified cost growth because it had no provision for escalation reimbursement beyond target.

A 5.5% cost growth under Method II appeared as a 9.2% cost growth under Method I. Similarly, a 16.5% cost growth under Method II appeared as a 25.5% cost growth under Method I.

In light of the above conclusions, the author feels that escalation payment Method II (Marshall's Method) provides a more accurate means of measuring the effect of price level changes. This reduces the contractor's risk of financial loss due to price level changes. By reducing this risk, the government can expect to reduce or eliminate price level contingency pricing on the part of the contractor.

Using fixed escalation payments curves in the contract, specified at contract award are at best rough estimates. Method II avoids this problem by measuring progress as it occurs. The required cost incurred information for Method II is available from data required to determine progress payments. The primary argument advanced for payment Method I is that it provides one of the Navy's few incentives for timely contractor performance. As shown above, this incentive is not very significant. The author feels that such a consideration, even if it was significant, is not appropriate for an escalation provision.

B. PROGRESS PAYMENT METHODS FOR THE FFG-7 CLASS PROCUREMENT

A second study conducted with the FPIF financing simulation model was in response to questions concerning the two progress payment thresholds and the withhold for the FFG-7. Two thresholds are described in SECNAV 7810.12, Appendix D of this thesis. The progress threshold is structured so that the contractor may receive some portion of profit, since the percent of progress threshold is applied against the billing price. The cost incurred threshold reflects the uncertainty in our ability to accurately measure physical progress. Unfortunately, the cost incurred threshold may be set too low and/or the withholding provision set too high, thus precluding payment of profit to the contractor, or limiting profit to a low percentage not consistent with actual contractor performance.

The purpose of the study was to evaluate the impact of the thresholds on the contractor's cash flow and the timing with which he received profit. The basic assumptions in this study were:

5 ship contract (63 months) "No special progress payments on individual ship deliveries"

Target Cost = $220(M)

Target Profit = $33(M)

Ceiling = $275(M)

NPV computed at 10%

Share Line: Percentage of Target Cost	Contractor Shares Below (before) Breakpoint
100	0.30
125	0.30

Escalation payment method II was used with monthly payments. Escalation payments ceased if calculated base costs exceeded contract ceiling.

The cost element structure in this analysis was constructed without any payment delays. The cash investment column in the detailed quarterly output tables, with the appropriate sign change, may therefore be used to approximate contractor profit, and the term profit will be used, vice negative cash flow investment, in this discussion for convenience.

Six sets (CASES) of progress payment thresholds for progress payment method II were evaluated. Progress payments were made biweekly for all CASES. The thresholds for each CASE are described below:

BEFORE 50% PROGRESS	CASE 1	2	3	4	5	6
PROGRESS	0.95	0.90	0.90	0.95	1.00	0.95
COST INCURRED	1.05	1.00	1.00	1.05	1.15	1.05
WITHHELD	0.05	0	0	0	0.026	0
AFTER 50% PROGRESS						
PROGRESS	0.95	1.00	1.00	1.00	1.00	1.00
COST INCURRED	1.05	1.05	1.00	1.15	1.15	1.15
WITHHELD	0.05	0.05	0.05	0.05	0.026	0.026

In all CASES, the withholding was applied against the billing price.

The CASE ONE method is the same as that proposed for the CVN-70 procurement. The CASE TWO method has the thresholds specified by SECNAVINST 7810.12 (Appendix D). The CASE THREE method is the method described in the FFG-7 Request for Proposals (RFP). CASE FOUR through SIX were chosen to evaluate a wider range of alternatives. The detailed quarterly output for CASES ONE through SIX are provided in Tables V through X, and the summary output is depicted in Tables XI and XII.

CASE ONE (Table V) demonstrates the effect of withholding based on the billing price during the first 50% of progress. The failure of the contractor to receive any progress payments through the first seven quarters of the contract can be directly attributed to this withholding, since he must accumulate costs up to 5% of the billing price ($12.65M) before progress payments can be made. The effect that this has on his cash investment does not appear desirable, since the contractor is forced to absorb a sizeable cash outflow that must be financed. It can also be noted that the contractor did not receive any profit until the 15th quarter of the contract. Throughout the remainder of the construction period, the amount of profit paid the contractor was not commensurate with the physical progress demonstrated by the contractor.

CASE TWO (Table VI) shows the effects of SECNAVINST 7810.12. Since no withholding was applied during the first 50% of progress the contractor was not deprived of progress payments as in CASE ONE. However, there was still a significant lag in the amount of profit paid to the contractor when compared to physical progress.

CASE THREE (Table VII) demonstrates what happens when progress payments during the last 50% of progress are limited to 100% of costs incurred. This provision ensures that no profit is paid the contractor until contract completion. In effect, this means the Navy is asking the contractor to perform $220M worth of work over a six year period while not receiving any profit until the work is completed. Any corporation undertaking such a contract must have very patient stockholders.

The CASE FOUR thresholds reflect an attempt to provide the contractor a portion of his profit throughout the construction period. The threshold of 115% of cost incurred after 50% progress allows the contractor to receive a

portion of profit earlier. This threshold, in the later quarters of the contract, will only come into play if costs remain on target, thus still providing the contractor an appropriate reward, or incentive, for controlling costs. The 5% withholding during the last 50% of progress ensures that the amount of profit paid the contractor still lags his physical performance so that at least $13M (approximately 40% of profit) is withheld until contract completion.

CASE FIVE demonstrates a further attempt to provide the contractor a portion of profit throughout the contract. The withholding of 2.6% of the billing price reflects approximately 20% of target profit, assuming the end cost comes in at target. The undesirable effects of having withholding during the first 50% of progress, also shown in CASE ONE, were still present in this case. After 50% progress however, CASE FIVE become quite favorable to the contractor and provided a reasonable portion of profit, although still retaining 20% of profit until actual contract completion.

CASE SIX was a composite of CASES FOUR and FIVE. The thresholds allowed the contractor a portion of profit throughout the contract while still retaining 20% of profit until contract completion. It is the author's opinion that these thresholds are the most equitable of all the cases presented. The thresholds incentivize the contractor to complete the contract while still allowing him profit nearly in proportion to work performed (progress).

The effect of cost and schedule overruns can be seen by observing the NPV with overruns in Tables XI and XII. All of the cases incentivize the contractor to control costs, however none provide a dramatic incentive for timely schedule performance.[7] Using NPV as a measure, CASE TWO provides the

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[7] The severe NPV situation for large cost overruns occurs because of the share line and elimination of escalation after the ceiling is reached.

greatest schedule incentive, reducing NPV by \$2M (a 10% reduction), if a 12 month schedule overrun occurs. CASE SIX provides the smallest incentive, reducing NPV by \$1.3M (a 6% reduction), if the 12 month overrun occurs. Examination of the six cases shows that the two thresholds and the withholding interact to have a strong effect on the contractor's cash flow. Choice of thresholds and withholding percentages without a model for demonstrating the effect, can result in the contractor receiving no profit until the end of the contract.

TABLE V

CASE 1
****

MONTHS LATE: 0
COST GROWTH: 0 PERCENT

QTR ***	% PROGRESS TO DATE ********	TOTAL COSTS BOOKED *******	PROGRES /INTRIM PAYMENT *******	TOTAL ESCAL PAYMENT *******	KR CASH INVEST *******	KR ABSORB ESCAL *******
			FY 76 ******			
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.30	0.0	0.02	0.28	0.0
3	0.3	0.69	0.0	0.06	0.62	-0.00
4	0.5	1.13	0.0	0.12	1.01	-0.00
			FY 77 ******			
1	0.7	1.74	0.0	0.21	1.53	-0.00
2	1.4	3.55	0.0	0.47	3.08	-0.00
3	3.2	8.30	0.0	1.24	7.06	-0.00
4	6.2	16.37	3.12	2.68	11.96	-0.00
			FY 78 ******			
1	10.3	27.36	12.01	4.79	10.56	-0.00
2	16.0	43.16	27.04	8.06	10.54	-0.00
3	22.6	62.08	41.77	12.27	8.04	-0.00
4	31.2	86.66	64.31	18.07	8.01	-0.00
			FY 79 ******			
1	41.3	116.41	86.65	25.51	4.24	-0.00
2	52.6	150.04	115.96	34.35	4.21	-0.00
3	63.7	183.74	140.33	43.71	-0.30	-0.00
4	73.7	215.12	166.36	52.90	-0.34	-0.00
			FY 80 ******			
1	82.7	243.51	186.07	61.61	-4.18	-0.00
2	89.2	264.53	202.80	68.27	-4.22	-0.00
3	94.2	280.97	213.88	73.62	-6.53	-0.00
4	97.8	292.70	222.79	77.55	-6.62	-0.00
			FY 81 ******			
1	99.6	298.56	226.62	79.54	-7.61	-0.00
2	100.0	300.05	253.00	80.05	-33.00	-0.00

LAST SHIP DELIVERED: FEB 1981

TABLE VI

CASE 2
****

MONTHS LATE: 0
COST GROWTH: 0 PERCENT

QTR ***	% PROGRESS TO DATE ********	TOTAL COSTS BOOKED *******	PROGRES /INTRIM PAYMENT *******	TOTAL ESCAL PAYMENT *******	KR CASH INVEST *******	KR ABSORB ESCAL *******
			FY 76 ******			
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.30	0.30	0.02	0.02	0.0
3	0.3	0.69	0.62	0.06	0.00	-0.00
4	0.5	1.13	1.05	0.12	0.03	-0.00
			FY 77 ******			
1	0.7	1.74	1.53	0.21	0.00	-0.00
2	1.4	3.55	3.41	0.47	0.13	-0.00
3	3.2	8.30	7.06	1.24	0.00	-0.00
4	6.2	16.37	14.43	2.68	0.55	-0.00
			FY 78 ******			
1	10.3	27.36	22.57	4.79	0.00	-0.00
2	16.0	43.16	36.33	8.06	1.04	-0.00
3	22.6	62.08	49.81	12.27	0.00	-0.00
4	31.2	86.66	70.44	18.07	1.56	-0.00
			FY 79 ******			
1	41.3	116.41	90.90	25.51	0.00	-0.00
2	52.6	150.04	122.73	34.35	-1.46	-0.00
3	63.7	183.74	147.03	43.71	-7.00	-0.00
4	73.7	215.12	172.05	52.90	-6.17	-0.00
			FY 80 ******			
1	82.7	243.51	190.99	61.61	-9.09	-0.00
2	89.2	264.53	207.07	68.27	-8.57	-0.00
3	94.2	280.97	217.71	73.62	-10.37	-0.00
4	97.8	292.70	226.28	77.55	-10.15	-0.00
			FY 81 ******			
1	99.6	298.56	229.96	79.54	-10.95	-0.00
2	100.0	300.05	253.00	80.05	-33.00	-0.00

LAST SHIP DELIVERED: FEB 1981

TABLE VII

CASE 3
****

MONTHS LATE: 0
COST GROWTH: 0 PERCENT

QTR ***	% PROGRESS TO DATE ********	TOTAL COSTS BOOKED *******	PROGRES /INTRIM PAYMENT *******	TOTAL ESCAL PAYMENT *******	KR CASH INVEST *******	KR ABSORB ESCAL *******
			FY 76 ******			
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.30	0.30	0.02	0.02	0.0
3	0.3	0.69	0.62	0.06	0.00	-0.00
4	0.5	1.13	1.05	0.12	0.03	-0.00
			FY 77 ******			
1	0.7	1.74	1.53	0.21	0.00	-0.00
2	1.4	3.55	3.41	0.47	0.13	-0.00
3	3.2	8.30	7.06	1.24	0.00	-0.00
4	6.2	16.37	14.43	2.68	0.55	-0.00
			FY 78 ******			
1	10.3	27.36	22.57	4.79	0.00	-0.00
2	16.0	43.16	36.33	8.06	1.04	-0.00
3	22.6	62.08	49.81	12.27	0.00	-0.00
4	31.2	86.66	70.44	18.07	1.56	-0.00
			FY 79 ******			
1	41.3	116.41	90.90	25.51	0.00	-0.00
2	52.6	150.04	117.72	34.35	2.07	-0.00
3	63.7	183.74	140.03	43.71	0.00	-0.00
4	73.7	215.12	163.86	52.90	1.85	-0.00
			FY 80 ******			
1	82.7	243.51	181.90	61.61	0.00	-0.00
2	89.2	264.53	197.21	68.27	1.18	-0.00
3	94.2	280.97	207.35	73.62	0.00	-0.00
4	97.8	292.70	215.50	77.55	0.58	-0.00
			FY 81 ******			
1	99.6	298.56	219.01	79.54	0.00	-0.00
2	100.0	300.05	253.00	80.05	-33.00	-0.00

LAST SHIP DELIVERED: FEB 1981

TABLE VIII

CASE 4
****

MONTHS LATE: 0
COST GROWTH: 0 PERCENT

QTR ***	% PROGRESS TO DATE ********	TOTAL COSTS BOOKED *******	PROGRES /INTRIM PAYMENT *******	TOTAL ESCAL PAYMENT *******	KR CASH INVEST *******	KR ABSORB ESCAL *******
			FY 76 ******			
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.30	0.32	0.02	0.01	0.0
3	0.3	0.69	0.65	0.06	-0.03	-0.00
4	0.5	1.13	1.11	0.12	-0.02	-0.00
			FY 77 ******			
1	0.7	1.74	1.61	0.21	-0.08	-0.00
2	1.4	3.55	3.58	0.47	-0.02	-0.00
3	3.2	8.30	7.41	1.24	-0.35	-0.00
4	6.2	16.37	15.15	2.68	-0.10	-0.00
			FY 78 ******			
1	10.3	27.36	23.70	4.79	-1.13	-0.00
2	16.0	43.16	38.14	8.06	-0.66	-0.00
3	22.6	62.08	52.30	12.27	-2.49	-0.00
4	31.2	86.66	73.97	18.07	-1.79	-0.00
			FY 79 ******			
1	41.3	116.41	95.44	25.51	-4.54	-0.00
2	52.6	150.04	122.73	34.35	-2.80	-0.00
3	63.7	183.74	148.39	43.71	-8.35	-0.00
4	73.7	215.12	175.79	52.90	-9.56	-0.00
			FY 80 ******			
1	82.7	243.51	196.53	61.61	-14.63	-0.00
2	89.2	264.53	214.14	68.27	-15.43	-0.00
3	94.2	280.97	225.80	73.62	-18.45	-0.00
4	97.8	292.70	235.18	77.55	-18.95	-0.00
			FY 81 ******			
1	99.6	298.56	239.22	79.54	-20.20	-0.00
2	100.0	300.05	253.00	80.05	-33.00	-0.00

LAST SHIP DELIVERED: FEB 1981

TABLE IX

CASE 5
****

MONTHS LATE: 0
COST GROWTH: 0 PERCENT

QTR ***	% PROGRESS TO DATE ********	TOTAL COSTS BOOKED *******	PROGRES /INTRIM PAYMENT *******	TOTAL ESCAL PAYMENT *******	KR CASH INVEST *******	KR ABSORB ESCAL *******
			FY 76 ******			
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.30	0.0	0.02	0.28	0.0
3	0.3	0.69	0.0	0.06	0.62	-0.00
4	0.5	1.13	0.0	0.12	1.01	-0.00
			FY 77 ******			
1	0.7	1.74	0.0	0.21	1.53	-0.00
2	1.4	3.55	0.0	0.47	3.08	-0.00
3	3.2	8.30	1.54	1.24	5.52	-0.00
4	6.2	16.37	10.02	2.68	5.16	-0.00
			FY 78 ******			
1	10.3	27.36	19.38	4.79	3.19	-0.00
2	16.0	43.16	35.20	8.06	2.51	-0.00
3	22.6	62.08	50.71	12.27	-0.89	-0.00
4	31.2	86.66	74.43	18.07	-1.91	-0.00
			FY 79 ******			
1	41.3	116.41	97.95	25.51	-7.06	-0.00
2	52.6	150.04	128.80	34.35	-8.40	-0.00
3	63.7	183.74	154.46	43.71	-14.43	-0.00
4	73.7	215.12	181.86	52.90	-15.63	-0.00
			FY 80 ******			
1	82.7	243.51	202.60	61.61	-20.71	-0.00
2	89.2	264.53	220.21	68.27	-21.51	-0.00
3	94.2	280.97	231.87	73.62	-24.52	-0.00
4	97.8	292.70	241.25	77.55	-25.03	-0.00
			FY 81 ******			
1	99.6	298.56	245.29	79.54	-26.27	-0.00
2	100.0	300.05	253.00	80.05	-33.00	-0.00

LAST SHIP DELIVERED: FEB 1981

TABLE X

CASE 6
****

MONTHS LATE: 0
COST GROWTH: 0 PERCENT

QTR ***	% PROGRESS TO DATE ********	TOTAL COSTS BOOKED *******	PROGRES /INTRIM PAYMENT *******	TOTAL ESCAL PAYMENT *******	KR CASH INVEST *******	KR ABSORB ESCAL *******
			FY 76 ******			
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.30	0.32	0.02	0.01	0.0
3	0.3	0.69	0.65	0.06	-0.03	-0.00
4	0.5	1.13	1.11	0.12	-0.02	-0.00
			FY 77 ******			
1	0.7	1.74	1.61	0.21	-0.08	-0.00
2	1.4	3.55	3.58	0.47	-0.02	-0.00
3	3.2	8.30	7.41	1.24	-0.35	-0.00
4	6.2	16.37	15.15	2.68	-0.10	-0.00
			FY 78 ******			
1	10.3	27.36	23.70	4.79	-1.13	-0.00
2	16.0	43.16	38.14	8.06	-0.66	-0.00
3	22.6	62.08	52.30	12.27	-2.49	-0.00
4	31.2	86.66	73.97	18.07	-1.79	-0.00
			FY 79 ******			
1	41.3	116.41	95.44	25.51	-4.54	-0.00
2	52.6	150.04	128.80	34.35	-7.36	-0.00
3	63.7	183.74	154.46	43.71	-14.43	-0.00
4	73.7	215.12	181.86	52.90	-15.63	-0.00
			FY 80 ******			
1	82.7	243.51	202.60	61.61	-20.71	-0.00
2	89.2	264.53	220.21	68.27	-21.51	-0.00
3	94.2	280.97	231.87	73.62	-24.52	-0.00
4	97.8	292.70	241.25	77.55	-25.03	-0.00
			FY 81 ******			
1	99.6	298.56	245.29	79.54	-26.27	-0.00
2	100.0	300.05	253.00	80.05	-33.00	-0.00

LAST SHIP DELIVERED: FEB 1981

TABLE XI

MONTH LATE	% GROWTH	CASE 1 TOTAL PAYMENT	CASE 1 NPV @ %10	CASE 2 TOTAL PAYMENT	CASE 2 NPV @ %10	CASE 3 TOTAL PAYMENT	CASE 3 NPV @ %10
0	0	333.0	19.0	333.0	20.8	333.0	19.7
0	10	357.8	13.8	357.8	16.7	357.8	15.7
0	20	373.8	2.3	373.8	5.3	373.8	5.3
0	30	377.4	-17.6	377.4	-14.6	377.4	-14.6
0	40	375.8	-40.9	375.8	-37.9	375.8	-37.9
3	0	335.5	18.5	335.5	20.4	335.5	19.3
3	10	360.5	13.3	360.5	16.3	360.5	15.3
3	20	376.7	2.0	376.7	5.1	376.7	5.1
3	30	380.2	-17.8	380.2	-14.7	380.2	-14.7
3	40	378.4	-41.2	378.4	-38.1	378.4	-38.1
6	0	337.9	18.0	337.9	20.0	337.9	18.8
6	10	363.2	12.9	363.2	16.0	363.2	14.9
6	20	379.7	1.6	379.7	4.9	379.7	4.9
6	30	383.0	-18.1	383.0	-14.9	383.0	-14.9
6	40	380.9	-41.4	380.9	-38.2	380.9	-38.2
9	0	340.3	17.5	340.3	19.6	340.3	18.4
9	10	365.9	12.4	365.9	15.7	365.9	14.6
9	20	382.6	1.3	382.6	4.7	382.6	4.7
9	30	385.9	-18.3	385.9	-15.0	385.9	-15.0
9	40	383.5	-41.6	383.5	-38.3	383.5	-38.3
12	0	342.8	17.0	342.8	19.2	342.8	17.9
12	10	368.5	12.0	368.5	15.3	368.5	14.2
12	20	385.5	1.0	385.5	4.5	385.5	4.5
12	30	388.8	-18.5	388.8	-15.0	388.8	-15.0
12	40	386.2	-41.8	386.2	-38.3	386.2	-38.3

TABLE XII

MONTH LATE *****	% GROWTH ******	CASE 4 TOTAL PAYMENT *****	CASE 4 NPV @ %10 *****	CASE 5 TOTAL PAYMENT *****	CASE 5 NPV @ %10 *****	CASE 6 TOTAL PAYMENT *****	CASE 6 NPV @ %10 *****
0	0	333.0	21.8	333.0	22.1	333.0	22.5
0	10	357.8	17.0	357.8	17.1	357.8	17.8
0	20	373.8	5.6	373.8	5.6	373.8	6.4
0	30	377.4	-14.2	377.4	-14.2	377.4	-13.4
0	40	375.8	-37.5	375.8	-37.5	375.8	-36.7
3	0	335.5	21.4	335.5	21.7	335.5	22.2
3	10	360.5	16.7	360.5	16.8	360.5	17.5
3	20	376.7	5.4	376.7	5.5	376.7	6.3
3	30	380.2	-14.4	380.2	-14.3	380.2	-13.5
3	40	378.4	-37.7	378.4	-37.6	378.4	-36.8
6	0	337.9	21.0	337.9	21.4	337.9	21.9
6	10	363.2	16.4	363.2	16.5	363.2	17.3
6	20	379.7	5.3	379.7	5.3	379.7	6.1
6	30	383.0	-14.5	383.0	-14.4	383.0	-13.6
6	40	380.9	-37.8	380.9	-37.7	380.9	-36.9
9	0	340.3	20.7	340.3	21.0	340.3	21.5
9	10	365.9	16.1	365.9	16.2	365.9	17.0
9	20	382.6	5.1	382.6	5.1	382.6	6.0
9	30	385.9	-14.6	385.9	-14.5	385.9	-13.6
9	40	383.5	-37.9	383.5	-37.8	383.5	-36.9
12	0	342.8	20.3	342.8	20.7	342.8	21.2
12	10	368.5	15.8	368.5	15.9	368.5	16.7
12	20	385.5	4.9	385.5	5.0	385.5	5.9
12	30	388.8	-14.6	388.8	-14.5	388.8	-13.6
12	40	386.2	-37.9	386.2	-37.8	386.2	-36.9

C. SUMMARY

The two applications of the model discussed above pointed out the complexity of FPIF financing provisions and the usefulness of the model in evaluating their impact. The qualitative results, in all cases, were consistent with the contract provisions specified, although the quantitative results were not intuitively obvious, thus demonstrating the value of such a model.

Due to the flexible nature of the model, it was not possible for the author to fully execute and validate all of its potential applications. The documentation provided should provide the user enough information to correct any problems encountered.

It is the author's recommendation that this model be employed in the contract reviewing process to ensure that the Navy has a full appreciation of the impact of the FPIF contract provisions.

APPENDIX A

PREPARING THE PROGRAM INPUT

PART I - GENERAL INSTRUCTIONS

Part II of this appendix provides explicit instructions on the preparation of input data for the model. It is essential that the sequence of data be followed exactly and that data be provided if, and only if, it is required by the instructions. There are no default values in the model. If data is not correctly provided, the simulation will either fail to run or generate erroneous results.

The data in part II are identified using the following system:

Record/Format/Field (Column(s))

where: Record = an input line

Format = F, for floating point variables

or I, for integer variables

Field = the space reserved for a data element within a record.

Columns = the column numbers (width) of a field.

If an F format is specified a decimal point must be included in the data element.

If an I format is specified the data element must be right justified in the field with no decimal. If this is not done, zeroes will be inserted between the data element and the last column of the field.

Unless otherwise indicated, all F-format data fields contain 10 columns (field width). Where the number of F-format data elements required to complete a record is greater than six, a new line should be started, and this process repeated until the record is completed.

APPENDIX A

Part II. Input Sequence

Record/Format/Field (Column(s))	
1 /I/1(5)	= OPTION
2(10)	= # of CASES to be compared.
2 /I/1(4-5)	= # of SHIPS.
2(10)	= 0, if progress curves are to be generated within the simulation (see section IV-B).
	= 1, if progress curves are to be provided as input. Not permitted if OPTION II is being exercised.
3 /F/1(1-10)	= The contractor's cost of capital, used to calculate NPV. Stated as a percentage interest rate (i.e. 0.15)
4 /I/1(2-5)	= The fiscal year in which the contract starts
2(9-10)	= The month of the fiscal year in which the contract starts (1 MFYBC 12)
5 /I/1(3-5)	= The total number of months (inclusive) from contract start to contract completion.
6 /F/1(1-10)	= Target Cost (\$M).
2(11-20)	= Target Profit (\$M).
3(21-30)	= Contract Ceiling (\$M).
4(31-40)	= Allowance for Long Lead Time Material (\$M). (see section II-C-2)
7 /F/1(1-10)	= PPL, fraction of Target Cost charged as Labor.
2(11-20)	= PPM, fraction of Target Costs charged as Material.
3(21-30)	= PPO, fraction of Target Cost charged as Overhead.

Note: PPL + PPM + PPO = 1.0

APPENDIX A

Record/Format/Field (Column(s))

8 /I/1(5) = the number of cost elements (see section II-C-7) ($1 \geq NCE \geq 10$)

Repeat Record 9 for each cost element

9 /I/1(5) = 1, if cost element escalation is to be determined using the LABOR index.

= 2, if cost element escalation is to be determined using the MATERIAL index.

= 3, if cost element escalation is to be determined using a third (spare) index.

2(10) = 1, if there is a delay between the time costs are booked for progress purposes and the time the contractor actually pays out for the costs incurred.

= 2, if booked costs are paid periodically (i.e., every two weeks).

= 3, if there is no delay between the time costs are booked for progress purposes and the time the contractor actually pays out for the costs incurred.

3(15) = the frequency in weeks with which payments are made if field 2 above is set to 1.

= the delay period in weeks if field 2 above is set to 2.

= 0, if field 2 above is set to 3.

Note: After field 3, record 9 converts to F format

9/F/4(16-25) = The proportion of the total Labor dollars covered by the cost element.

5(26-35) = The proportion of the total Material dollars covered by the cost element.

6(36-45) = The proportion of the total Overhead dollars covered by the cost element.

APPENDIX A

Record/Format/Field (Column(s))

10 /I/1(3-5) = the maximum schedule overrun condition (in months) to be evaluated by the program (0≤MORMAX≤ 24)

2(8-10) = the increment (in months) of schedule overruns to be evaluated by the program. (MORINC≤ 1)

Note: field 1 must be an integer product of field 2

11 /I/1(3-5) = the percent (integer value) of target cost for the maximum cost growth condition to be evaluated by the program. (KORMAX≥ 0)

2(8-10) = the percent (integer value) with which cost growth is to be incremented in the cost growth evaluations. (KORINC ≥ 1)

Note: field 1 must be an integer product of field 2

3(15) = 0, if the cost growth above is <u>not</u> to be applied to LABOR and OVERHEAD.
= 1, converse.

4(20) = 0, if the cost growth above is <u>not</u> to be applied to MATERIAL.
= 1, converse.

Note: cost savings may be simulated by setting field 3 and/or 4 to: -1.

If progress curves are to be provided as inputs by the programmer, (i.e.,2/I/2=1) learning curve weights may not be internally generated and 12/A/I/1 must be set to 1 or 4.

12A/I/1(5) = 1, No learning curves are to be applied to the individual ship costs (OMIT FILES: 12B, 12C, 12D, 12E).

= 2, if unit learning curves are to be computed by the program and applied to the individual ship costs. Not permitted if progress curves are provided by the user (i.e. 2/I/2=1) (OMIT FILES: 12B, 12E).

Record/Format/Field (Column(s))

= 3, This is an extension of 2 (above) and allows for a special progress curve and learning curve weight for program development and engineering costs to be shared by all ships. The weights for these costs are specified by the programmer in file 12E. These weights then remain fixed for all CASES under OPTION ONE. See Section IV-A-2. Not permitted if progress curves are provided by the user (i.e., 2/I/2=1) (OMIT FILES: 12E)

= 4, Learning curve weights for the costs of each ship will be furnished as input to the program (OMIT FILES: 12B, 12C, 12D). Not permitted if OPTION ONE is being executed.

Provide File 12B only if (12A/I/1=3)

12B/I/1(3-5)	= The LABOR Learning Curve Weight (integer) valued for Development and Engineering Costs shared by all ships in the contract. (Note - the program assigns a weight of 100 to the first ship).
2(7-10)	= Same as field 1, for MATERIAL.
12C/I/1(4-5)	= The LABOR Learning Curve Percent (stated as an integer) describing the unit learning curve.
12D/I/1(4-5)	= Same as 12B for MATERIAL.

If OPTION ONE has been selected, refer to OPTION ONE, Part III of this appendix.

Omit file 12E unless 12A/I/1=4.

12E/I/1(3-5) 2(8-10) 3(13-15) . . . NSHIPS	= The LABOR Learning Weights (integer valued) provided by the programmer.

Repeat File 12E for MATERIAL.

APPENDIX A

Record/Format/Field (Column(s))

Complete records 13A and 13B <u>or</u> 13C and 13D.

If progress curves are to be provided as input by the programmer (i.e.,2/I/2=1) go to record 13C.

Files 13A and 13B are repeated for each ship in the contract with LABOR inputs for all ships followed by MATERIAL inputs for all ships. Where a special curve is generated for program development and engineering costs (12A/I/1=3), the curve is treated as the first ship in the contract and the number of 13A/13B files is the number of ships +1.

13A/I/1(3-5)	= the <u>month of the contract</u> during which construction (LABOR) of the ship is started (integer value): $1 \leq MBE \leq MONTHK$.
2(8-10)	= the total (inclusive) number of months required to complete construction (LABOR). (integer value: $1 \leq MTE \leq (MONTHK-MBE+1)$).
F/3(11-20) 4(21-30) 5(31-40)	= the fractional breakdown of time during the LABOR building period for the ship. These three entries must sum to 1.0. X,Y,Z, in Section V-B-2.
F/6(41-50) 7(51-60) 8(61-70)	The fractional breakdown of effort (MANHOURS/COSTS) during the building period for the ship. These three entries must sum to 1.0. A,B,C in, Section V-B-2.

Repeat record 13A(LABOR) for each ship, before starting the 13B(MATERIAL) records.

13B	= same as file 13A for MATERIAL.

Repeat record 13B for each ship

Go to record 14 if 2/I/2=0.

If OPTION TWO is being executed, records 13C through 13F may be provided for CASE I only.

APPENDIX A

Record/Format/Field (Column(s))

13C/I/1(5)	= 1, if input curves are MONTHLY = 2, if input curves are QUARTERLY
2(10)	= 1, if input curves are INCREMENTAL values = 2, if input curves are MONTHLY values
3(15)	= 1, if input curves are being provided individually for each ship = 2, if the input curves cover all ships in the contract

Records 13D through 13F must be provided for each ship unless 13/I/3=2.

13D/I/1(3-5)	the month of the contract in which the curve starts
2(8-10)	the total number of months covered by the curve
13E/I/1(9-10)	= the number of quarterly values provided if 13C/I/1=2. Omit otherwise.
13F/F/1(1-10) 2(11-20) . . .	= the appropriate progress values for the LABOR curve

Repeat records 13D, 13E, 13F, as appropriate for MATERIAL

If 13C/I/2=1, repeat records 13D through 13F (LABOR and MATERIAL) for each ship.

If OPTION TWO is selected, refer to OPTION TWO, Part III of this appendix.

14/I/1(5)	= The number of escalation indices utilized during program execution ($1 \le NBLS \le 3$).

Records 15A through 15F, as appropriate, are repeated for each escalation index.

APPENDIX A

Record/Format/Field (Column(s))

15A/I/1(2-5) = The fiscal year of the last actual (reported) index value (i.e., 1975).

2(9-10) = The month of the fiscal year of the last actual (reported) index value ($1 \le MBLSA \le 12$) (i.e., OCT=1).

3(12-15) = The fiscal year of the index base month as specified in the contract.

4(19-20) = The index base month (fiscal year) as specified in the contract. ($1 \le MBLSK \le 12$; i.e., OCT=1).

5(25) = 1, if the base month value is to be provided as input. This value must be provided if the contract base date is earlier than the start date of the contract.

= 0, the base month value is to be generated by the program.

15B/F/1(1-10) = Base Month Index Value. OMIT this record if record is 15A/I/5=0.

Record 15C must be provided if an only if, the last actual index value is earlier than the start date of the contract.

15C/F/1(1-10) = The last actual (reported) index value.

If record 15C is provided, omit record 15D.

15D/F/1(1-10)
2(11-20)
3(21-30)
.
.
. = The actual (reported) escalation index values for each month of the contract from the first month of the contract through the month of the last reported actual value.

15E/I/1(4-5) = The number of fiscal years for which LABOR Escalation Index forecasts are provided. If the full period of the contract is not covered, the last forecast will be assumed for the remaining years.

APPENDIX A

Record/Format/Field (Column (s))

15F/I/1(4-5) = The fiscal year of the forecast. Note that if 15A/I5/2≠12, then an <u>annual</u> forecast for that year must be provided.

F/2(6-15) = The forecasted annual change in index for the year specified. Stated as a fraction (i.e., -9% = -0.09).

Repeat 15F as indicated by 15E/I5/1.

Repeat 15E and 15F for the MATERIAL Index forecasts, and again for the SPARE Index if utilized.

If OPTION THREE is selected, refer to OPTION THREE, part III of this appendix.

16A/I/1(1-5) = The number of share points (knees) in the share line (2≤NSP≤5).

16B/F/1(1-5) = The fraction of target cost that describes the break point. Break points must be in ascending order and break point #1 must be 1.00 (i.e., 1 share portion before (under) Target Cost). The last break point must be at least as great as the Point of Total Assumption.

2(6-10) = The <u>contractor's</u> share of costs (savings) <u>before</u> the break point is reached.

Repeat 16B for each share point as indicated in 16A/I5/1.

If OPTION FIVE is specified, repeat records 16A and 16B for each new CASE.

17A/I/1(5) = 1, for escalation payment Method I, using fixed payment (progress) schedules defined in the contract. (See Section IV-D-2) OMIT record 17D.

= 2, for escalation payment Method II, the method proposed by LCDR Clyde Marshall. (See Section IV-D-3) OMIT records 17B, and 17C.

APPENDIX A

Record/Format/Field (Column (s))

2(8-10)	=	the frequency, in weeks, with which escalation payments are to be paid
		or
	=	100, if payments are to be paid monthly
		or
	=	200, if payments are to be paid at the end of each contract quarter (i.e., every 3 months).

Files 17B, and 17C are used for Method I payments only.

17B/F/1(1-10) 2(11-20) 3(21-30) . . . MKC	=	the monthly incremental LABOR progress schedule specified in the contract. All entries sum to 1.0, and the full length of the contract must be covered (i.e., # of fields = 5/I/1)
17C/F/1(1-10) 2(11-20) 3(21-30) . . . MKC	=	same as 17C for MATERIAL. All entries sum to 1.0, and the full length of the contract must be covered (i.e., # of fields =5/I/1)

File 17D is used for Method II payments only.

17D/I/1(5)	=	1, if the escalation index value is to be frozen beyond scheduled delivery. If overrun occurs, the index value for the contracted delivery month is used for determining all subsequent escalation payments, unless the index is decreasing.
	=	0, if the above provision is not specified in the contract.

2(10) = 1, if, at the month actual base costs exceed target, all escalation payments are reduced in accordance with the share line. The contractors share of these escalation costs is <u>not</u> reapplied to base costs, but treated as an unreimbursable expense.

= 0, if the above provision is not specified in the contract.

3(15) = 1, if all escalation payments cease after base costs exceed contract ceiling.

= 0, if the above provision is not specified in the contract.

Record/Format/Field (Column(s))

If OPTION FOUR is selected, repeat records 17A and 17D for each new case. Note that Method I is permitted only in CASE I, if OPTION FOUR is selected.

18A/I/1(5) = 1, if Progress Payments are to be made in accordance with SECNAVINST 7810.11 of 15 MAR 73, enclosed as Appendix . This instruction was cancelled by SECNAVINST 7810.12 of 17 JUL 75, but is retained as an option in the model. (OMIT record 18G).

= 2, if Progress Payments are to be made in accordance with SECNAVINST 7810.12, of 15 JUL 75. (OMIT RECORDS: 18B through 18F).

18A/I/2(8-10) = the frequency, in weeks with which payments are to be made,

<u>or</u>

= 100, if payments are to be made at the end of each month,

<u>or</u>

= 200, if payments are to be made at the end of each contract quarter (i.e., every 3 months).

APPENDIX A

Record/Format/Field (Column(s))

18B/F/1(1-5)	= the percent of progress, applied against contract price (billing price) that determines the minimum progress payment throughout the contract period. (For Method I only).

Records 18C through 18F are for Method I only.

18C/I/(11-15)	= the total number of interim payments ($1 \leq INTRIM \leq 10$)
18D/F/1(1-10) 2(11-20) 3(21-30) . . . INTRIM	- the decimal percent of the billing price, that determines when the appropriate interim payment is to be made. Column "A" in SECNAVINST 7810.00.
18E/F/1(1-10) 2(11-20) 3(21-30) . . . INTRIM	= the decimal percent of the billing price, that determines the size of the corresponding interim payment. Column "B" in SECNAVINST 7810.11
18F/F/1(1-10) 2(11-20) 3(21-30) . . . INTRIM	= the minimum percent (decimal) progress necessary for the contractor to receive the corresponding interim payment. Column "C" in SECNAVINST 7810.11.

Record 18G is for Method II only.

18G/F/1(1-10)	= the decimal percent of the billing price that determines the progress payment during the first X% of measured progress.

APPENDIX A

Record/Format/Field (Column(s))

2(11-20)	= the decimal percent of base costs incurred that determines the maximum progress payment allowed during the first X% of measured progress.
3(21-30)	= the decimal percent of the billing price to be witheld during the first X% of measured progress.
4(31-40)	= X, the decimal percent of measured progress at which the progress payment thresholds are changed.
5(41-50)	= the decimal percent of the billing price that determines the progress payment after X% of measured progress.
6(51-60)	= the decimal percent of base costs incurred that determines the maximum progress payment allowed after X% of measured progress.
7(61-70)	= the decimal percent of the billing price to be withheld after X% of measured progress.

If OPTION SIX is selected, repeat record 18A, and records 18B through 18G as appropriate, for each new CASE.

19A/I/1(4-5)	= the number of different lines on the SUMMARY OUTPUT, for which a DETAILED QUARTERLY OUTPUT is desired. See Section III D.
	= 0, if no DETAILED QUARTERLY OUTPUT data are desired. Omit the remaining "19" records.

Files 19B and 19C are repeated for each line, as specified in 19A.

19B/I/1(3-5)	= the line number
2(10)	= the number of CASES, on the line number specified, for which DETAILED QUARTERLY OUTPUT DATA are desired.
	= 100, if DETAILED QUARTERLY OUTPUT data are desired for all CASES on the line.

APPENDIX A

Record/Format/Field/Column(s))

Omit 19C if 19B/I/2=100

19C/I/1(5)	= CASE Number
2(10)	= CASE Number
3(15)	= CASE Number
.	
.	
.	

the number of fields requiring data entries is determined by 19B/I/2

20/I/1(5)	= 1, if progress tables are requested. See Section III-A
	= 0, otherwise
2(10)	= 1, if escalation index tables are requested. See section III-B
	= 0, otherwise

END OF DATA FILE

PART III - OPTION CARDS FOR OPTIONS ONE, TWO, AND THREE

OPTION ONE:

OPTION ONE may NOT be exercised IF LEARNING CURVE weights or progress curves are provided by user.

Immediately after the first set of data records are provided for the CASE I Learning Curves (Records 12A, 12B, and 12C), the data records for the remaining CASES are inserted as follows:

Record/Format/Field(Column(s))

12F/I/1(5)	= 1, if the LABOR Learning Curve Percent is being changed for the new CASE
	= 0, if the LABOR Learning Curve Percent is not being changed for the new CASE
2(10)	= 1, if the MATERIAL Learning Curve Percent is being changed for the new CASE
	= 0, if the MATERIAL Learning Curve Percent is not being changed for the new CASE

If field 1 above is set to 1 - provide record 12B for the new case - otherwise omit.

If field 2 above is set to 1 - provide record 12C for the new case - otherwise omit.

Repeat the above sequence of 12F, 12B, 12C and 12D records, as appropriate, for each new CASE under this OPTION.

OPTION TWO:

OPTION TWO may not be exercised if record 2/I/2=1.

Immediately after the first set of data records are provided for the CASE 1 Progress Curves (Records 13A and 13B), the data records for the remaining CASES are inserted as follows:

13G/I/1(5)	= 1, if Contract Terms for the new CASE are being changed = 0, otherwise

Record/Format/Field (Column(s))

2(10)	= 1, if any LABOR/OVERHEAD Progress Curves are being changed for the new CASE	
	= 0, otherwise	
3(15)	= 1, if any MATERIAL Progress Curves are being changed for the new CASE	
	= 0, otherwise	

Insert a new record 5 if 13G/I/1=1, omit otherwise

Insert a new record 6 if 13G/I/1=1, omit otherwise

New records 13A and 13B are inserted for the first ship and each succeeding ship in the new CASE. If 13G/I/2=0, omit the 13A records. If 13G/I/3=0, omit the 13B records

Repeat records 13G, and records 5,6, 13A and 13B as appropriate for each new case.

OPTION THREE:

Immediately after the first set of data records are provided for the CASE I Escalation Index Forecasts (Records 14 and 15), the data records for the remaining CASES are inserted as follows:

15G/I/1(5)	= 1, if the LABOR Escalation Index forecasts are being changed for the new CASE
	= 0, otherwise
2(10)	= 1, if the MATERIAL Escalation Index forecasts are being changed for the new CASE
	= 0, otherwise
3(15)	= 1, if the third, SPARE, Escalation Index forecasts are being changed for the new CASE
	= 0, otherwise

Record/Format/Field (Column(s))

Insert new records 15E and 15F for the LABOR forecasts, if 15G/I/1=1. Omit otherwise.

Insert new records 15E and 15F for the MATERIAL forecasts, if 15G/I/2=1. Omit otherwise.

Insert new records 15E and 15F for the SPARE forecasts, if 15G/I/3=1. Omit otherwise.

Repeat 15G, 15E, and 15F for each new CASE.

APPPENDIX B

GLOSSARY OF VARIABLE NAMES

The following Codes identify the meaning of subscripts for arrays listed in this index.

I	=	Case Number
J	=	1 , Labor
	=	2 , Material
	=	3 , Other
K	=	Week of the Contract ($1 \leq K \leq NWEEKA$)
LC	=	Calender Year
LF	=	Fiscal Year
LK	=	Year of the Contract
LQ	=	Quarter of the Fiscal Year
MC	=	Month of the Calender Year ($1 \leq MC \leq 12$)
MF	=	Month of the Contract ($1 \leq MF \leq MA$)

ALLTM (I)	Allowance for long lead time material for which no escalation reimbursement is made under the contract, but which is included as a part of TCOST(I). If escalation payment method one is used it is also assumed that PMESC includes this value and will therefore back out an adjustment for ALLTMA(I) when determining escalation payments.
BBLS (J)	The base month value of the escalation Index
BC2 (MK)	Monthly base costs (Monthly costs minus any reimbursement earned under provisions of the escalation clause)
BLS (J,MK)	Escalation index values

BLSLA (J)	The last actual reported escalation index
CALMON (MC)	Alphanumeric storage of month values
CEIL (I)	Contract ceiling
CI (I,K)	Weekly cash investment required of the contractor (Net for week, not cumulative)
EPAY (MK)	Monthly escalation payments earned by the contractor
FFY (I,J,N)	Forecasts of escalation index performance by fiscal year. See 1FY (I,J,N)
FPM1 (NJ,MK)	Forecasted monthly progress curves for baseline situation (No schedule overrun)
FPM2 (NJ,MK)	Forecasted monthly progress curves with
FSCMON (MF)	Alphanumeric storage of month names
FTCM (MK)	Forecasted monthly incurred costs (Includes "Escalation")
CPROG (J,N1,N)	Progress curve descriptions for each ship (See Section IV-B) where: N = 1,2,3, % of time elapsed (X,Y,Z) N = 4,5,6, % effort expended (A,B,C) N = 7 through 12; Same as 1-6 for Material
IBLS (J)	= 1 , The index value for the contract base month is provided externally = 0 , Forecasts base month value internally
ICFDP (N)	The cash flow delay period N = Cost Element
ICHGL (I,J)	= 1 , Change learning curve J for CASE 1 = 0 , No change to learning curve J
IFY (I,J,N)	The fiscal year corresponding to the escalation forecasts in FFY (I,J,N) (2 or 4 digits)
IRUN	Defines OPTION being executed.
ISPROG (J,N1,N)	Progress curve descriptions for each ship (See Section IV-B) where: N = 1, Start month for labor progress N = 2, Total duration of labor effort (Months) N = 3, Start month for material progress N = 4, Total duration of material effort (Months)

KORMAX	The maximum cost overrun to be evaluated by the program, stated as a percentage (Integer Value) (IE: for Maximum Cost growth of 150% KORMAX = 50)
MAXPM (J)	The month of the contract in which maximum incremental progress is made
MAXYR	The total number of years for which escalation index values must be provided
MBLSA (J)	The month of the fiscal year corresponding to the base month of the escalation index specified in the contract
MFYBC	The month of the fiscal year in which the contract is started
MKC	The total number of months covered by the contract curves when escalation payment method ONE is used = 100 , if payments are made monthly = 200 , if payments are made quarterly
MONTHK (I)	Total number of months (Inclusive) from the start of the contract until the last unit is contracted to be completed
MORINC	The incremental of schedule overrun, in months, to be evaluated by the program
MORMAX	The maximum schedule overrun, in months, to be evaluated by the Program.
MPAY (I)	Identifies progress payment method = 1 , For payment IAW SECNAVINST 7810.11 = 2 , For payment IAW SECNAVINST 7810.12
MPAYF (I)	The frequency with which progress payments are made to the contractor (in weeks) = 100 , If payments are made monthly = 200 , If payments are made quarterly
NBLSA (J)	The fiscal year of the last actual reported escalation index value
NBLSK (J)	The fiscal year of the contract base month for the escalation index

NCE	The number of contract "Cost Elements" $(1 \leq NCE \leq 10)$
NFYBC	The fiscal year in which the contract is started
NFYF (I,J)	The number of years for which forecasts of escalation index performance are provided
NLINES	The total number of different output lines for which additional quarterly summaries by case, are desired (see section on description of output)
NSP (I)	The number of break points in the share line $(2 \leq NSP \leq 5)$
NVAR	The total number of CASES to be evaluated
PLESC	Used for escalation payment method I only that percent of target cost that will be applied against the contract escalation curves for labor
PMESC	Used for escalation payment method I only that percent of target cost that will be applied against the contract escalation curves for material (see ALLTMA (I))
SL (I,N)	The contractor's share of costs/savings below (before) share point SP (I,N) (IE 0.1)
SP (I,N)	The fraction of target cost that describes break point N (IE 1.10 for 110%) break point 1 must be 1.00 (There can only be one share portion before target is reached and this point must be the first break point read into the program all other break points must be in ascending order
TCM (MK)	Monthly cumulative base costs (BC2(MK))
TCOST (I)	Target cost
TPAY (K)	Total payments made to the contractor (Progress+Escalation+Interim)
TPROF (I)	Target Profit
XLC (I,J)	Forecasted learning curve rate

APPENDIX C

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20350

SECNAVINST 7810.11
NAVCOMPT: NCD4
15 March 1973

SECNAV INSTRUCTION 7810.11

From: The Secretary of the Navy

Subj: Progress payment procedures under fixed-price and fixed-price incentive contracts for shipbuilding or ship conversion, alteration or repair

Ref: (a) Report of the Industry Advisory Council Subcommittee to Consider Defense Industry Financing dtd 11 June 1972
(b) Report of Task Group to Study Shipbuilding Progress Payments dtd 31 July 1972
(c) Armed Services Procurement Regulations (ASPR)

1. Purpose. To revise and set forth the payment procedures under fixed-price and fixed-price incentive contracts for shipbuilding or ship conversion, alteration or repair.

2. Cancellation. NAVCOMPT Instruction 7810.3A of 13 February 1957; Subj: Progress Payments Based on Percentage or Stage-of-Completion, is hereby cancelled.

3. Background. Reference (a) recommended that an in-depth study be conducted for progress payments based on a percentage or stage-of-completion basis. The Deputy Secretary of Defense endorsed the recommendation and directed that such a study be conducted. With the concurrence of the Assistant Secretaries of Defense (Compt) and (I&L), the Assistant Secretaries of the Navy (FM) and (I&L) appointed a Task Group to study shipbuilding progress payments. The Task Group recommended in reference (b) the adoption of payment procedures as set forth therein under shipbuilding contracts. Inasmuch as Master Ship Repair Contracts (DD ASPR Form 731) are utilized by both the Department of the Army and the Department of the Navy and the format for such contracts are set forth in Appendix F of reference (c), they were not embraced within the scope of the Task Group study. This instruction implements the Task Group's recommendations.

4. Scope. This instruction shall apply to all Navy contracts for shipbuilding or ship conversion, alteration or repair, sometimes referred to herein collectively as shipbuilding contracts, entered into on or after April 1, 1973, except cost reimbursement type

contracts and Master Ship Repair Contracts (DD ASPR Form 731). However, contracts entered into on or after 1 April 1973 pursuant to an Invitation for Bid or Request for Proposal issued prior to that date will not be subject to these provisions.

5. Definitions and explanation of terms

a. Interim payments. A term that represents a payment to a contractor for a significant milestone of accomplished performance. Such interim payments will be provisional and conditional and shall be repayable to the Government by the contractor upon default of the contract.

b. Dollar progress. A term that represents the contractor's costs which shall include only those recorded costs which result from payment made by cash, check, or other form of actual payment for items or services purchased directly for the contract, together with costs incurred, but not necessarily paid, for materials which have been issued from the contractor's stores inventory and placed in the production process for use on the contract, for direct labor, for direct travel, for other direct inhouse costs, and for properly allocated and allowable indirect costs, all as shown by records maintained by the contractor for purposes of obtaining payment under a shipbuilding contract.

c. Physical progress. A term that represents at any particular point in time the progress achieved toward the physical completion of the contract. The procedures covering the computation of physical progress are set forth in Chapter 9 of NAVSHIPS Manual 0900-000-3011.

d. Contract price. The term "contract price" means the total amount fixed by the contract, as amended, to be paid for complete performance of the contract. If the contract provides for escalation or for redetermination of price, this term means the initial price until changed and not the ceiling price. If the contract is of the incentive type the term means the target or billing price, as amended, until final pricing. Ordinarily the definitized price shall be the basis for limiting the aggregate amount of progress payments within the meaning of "total contract price" as used in the clauses set forth in paragraph E-510 (a)(4) of reference (c). An exception exists if the application of this limitation would result in an inability to pay progress payments and/or interim payments for costs properly incurred

for authorized but unpriced contractual actions pertaining to the definitized contract. When such an exception exists, the contracting officer may make an appropriate provisional increase in the contract price; however, the increase will not exceed the amount recorded as an obligation based upon the Government's estimate of its liability for those unpriced contractual efforts.

6. Progress payments. Progress payments will be made in accordance with the progress payment provisions for supply-type contracts as set forth in Appendix E, Part 5, of reference (c), except as specifically modified herein. Progress payments based on costs will be made at the rate of 85% to small business concerns (as defined in paragraph 1.701.1(b) of reference (c)) and at the rate of 80% for firms which are not small business concerns.

7. Interim payments. Shipbuilding contracts generally extend over a rather protracted period of time and require large investments before any deliveries are made in contrast to most supply-type contracts. Some supply-type contracts for large procurements covering long periods of performance contain provisions for payments in addition to progress payments based on the contractor achieving certain goals. Because of the lack of universal physical milestones which might serve as similar appropriate measures of payment in shipbuilding contracts during the period of contract performance, interim payments, in addition to progress payments, based on dollar progress will be provided. However, constraints are necessary to dissuade overpayments in those cases where the physical progress is not commensurate with dollar progress. Therefore, an additional payment clause will be incorporated in shipbuilding contracts covered by this instruction to provide for periodic interim payments as follows:

"When the progress payments paid hereunder are equal to the percentage of the contract price shown in Column A, an interim payment will be made. Such interim payments will be an amount equal to the percentage of the contract price shown in Column B, less the amount of total payments theretofore made, provided that the physical percentage-of-completion, as determined by the Supervisor of Shipbuilding (SUPSHIP), is equal to a percentage-of-completion not less than the percentage shown in Column C; however, if the physical completion, as determined by the SUPSHIP, is less than the percentage in Column C, each such interim payment will not be made until physical completion reaches the corresponding percentage shown in Column C. The following schedule is applicable to contracts which provide for 80% progress payments:

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15 March 1973

Interim Payment Number	Column A	Column B 1/	Column C
1	10%	12.25%	10.0%
2	20	24.50	22.0
3	30	36.75	34.0
4	40	49.00	46.0
5	50	61.25	58.0
6	60	73.50	70.0
7	70	85.75	82.0

For small business contractors where progress payments are based on 85%, the following schedule is applicable:

Interim Payment Number	Column A	Column B 2/	Column C
1	10.625%	12.25%	10.0%
2	21.250	24.50	22.0
3	31.875	36.75	34.0
4	42.500	49.00	46.0
5	53.125	61.25	58.0
6	63.750	73.50	70.0
7	74.375	85.75	82.0

If the period of time from the signing of the contract to delivery of the first vessel is less than three years, only the interim payments Nos. 2, 4, and 6 will be made; if more than three but less than four years, only 1, 2, 4, 5 and 7 will be made; if more than four years, interim payments 1 through 7 will be made.

If the physical progress as determined by the SUPSHIPS lags significantly behind dollar progress, the interim payments will be delayed until the required physical progress is achieved. The interim payment procedures allow for some lag between physical progress and dollar progress without delay in interim payments. The allowable lag in physical progress at various stages of dollar progress is as follows:

Dollar Progress	Physical Progress	Allowable Lag 3/
12.5%	10.0%	2.5%
25.0	22.0	3.0
37.5	34.0	3.5
50.0	46.0	4.0
62.5	58.0	4.5
75.0	70.0	5.0
87.5	82.0	5.5

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In addition, nothing herein is intended to modify the provision of the progress payment clause which provides that the Contracting Officer may reduce and/or suspend progress payments, pursuant to paragraph (c) of the Progress Payment Clause, if the contractor has so failed to make progress that the unliquidated progress payments exceed the fair value of the work accomplished on the undelivered portion of the contract."

1/ This percentage represents 98% of the percentage-of-completion determined by the dollar progress. On 80% progress payments based on costs, 12.5% of the contract would be reached when progress payments are equal to 10% of the contract price. (12.5% x 80% = 10.0%).

2/ This percentage represents 98% of the percentage-of-completion determined by the dollar progress. On 85% progress payments based on costs, 12.5% of the contract would be reached when progress payments are equal to 10.625% of the contract price. (12.5% x 85% = 10.625%).

3/ This lag has been provided for in an effort to avoid arguments between supervisors of shipbuilding and shipbuilders as to percentage-of-completion, but at the same time recognizing that interim payments should not be made when the physical percentage-of-completion substantially lags behind dollar progress.

8. Extension of delivery schedule. If the period of time from the signing of a contract to the first vessel delivery is extended by an amendment to the contract and such extension would meet the criteria for an additional interim payment(s) as set forth in paragraph 7, the additional interim payment(s) will be made to the contractor.

9. Delivery payment. A vessel is not considered 100% complete until all construction has been completed including accomplishment of builder's trials, acceptance trials and correction of all defects requiring correction prior to delivery of the vessel to the Navy. Upon delivery of each vessel the Government will pay the following percentages of the contract price of the vessel:

If interim payments are made for following number of payments	If progress payment rate is 80%	85%
1 thru 7	2.25%	1.625%
1, 2, 4, 5, 7	2.25	1.625
2, 4, 6	4.50	3.25

APPENDIX C

Performance reserve and final settlement. Reserves are established to cover correction of contractor-responsible defects and to insure the submission of the contractor's release and the completion of the other requirements for final settlement of the contract. The payment procedures provide for a reserve of 2.0%. The difference between the indicated percentage-of-completion and the amount paid, including the interim payments and delivery payment, as indicated, shall be held for the aforesaid purpose of reserves. The following schedule depicts the reserve as a percentage of the contract price at various levels of completion:

When progress payments reach: 80% prog payt	When progress payments reach: 85% prog payt	Indicated percentage of completion of contract is	Payments to be made are	Reserve is
10	10.625	12.5	12.25	.25
20	21.250	25.0	24.50	.50
30	31.875	37.5	36.75	.75
40	42.500	50.0	49.00	1.00
50	52.125	62.5	61.25	1.25
60	63.750	75.0	73.50	1.50
70	74.375	87.5	85.75	1.75
80	85.000	100.0	98.00 1/	2.00

1/ The delivery payment provided for in paragraph 9 above is included herein.

A portion of the 2.0% reserve equivalent to the lesser of 1.0% of the contract price, or $100,000, will be held by the Government as a final settlement reserve. The balance of the 2.0% reserve, less whatever amount the Contracting Officer determines sufficient to cover any defects or deficiencies which have not been corrected by the contractor, will be paid to the contractor upon expiration of the guaranty period. However, if the 2.0% reserve is insufficient to cover the final settlement reserve and the contractor-responsible defects, demand will be made upon the contractor, pursuant to paragraph E-608 of reference (c), for payment of the additional amount required to cover the subsequent costs of correcting the defects. Upon acceptance of any separately priced line item other than a vessel, the Government will pay the contractor the following percentage of the contract value of the line item:

If interim payments are made for following number of payments	If progress payment rate is 80%	If progress payment rate is 85%
1 thru 7	4.25%	3.625%
1, 2, 4, 5, 7	4.25	3.625
2, 4, 6	6.50	5.25

The Government shall at the time of final settlement, in accordance with the provisions of the clause entitled "Final Settlement", pay the contractor the balance owing to it under the contract promptly after the amount of such balance shall have been determined.

11. Liquidation of progress payments. All shipbuilding contracts will be required for administrative purposes to specify a contract price for each vessel; however, it is not the intent of this instruction that a separate price be negotiated for each vessel. If the contract requires the contractor to provide or furnish drawings, designs, specifications, computer software or other items, such items may be set forth as a separately priced line item in the contract or these items may be included as a part of the price of the vessels. Progress payments will be liquidated by the Government upon delivery of any separately priced line item and/or upon delivery of each vessel at the rate that progress payments were made (80% or 85%, whichever is applicable). However, in view of the interim payment provided for in paragraph 7, the alternate method of liquidation as provided by paragraph E-512.2 of reference (c) will not be applicable to contracts covered by this instruction.

12. Escalation. The escalation provision presently prescribed for shipbuilding contracts will be continued essentially the same, except for the manner of payment. Progress payments will be made on a dollar progress basis which will include escalation. Therefore, escalation will be a separate contract item and the escalation provision will provide for a final determination of the amount of escalation upon completion of the contract. The contract will also provide for an adjustment for progress payment determination purposes only of the contract price each calendar quarter, by upward or downward conditional revisions of the contract price, to reflect the applicable escalation resulting from the change in the Department of Labor indices. Additionally, the provision for escalation in fixed-price incentive type contracts will provide that Target Cost and Target Price are exclusive of payments for escalation and Total Final Negotiated Cost shall not include any escalation paid or to be paid.

13. Requests for progress payments. Requests for progress payments will be made on Contractor's Request for Progress Payments (DD Form 1195), with additional supporting schedules which will be prescribed for use on shipbuilding contracts.

14. Subcontracts. Payments to finance performance of contracts between shipbuilding prime contractors and their subcontractors will be limited to progress payments based on costs pursuant to Part 5 of Appendix E to reference (c).

APPENDIX C

SECNAVINST 7810.11
15 March 1973

15. Required audits. SUPSHIPS will request the Defense Contract Audit Agency to conduct an audit of shipbuilding contractors as often as may be necessary but not less frequently than semiannually in order to ensure that contractors are not being over-paid progress payments.

16. Effective date. The provisions of this instruction shall be effective immediately within the scope of paragraph 4.

Frank Sanders

Frank Sanders
Under Secretary of the Navy

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APPENDIX D

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON D. C. 20350

SECNAVINST 7810.12
NAVCOMPT NCD4
17 July 1975

SECNAV INSTRUCTION 7810.12

From: The Secretary of the Navy

Subj: Progress payments based on percentage of completion for shipbuilding or ship conversion, alteration, or repair contracts

1. Purpose. The purpose of this instruction is to authorize progress payments based on a percentage of completion for fixed price and fixed price incentive contracts for shipbuilding or ship conversion, alteration, or repair.

2. Cancellation. SECNAV Instruction 7810.11 of 15 March 1973.

3. Scope. This instruction shall apply to all Navy contracts for shipbuilding (including small boats) or ship conversion, alteration, or repair, sometimes referred to herein collectively as shipbuilding contracts, entered into on or after 1 July 1975, except cost reimbursement type contracts and Master Ship Repair Contracts (DD ASPR 731). For all other contracts (except construction contracts as defined in ASPR 18-101.1), including any separate contracts for engines, machinery, equipment, or other components for ships, the only type progress payment provisions will be those based on costs in accordance with ASPR, appendix E, part 5.

4. Small boat contracts. ASPR 7.104.35 type progress payments clause may be used in boat acquisition contracts when deemed appropriate with respect to the size of the contract and length of performance thereof. This clause provides for progress payments based on cost incurred. In such cases, the requirements of ASPR, appendix E, part 5 are applicable. Payment of progress payments on boat contracts by any method other than physical completion or costs incurred as provided herein requires the approval of the Director of Banking and Contract Financing, Office of the Navy Comptroller (NCD4) and the Chief of Naval Material (MAT-02).

5. Progress payments based on percentage of physical completion. Shipbuilding contracts (with the exception set forth in paragraph 4 above) will provide for progress payments on the basis of percentage of physical progress made in the performance of a contract.

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a. Progress payments will be made during the first fifty percent (50%) of performance at ninety percent (90%) of the amount determined by multiplying the contract or billing price by the percentage of progress, provided that no such payment shall be made in an amount which when added to the total of all previous payments made (including escalation payments), except release of reserves as otherwise provided for or permitted by the contract, exceeds one hundred percent (100%) of the costs certified by the contractor to have been incurred (as defined in paragraph 6) in the performance of the contract.

b. After the percentage of physical progress has reached fifty percent (50%) of total performance, progress payments on undelivered work will be made at one hundred percent (100%) of the amount determined by multiplying the contract or billing price by the percentage of progress less five percent (5%) of the contract or billing price provided that no such payment shall be made in an amount which when added to the total of all previous payments made (including escalation payments), except release of reserves as otherwise provided for or permitted by the contract, exceeds one hundred and five percent (105%) of the costs certified by the contractor to have been incurred (as defined in paragraph 6) in the performance of the contract, further provided that the contractor furnishes data on actual cumulative costs and estimated future costs acceptable to the Contracting Officer which demonstrates to the satisfaction of the Contracting Officer that the contractor will make a profit of at least five percent (5%) on completion of the contract, and the contractor agrees to provide updated information on an annual basis or upon request of the Government. If such data is not provided or if the Government notifies the contractor in writing that such data is unacceptable, payment during the second half of the contract will not exceed one hundred percent (100%) of the costs certified by the contractor to have been incurred in the performance of the contract. Further, if any updated information required or requested indicates that the contractor will not make a profit of at least five percent (5%), or if the contractor does not provide such information, the progress payments shall revert retroactively to a percentage not to exceed one hundred percent (100%) of the costs certified by the contractor to have been incurred in the performance of the contract.

6. Incurred costs

a. For the purpose of computing the limitation on progress payments to other than small business concerns, incurred costs for items or services purchased directly for the contract must be paid, as well as incurred, as shown by payment made by cash, check, or other form of actual payment. For small business concerns, items or services purchased directly for the contract need only be incurred as supported by the

records maintained by the contractor (when the contractor is not delinquent in payment of costs of contract performance in the ordinary course of business), provided, however, that such incurred costs may not include any retainages unpaid or not to be paid on current invoices. All other costs, except pension costs as discussed below, for direct labor, direct travel, direct in-house costs, materials issued from stores inventory and placed in the production process, and properly allocated and allowable overhead (indirect) costs are included when incurred, as supported by the records maintained by the contractor (when the contractor is not delinquent in payment in the ordinary course of business) in computing the limitation on progress payments.

b. With respect to allocated and allowable pension contributions, when pension contributions are paid by the contractor to the retirement fund less frequently than quarterly, accruals of the costs of these pension contributions shall be excluded from the contractor's incurred costs for computation of the limitation on progress payments until such costs are paid. If pension contributions are paid on a quarterly or more frequent basis, accruals of the costs of the pension contributions may be included in the contractor's incurred costs for computation of the progress payment limitation, provided that the pension contributions are paid to the retirement fund within thirty (30) days after the close of the period covered by the payment. If payments are not paid within such thirty-day period, pension contributions shall be excluded from the contractor's incurred cost until paid.

7. Frequency of payment. Progress payments based on percentage of physical progress will be made to the contractor when requested as work progresses under the contract, but not more frequently than every two weeks.

8. Unusual progress payments. Progress payments made more frequently than every two weeks or contrary to this instruction are considered unusual progress payments and require the approval of the Navy Comptroller (NCD4). Requests for such approvals, with supporting data justifying the financial need for more frequent payments, shall be forwarded to the Navy Comptroller (NCD4) via the Chief of Naval Material (MAT-02).

9. Liquidation. Progress payments (except for small boat contracts using the ASPR 7.104.35 clause) will be liquidated upon preliminary acceptance of each vessel to the extent that progress payments made under the contract are allocable to the vessel accepted.

SECNAVINST 7810.12
17 JUL 1975

10. Required audit. The Supervisor of Shipbuilding, Conversion and Repair, USN, will request the Defense Contract Audit Agency to conduct an audit of shipbuilding contractors as often as may be necessary but not less frequently than semiannually in order to ensure that contractors are not being overpaid progress payments.

J. William Middendorf II
Secretary of the Navy

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     13), ESCAB(180), SUMOUT(48,16), LABOUT(48,2), CALMON(12), BC1(5)
      DIMENSICN LABEL3(3), LABEL4(3), LABEL5(3)
      COMMON /Y1/ MONTHK(8),TCOST(8),TPROF(8),CEIL(8),ALLTM(8),PPLO,PPM,
     1N1,N2,GPROG(8,31,12),ISPROG(8,31,4),ICHGP(8,3)
      COMMON /Y2/ FPM1(2,120),MAXM(2),MPMAX(2),PMAX(2)
      COMMON /Y3/ FCPM(180)
      COMMON /Y4/ NBLSA(3),MBLSA(3),NBLSK(3),MBLSK(3),ICHGB(8,3),BLSLA(3
     1),FFY(8,3,25),IFY(8,3,25),IBLS(3),NFYF(8,3)
      COMMON /Y5/ BBLS(8,3),BLS(8,3,180),NBLS
      COMMON /Y6/ NFYBC,MFYBC
      COMMON /Y7/ FPM2(2,180)
      COMMON /Y8/ EPAY(180),BC2(180),FTCM(180),CUME(180)
      COMMON /Y9/ PPAID(8,10),PAYPER(8,10),PROGMN(8,10),INTRIM(8)
      COMMON /Y10/ COSTIN(8)
      COMMON /Y11/ PERPRO(8)
      COMMON /Y12/ TCM(180)
      COMMON /Y13/ CX,MK,TC,TP,TX,ALM,MA
      COMMON /Y14/ IND(10),NCE,TC1(10,180),NEPAY(8,5)
      COMMON /Y15/ LCWS(2,31),LCWT(2),XLC(8,2),ICHGL(8,2),LINDEX(8)
      COMMON /Y16/ PLESC,PMESC,KECM(2,120),MKC
      COMMON /Y17/ CUMB(180),PPAY(180)
      COMMON /Y18/ NSP(8),SP(8,5),SL(8,5)
      COMMON /Y19/ MORMAX,MAXYR
      COMMON /Y20/ CI(2,810),QTROUT(64,6),J2,J3,J4,NWAD
      COMMON /Y21/ PCEL(3,10),AL(180)
      COMMON /Y23/ PAY2(8,7)
      DATA CALMON/48H JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC/
      DATA LABEL1/4HCASE/
      DATA LABEL2/4H****/
      DATA LABEL3/12HTOTAL  NPV @/
      DATA LABEL4/12H PAYMENT  %/
      DATA LABEL5/12H*****  *****/
      DO 20 I=1,2
      DO 20 J=1,31
   20 LCWS(I,J) = 1
      N1 = 1
      N2 = 1
      N3 = 1
      N4 = 1
      N5 = 1
      N6 = 1
      ICHGL(1,1) = 1
      ICHGL(1,2) = 1
      ICHGB(1,1) = 1
      ICHGB(1,2) = 1
```

```
      ICHGB(1,3) = 1
      ICHGP(1,1) = 0
      ICHGP(1,2) = 1
      ICHGP(1,3) = 1
      READ (5,800) IRUN,NVAR
      READ (5,800) NSHIPS,IPROGE
      READ (5,1040) CINT
      IF (IRUN.EQ.1) N1 = NVAR
      IF (IRUN.EQ.2) N2 = NVAR
      IF (IRUN.EQ.3) N3 = NVAR
      IF (IRUN.EQ.4) N4 = NVAR
      IF (IRUN.EQ.5) N5 = NVAR
      IF (IRUN.EQ.6) N6 = NVAR
      N7 = MAXO(N1,N2,N3)
      N8 = MAXO(N4,N5,N6)
      N9 = MAXO(N1,N2)
      LCWT(1) = NSHIPS
      LCWT(2) = NSHIPS
      READ (5,800) NFYBC,MFYBC
      READ (5,800) MONTHK(1)
      READ (5,790) TCOST(1),TPROF(1),CEIL(1),ALLTM(1)
      READ (5,790) PPL,PPM,PPO
      PPLO = PPL+PPO
      READ (5,800) NCE
      DO 30 I=1,NCE
   30 READ (5,780) IND(I),ICFT(I),ICFDP(I),PCEL(1,I),PCEL(2,I),PCEL(3,I)
      READ (5,800) MORMAX,MORINC
      READ (5,800) KORMAX,KORINC,KORL,KORM
      DO 70 J=1,N1
      IF (J.GT.1) READ (5,800) (ICHGL(J,K),K=1,2)
      IF (J.EQ.1) READ (5,800) LINDEX(J)
      LOCAT = 792
      IF (LINDEX(J).EQ.1) GO TO 70
      IF (LINDEX(J).EQ.4) GO TO 40
      IF (LINDEX(J).EQ.3) READ (5,800) (LCWS(N,1),N=1,2)
      IF (ICHGL(J,1).EQ.1) READ (5,790) XLC(J,1)
      IF (ICHGL(J,2).EQ.1) READ (5,790) XLC(J,2)
      GO TO 70
   40 DO 60 I=1,2
      READ (5,800) (LCWS(I,N),N=1,NSHIPS)
      J1 = 0
      DO 50 K=1,NSHIPS
   50 J1 = J1+LCWS(I,K)
   60 LCWT(I) = J1
   70 CONTINUE
      IF (IPROGE.EQ.1) GO TO 130
      DO 120 J=1,N2
      IF (J.GT.1) READ (5,800) (ICHGP(J,K),K=1,3)
```

```
      IF (ICHGP(J,1).EQ.0) GO TO 80
      READ (5,800) MONTHK(J)
      READ (5,790) TCOST(J),TPROF(J),CEIL(J),ALLTM(J)
   80 CONTINUE
      L1 = NSHIPS
      IF (LINDEX(MIN0(J,N1)).EQ.3) L1=L1+1
      IF (ICHGP(J,2).EQ.0) GO TO 100
      DO 90 K=1,L1
   90 READ (5,810) (ISPROG(J,K,L),L=1,2),(GPROG(J,K,N),N=1,6)
  100 IF (ICHGP(J,3).EQ.0) GO TO 120
      DO 110 K=1,L1
  110 READ (5,810) (ISPROG(J,K,L),L=3,4),(GPROG(J,K,N),N=7,12)
  120 CONTINUE
      GO TO 270
  130 READ (5,800) IPROG4,IPROG5,IPROG6
      DO 140 I=1,2
      DO 140 J=1,120
  140 FPM1(I,J) = 0.0
      MAXM(1) = 0
      MAXM(2) = 0
      DO 250 J=1,NSHIPS
      DO 240 K=1,2
      READ (5,800) K1,K2
      IF (IPROG4.EQ.2) READ (5,800) IPROG7
      K3 = K1+K2-1
      K4 = K1
      K5 = K3
      IF (IPROG4.EQ.1) GO TO 150
      K4 = 1
      K5 = IPROG7
  150 READ (5,790) (FPM2(K,L),L=K4,K5)
      IF (IPROG5.EQ.1) GO TO 170
      K4 = K4+1
      K6 = K5+1
      DO 160 L=K4,K5
      K6 = K6-1
  160 FPM2(K,K6) = FPM2(K,K6)-FPM2(K,(K6-1))
  170 IF (IPROG4.EQ.1) GO TO 220
      K6 = MFYBC+K1+K2-2
      K5 = (K6/3)*3
      Y = FLOAT(K6-K5)
      K4 = K6-K5
      IF (K4.EQ.0) Y = 3.0
      IF (K4.EQ.0) K4 = 3
      K6 = K3
      K5 = K6-K4+1
      K4 = IPROG7
      DO 190 L=1,IPROG7
```

```
      IF (K5.LT.K1) GO TO 200
      X = FPM2(K,K4)/Y
      DO 180 M=K5,K6
  180 FPM2(K,M) = X
      K4 = K4-1
      K6 = K5-1
      K5 = K6-2
  190 Y = 3.0
      GO TO 220
  200 X = FPM2(K,K4)/FLOAT(K6-K1+1)
      DO 210 M=K1,K6
  210 FPM2(K,M) = X
  220 X = FLOAT(LCWS(K,J))
      IF (IPROG6.EQ.2) X = 1.0
      DO 230 M=K1,K3
  230 FPM1(K,M) = FPM1(K,M)+(FPM2(K,M)*X)
      MAXM(K) = MAX0(MAXM(K),K3)
      IF (IPROG6.EQ.2) LCWT(K)=1
  240 CONTINUE
      IF (IPROG6.EQ.2) GO TO 260
  250 CONTINUE
  260 CONTINUE
  270 CONTINUE
      READ (5,800) NBLS
      DO 280 I=1,NBLS
      READ (5,800) NBLSA(I),MBLSA(I),NBLSK(I),MBLSK(I),IBLS(I)
      IF (IBLS(I).EQ.1) READ (5,790) BBLS(1,I)
      J10 = 12*(NBLSA(I)-NFYBC)+MBLSA(I)-MFYBC+1
      IF (J10.LE.0) READ (5,790) BLSLA(I)
      IF (J10.LE.0) GO TO 280
      READ (5,790) (BLS(1,I,M),M=1,J10)
  280 CONTINUE
      DO 300 I=1,N3
      IF (I.GT.1) READ (5,800) (ICHGB(I,J),J=1,NBLS)
      DO 300 J=1,NBLS
      IF (ICHGB(I,J).EQ.0) GO TO 300
      READ (5,800) NFYF(I,J)
      J10 = NFYF(I,J)
      DO 290 K=1,J10
  290 READ (5,820) IFY(I,J,K),FFY(I,J,K)
  300 CONTINUE
      DO 310 I=1,N5
      READ (5,800) NSP(I)
      I1 = NSP(I)
  310 READ (5,790) ((SP(I,J),SL(I,J)),J=1,I1)
      DO 320 I=1,N4
  320 READ (5,800) (NEPAY(I,J),J=1,5)
      IF (NEPAY(1,1).NE.1) GO TO 330
```

```
      MKC = MONTHK(1)
      READ (5,790) (KECM(1,I),I=1,MKC)
      READ (5,790) (KECM(2,I),I=1,MKC)
  330 CONTINUE
      DO 350 I=1,N6
      READ (5,810) MPAY(I),MPAYF(I)
      IF (MPAY(I).EQ.2) GO TO 340
      READ (5,790) PERPRO(I)
      READ (5,800) INTRIM(I)
      I1 = INTRIM(I)
      READ (5,790) (PPAID(I,J),J=1,I1)
      READ (5,790) (PAYPER(I,J),J=1,I1)
      READ (5,790) (PROGMN(I,J),J=1,I1)
      GO TO 350
  340 READ (5,840) (PAY2(I,J),J=1,7)
  350 CONTINUE
      READ (5,800) NLINES
      IF (NLINES.EQ.0) GO TO 370
      DO 360 I=1,NLINES
      READ (5,800) (LINOUT(I,K),K=1,2)
      IF (LINOUT(I,2).EQ.100) GO TO 370
      I1 = LINOUT(I,2)+2
  360 READ (5,800) (LINOUT(I,J),J=3,I1)
  370 CONTINUE
      READ (5,800) IPROTB,INDTAB
      J3 = (MFYBC+2)/3
      J4 = 3*J3-MFYBC+1
      MAXPD = 0
      DO 380 J=1,NCE
  380 MAXPD = MAX0(MAXPD,ICFDP(J))
      DO 760 LOOPA=1,N9
      IF (IPROGE.EQ.1) GO TO 390
      IF (LOOPA.LE.N1) CALL LEARN (LOOPA,NSHIPS)
  390 CALL PRGRES (LOOPA,NSHIPS,IPROGE)
      JZ = MAX0(MAXM(1),MAXM(2))
      IF (IPROTB.EQ.0) GO TO 420
      WRITE (6,830)
      IF (N9.EQ.1) WRITE (6,860)
      IF (N9.GT.1) WRITE (6,870) LOOPA
      WRITE (6,850)
      TOTAL1 = 0.
      TOTAL2 = 0.
      TOTAL4 = 0.0
      MO = MFYBC+9
      IF (MO.GT.12) MO = MO-12
      I2 = 1
      I3 = NFYBC-100*(NFYBC/100)
      IF (MFYBC.LE.3) I3 = I3-1
```

```
400 DO 410 I1=MO,12
    IF (I2.GT.JZ) GO TO 420
    IF (I1.EQ.1) WRITE (6,1060)
    TOTAL1 = TOTAL1+FPM1(1,I2)
    TOTAL2 = TOTAL2+FPM1(2,I2)
    TOTAL3 = PPLO*FPM1(1,I2)+PPM*FPM1(2,I2)
    TOTAL4 = TOTAL4+TOTAL3
    WRITE (6,880) CALMON(I1),I3,FPM1(1,I2),TOTAL1,FPM1(2,I2),TOTAL2,TO
   1TAL3,TOTAL4
410 I2 = I2+1
    MO = 1
    I3 = I3+1
    GO TO 400
420 CONTINUE
    MAXYR = 2+(JZ+MORMAX+MFYBC-2)/12
    NWK = 13*(MK/3)+4*(MK-3*(MK/3))
    M = 0
    IF (LOOPA.EQ.1) CALL BLSGEN (N3,INDTAB)
    IF (ALM.LE.0.0000) GO TO 440
    DO 430 M=1,MK
430 AL(M) = ALM*FPM1(2,M)
440 CONTINUE
    M1 = M+1
    DO 450 M=M1,180
450 AL(M) = 0.0
    MOR1 = MORMAX+1
    LINE = 0
    DO 760 IMOR=1,MOR1,MORINC
    MOR2 = IMOR-1
    CALL SKEDOR (MA,MOR2,PPLO,PPM)
    NWA = 13*(MA/3)+4*(MA-3*(MA/3))
    NWAD = NWA+MAXPD
    J2 = (NWAD+12)/13
    IF (J4.NE.3) J2 = J2+1
    KOR1 = KORMAX+1
    DO 760 NCOR=1,KOR1,KORINC
    LINE = LINE+1
    NCOR1 = NCOR-1
    FMC = TC*(1.0+0.01*FLOAT(KORM*NCOR1))*PPM
    FLC = TC*(1.0+0.01*FLOAT(KORL*NCOR1))*PPL
    FOC = TC*(1.0+0.01*FLOAT(KORL*NCOR1))*PPO
    FTC = FLC+FMC+FOC
    DO 760 I8=1,N3
    DO 460 M=1,810
460 CI(1,M) = 0.0
    DO 470 M=1,180
470 ESCAB(M) = 0.0
    I10 = MA+1
```

```
      DO 480 I=I10,180
  480 FTCM(I) = 0.0
      I10 = 0
      I30 = 0
      DO 560 M=1,MA
      I10 = I10+1
      IF (I10.EQ.4) I10 = 1
      I20 = I30+1
      I30 = I20+3
      X = 4.0
      IF (I10.LE.2) GO TO 490
      I30 = I20+4
      X = 5.0
  490 CONTINUE
      FTCM(M) = 0.0
      DO 500 J=1,NBLS
  500 A(J) = (BLS(IB,J,M)-BBLS(IB,J))/BBLS(IB,J)
      A5 = FPM2(1,M)*FLC
      A6 = FPM2(2,M)*FMC
      A7 = FPM2(1,M)*FDC
      DO 550 J=1,NCE
      IC = ICFT(J)
      A8 = 0.0
      BC1(J) = A5*PCEL(1,J)+A6*PCEL(2,J)+A7*PCEL(3,J)
      IF (IND(J).EQ.0) GO TO 510
      A8 = BC1(J)*A(IND(J))
      IF (PCEL(2,J).GT.0.0000) A8=A(IND(J))*(BC1(J)-(PCEL(2,J)*AL(M)))
  510 CONTINUE
      ESCAB(M) = ESCAB(M)+A8
      TC1(J,M) = BC1(J)+A8
      FTCM(M) = FTCM(M)+TC1(J,M)
      A9 = TC1(J,M)/X
      DO 550 K=I20,I30
      K1 = K
      GO TO (520,530,540), IC
  520 K1 = K+ICFDP(J)
      GO TO 540
  530 K1 = K+K-ICFDP(J)*(K/ICFDP(J))
  540 CI(1,K1) = CI(1,K1)+A9
  550 CONTINUE
  560 CONTINUE
      DO 760 LOOPC=1,N8
      DO 570 K=1,810
  570 CI(2,K) = CI(1,K)
      L1 = 0
      ICASE = MAX0(LOOPA,IB,LOOPC)
      IF (NLINES.EQ.0) GO TO 620
      DO 580 L2=1,NLINES
```

```
      IF (LINOUT(L2,1).EQ.LINE) GO TO 590
  580 CONTINUE
      GO TO 620
  590 IF (LINOUT(L2,2).EQ.100) GO TO 610
      L3 = LINOUT(L2,2)+2
      DO 600 L4=3,L3
      IF (LINOUT(L2,L4).EQ.ICASE) GO TO 610
  600 CONTINUE
      GO TO 620
  610 L1 = 1
  620 CONTINUE
      N40 = 1
      N50 = 1
      N60 = 1
      IF (IRUN.EQ.4) N40 = LOOPC
      IF (IRUN.EQ.5) N50 = LOOPC
      IF (IRUN.EQ.6) N60 = LOOPC
      IF (NEPAY(N40,1).EQ.1) CALL ESCPA1 (IB)
      IF (NEPAY(N40,1).EQ.2) CALL ESCPA2 (N40,N50,IB,IRUN)
      IF (MPAY(N60).EQ.1) CALL PROPA1 (N60,N50)
      IF (MPAY(N60).EQ.2) CALL PROPA2 (N60,N50)
      CALL WKPAY (EPAY,CUME,NEPAY(N40,2),MA,L1,4)
      CALL WKPAY (PPAY,CUMB,MPAYF(N60),MA,L1,3)
      LABOUT(LINE,1) = MOR2
      LABOUT(LINE,2) = NCOP1
      I10 = 2*ICASE-1
      I20 = I10+1
      X = 0.0
      CINT1 = (1.0+CINT)**(1.0/52.0)
      CINT2 = 1.0
      J1 = NWAD+MAX0(NEPAY(N40,2),MPAYF(N60))
      DO 630 J=1,J1
      CINT2 = CINT2*CINT1
  630 X = X-CI(2,J)/CINT2
      SUMOUT(LINE,I10) = CUMB(MA)+CUME(MA)
      SUMOUT(LINE,I20) = X
      IF (L1.EQ.0) GO TO 760
      WRITE (6,830)
      W = 0.0
      X = 0.0
      Z = 0.0
      I30 = 0
      J5 = J4
      J6 = 0
      J7 = 1
      IF (J4.EQ.3) GO TO 670
      I30 = 4*J4
      QTROUT(1,1) = FCPM(J4)
```

```
      DO 640 I=1,J4
  640 X = X+FTCM(I)
      QTROUT(1,2) = X
      DO 650 J=1,I30
  650 Z = Z+CI(2,J)
      QTROUT(1,5) = Z
      DO 660 I=1,J4
  660 W = W+ESCAB(I)-EPAY(I)
      QTROUT(1,6) = W
      J6 = 1
      J5 = J4+3
      J7 = J4+1
  670 CONTINUE
      J8 = J2*3+2
      DO 710 I=J5,J8,3
      IJ = I
      I20 = I30+1
      I30 = I20+I2
      J6 = J6+1
      QTROUT(J6,1) = FCPM(I)
      DO 680 J=J7,IJ
  680 X = X+FTCM(J)
      QTROUT(J6,2) = X
      DO 690 J=J7,IJ
  690 W = W+ESCAB(J)-EPAY(J)
      QTROUT(J6,6) = W
      J7 = I+1
      DO 700 J=I20,I30
  700 Z = Z+CI(2,J)
  710 QTROUT(J6,5) = Z
      L4 = J3
      WRITE (6,890) ICASE,MOR2,NCOR1
      IF ((KORL*KORM).EQ.1) GO TO 720
      IF (KORL.EQ.1) WRITE (6,900)
      IF (KORM.EQ.1) WRITE (6,910)
  720 WRITE (6,920)
      WRITE (6,930)
      WRITE (6,940)
      WRITE (6,950)
      LL = 5-J3
      L2 = NFYBC-100*(NFYBC/100)
      L3 = 1
  730 WRITE (6,960) L2
      DO 740 I=1,LL
      WRITE (6,970) L4,(QTROUT(L3,J),J=1,6)
      L3 = L3+1
      IF ((J2+1).EQ.L3) GO TO 750
  740 L4 = L4+1
```

```
      LL = 4
      L2 = L2+1
      L4 = 1
      GO TO 730
  750 L2 = NFYBC+((MFYBC+MA-1)/12)
      L3 = MA+MFYBC+8
      L4 = L3-((L3/12)*12)
      IF (L4.EQ.0) L4 = 12
      WRITE (6,980) CALMON(L4),L2
  760 CONTINUE
      WRITE (6,830)
      C = 100.0*CINT+0.1
      I10 = C
      L5 = 3*NVAR
      WRITE (6,990) ((LABEL1,I),I=1,NVAR)
      WRITE (6,1000) (LABEL2,I=1,L5)
      WRITE (6,1010) ((LABEL3(J),J=1,3),I=1,NVAR)
      WRITE (6,1020) (((LABEL4(J),J=1,3),I10),I=1,NVAR)
      WRITE (6,1030) ((LABEL5(J),J=1,3),I=1,NVAR)
      I30 = 2*NVAR
      I40 = ((MORMAX/MORINC)+1)*((KORMAX/KORINC)+1)
      DO 770 I=1,I40
      IF (LABOUT(I,2).EQ.0) WRITE (6,1060)
      WRITE (6,1050) (LABOUT(I,J),J=1,2),(SUMOUT(I,J),J=1,I30)
  770 CONTINUE
      STOP
  780 FORMAT (3I5,6F10.5)
  790 FORMAT (6F10.2)
  800 FORMAT (12I5)
  810 FORMAT (2I5,6F10.2)
  820 FORMAT (I5,5F10.1)
  830 FORMAT ('1')
  840 FORMAT (7F10.2)
  850 FORMAT (22X,'PROGRESS CURVES',/,19X,'(NO SCHEDULE OVERRUN)',
     1   ///,11X,'LABOR PROGRESS', 2X, 'MATERIAL', 1X,
     2 'PROGRESS WEIGHTED TOTAL',/,3X,'DATE    *****************',
     3 1X, '******************* ****************',/,11X,'INCRE.',
     4 2X, 'TO DATE  INCRE.  TO DATE  INCRE.  TO DATE',//)
  860 FORMAT (25X,'ALL CASES', /, 25X, '**********', /)
  870 FORMAT (26X,'CASE ', I2, /, 26X,'*******',/)
  880 FORMAT (2X,A4,I3,2X,F5.3,4X,F5.3,3X,F5.3,4X,3(F5.3,3X))
  890 FORMAT (27X,'CASE ',I2,/,27X,'*******',//,11X,'MONTHS ',
     1'LATE:',I4,/, 11X,'COST GROWTH:  ',I2,' PERCENT',///)
  900 FORMAT (11X,'*NOTE:  % COST GROWTH APPLIED', /,
     1 19X, 'TO LABOR/OVERHREAD DOLLARS ONLY')
  910 FORMAT (11X,'*NOTE:  % COST GROWTH APPLIED', /,
     1 19X, 'TO MATERIAL DOLLARS ONLY')
  920 FORMAT (9X,'%', 6X, 'TOTAL     PROGRES   TOTAL     KR',
```

```
     17X, 'KP')
 930 FORMAT (6X,'PROGRESS  COSTS    /INTRIM   ESCAL    CASH',          4
     1X, 'ABSORB')
 940 FORMAT (1X,'QTR  TO DATE   BOOKED   PAYMENT  PAYMENT',            2
     1X, 'INVEST   ESCAL')
 950 FORMAT (1X,'*** ', 1X, '******** ', 5(' ******* '))
 960 FORMAT (1X,/,27X,'FY  ',I2,/,27X,'******')
 970 FORMAT (1X,I2,4X,2PF5.1,1X,5(0PF8.2,1X))
 980 FORMAT (/,1X,'LAST SHIP DELIVERED:  ',A4,2X,I4)
 990 FORMAT (17X,8(3X,A4,I3,4X))
1000 FORMAT (16X,8(1X,3A4,1X))
1010 FORMAT (1X,'MONTH    %',5X,8(1X,3A4,1X))
1020 FORMAT (1X,'LATE   GROWTH',8(3A4,I2))
1030 FORMAT (1X,'*****  ******  ',8(1X,3A4,1X))
1040 FORMAT (D10.8)
1050 FORMAT (2X,I3,4X,I3,4X,8(F7.1,F6.1,1X))
1060 FORMAT (1X,/)
     END
```

```
      SUBROUTINE LEARN (I,NSHIPS)
      COMMON /Y15/ LCWS(2,31),LCWT(2),XLC(8,2),ICHGL(8,2),LINDEX(8)
      DO 1080 J=1,2
      IF (ICHGL(I,J).EQ.0) GO TO 1080
      I1 = LINDEX(I)
      GO TO (1010,1030,1040,1080), I1
1010  LCWT(J) = NSHIPS*100
      DO 1020 K=1,NSHIPS
1020  LCWS(J,K) = 100
      GO TO 1080
1030  N1 = 2
      N2 = NSHIPS+1
      LCWT(J) = LCWS(J,1)+100
      GO TO 1050
1040  N1 = 1
      N2 = NSHIPS
      LCWT(J) = 100
1050  LCWS(J,N1) = 100
      B = ALOG(XLC(I,J))/ALOG(2.0)
      N1 = N1+1
      N3 = 1
      DO 1060 M=N1,N2
      N3 = N3+1
      LCWS(J,M) = 100.0*(FLOAT(N3)**B)+0.5
1060  LCWT(J) = LCWT(J)+LCWS(J,M)
1080  CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PRGRES (I,NSHIPS,INPROG)
      COMMON /Y1/ MONTHK(8),TCOST(8),TPROF(8),CEIL(8),ALLTM(8),PPLO,PPM,
     1N1,N2,GPROG(8,31,12),ISPROG(8,31,4),ICHGP(8,3)
      COMMON /Y2/ FPM1(2,120),MAXM(2),MPMAX(2),PMAX(2)
      COMMON /Y13/ CX,MK,TC,TP,TX,ALM,MA
      COMMON /Y15/ LCWS(2,31),LCWT(2),XLC(8,2),ICHGL(8,2),LINDEX(8)
      COMMON /Y19/ MORMAX,MAXYR
      IF (INPROG.EQ.1) GO TO 2010
      L1 = NSHIPS
      IF (LINDEX(MIN0(N1,I)).EQ.3) L1=L1+1
      I1 = MIN0(I,N1)
      I2 = MIN0(I,N2)
      IF (N2.EQ.1.AND.I.GT.1) GO TO 2020
      IF (I.EQ.1) GO TO 2010
      IF (ICHGP(I,1).EQ.0) GO TO 2020
 2010 MK = MONTHK(I)
      TC = TCOST(I)
      TP = TPROF(I)
      TX = TC+TP
      CX = CEIL(I)
      ALM = ALLTM(I)
 2020 DO 2150 J=1,2
      IF (INPROG.EQ.1) GO TO 2120
      IF (ICHGP(I2,(J+1)).EQ.0) GO TO 2150
      IF (ICHGL(I1,J).EQ.0) GO TO 2150
      MAXM(J) = 0
      DO 2030 K=1,120
 2030 FPM1(J,K) = 0.0
      J1 = 1
      J2 = 1
      IF (J.EQ.2) J1 = 3
      IF (J.EQ.2) J2 = 7
      DO 2110 L=1,L1
      MBE = ISPROG(I2,L,J1)
      MTE = ISPROG(I2,L,(J1+1))
      BPA = GPROG(I2,L,J2)
      BPB = GPROG(I2,L,(J2+1))
      BPC = GPROG(I2,L,(J2+2))
      PA = GPROG(I2,L,(J2+3))
      PB = GPROG(I2,L,(J2+4))
      PC = GPROG(I2,L,(J2+5))
      C = BPA*MTE+0.5
      NBP = C
      IF (NBP.EQ.0) NBP = 1
      A1 = LCWS(J,L)
      A2 = A1*PA/NBP**2
      A3 = 0.0
      NBP1 = NBP-1
```

```
      J3 = MBE-1
      IF (NBP1.LE.0) GO TO 2050
      J4 = -1
      DO 2040 K=1,NBP1
      J4 = J4+2
      J3 = J3+1
      A4 = A2*J4
      FPM1(J,J3) = FPM1(J,J3)+A4
 2040 A3 = A3+A4
      J3 = J3+1
      FPM1(J,J3) = FPM1(J,J3)+A1*PA-A3
      A3 = A1*PA
 2050 IF (NBP1.LE.0) A3 = 0.0
      C = (BPA+BPB)*FLOAT(MTE)+0.5-NBP
      NBP = C
      IF (NBP.LE.0) GO TO 2080
      A2 = A1*PB/(FLOAT(NBP))
      NBP1 = NBP-1
      IF (NBP1.LE.0) GO TO 2070
      DO 2060 K=1,NBP1
      J3 = J3+1
      FPM1(J,J3) = FPM1(J,J3)+A2
 2060 A3 = A3+A2
 2070 J3 = J3+1
      PB = (PA+PB)*A1
      FPM1(J,J3) = FPM1(J,J3)+PB-A3
      A3 = PB
 2080 NBP = MBE+MTE-J3-1
      IF (NBP.LE.0) GO TO 2100
      A2 = A1*PC/FLOAT(NBP**2)
      NBP1 = NBP-1
      DO 2090 K=1,NBP1
      J4 = 2*(NBP-K)+1
      J3 = J3+1
      A4 = A2*J4
      FPM1(J,J3) = FPM1(J,J3)+A4
 2090 A3 = A3+A4
 2100 J3 = J3+1
      FPM1(J,J3) = FPM1(J,J3)+A1-A3
      MAXM(J) = MAXO(MAXM(J),J3)
 2110 CONTINUE
 2120 CONTINUE
      A1 = FLOAT(LCWT(J))
      X = 0.0
      MPMAX(J) = 1
      PMAX(J) = FPM1(J,1)
      J2 = MAXM(J)-1
      DO 2130 L=1,J2
```

```
      FPM1(J,L) = FPM1(J,L)/A1
      IF (FPM1(J,L).GT.PMAX(J)) MPMAX(J)=L
      PMAX(J) = FPM1(J,MPMAX(J))
 2130 X = X+FPM1(J,L)
      FPM1(J,MAXM(J)) = 1.0-X
      IF (MAXM(J).GE.120) GO TO 2150
      J2 = MAXM(J)+1
      DO 2140 L=J2,120
 2140 FPM1(J,L) = 0.0
 2150 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BLSGEN (N3,INDTAB)
      DIMENSION CALMON(12), N1(3), N2(3), N4(3), N5(3), I10(3), N10(10),
     1 I50(3)
      COMMON /Y4/ NBLSA(3),MBLSA(3),NBLSK(3),MBLSK(3),ICHGB(8,3),BLSLA(3
     1),FFY(8,3,25),IFY(8,3,25),IBLS(3),NFYF(8,3)
      COMMON /Y5/ BBLS(8,3),BLS(8,3,180),NBLS
      COMMON /Y6/ NFYBC,MFYBC
      COMMON /Y19/ MORMAX,MAXYR
      DATA CALMON/48H JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC/
      DO 3250 J=1,N3
      DO 3250 I=1,NBLS
      IF (ICHGB(J,I).EQ.0) GO TO 3140
      IF (J.GT.1) GO TO 3010
      N1(I) = 12*(NBLSA(I)-NFYBC)+MBLSA(I)-MFYBC+1
      N2(I) = MAX0(0,N1(I))
      N4(I) = 12-MBLSA(I)
      N5(I) = 12*(NBLSK(I)-NBLSA(I))+MBLSK(I)-MBLSA(I)
 3010 M = N2(I)
      I10(I) = NFYF(J,I)
      IF (N1(I).LE.0) A = BLSLA(I)
      IF (M.LE.0.OR.J.EQ.1) GO TO 3030
      DO 3020 K=1,M
 3020 BLS(J,I,K) = BLS(1,I,K)
 3030 CONTINUE
      IF (M.GT.0) A = BLS(J,I,M)
      I5 = 0
      IF (N4(I).EQ.0) GO TO 3050
      B = FFY(J,I,1)*A/12.0
      N = N4(I)
      DO 3040 K=1,N
      I6 = M+K
 3040 BLS(J,I,I6) = A+B*FLOAT(K)
      M = I6
      I5 = 1
      A = BLS(J,I,I6)
 3050 I5 = I5+1
      IF (N1(I).GE.0) GO TO 3110
      I6 = -N1(I)
      IF (M.GE.I6) GO TO 3080
      I8 = (I6-M+12)/12+I5-1
      DO 3070 K=I5,I8
      B = FFY(J,I,MIN0(K,I10(I)))*A/12.0
      I9 = M+1
      M = M+12
      I11 = 0
      DO 3060 L=I9,M
      I11 = I11+1
 3060 BLS(J,I,L) = A+B*FLOAT(I11)
```

```
      BLS(J,I,M) = A*(1.0+FFY(J,I,MINO(K,I10(I))))
 3070 A = BLS(J,I,M)
      I5 = I8+1
 3080 IF (IBLS(I).EQ.0) BBLS(J,I)=BLS(J,I,N5(I))
      I7 = M-I6
      IF (I7.EQ.0) GO TO 3100
      DO 3090 L=1,I7
      I6 = I6+1
 3090 BLS(J,I,L) = BLS(J,I,I6)
 3100 A = BLS(J,I,I7)
      M = I7
 3110 CONTINUE
      IF (IBLS(I).EQ.1) BBLS(J,I)=BBLS(1,I)
      MAXYR1 = MINO(MAXYR,15)
      IF (I5.GT.MAXYR1) GO TO 3160
      DO 3130 L=I5,MAXYR1
      B = FFY(J,I,MINO(L,I10(I)))*A/12.0
      I7 = M+1
      M = MINO(180,(M+12))
      I8 = 0
      DO 3120 N=I7,M
      I8 = I8+1
 3120 BLS(J,I,N) = A+(B*FLOAT(I8))
      BLS(J,I,M) = A*(1.0+FFY(J,I,(MINO(L,I10(I)))))
      I50(I) = M
      IF (M.EQ.180) GO TO 3160
 3130 A = BLS(J,I,M)
      GO TO 3160
 3140 J1 = J-1
      BBLS(J,I) = BBLS(J1,I)
      MA = I50(I)
      DO 3150 M=1,MA
 3150 BLS(J,I,M) = BLS(J1,I,M)
 3160 IF (INDTAB.EQ.0) GO TO 3250
      WRITE (6,3380)
      I6 = J+1
      I7 = 0
      IF (J.EQ.N3) GO TO 3190
      DO 3170 L=I6,N3
      I7 = I7+1
      IF (ICHGB(L,I).EQ.1) GO TO 3180
 3170 CONTINUE
      GO TO 3250
 3180 I6 = J+I7
 3190 I6 = I6-1
      IF (I.EQ.1) WRITE (6,3260)
      IF (I.EQ.2) WRITE (6,3270)
      IF (I.EQ.3) WRITE (6,3280)
```

```
      IF ((I6-J).NE.(N3-1)) WRITE (6,3290) (N,N=J,I6)
      IF ((I6-J).EQ.(N3-1)) WRITE (6,3300)
      I9 = NBLSA(I)
      I8 = MBLSA(I)-3
      IF (I8.LE.0) I9 = I9-1
      IF (I8.LE.0) I8 = MBLSA(I)+9
      WRITE (6,3370) CALMON(I8),I9,BLSLA(I)
      I7 = MINO(9,I10(I))
      DO 3200 N=1,I7
 3200 N10(N) = IFY(J,I,N)-(100*(IFY(J,I,N)/100))
      WRITE (6,3320) (N10(N),N=1,I7)
      WRITE (6,3330) (FFY(J,I,N),N=1,I7)
      I7 = NFYBC-1
      IF (MFYBC.LE.3) I7 = I7-1
      DO 3210 N=1,9
      I7 = I7+1
 3210 N10(N) = I7-(100*(I7/100))
      WRITE (6,3340)
      WRITE (6,3310) (N10(N),N=1,9)
      N7 = MFYBC+9
      IF (N7.GT.12) N7 = N7-12
      IF (N7.EQ.1) GO TO 3230
      I8 = 14-N7
      I9 = I8+12*(MINC(MAXYR-2,7))
      I7 = N7-1
      DO 3220 N=1,I7
      WRITE (6,3350) CALMON(N),(BLS(J,I,M),M=I8,I9,12)
      I9 = I9+1
 3220 I8 = I8+1
 3230 I9 = 1+12*(MINO(MAXYR-1,8))
      I8 = 1
      DO 3240 N=N7,12
      WRITE (6,3360) CALMON(N),(BLS(J,I,M),M=I8,I9,12)
      I8 = I8+1
 3240 I9 = I9+1
 3250 CONTINUE
      RETURN
 3260 FORMAT (////,13X,'LABOR ESCALATION INDEX PROJECTIONS')
 3270 FORMAT (////,11X,'MATERIAL ESCALATION INDEX PROJECTIONS')
 3280 FORMAT (////,13X,'THIRD ESCALATION INDEX PROJECTIONS')
 3290 FORMAT (//,20X,20('*'),/, 21X,'CASE  ',I2,7(', ',I2),
     1 20X,20('*'))
 3300 FORMAT (//,20X,20('*'),/,25X,'ALL  CASES',/,20X,20('*'))
 3310 FORMAT (/,23X,'CALENDER  YEAR',/,22X, 15('*'), /,1X,
     1MONTH ',9(I4,2X), /, 2X,'***  ',9(' **** '))
 3320 FORMAT (//,8X,'FORECASTS OF PERCENT CHANGE DURING',
     11X,'FISCAL YEAR', /,  1X,59('*'), /,1X, 'YEAR ',
     29(3X,I2,1X), /, 1X, 59('*'))
```

```
3330 FORMAT (1X,'%CHG ',9(2PF5.1,1X),/, 1X, 59('*'))
3340 FORMAT (//,20X,'MONTHLY PROJECTIONS',/, 1X, 59('*'))
3350 FORMAT (/,1X,A4,7X,8F6.1)
3360 FORMAT (/,1X,A4,1X,9F6.1)
3370 FORMAT (14X,'LAST ACTUAL: ',A4,I5,3X,'(',F5.1,')',/,
    1 14X, 32('*'))
3380 FORMAT ('1')
     END
```

```
      SUBROUTINE SKEDOR (MA,MOR2,PPLO,PPM)
      COMMON /Y2/ FPM1(2,120),MAXM(2),MPMAX(2),PMAX(2)
      COMMON /Y3/ FCPM(180)
      COMMON /Y7/ FPM2(2,180)
      DO 4090 J=1,2
      N1 = MAXM(J)
      N4 = MAXM(J)+MOR2+1
      IF (MOR2.EQ.0) GO TO 4070
      I1 = MPMAX(J)
      DO 4010 L=1,I1
 4010 FPM2(J,L) = FPM1(J,L)
      N2 = MAXM(J)-MPMAX(J)
      DO 4020 I=1,N2
      N5 = N4-I
 4020 FPM2(J,N5) = FPM1(J,(N5-MOR2))
      DO 4030 I=1,MOR2
 4030 FPM2(J,(MPMAX(J)+I))=PMAX(J)
      A = 1.0+MOR2*PMAX(J)
      B = 0.0
      N5 = N4-2
      DO 4040 I=1,N5
      FPM2(J,I) = FPM2(J,I)/A
 4040 B = B+FPM2(J,I)
      FPM2(J,(N5+1)) = 1.0-B
 4050 DO 4060 I=N4,180
 4060 FPM2(J,I) = 0.0
      GO TO 4090
 4070 DO 4080 I=1,120
 4080 FPM2(J,I) = FPM1(J,I)
      GO TO 4050
 4090 CONTINUE
      MA = MOR2+MAX0(MAXM(1),MAXM(2))
      FCPM(1) = PPLO*FPM2(1,1)+PPM*FPM2(2,1)
      DO 4100 I=2,MA
 4100 FCPM(I) = PPLO*FPM2(1,I)+PPM*FPM2(2,I)+FCPM(I-1)
      DO 4110 I=MA,180
 4110 FCPM(I) = 1.0
      RETURN
      END
```

```
      SUBROUTINE CPROF (PROF,COST,K)
      COMMON /Y13/ CX,MK,TC,TP,TX,ALM,MA
      COMMON /Y18/ NSP(8),SP(8,5),SL(8,5)
      IF (COST.GT.TC) GO TO 5010
      PROF = TP+SL(K,1)*(TC-COST)
      RETURN
 5010 IF (COST.LT.CX) GO TO 5020
      PROF = 0.0
      RETURN
 5020 T1 = COST/TC
      PROF = TP
      N3 = NSP(K)
      DO 5040 N=2,N3
      IF (T1.LE.SP(K,N)) GO TO 5030
      PROF = PROF-(SP(K,N)-SP(K,N-1))*SL(K,N)*TC
      GO TO 5040
 5030 PROF = PROF-(T1-SP(K,N-1))*SL(K,N)*TC
      GO TO 5050
 5040 CONTINUE
 5050 IF (COST+PROF.GT.CX) PROF=CX-COST
      RETURN
      END
```

```
      SUBROUTINE ESCPA1 (IB)
      COMMON /Y5/ BBLS(8,3),BLS(8,3,180),NBLS
      COMMON /Y8/ EPAY(180),BC2(180),FTCM(180),CUME(180)
      COMMON /Y12/ TCM(180)
      COMMON /Y16/ PLESC,PMESC,KECM(2,120),MKC
      A1 = PLESC*TC
      A2 = BBLS(IB,1)
      A3 = PMESC*(TC-ALM)
      A4 = BBLS(IB,2)
      EPAY(1) = KECM(1,1)*A1*(BLS(IB,1,1)-A2)/A2+KECM(2,1)*A3*(BLS(IB,2,
     11)-A4)/A4
      CUME(1) = EPAY(1)
      BC2(1) = FTCM(1)-EPAY(1)
      TCM(1) = BC2(1)
      DO 6010 M=2,MKC
      EPAY(M) = KECM(1,M)*A1*(BLS(IB,1,M)-A2)/A2+KECM(2,M)*A3*(BLS(IB,2,
     1M)-A4)/A4
      CUME(M) = CUME(M-1)+EPAY(M)
      BC2(M) = FTCM(M)-EPAY(M)
 6010 TCM(M) = TCM(M-1)+BC2(M)
      M1 = MKC+1
      DO 6020 M=M1,180
 6020 EPAY(M) = 0.0
      DO 6030 M=M1,180
 6030 BC2(M) = FTCM(M)
      DO 6040 M=M1,180
 6040 TCM(M) = TCM(M-1)+FTCM(M)
      DO 6050 M=M1,180
 6050 CUME(M) = CUME(MKC)
      RETURN
      END
```

```
      SUBROUTINE ESCPA2 (I,K,IB,IRUN)
      DIMENSION A(3)
      COMMON /Y5/ BBLS(8,3),BLS(8,3,180),NBLS
      COMMON /Y8/ EPAY(180),BC2(180),FTCM(180),CUME(180)
      COMMON /Y12/ TCM(180)
      COMMON /Y13/ CX,MK,TC,TP,TX,ALM,MA
      COMMON /Y14/ IND(10),NCE,TC1(10,180),NEPAY(8,5)
      COMMON /Y18/ NSP(8),SP(8,5),SL(8,5)
      COMMON /Y21/ PCEL(3,10),AL(180)
      IF (IRUN.EQ.5.AND.NEPAY(1,4).EQ.0.AND.I.GT.1) RETURN
      BC2(1) = 0.0
      DO 7020 L=1,NCE
      C1 = 0.0
      C2 = TC1(L,1)
      IF (IND(L).EQ.0) GO TO 7010
      IF (PCEL(2,L).GT.0.0) C1=PCEL(2,L)*AL(1)
      BC2(1) = BC2(1)+C1+(C2-C1)*BBLS(IB,IND(L))/BLS(IB,IND(L),1)
      GO TO 7020
 7010 BC2(1) = BC2(1)+C2
 7020 CONTINUE
      TCM(1) = BC2(1)
      EPAY(1) = FTCM(1)-BC2(1)
      CUME(1) = EPAY(1)
      DO 7060 M=2,MA
      BC2(M) = 0.0
      DO 7030 L=1,NBLS
 7030 A(L) = BBLS(IB,L)/BLS(IB,L,M)
      DO 7050 L=1,NCE
      C1 = 0.0
      C2 = TC1(L,M)
      IF (IND(L).EQ.0) GO TO 7040
      IF (PCEL(2,L).GT.0.0) C1=PCEL(2,L)*AL(M)
      BC2(M) = BC2(M)+C1+(C2-C1)*A(IND(L))
      GO TO 7050
 7040 BC2(M) = BC2(M)+C2
 7050 CONTINUE
      TCM(M) = TCM(M-1)+BC2(M)
      EPAY(M) = FTCM(M)-BC2(M)
 7060 CUME(M) = CUME(M-1)+EPAY(M)
      M3 = MA+1
      IF (NEPAY(I,3).EQ.0) GO TO 7100
      M2 = MK+1
      IF (MA.LE.MK) GO TO 7100
      DO 7090 M=M2,MA
      DO 7070 L=1,NBLS
 7070 A(L) = BBLS(IB,L)/(AMIN1(BLS(IB,L,M),BLS(IB,L,MK)))
      BC2(M) = 0
      DO 7080 L=1,NCE
```

```
      IF (IND(L).EQ.0) GO TO 7080
      BC2(M) = BC2(M)+TC1(L,M)*A(IND(L))
 7080 CONTINUE
      TCM(M) = TCM(M-1)+BC2(M)
      EPAY(M) = FTCM(M)-BC2(M)
 7090 CUME(M) = CUME(M-1)+EPAY(M)
 7100 M2 = 1
      IF (NEPAY(I,4).EQ.0) GO TO 7170
      DO 7110 M=1,M3
      IF (TCM(M).GT.TC) GO TO 7120
 7110 CONTINUE
      GO TO 7210
 7120 M2 = M
      IF (M2.GT.MA) GO TO 7210
      DO 7150 M=M2,MA
      IF (TCM(M).GT.CX) GO TO 7160
      BB = TCM(M)/TC
      I1 = NSP(K)
      DO 7130 L=1,I1
      L1 = L
      IF (BB.LE.SP(K,L1)) GO TO 7140
 7130 CONTINUE
 7140 EPAY(M) = EPAY(M)*(1.0-SL(K,L1))
 7150 CUME(M) = CUME(M-1)+EPAY(M)
      GO TO 7210
 7160 M3 = M
      GO TO 7190
 7170 IF (NEPAY(I,5).EQ.0) GO TO 7210
      DO 7180 N=M2,MA
      M3 = N
      IF (TCM(N).GT.CX) GO TO 7190
 7180 CONTINUE
 7190 IF (M3.GE.MA) GO TO 7210
      EPAY(M3) = EPAY(M3)*(CX-TCM(M3-1))/(TCM(M3)-TCM(M3-1))
      CUME(M3) = CUME(M3-1)+EPAY(M3)
      BC2(M3) = FTCM(M3)-EPAY(M3)
      TCM(M3) = TCM(M3-1)+BC2(M3)
      M3 = M3+1
      DO 7200 M=M3,MA
      BC2(M) = FTCM(M)
      TCM(M) = TCM(M-1)+BC2(M)
      CUME(M) = CUME(M3-1)
 7200 EPAY(M) = 0.0
 7210 M3 = MA+1
      IF (M3.GT.180) RETURN
      DO 7220 M=M3,180
 7220 EPAY(M) = 0.0
      DO 7230 M=M3,180
```

```
7230 BC2(M) = 0.0
     DO 7240 M=M3,180
7240 TCM(M) = TCM(MA)
     DO 7250 M=M3,180
7250 CUME(M) = CUME(MA)
     RETURN
     END
```

```
      SUBROUTINE PROPA1 (I,K)
      COMMON /Y3/ FCPM(180)
      COMMON /Y9/ PPAID(8,10),PAYPER(8,10),PROGMN(8,10),INTRIM(8)
      COMMON /Y10/ COSTIN(8)
      COMMON /Y11/ PERPRO(8)
      COMMON /Y12/ TCM(180)
      COMMON /Y13/ CX,MK,TC,TP,TX,ALM,MA
      COMMON /Y17/ CUMB(180),PPAY(180)
      J1 = 0
      BB = TX
      IF (INTRIM(I).EQ.0) GO TO 8010
      A = PPAID(I,1)*BB
      J1 = 1
      J2 = 1
 8010 B = COSTIN(I)
      PPAY(1) = B*TCM(1)
      CUMB(1) = PPAY(1)
      DO 8030 L=2,MA
      J2 = L
      PPAY(L) = B*TCM(L)-CUMB(L-1)
      CUMB(L) = CUMB(L-1)+PPAY(L)
      IF (CUMB(L).GT.CX) GO TO 8040
      IF (J1.EQ.0) GO TO 8030
      IF (CUMB(L).LT.A) GO TO 8030
      IF (FCPM(L).LT.PROGMN(I,J1)) GO TO 8030
      BB = TCM(L)/FCPM(L)
      CALL CPROF (PROF,BB,K)
      BB = TCM(L)+PROF
      IF (BB.GT.CX) BB = CX
      PPAY(L) = BB*PAYPER(I,J1)-CUMB(L-1)
      CUMB(L) = CUMB(L-1)+PPAY(L)
      J1 = J1+1
      IF (J1.GT.INTRIM(I)) GO TO 8020
      A = PPAID(I,J1)*BB
      GO TO 8030
 8020 J1 = 0
 8030 CONTINUE
      BB = TCM(MA)
      CALL CPROF (PROF,BB,K)
      BB = TCM(MA)+PROF
      IF (BB.GT.CX) BB = CX
      CUMB(MA) = BB
      PPAY(MA) = BB-CUMB(MA-1)
      GO TO 8050
 8040 PPAY(J2) = CX-CUMB(J2-1)
      CUMB(J2) = CX
 8050 J3 = J2+1
      DO 8060 L=J3,180
```

```
8060 CUMB(L) = CUMB(J2)
     DO 8070 L=J3,180
8C70 PPAY(L) = 0.0
     RETURN
     END
```

```
      SUBROUTINE PROPA2 (I,J)
      COMMON /Y3/ FCPM(180)
      COMMON /Y10/ COSTIN(8)
      COMMON /Y12/ TCM(180)
      COMMON /Y13/ CX,MK,TC,TP,TX,ALM,MA
      COMMON /Y17/ CUMB(180),PPAY(180)
      COMMON /Y23/ PAY2(8,7)
      PROG = PAY2(I,1)
      COST = PAY2(I,2)
      K1 = 0
      A = PAY2(I,3)
      PROCHG = PAY2(I,4)
      DO 9010 L=1,180
      L1 = L
      IF (FCPM(L).GT.0.000001) GO TO 9020
      CUMB(L) = 0.0
 9010 PPAY(L) = 0.0
      RETURN
 9020 CONTINUE
      BB = TCM(L1)/FCPM(L1)
      CALL CPROF (PROF,BB,J)
      BB = AMIN1((BB+PROF),CX)
      PPAY(L1) = AMIN1((BB*PROG*FCPM(L1)-(A*BB)),(COST*TCM(L1)))
      IF (PPAY(L1).LE.0.0) PPAY(L1) = 0.0
      CUMB(L1) = PPAY(L1)
      L1 = L1+1
      DO 9040 K=L1,MA
      BB = TCM(K)/FCPM(K)
      CALL CPROF (PROF,BB,J)
      BB = AMIN1((BB+PROF),CX)
      IF (K1.EQ.1) GO TO 9030
      IF (FCPM(K).LE.PROCHG) GO TO 9030
      PROG = PAY2(I,5)
      COST = PAY2(I,6)
      A = PAY2(I,7)
      K1 = 1
 9030 CONTINUE
      WHOLD = A*BB
      X = (BB*PROG*FCPM(K))-WHOLD
      CUMB(K) = AMIN1(X,(COST*TCM(K)))
      IF ((-X).GT.CUMB(K-1)) CUMB(K) = 0.0
 9040 PPAY(K) = CUMB(K)-CUMB(K-1)
      CALL CPROF (PROF,TCM(MA),J)
      A = AMIN1((TCM(MA)+PROF),CX)
      CUMB(MA) = A
      PPAY(MA) = A-CUMB(MA-1)
      IF (MA.EQ.180) RETURN
      K1 = MA+1
```

```
      DO 9050 K=K1,180
 9050 CUMB(K) = A
      DO 9060 K=K1,180
 9060 PPAY(K) = 0.0
      RETURN
      END
```

```
      SUBROUTINE WKPAY (Z,W,NF,MA,J1,J9)
      COMMON /Y20/ CI(2,810),QTROUT(64,6),J2,J3,J4,NWAD
      DIMENSION Z(180), W(180), STORWK(810)
      IF (NF.EQ.100.OR.NF.EQ.200) GO TO 10140
      I10 = 0
      I30 = 0
      A4 = 0.0
      DO 10040 M=1,MA
      I10 = I10+1
      I20 = I30+1
      IF (I10.EQ.4) I10 = 1
      IF (I10.EQ.3) GO TO 10010
      X = 4.0
      I30 = I20+2
      GO TO 10020
10010 X = 5.0
      I30 = I20+3
10020 A5 = Z(M)/X
      A = 0.0
      DO 10030 K=I20,I30
      STORWK(K) = A5
10030 A = A+A5
      I30 = I30+1
10040 STORWK(I30) = Z(M)-A
      IF (I30.GE.810) GO TO 10060
      I30 = I30+1
      DO 10050 K=I30,810
10050 STORWK(K) = 0.0
10060 CONTINUE
      IF (NF.EQ.1) GO TO 10220
      N = MIN0(810,NWAD)
      A = 0.0
      N = (((N+NF)/NF)*NF)+NF
      DO 10070 K=1,NF
      A = A+STORWK(K)
10070 STORWK(K) = 0.0
      CI(2,NF) = CI(2,NF)-A
      STORWK(NF) = A
      DO 10090 K=NF,N,NF
      I20 = K+1
      I30 = K+NF
      A = 0.0
      DO 10080 K1=I20,I30
      A = A+STORWK(K1)
10080 STORWK(K1) = 0.0
      STORWK(I30) = A
10090 CI(2,I30) = CI(2,I30)-A
      IF (J1.EQ.0) RETURN
```

```
      A = 0.0
      J6 = 0
      J7 = 0
      IF (J4.EQ.3) GO TO 10110
      J5 = 13-4*(3-J4)
      J6 = J5
      J7 = 1
      DO 10100 K=1,J5
10100 A = A+STORWK(K)
      QTROUT(1,J9) = A
10110 J7 = J7+1
      DO 10130 K=J7,J2
      J5 = J6+1
      J6 = J5+12
      DO 10120 K1=J5,J6
10120 A = A+STORWK(K1)
10130 QTROUT(K,J9) = A
      RETURN
10140 CONTINUE
      IF (NF.EQ.200) GO TO 10190
      DO 10150 K=1,MA
      J5 = 4*K+K/3
10150 CI(2,J5) = CI(2,J5)-Z(K)
      IF (J1.EQ.0) RETURN
10160 CONTINUE
      J5 = J4
      J6 = 0
      IF (J4.EQ.3) GO TO 10170
      QTROUT(1,J9) = W(J4)
      J6 = 1
      J5 = J4+3
10170 CONTINUE
      J7 = J2*3+2
      DO 10180 K=J5,J7,3
      J6 = J6+1
10180 QTROUT(J6,J9) = W(K)
      QTROUT(J2,J9) = W(MA)
      RETURN
10190 CONTINUE
      J5 = 13
      J6 = 1
      CI(2,13) = CI(2,13)-W(3)
      DO 10200 K=6,MA,3
      J7 = K
      J5 = J5+13
10200 CI(2,J5) = CI(2,J5)-W(K)+W(K-3)
      IF (K.EQ.MA) GO TO 10210
      J6 = MIN0(J5+13,810)
```

```
      CI(2,J6) = CI(2,J6)-W(MA)+W(J7)
10210 CONTINUE
      IF (J1.EQ.0) RETURN
      GO TO 10160
10220 CONTINUE
      DO 10230 K=1,NWAD
10230 CI(2,K) = CI(2,K)-STORWK(K)
      IF (J1.EQ.0) RETURN
      GO TO 10160
      END
```

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