

NASA TECHNICAL MEMORANDUM

NASA TM 78121



PAGE II

PRICING AND COST ESTIMATING HANDBOOK

Prepared by
Systems Analysis and Integration Laboratory
and Computer Services Office

July 1977

NASA

*George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama*

(NASA-TM-78121) PAGE 2: PRICING AND COST
ESTIMATING HANDBOOK (NASA) 61 p HC A04/MF
A01 CSCL 09B

N77-29801

Unclas

G3/60 40850

1. REPORT NO. NASA TM-78121	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.	
4. TITLE AND SUBTITLE PACE II — Pricing and Cost Estimating Handbook		5. REPORT DATE July 1977	
		6. PERFORMING ORGANIZATION CODE	
7. AUTHOR(S) Rodney D. Stewart and Tom Shepherd		8. PERFORMING ORGANIZATION REPORT #	
9. PERFORMING ORGANIZATION NAME AND ADDRESS George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama 35812		10. WORK UNIT NO.	
		11. CONTRACT OR GRANT NO.	
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration Washington, D.C. 20546		13. TYPE OF REPORT & PERIOD COVERED Technical Memorandum	
		14. SPONSORING AGENCY CODE	
15. SUPPLEMENTARY NOTES Prepared by Systems Analysis and Integration Laboratory and Computer Services Office			
16. ABSTRACT In early 1973 the Marshall Space Flight Center (MSFC) initiated an effort to develop and establish an automatic data processing system to be used primarily for the preparation of industrial-engineering-type manhour-and-material cost estimates. This computer system, termed PACE (Pricing and Cost Estimating), was established and has evolved over the past several years through the PACE I and PACE II systems into a highly versatile and highly flexible tool which significantly reduces computation time, eliminates computational errors, and reduces typing and reproduction time for estimators and pricers. Because this system makes all mathematical and clerical functions automatic once basic inputs are derived, the time of estimators, estimate managers, secretarial personnel, and engineers involved in the estimating and cost analysis process can be devoted to publication of ground rules, and collection, analysis, and adjustment of inputs and rationale. This system also reduces the man-hours required for manual computations and documentation. This handbook has been prepared to facilitate use by those not familiar with the PACE II system or with detailed automatic data processing techniques; therefore, an attempt has been made to be explanatory and specific in all areas where actions are required to implement and activate the system. (The PACE I system is described in detail in TM X-73325.)			
17. KEY WORDS		18. DISTRIBUTION STATEMENT Unclassified — Unlimited	
19. SECURITY CLASSIF. (of this report) Unclassified	20. SECURITY CLASSIF. (of this page) Unclassified	21. NO. OF PAGES 64	22. PRICE NTIS

TABLE OF CONTENTS

	Page
I. INTRODUCTION AND BACKGROUND	1
II. USES OF THE PACE II COMPUTER SYSTEM	2
A. Major Projects	2
B. Experiments, Modules, and Subsystems	2
C. Source Evaluation	3
D. Other Possible Uses	3
III. METHODOLOGY OF ESTIMATING	3
IV. PACE II COMPUTER SYSTEM	4
A. Automation of Basic Estimates	4
B. Cost Estimate Variations	14
V. FUTURE IMPROVEMENTS AND POTENTIAL MODIFICATIONS	19
A. De-escalation, Computation of Present Worth, Future Worth, or Annual Equivalent Costs of Alternate Proposals	19
B. Computation of Make/Buy and Skill Mix Ratios and Percentages	19
C. Respreding of Costs	19
D. Reduction of Time Increments Estimated	20
E. Cost Impact of Schedule Adjustments	20
F. Graphics	21
APPENDIX A — WORKSHEETS	23
APPENDIX B — COST ESTIMATE REPORT	27
APPENDIX C — ERROR MESSAGES	53
APPENDIX D — SENSITIVE RUN PROCEDURE	57

LIST OF ILLUSTRATIONS

Figure	Title	Page
1.	General schematic of PACE II flow	5
2.	Sample WBS	6
3.	Error report	9
4.	Dollar escalation report	9
5.	Placement of data cards in run deck	10
6.	Design-to-cost and contractor fee card	16
7.	Dollar escalation cards	18

PACE II

PRICING AND COST ESTIMATING HANDBOOK

I. INTRODUCTION AND BACKGROUND

In early 1973 the Marshall Space Flight Center (MSFC) initiated an effort to develop and establish an automatic data processing system to be used primarily for the preparation of industrial engineering type manhour and material cost estimates. This computer system, termed PACE (Pricing and Cost Estimating), was established and has evolved over the past several years through the PACE I and PACE II systems into a highly versatile and highly flexible tool which significantly reduces computation time, eliminates computational errors, and reduces typing and reproduction time for estimators and pricers. Because this system makes all mathematical and clerical functions automatic once basic inputs are derived, the time of estimators, estimate managers, secretarial personnel, and engineers involved in the estimating and cost analysis process can be devoted to publication of ground rules, and collection, analysis, and adjustment of inputs and rationale. This system also reduces the manhours required for manual computations and documentation.

Basic features of the PACE II system are: (1) a uniform method of depicting and numbering a Work Breakdown Structure (WBS), (2) a uniform labor rate structure, (3) a uniform format for input and output data, and (4) uniform methods in applying overhead, General and Administrative (G&A) costs, fee, and escalation. Principal improvements of the PACE II system over the PACE I system are: (1) a simplified input and run deck, (2) a revised output format, and (3) a detailed "edit" procedure designed to identify, reduce, and eliminate input errors. The PACE II system is also more efficient from the standpoint of computer time utilization.

The PACE II programs are written in COBOL programming language for execution on a UNIVAC 1108 computer under the EXEC 8 operating system. The minimum hardware configuration required for running the PACE II system is one central processor, one card reader, one uniservo tape drive, one FASTRAND or disk mass storage unit, and an on-line printer.

This handbook has been prepared to facilitate use by those not familiar with the PACE II system or with detailed automatic data processing techniques; therefore, an attempt has been made to be explanatory and specific in all areas where actions are required to implement and activate the system. (The PACE I system is described in detail in TM X-73325.)

II. USES OF THE PACE II COMPUTER SYSTEM

The PACE II computer system is designed primarily for the preparation of "industrial-engineering-type" "manhour-and-material" cost estimates; however, a number of other applications are feasible. Some of the existing and possible uses of the PACE II system are described in the following paragraphs.

A. Major Projects

For major projects, entering Phases C and D, the PACE II system can be used to generate budgetary estimates down to the lowest WBS level. The PACE II system can also be used for a comparative analysis of preliminary concepts where several options are being considered. Speed of computation and ease of comparison due to uniform format make the PACE II system attractive for this purpose. The current principal use of the PACE II system is the initial pricing and updating of government estimates in support of Source Evaluation Board (SEB) proceedings; but it can also be used in tradeoff studies, change estimates, and budgetary studies. (A "grounds-up" industrial-engineering-type, manhour-and-material cost estimate using the PACE II system can be used as a baseline for estimating changes, for evaluating contractor proposals, and for establishing preliminary budgets.) These applications are described in more detail in the following paragraphs.

B. Experiments, Modules, and Subsystems

Because of flexibility in the WBS numbering system, the PACE II system can be used for developing a "stand-alone" estimate for part of a major program. Hence, estimates of experiments, modules, and subsystems can be made independent of the major program.

C. Source Evaluation

The PACE II computer system will find its greatest use in the preparation of independent government estimates to be used in SEB evaluation proceedings. Some additional foreseeable applications to support SEB's are: (1) preparation of initial adjustments to the government estimate, (2) adjustments resulting from written and oral discussions, and (3) adjustments based on best and final offers. The "adjusted government estimate" is often used for substantiation of the government's position in the event of a protest; therefore, the accuracy and speed provided by the PACE II system are of the utmost importance. Adaptability of the PACE II system to the pricing or verification of contractor quotes, or preparation of "most probable costs," would depend upon the specific contractor pricing formula and estimating methodology.

D. Other Possible Uses

The basic structure and methodology of the PACE II system make it adaptable to the performance of sensitivity analyses (i.e., sensitivity of labor rate and skill mix variations), "design-to-cost" exercises, and economic analyses involving the time value of money.

III. METHODOLOGY OF ESTIMATING¹

Use of the PACE II computer system is based on the development of manhours and materials, travel, and other direct costs for the lowest level (down to level eight) of each WBS being estimated. Therefore, application of the PACE II system is appropriate primarily where sufficient definition exists to define design and configuration parameters of hardware, man-loading, and time-phasing of engineering and support type functions; specific plans relative to location of the work documentation required; and type of skill required.

In a design-to-cost situation, a grounds-up estimate must be made first to develop a baseline. The design-to-cost factor is then applied to spread the reduction or increase to the lowest WBS level. Use of this technique requires a detailed negotiation and rationalization of the adjusted manhours of the work to be performed (i.e., the schedule, hardware requirements, specifications, or

1. Estimating methodology is described in more detail in TMX-64966.

design must be adaptable to the manhour and material constraints developed in the design-to-cost estimate). The methodology of estimating described in TMX-64966 shows how the basic estimate worksheets are derived through a process of ground rule development, information interchange, and estimate synthesis.

IV. PACE II COMPUTER SYSTEM

A. Automation of Basic Estimates

1. General. Figure 1 illustrates the general flow of the PACE II system. This includes the necessary inputs to the system, the computer program phases of data manipulation, and the various reports generated by the system in the course of a basic cost estimate computer run. Figure 2 illustrates a sample WBS hierarchy structure.

a. Input Types and Definitions. The five types of user-supplied inputs to the PACE II system are as follows:

1. Labor Rate Header — This input type includes the project name, the fiscal year span for the cost estimate, the design-to-cost percentage factor (if applicable), and contractor fee percentage (if applicable). Only one labor rate header card is allowed.

2. Labor and Overhead Rate Card — This input type contains one labor category per card, the labor rate in dollars, and an overhead percentage factor per fiscal year.

3. Dollar Escalation — Data defined by this input type are projected dollar escalation rates per fiscal year for the span of the cost estimate. These rates apply only to material, travel, and other direct dollar expenses.

4. WBS Title — The cards for this input type supply descriptive titles to the corresponding WBS element number. The WBS element number and corresponding title are displayed in the total cost report.

5. Base Data — Each card of this input type represents one element or block at the lowest extremities of the WBS for a particular fiscal year and contains the estimated amount of labor in manhours per labor category, and dollar expenses (material, travel, and other direct) for that fiscal year WBS element combination.

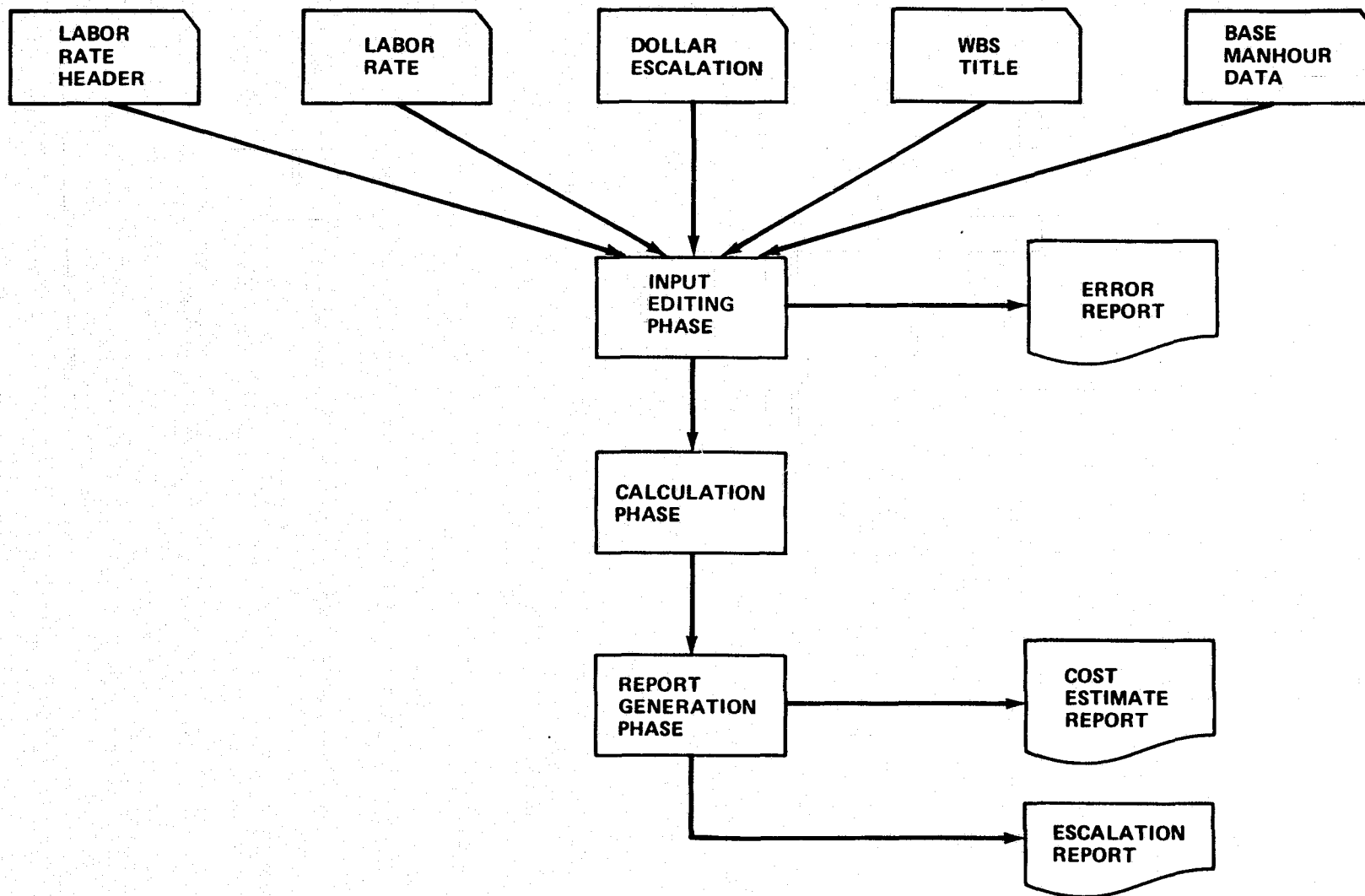


Figure 1. General schematic of PACE II flow.

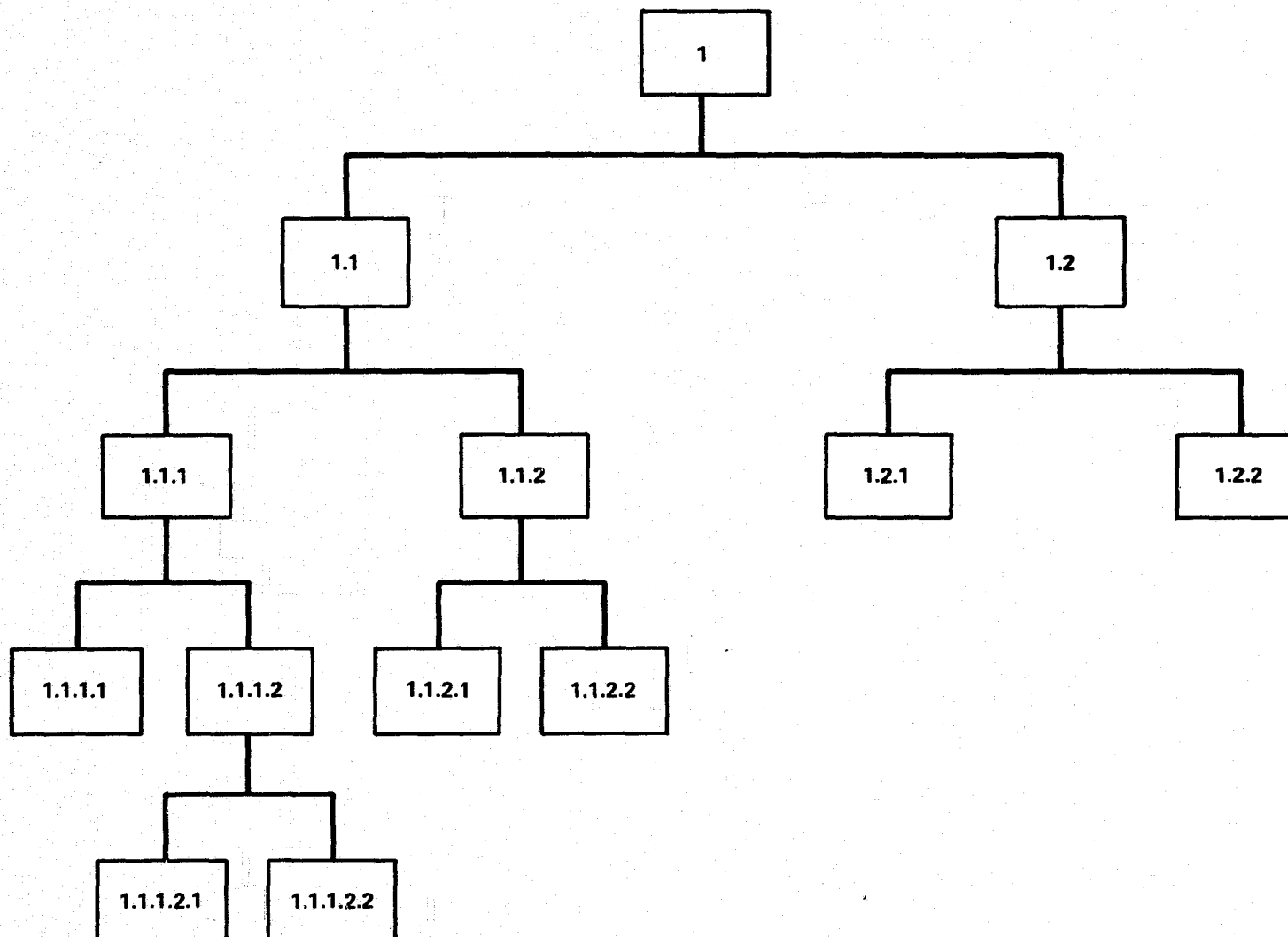


Figure 2. Sample WBS.

b. Input Data Worksheets. Input worksheets are used by the cost estimator to code input data for the PACE II run. An example of these worksheets is shown in Appendix A.

c. System Data Manipulations. As the inputs flow through the logic of the system, they are channelled through numerous arithmetic calculations and data manipulation routines. These routines are categorized into the following three basic phases:

1. Input Editing Phase — The editing phase ensures that the inputs conform to the specified requirements of the different types. All cards with input errors are printed on the error report along with an error code and an error message.

2. Calculation Phase — PACE II system's logic contains numerous calculations which are made in the course of preparing a cost estimate of a given WBS element for each fiscal year. The following is a list of the calculations made in computing a given estimate:

- Multiply the labor hours of each labor category by their respective labor rates to obtain labor dollars.
- Multiply the labor dollars of each labor category by their respective overhead rates giving overhead dollars.
- Multiply the unescalated material (shown as material and subcon), travel, and other direct dollars by 1 plus their respective escalation rates, if any.
- Multiply the material dollars by the material burden percentage giving material overhead.
- Add, the total labor dollars, labor overhead, material, material overhead, and the travel and other direct dollars giving the subtotal estimated cost.
- Multiply the subtotal estimated cost by the G& A expense percentage for the appropriate fiscal year, giving the G& A expense.
- Add the subtotal estimated cost and the G& A expense giving the total estimated cost.

- Multiply the total estimated cost by the contractor fee percentage, if any, which is constant for all fiscal years, giving the fee amount.
- Add the total estimated cost and the fee amount giving the grand total for the fiscal year.

3. Report Generation Phase — The data structure produced by the calculation and editing phases comprise the inputs to the cost estimate report generation phase. The cost estimate report is formatted and printed on continuous forms showing the cost breakdown per fiscal year of the estimated project from the highest to the lowest levels of the WBS.

The escalation report is produced and formatted on a separate page from the cost estimate report.

d. Outputs Developed. Three reports are generated in a cost estimate run. These reports are: (1) error report (Fig. 3), (2) cost estimate report (Appendix B), and (3) dollar escalation report (Fig. 4). All reports are printed on standard 11 × 14-1/2 in. continuous computer forms.

2. Input Preparation. Data cards will be placed in the run deck as shown in Figure 5. All types of input data are identified by the first two columns of the card. The first two columns of every card must contain a numerical two digit identifier. This identifier will be called type-code. The type-codes for PACE II input data are:

- Labor Rate Heater — Type 10 card
- Labor Rate — Type 20 card
- Dollar Escalation — Type 30 card
- WBS Title — Type 40 card
- Base Data — Type 50 card

Descriptions of the cards are as follows:

TRANSACTIONS										EC	ERROR MESSAGE		
300DR	020	1LD	JJJ								11	INVALID PERCENTAGE FACTOR	
10CDE			***	1960						050 B9	12	INVALID FEE PERCENTAGE	
401.0.9.8.4										**	06	INVALID WBS NUMBER	
*****											01	INVALID TRANSACTION TYPE	
60XVZ		KKK	AAA	UDD		111					17	DUPLICATE ACT CODE ON 30CD	
300DR	100		C35			030					02	INVALID ACTIVITY CODE	
20X4GZ457											03	INVALID RATE	
60010203			TOM								01	INVALID TRANSACTION TYPE	
30ENG	100		*****								07	INVALID-MUST BE NUMERIC	
30MAT	100	200	300	350	405	410					10	INVALID CATEGORY	
300DR	200	300	350	215	220	230					17	DUPLICATE ACT CODE ON 30CD	
30TRV	300	450	475	480	490	500					17	DUPLICATE ACT CODE ON 30CD	
10PCX PROJECT				1977	1978	1979	1980	1981	1982	1983	1984	08	17
20ENG14901000	14901000	14901000	14901000	14901000	14901000	14901000	14901000	14901110				14	MORE THAN 1 TYPE 10 CARD
20GA	120	120	120	120	120	120	120	120	120			16	DUPLICATE ACT CODE ON 20CD
												15	EXCESSIVE TYPE 20 CARDS

2ADD,P .PACEII-2

Figure 3. Error report.

ORIGINAL PAGE IS
OF POOR QUALITY

DATE 01 DEC 77		PROJECT- PCX PROJECT			DESIGN-TO-COST-FACTOR = 0.00			PAGE	
WBS 1		TITLE-							
ESCALATION RATES									
ELEMENTS OF COST	FY - 77	FY - 78	FY - 79	FY - 80	FY - 81	FY - 82	FY - 83	FY - 84	
MATERIAL & SUBCON.	.100	.200	.300	.350	.405	.410	.000	.000	
TRAVEL	.200	.300	.350	.215	.220	.230	.000	.000	
OTHER	.300	.450	.475	.480	.490	.500	.000	.000	

Figure 4. Dollar escalation report.

@RUN PACEII, 1HEL02A2061A,JONESGBIN229,15,500

@ASG,T PUR,T,XXXXX
 @FREE TPF\$
 @ASG,T TPF\$,F/1/POS/10
 @COPIN PUR.,TPF\$.
 @FREE PUR.
 @ADD,P .PACEII-1
 DATA CARDS
 @ADD,P .PACEII-2
 @FIN

Figure 5. Placement of data cards in run deck.

Labor Rate Header Card — Type 10

<u>Card Columns</u>	<u>Item</u>	<u>Content</u>
1-2	Type Code	Must Be 10
3-32	Project Name	Free Form
33-36	Fiscal Year No. 1	Four Digits, Numeric (1977, etc.)
37	N/A	Blank
38-41	Fiscal Year No. 2	Four Digits, Numeric
42	N/A	Blank
43-46	Fiscal Year No. 3	Four Digits, Numeric
47	N/A	Blank
48-51	Fiscal Year No. 4	Four Digits, Numeric
52	N/A	Blank
53-56	Fiscal Year No. 5	Four Digits, Numeric
57	N/A	Blank
58-61	Fiscal Year No. 6	Four Digits, Numeric
62	N/A	Blank
63-66	Fiscal Year No. 7	Four Digits, Numeric
67	N/A	Blank
68-71	Fiscal Year No. 8	Four Digits, Numeric
72	N/A	Blank
73-75	Design-to-Cost Percentage Factor	Three Digits, Numeric
76	N/A	Blank
77-78	Contractor Fee Percentage	Two Digits, Numeric
78-80	N/A	Blanks

Note: Only one labor rate header card is allowed for a production run.

Labor Rate Card — Type 20

<u>Card Columns</u>	<u>Item</u>	<u>Content</u>
1-2	Type Code	Must Be 20
3-5	Activity Code	'ENG' (Engineering) 'GA' (General and Administrative Expense Percentage) 'MAT' (Material Burden Percentage) 'OTH' (Other) 'QRA' (Quality and Reliability Assurance) 'TLG' (Tooling) 'TST' (Testing)
6-9	Labor Rate No. 1	Numeric Rate with Two Decimal Positions (99.99)
10-13	Overhead Percent No. 1	Numeric Percentage One Decimal Position (999.9)
14	N/A	Blank
15-18	Labor Rate No. 2	Numeric Rate with Two Decimal Positions (99.99)
19-22	Overhead Percent No. 2	Numeric Percentage One Decimal Position (999.9)
23	N/A	Blank
24-27	Labor Rate No. 3	Numeric Rate with Two Decimal Positions (99.99)
28-31	Overhead Percent No. 3	Numeric Percentage with One Decimal Position (999.9)
32	N/A	Blank
33-36	Labor Rate No. 4	Numeric Rate with Two Decimal Positions (99.99)
37-40	Overhead Percent No. 4	Numeric Percentage with One Decimal Position (999.9)
41	N/A	Blank
42-45	Labor Rate No. 5	Numeric Rate with Two Decimal Positions (99.99)
46-49	Overhead Percent No. 5	Numeric Percentage with One Decimal Position (999.9)
50	N/A	Blank
51-54	Labor Rate No. 6	Numeric Rate with Two Decimal Positions (99.99)

<u>Card Columns</u>	<u>Item</u>	<u>Content</u>
55-58	Overhead Percent No. 6	Numeric Percentage with One Decimal Position (999.9)
59	N/A	Blank
60-63	Labor Rate No. 7	Numeric Rate with Two Decimal Positions (99.99)
64-67	Overhead Percent No. 7	Numeric Percentage with One Decimal Position (999.9)
68	N/A	Blank
69-72	Labor Rate No. 8	Numeric Rate with Two Decimal Positions (99.99)
73-76	Overhead Percent No. 8	Numeric Percentage with One Decimal Position (999.9)
77-80	N/A	Blanks

Dollar Escalation Card — Type 30

<u>Card Columns</u>	<u>Item</u>	<u>Content</u>
1-2	Type Code	Must Be 30
3-5	Category of Escalation	'MAT' (Material and Subcontractor) 'TRAV' (Travel) 'ODR' (Other Direct)
6-10	N/A	Blanks
11-13	Escalation Percent No. 1	Three Numeric Digits, No Decimals (999)
14-19	N/A	Blanks
20-22	Escalation Percent No. 2	Three Numeric Digits, No Decimals (999)
23-28	N/A	Blanks
20-31	Escalation Percent No. 3	Three Numeric Digits, No Decimals (999)
32-37	N/A	Blanks
38-40	Escalation Percent No. 4	Three Numeric Digits, No Decimals (999)
41-46	N/A	Blanks
47-49	Escalation Percent No. 5	Three Numeric Digits, No Decimals (999)

<u>Card Columns</u>	<u>Item</u>	<u>Content</u>
50-55	N/A	Blanks
56-58	Escalation Percent No. 6	Three Numeric Digits, No Decimals (999)
59-64	N/A	Blanks
65-67	Escalation Percent No. 7	Three Numeric Digits, No Decimals (999)
68-73	N/A	Blanks
74-76	Escalation Percent No. 8	Three Numeric Digits, No Decimals (999)
77-80	N/A	Blanks

WBS Title Card — Type 40

<u>Card Columns</u>	<u>Item</u>	<u>Content</u>
1-2	Type Code	Must Be 40
3-18	WBS Element No.	Left Justified, Numeric, with Decimals
19-48	WBS Title	Free Form
49-80	N/A	Blanks

Base Data Card — Type 50

<u>Card Columns</u>	<u>Item</u>	<u>Content</u>
1-2	Type Code	Must Be 50
3-18	WBS Element No.	Left Justified, Numeric, with Decimals
19-20	Fiscal Year	Two Digits, Numeric (77, 78 etc.)
21-47	Engineering	Numeric Whole Numbers
28-34	Manufacturing	Same as Above
35-40	Tooling	Same as Above
41-46	Q& RA	Same as Above
47-52	Testing	Same as Above
53-58	Other	Same as Above
59-66	Material Dollars	Same as Above
67-72	Travel Dollars	Same as Above
73-79	Other Direct Dollars	Same as Above
80	N/A	Blank

3. Editing of User Input Data. To improve the reliability and validity of the user's input data before it becomes an integral part of permanent files, reports, etc., it is a policy of good automatic data processing practices to provide as many tests for accuracy as is possible early in the processing flow. This process is commonly referred to as editing.

The editing procedures executed within the PACE II system are accomplished by the first phase of the execution flow. This phase includes the input editing functions as well as the sorting and sequencing of all valid input transactions for subsequent processing.

Whenever a data error is detected in an input card, an image of the transaction card is printed on an error listing accompanied by an error code and an error message. Asterisks will be printed under each card column which is in error to assist the user in correcting errors. The explanation of error codes and required corrections are shown in Appendix C.

4. Processing of Sensitive Data. Because the PACE II system was designed for use in support of NASA SEB's and other groups of government personnel who handle proprietary data developed by private contractors, a procedure is in effect at MSFC for eliminating the exposure of cost estimate data to nongovernment personnel so as to protect the confidentiality of the contracting relationship.

This sensitive run procedure places the control of data preparation (key-punching) and run deck setup directly in the hands of the system user. The entire execution process from job submittal through collection of printed output is performed under the direct observation of a government monitor. At the completion of each production run, the computer memory and all mass-storage hardware are cleared of data utilized or generated by PACE II. A copy of the sensitive run procedure is illustrated in Appendix C.

B. Cost Estimate Variations

In addition to calculating the basic cost estimates previously described, the PACE II system contains options for modifying the results that are produced by a basic estimate. The options are design-to-cost; labor, burden, and G&A factors; direct dollar escalation; and contractor fee.

1. Design-to-Cost. The design-to-cost option is available for use in situations where a previously calculated cost estimate varies significantly from a design target cost and where it is desired to determine the impact of a change at all levels of the estimate so that the project technical and programmatic aspects can be altered to meet the cost target. If the need for a uniform

redistribution of resources occurs, this can be achieved by including a design-to-cost factor as input in the PACE II run deck. This factor, expressed as either a percent increase or decrease, will then be applied to the manpower and fixed dollar values in the base data for all WBS elements present. The resulting printouts will indicate the modified costs from the highest to the lowest level of the WBS, and the design-to-cost factor utilized will be shown on the total cost estimate report.

In using this feature, care must be taken to assure that man-hour and material quantities resulting from the overall increase or decrease are reconciled with the schedule, hardware quantities, skill mix, specifications, and/or work elements of a revised (reduced or expanded) program or project. A cut or increase unaccompanied by a corresponding change in the work to be performed can be dangerously misleading to estimators, work package managers, or management. Use of the design-to-cost feature must, therefore, be accompanied by a renegotiation of resources versus specification, design, and/or hardware requirements down to the lowest level. If this renegotiation of resources estimates fails to yield a commitment to perform or a commitment to manage within these resources, the design-to-cost estimate must be voided in preference for either the original grounds-up estimate or an alternate estimate that can be restructured down to the lowest level by deleting or adding certain elements to assure total project accomplishment within the target resource level. This stipulation, although it is a part of a project definition/engineering/cost estimating activity rather than the ADP data manipulation activity, must be remembered and followed to prevent the generation of unrealistic estimates.

a. Input Preparation. The design-to-cost factor should be entered in columns 73-75 on the Labor Rate Header card. Figure 6 illustrates the design-to-cost factor on the Labor Rate Header card. An increase percentage may be specified by entering any number greater than 100 up to a maximum value of 999. With the assumed decimal, an entry of 105 would result in a 5 percent increase, 110 a 10 percent increase, etc. Likewise, an entry of 099 would represent a 1 percent decrease, 095 a 5 percent decrease, etc., with a lower input limit of 001.

b. Calculations. Upon execution, the PACE II system will modify the values of the manpower figures and fixed dollar costs specified in the WBS base data by multiplying them by the design-to-cost factor. The remaining processing then continues identically to that of a basic estimate with the exception that the modified labor and dollar values will appear on the manpower summary and total cost estimate reports in place of the basic values. The data on the transaction list report, however, will be unaffected by this change. Revised manhour and material figures are then ready for return to and examination by individual estimators for development of impact statements, work scope, changes,

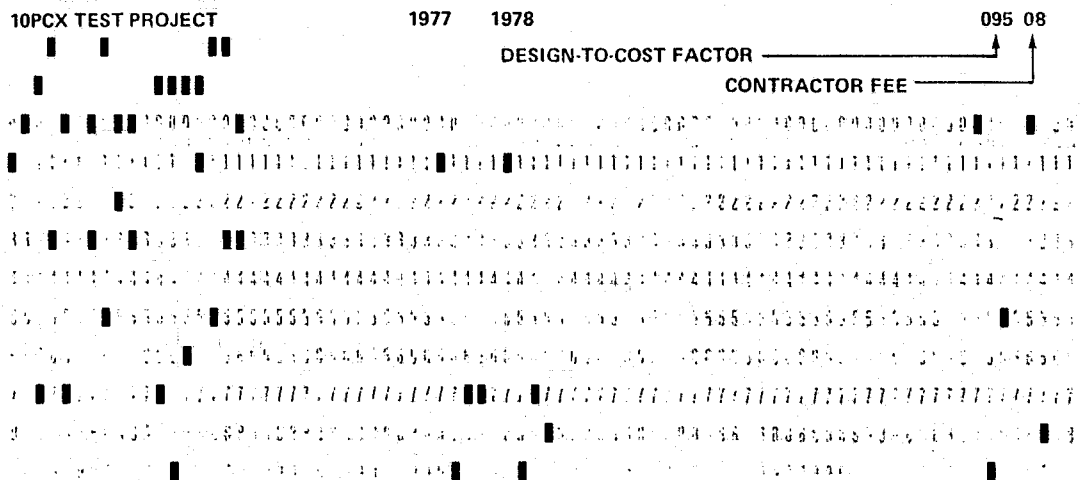


Figure 6. Design-to-cost and contractor fee card.

schedule changes, or recombination or redivision of work elements resulting from the change in resources. It is reemphasized that this reconciliation process is mandatory to retain the credibility of the estimate.

2. Labor, Burden, and G&A Factors. Labor rates, overhead, and G&A rates are subject to fluctuation. The PACE II system affords fast turn-around when revised rates and the resulting impact are required. The revised rates are input in the same manner as previously described in this handbook.

3. Direct Dollar Escalation. Material and subcontractor costs, travel costs, and other direct dollar values which have previously been utilized in a basic cost estimate on the PACE II system can be modified for subsequent runs without disturbing the WBS base data cards used in the basic run. This feature has been provided to satisfy situations where it is desired to know the impact of increases to these costs over the time span of the estimate due to economic influences such as inflation. By means of escalation factors which are specified in the run deck, one or more PACE II production runs can be made to show the effects of these variations while leaving the basic data intact.

a. Input Preparation. The categories of escalation are as follows:

- MAT = MATERIAL ESCALATION
- TRV = TRAVEL COSTS ESCALATION
- ODR = OTHER DIRECT ESCALATION

Three numeric characters must be furnished for each fiscal year value to be escalated with a decimal point assumed between the second and third character. Thus an entry of 025 would represent an increase of 2.5 percent. Any non-numeric input other than blanks will be interpreted as an error. Escalation percentages are entered on the Dollar Escalation Card (Type 30). An escalation percentage may be entered for each or any of the fiscal years in the cost estimate.

Any or all of the three categories of cost can be escalated in the same PACE II run. The direct dollar escalation cards are illustrated in Figure 7.

b. **Calculations.** In preparing the total cost estimate report for escalation, the WBS base data for direct dollars are increased in the first fiscal year by the amounts specified by the first percentage factor entered in their respective escalation cards. The remaining fiscal years are increased by adding their escalation factors to the sum of all previous factors and multiplying the direct dollar value for that year by the accumulated factor. These increased values will be shown for each WBS element and on all versions of the total cost estimate report.

4. **Contractor Fee.** Fees paid to government contractors can be included in a cost estimate by means of an optional input to the PACE II system which specifies a percentage factor which is to be used in figuring the fee. The fee amount is calculated at the highest level of the WBS and is printed out on the total cost estimate report together with a grand total for the entire estimate which includes the total estimated cost plus the fee.

a. **Input Preparation.** The contractor fee percentage is entered in columns 77-78 on the Labor Rate Header card. Fees may range from 01 to 99 representing whole number percentage.

b. **Calculations.** After the final summation of total estimated cost is made, the contractor fee percentage is applied to the summary figures for each fiscal year and added to the total cost giving a grand total. The fee amounts and grand totals are then printed out as additional data on the total cost estimate page for the highest level WBS element. This is the only place where this information is shown. No other reports or report variations are affected by the contractor fee option.

c. **Sample Report.** A sample page of the total cost estimate report for the highest level WBS element in the basic estimate example using a contractor fee input of eight percent is shown in Appendix B. Figure 6 illustrates the contractor fee card used to produce this option.

30MAT 025 025 030

100 53 97

30TRV 030 030 035

18X **5317**

300DR 035 035 040

10 11 12 13 14
15 16 17 18 19

18

V. FUTURE IMPROVEMENTS AND POTENTIAL MODIFICATIONS

As presently configured, the PACE II system is a highly versatile and flexible tool that can be used for a wide variety of functions. However, one can envision a number of other applications for the system ranging from minor to significant, if modifications were made to the system. A general description of these potential uses are described in this section. It is emphasized that detailed planning or estimating of programming effort to accomplish these modifications or changes have not been completed. At the present time, the following are only ideas for potential improvements.

A. De-escalation, Computation of Present Worth, Future Worth, or Annual Equivalent Costs of Alternate Proposals

Certain limited economic studies can be accomplished with the PACE II system as now configured by applying various escalation rates to fixed dollar costs. Adaptation of this feature to accommodate de-escalation of labor, materials cost, and other costs could facilitate the computation of present worth, future worth, or annual equivalent costs for use in economic analyses and comparison of alternate proposals. Thus, the "time value of money" could be taken into account in comparing two program funding alternatives. This feature would be particularly useful when the two alternatives vary considerably in distribution of funding requirements over the program time span. Comparisons on a present worth or annual equivalent basis are prevalent in industrial decisions where interest rates, discount factors, or rate-of-return comparisons are essential to choose the most economically attractive alternative.

B. Computation of Make/Buy and Skill Mix Ratios and Percentages

All of the basic data needed to compute labor/materials and/or make/buy ratios at each level of the WBS are available in a PACE II estimate. These ratios are particularly meaningful when it is necessary to determine what proportion of the work in each area and in the total proposal or estimate is to be accomplished in-house and what portion is to be subcontracted. Sufficient data are also available in a PACE II estimate to compute skill-mix ratios at each level of the WBS. These ratios would indicate what proportion of the total labor hours is in the engineering category, what portion is manufacturing, etc.

C. Respreding of Costs

Real government estimating situations often encounter problems where (1) funding is limited for the first year or two years to a specified amount,

(2) the maximum annual funding is specified, or (3) the shape of the funding curve is specified in some other manner. Many industrial concerns have a standard set of funding spread curves which can be applied to any estimate and which will adjust the total and detailed costs to match the time-oriented expenditure of manhours or funds. The basic information required to accomplish this type of fund curve adjustment is available in a PACE II generated cost estimate.

D. Reduction of Time Increments Estimated

Perhaps the most extensive modification to the system envisioned would be the reduction of the time span estimated for each element from the 1 year increment to a quarterly, monthly, or even weekly increment. Alteration of this time increment would involve sizable changes in the current estimating process as well as the computer system, but may be worthwhile at a later date due to various factors. First, requests for proposal are now requiring that the proposers subdivide costs into quarter-year increments. Verification of cost computations at this level of breakout by the PACE II system would require reduction of the time increment estimated from yearly to quarterly. Secondly, a quarterly or monthly breakout would facilitate collection of fiscal year costs when different fiscal year bases are used (i.e., July 1 to June 30 versus October 1 to September 30 versus January 1 to December 31). Third, greater visibility of manpower and fund buildup over shorter increments in early years may be desirable because funding constraints during buildup are normally given close scrutiny to avoid too rapid an acquisition of a recurring funding requirements.

E. Cost Impact of Schedule Adjustments

Various PACE II system modifications can be envisioned which would modify the fiscal year spread of manhours and resulting labor or material costs to account for differences in the scheduling of development, production, or operations support activities of a program. With the present cost breakout by fiscal year, costs for each WBS increment could be accelerated or decelerated in yearly increments. Further PACE II system modifications to permit smaller time increments (semiannual, quarterly, or monthly) would permit finer adjustments in schedule-related costs. Differences in escalation costs brought about by these cost/schedule adjustments would be taken into account in the use of the appropriate escalated labor rate for each increment of time.

These and other modifications of the PACE II system will be studied in the coming months to determine the economic and practical benefits of implementing them. Provided sufficient demand develops for the PACE II system and its potential modifications, a time-phase program for system improvement will be instituted.

F. Graphics

An early addition to the PACE II system which is envisioned is a graphics output capability which would allow the plotting of manhours and/or dollars versus fiscal year for the total estimate or for selected WBS elements. This capability will provide a quick-look visual picture of cost and/or manpower trends.

APPENDIX A

WORKSHEETS

22
n

PAGE INTENTIONALLY BLANK

WBS NUMBER:		COMPUTER INPUT AND WORKSHEET (Control Data) PACE II SYSTEM (Pricing and Cost Estimating)		DATE: May 10, 1977		PAGE 1 OF 1																																				
WBS TITLE:		PROJECT NAME: ACPL		PREPARED BY: L. J. J. J.																																						
LABOR RATE HEADER																																										
TYPE CODE	PROJECT NAME																															FISCAL YEAR NO. 1	FISCAL YEAR NO. 2	FISCAL YEAR NO. 3	FISCAL YEAR NO. 4	FISCAL YEAR NO. 5	FISCAL YEAR NO. 6	FISCAL YEAR NO. 7	FISCAL YEAR NO. 8	DESIGN TO COST FACTOR %	CONTRACTOR FEE %	
10	ATMOSPHERIC CLOUD PHYSICS LABS																															1977	1978	1979	1980	1981					092	08
LABOR RATE CARDS																																										
TYPE CODE	ACTIVITY CODE	LABOR RATE NO. 1	OVERHEAD PERCENT NO. 1	LABOR RATE NO. 2	OVERHEAD PERCENT NO. 2	LABOR RATE NO. 3	OVERHEAD PERCENT NO. 3	LABOR RATE NO. 4	OVERHEAD PERCENT NO. 4	LABOR RATE NO. 5	OVERHEAD PERCENT NO. 5	LABOR RATE NO. 6	OVERHEAD PERCENT NO. 6	LABOR RATE NO. 7	OVERHEAD PERCENT NO. 7	LABOR RATE NO. 8	OVERHEAD PERCENT NO. 8																									
20	ENG	1015	150	1167	120	1218	120	1289	120	1310	120																															
20	MFG	718	130	845	130	897	130	946	130	1027	130																															
20	TLG																																									
20	QRA	857	110	909	110	983	110	1024	110	1076	110																															
20	TST	756	110	883	110	1041	110	1101	110	1158	110																															
20	OTH	1058	120	1167	120	1218	120	1289	120	1310	120																															
TYPE CODE	ACTIVITY CODE	PERCENT NO. 1		PERCENT NO. 2		PERCENT NO. 3		PERCENT NO. 4		PERCENT NO. 5		PERCENT NO. 6		PERCENT NO. 7		PERCENT NO. 8																										
20	G A	180		180		180		180		180																																
20	MAT	50		50		50		50		50																																
DOLLAR ESCALATION CARDS																																										
TYPE CODE	CATEGORY OF ESCALATION	ESCALATION PERCENT NO. 1	ESCALATION PERCENT NO. 2	ESCALATION PERCENT NO. 3	ESCALATION PERCENT NO. 4	ESCALATION PERCENT NO. 5	ESCALATION PERCENT NO. 6	ESCALATION PERCENT NO. 7	ESCALATION PERCENT NO. 8																																	
30	MAT	70	70	70	70	70																																				
30	TRY	60	60	60	60	60																																				
30	ODR	65	65	65	65	65																																				

MSFC - Form 514-1 (March 1977)

ORIGINAL PAGE IS
OF POOR QUALITY

WBS NUMBER:		COMPUTER INPUT AND WORKSHEET (Base Data) PACE II SYSTEM (Pricing and Cost Estimating)							DATE: May 10, 1971 PREPARED BY: L. Hardin		PAGE 1 OF 6
WBS TITLE:		PROJECT NAME: ACPL							DOLLARS		
TYPE CODE	WORK BREAKDOWN STRUCTURE CODE	FY	ENGINEERING	MANUFACTURING	TOOLING	DUAL & DEL ASSURANCE	TESTING	OTHER	MATERIALS	TRAVEL	OTHER DIRECT
5.0	1.1.1.1	77						744		1200	
5.0		78						9731		850	
5.0		79						117		1700	
	1.1.1.2	77		6391							
		78		183		861					
		79		756					6000		
		80		432			382				8000
		81		1245							
	1.1.2.2	77	683								6763
		78	52								
		79	7321				683		6234		
		80	850					121			
		81	1123								
	1.1.3.4	78					673		75461		5431
		79		631			784				
		80					860				

ORIGINAL PAGE IS
OF POOR QUALITY

MSFC - Form 514-2 (February 1977)

APPENDIX B

COST ESTIMATE REPORT

DATE 19 NOV 77 WBS 1		PROJECT- PCX PROJECT TITLE-				DESIGN-TO-COST-FACTOR = 0.00				PAGE 1
ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS	198,953	272,733	271,534	191,498	94,521				1,029,239
	LABOR \$	2,964,401	4,043,722	4,045,855	2,853,319	1,408,343				15,335,660
	OVERHEAD \$	2,964,401	4,043,722	4,045,855	2,853,319	1,408,343				15,335,660
MFG.	HOURS	123	3,241	22,683	20,712					46,759
	LABOR \$	1,108	29,202	204,374	186,616					421,300
	OVERHEAD \$	1,662	43,804	306,563	279,924					631,953
TOOLING	HOURS	73	43,643	26,629						70,348
	LABOR \$	623	372,276	227,145						600,044
	OVERHEAD \$	935	558,416	340,719						900,070
Q&RA	HOURS	71,914	98,925	137,470	121,858	12,428				442,592
	LABOR \$	771,636	1,061,465	1,475,054	1,307,536	133,320				4,749,011
	OVERHEAD \$	1,157,456	1,592,199	2,212,583	1,961,306	199,980				7,123,524
TEST	HOURS	16,794	24,250	19,427	24,486					84,957
	LABOR \$	176,169	254,383	203,789	256,859					891,200
	OVERHEAD \$	264,254	381,577	305,684	385,290					1,336,805
OTHER	HOURS	36,926	56,134	53,622	30,478	22,814				199,974
	LABOR \$	664,668	1,010,412	965,196	548,604	410,652				3,599,532
	OVERHEAD \$	664,668	1,010,412	965,196	548,604	410,652				3,599,532
TOTAL	HOURS	324,783	498,926	531,365	389,032	129,760				1,873,866
	LABOR \$	4,578,605	6,791,460	7,121,413	5,152,934	1,952,335				25,596,747
	OVERHEAD \$	5,053,376	7,650,130	8,176,600	6,628,443	2,018,995				28,927,544
MATERIAL & SUBCON.		473,816	652,150	329,962	74,148	11,224				1,538,300
MATERIAL OVERHEAD		23,541	32,608	16,497	3,708	561				76,915
TRAVEL		12,782	21,951	23,631	16,557	9,262				84,183
OTHER		606,516	858,693	878,307	609,459	377,386				3,330,361
SUBTOTAL EST. COST		10,745,636	16,006,992	16,546,410	11,885,249	4,369,763				59,554,050
G & A EXPENSE		1,289,476	1,920,839	1,985,569	1,426,231	524,372				7,146,487
TOTAL EST. COST		12,035,112	17,927,831	18,531,979	13,311,480	4,894,135				66,700,537
FEE \$		962,808	1,434,226	1,482,558	1,084,918	391,530				5,336,040
GRAND TOTAL		12,997,920	19,362,057	20,014,537	14,396,398	5,285,665				72,036,577

DATE 19 NOV 77
WBS 1.4

PROJECT- PCX PROJECT
TITLE- PCX PROJECT

DESIGN-TO-COST-FACTOR = 0.00

PAGE 2

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS	198,953	272,733	271,534	191,498	94,521				1,029,239
LABOR \$	2,964,401	4,063,722	4,045,855	2,853,319	1,408,363				15,335,660
OVERHEAD \$	2,964,401	4,063,722	4,045,855	2,853,319	1,408,363				15,335,660
MFG. HOURS	123	3,241	22,683	20,712					46,759
LABOR \$	1,108	29,202	204,374	186,616					421,300
OVERHEAD \$	1,662	43,804	326,563	279,924					631,953
TOOLING HOURS	73	43,643	26,629						70,345
LABOR \$	623	372,276	227,145						600,044
OVERHEAD \$	935	558,416	340,719						900,070
Q&RA HOURS	71,914	98,925	137,470	121,858	12,425				442,592
LABOR \$	771,636	1,061,465	1,475,054	1,307,536	133,320				4,749,011
OVERHEAD \$	1,157,456	1,592,199	2,212,583	1,961,326	199,980				7,123,524
TEST HOURS	16,794	24,250	19,427	24,486					84,957
LABOR \$	176,169	254,383	203,789	256,859					891,200
OVERHEAD \$	264,254	381,577	305,684	385,290					1,336,805
OTHER HOURS	36,926	56,134	53,622	30,478	22,814				199,974
LABOR \$	664,668	1,011,412	965,196	548,604	410,652				3,599,532
OVERHEAD \$	664,668	1,011,412	965,196	548,604	410,652				3,599,532
TOTAL HOURS	324,783	498,926	531,365	389,232	129,760				1,873,866
LABOR \$	4,578,605	6,791,460	7,121,413	5,152,934	1,952,335				25,596,747
OVERHEAD \$	5,753,376	7,650,130	8,176,600	6,128,443	2,018,995				28,927,544
MATERIAL & SUBCON.	470,816	652,150	329,962	74,148	11,224				1,538,300
MATERIAL OVERHEAD	23,541	32,608	16,497	3,708	561				76,915
TRAVEL	12,782	21,951	23,631	16,557	9,262				84,183
OTHER	606,516	858,693	878,307	609,459	377,386				3,330,361
SUBTOTAL EST. COST	10,745,636	16,006,992	16,546,410	11,885,249	4,369,763				59,554,050
G & A EXPENSE	1,289,476	1,920,839	1,985,569	1,426,231	524,372				7,146,487
TOTAL EST. COST	12,035,112	17,927,831	18,531,979	13,311,480	4,894,135				66,700,537
GRAND TOTAL	12,035,112	17,927,831	18,531,979	13,311,480	4,894,135				66,700,537

DATE 19 NOV 77
NBS 1.9.1

PROJECT- PCX PROJECT
TITLE- PROJECT MANAGEMENT

DESIGN-TO-COST-FACTOR = 0.00

PAGE 3

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS	980	1,960	8,020	7,360	2,940				22,060
LABOR \$	14,602	29,204	131,918	109,664	43,806				328,694
OVERHEAD \$	14,602	29,204	131,918	109,664	43,806				328,694
MFG. HOURS									
LABOR \$									
OVERHEAD \$									
TOOLING HOURS									
LABOR \$									
OVERHEAD \$									
Q&RA HOURS	45,492	47,608	78,792	90,689	12,425				275,006
LABOR \$	488,129	511,833	845,439	973,093	133,320				2,950,814
OVERHEAD \$	732,194	766,250	1,268,159	1,459,640	199,980				4,426,223
TEST HOURS	490	490	490	17,890					19,360
LABOR \$	5,140	5,140	5,140	187,664					203,086
OVERHEAD \$	7,710	7,710	7,710	281,499					309,629
OTHER HOURS	30,458	47,138	44,590	24,598	21,050				167,834
LABOR \$	546,244	848,484	802,620	442,764	378,900				3,021,012
OVERHEAD \$	546,244	848,484	802,620	442,764	378,900				3,021,012
TOTAL HOURS	77,420	97,196	132,692	140,537	36,415				484,260
LABOR \$	1,756,115	1,393,661	1,784,617	1,713,187	556,026				6,503,606
OVERHEAD \$	1,312,750	1,651,648	2,209,907	2,293,567	622,686				8,080,558
MATERIAL & SUBCON.	9,015	9,140	19,400	20,976	11,224				69,755
MATERIAL OVERHEAD	451	458	980	1,049	561				3,499
TRAVEL	5,849	8,932	10,458	9,439	6,315				41,193
OTHER	28,759	41,042	54,934	60,757	33,239				218,731
SUBTOTAL EST. COST	2,402,939	3,114,901	4,080,696	4,098,975	1,230,051				14,917,562
G & A EXPENSE	288,352	372,588	489,483	491,878	147,605				1,790,106
TOTAL EST. COST	2,691,291	3,477,489	4,570,379	4,590,853	1,377,656				16,707,668
GRAND TOTAL	2,691,291	3,477,489	4,570,379	4,590,853	1,377,656				16,707,668

ORIGINAL PAGE IS
OF POOR QUALITY

DATE 19 NOV 77
WBS 1.4.1.1

PROJECT- PCX PROJECT
TITLE- COST CONTROL MANAGEMENT

DESIGN-TO-COST-FACTOR = C-00

PAGE 4

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS									
LABOR \$									
OVERHEAD \$									
MFG. HOURS									
LABOR \$									
OVERHEAD \$									
TOOLING HOURS									
LABOR \$									
OVERHEAD \$									
G&A HOURS									
LABOR \$									
OVERHEAD \$									
TEST HOURS									
LABOR \$									
OVERHEAD \$									
OTHER HOURS	3,312	4,410	4,410	4,410	3,312				19,854
LABOR \$	59,616	79,380	79,380	79,380	59,616				357,372
OVERHEAD \$	59,616	79,380	79,380	79,380	59,616				357,372
TOTAL HOURS	3,312	4,410	4,410	4,410	3,312				19,854
LABOR \$	59,616	79,380	79,380	79,380	59,616				357,372
OVERHEAD \$	59,616	79,380	79,380	79,380	59,616				357,372
MATERIAL & SUBCON.									
MATERIAL OVERHEAD									
TRAVEL	642	1,374	1,470	1,573	842				5,901
OTHER	19,100	26,450	28,298	30,284	25,044				129,176
SUBTOTAL EST. COST	138,974	186,584	188,528	190,617	145,118				849,821
G & A EXPENSE	16,677	22,390	22,623	22,874	17,414				101,978
TOTAL EST. COST	155,651	208,974	211,151	213,491	162,532				951,799
GRAND TOTAL	155,651	208,974	211,151	213,491	162,532				951,799

ORIGINAL PAGE IS
OF POOR QUALITY

DATE 19 NOV 77
WBS 1.4.1.2

PROJECT- PCX PROJECT
TITLE- LOGISTICS MANAGEMENT

DESIGN-TO-COST-FACTOR = 0.00

PAGE 5

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR- HOURS	980	1,960	1,960						4,900
LABOR \$	14,602	29,204	29,204						73,010
OVERHEAD \$	14,602	29,204	29,204						73,010
MFG- HOURS									
LABOR \$									
OVERHEAD \$									
TOOLING HOURS									
LABOR \$									
OVERHEAD \$									
Q&RA HOURS									
LABOR \$									
OVERHEAD \$									
TEST HOURS									
LABOR \$									
OVERHEAD \$									
OTHER HOURS	588	2,458	2,548	4,018	4,508				13,720
LABOR \$	10,584	37,444	45,864	72,324	81,144				246,960
OVERHEAD \$	10,584	37,444	45,864	72,324	81,144				246,960
TOTAL HOURS	1,568	4,418	4,508	4,018	4,508				18,420
LABOR \$	25,186	66,248	75,068	72,324	81,144				319,970
OVERHEAD \$	25,186	66,248	75,068	72,324	81,144				319,970
MATERIAL & SUBCON.									
MATERIAL OVERHEAD									
TRAVEL	321	687	735	787	921				2,951
OTHER									
SUBTOTAL EST. COST	50,693	133,183	150,871	145,435	162,709				642,891
G & A EXPENSE	6,383	15,982	18,105	17,452	19,525				77,447
TOTAL EST. COST	56,776	149,165	168,976	162,887	182,234				720,038
GRAND TOTAL	56,776	149,165	168,976	162,887	182,234				720,038

DATE 19 NOV 77
WBS 1.4.1.3

PROJECT- PCX PROJECT
TITLE- PROCUREMENT MANAGEMENT

DESIGN-TO-COST-FACTOR = C-00

PAGE 6

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS									
LABOR \$									
OVERHEAD \$									
MFG. HOURS									
LABOR \$									
OVERHEAD \$									
TOOLING HOURS									
LABOR \$									
OVERHEAD \$									
Q&RA HOURS									
LABOR \$									
OVERHEAD \$									
TEST HOURS									
LABOR \$									
OVERHEAD \$									
OTHER HOURS	490	4,900	4,900	4,410	4,410				19,110
LABOR \$	8,820	88,200	88,200	79,380	79,380				343,980
OVERHEAD \$	8,820	88,200	88,200	79,380	79,380				343,980
TOTAL HOURS	490	4,900	4,900	4,410	4,410				19,110
LABOR \$	8,820	88,200	88,200	79,380	79,380				343,980
OVERHEAD \$	8,820	88,200	88,200	79,380	79,380				343,980
MATERIAL & SUBCON.									
MATERIAL OVERHEAD									
TRAVEL	369	1,374	1,470	1,180	842				5,235
OTHER									
SUBTOTAL EST. COST	18,009	177,774	177,870	159,940	159,602				693,195
G & A EXPENSE	2,161	21,333	21,344	19,193	19,152				83,183
TOTAL EST. COST	20,170	199,107	199,214	179,133	178,754				776,378
GRAND TOTAL	20,170	199,107	199,214	179,133	178,754				776,378

DATE 19 NOV 77 WBS 1.4-1.4		PROJECT- PCX PROJECT TITLE- CONFIGURATION MANAGEMENT					DESIGN-TO-COST-FACTOR = 0.08			PAGE 7
ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS			3,920	3,920	2,940				10,780
	LABOR \$			58,408	58,408	43,806				160,622
	OVERHEAD \$			58,408	58,408	43,806				160,622
MFG.	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOOLING	HOURS									
	LABOR \$									
	OVERHEAD \$									
Q&RA	HOURS			990	990					980
	LABOR \$			5,258	5,258					10,516
	OVERHEAD \$			7,887	7,887					15,774
TEST	HOURS									
	LABOR \$									
	OVERHEAD \$									
OTHER	HOURS	1,470	1,960	1,960	1,960	1,470				8,820
	LABOR \$	26,460	35,280	35,280	35,280	26,460				158,760
	OVERHEAD \$	26,460	35,280	35,280	35,280	26,460				158,760
TOTAL	HOURS	1,470	1,960	6,370	6,370	4,410				20,580
	LABOR \$	26,460	35,280	98,946	98,946	70,266				329,898
	OVERHEAD \$	26,460	35,280	101,575	101,575	70,266				335,156
MATERIAL & SUBCON.										
MATERIAL OVERHEAD										
TRAVEL										
		963	1,374	1,470	1,573	1,263				6,643
OTHER										
		9,659	14,592	26,636	28,506	8,195				87,588
SUBTOTAL EST. COST		63,542	86,526	228,627	230,600	149,990				759,285
G & A EXPENSE		7,625	10,383	27,435	27,672	17,999				91,114
TOTAL EST. COST		71,167	96,909	256,062	258,272	167,989				850,399
GRAND TOTAL		71,167	96,909	256,062	258,272	167,989				850,399

DATE 19 NOV 77
WBS 1.4.1.5

PROJECT- PCX PROJECT
TITLE- INFORMATION MANAGEMENT

DESIGN-TO-COST-FACTOR = 0.00

PAGE 8

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS									
LABOR \$									
OVERHEAD \$									
MFG. HOURS									
LABOR \$									
OVERHEAD \$									
TOOLING HOURS									
LABOR \$									
OVERHEAD \$									
MGRA HOURS									
LABOR \$									
OVERHEAD \$									
TEST HOURS									
LABOR \$									
OVERHEAD \$									
OTHER HOURS	1,960		3,920	3,920	2,940				12,740
LABOR \$	35,280		70,560	70,560	52,920				229,320
OVERHEAD \$	35,280		70,560	70,560	52,920				229,320
TOTAL HOURS	1,960		3,920	3,920	2,940				12,740
LABOR \$	35,280		70,560	70,560	52,920				229,320
OVERHEAD \$	35,280		70,560	70,560	52,920				229,320
MATERIAL & SUBCON.									
MATERIAL OVERHEAD									
TRAVEL	344		368	393	421				1,526
OTHER									
SUBTOTAL EST. COST	70,904		141,488	141,513	106,261				460,166
G & A EXPENSE	8,508		16,979	16,982	12,751				55,220
TOTAL EST. COST	79,412		158,467	158,495	119,012				515,386
GRAND TOTAL	79,412		158,467	158,495	119,012				515,386

DATE 19 NOV 77 WBS 1.4.1.6		PROJECT- PCX PROJECT TITLE- QUALITY AND REL MANAGEMENT					DESIGN-TO-COST-FACTOR = 0.00			PAGE 9
ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS									
	LABOR \$									
	OVERHEAD \$									
MFG.	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOOLING	HOURS									
	LABOR \$									
	OVERHEAD \$									
Q&RA	HOURS	42,140	37,028	65,260	40,510	9,000				203,540
	LABOR \$	452,142	425,094	700,326	520,512	105,154				2,104,048
	OVERHEAD \$	678,243	608,841	1,050,489	780,768	157,731				3,276,072
TEST	HOURS	490	490	490	490					1,960
	LABOR \$	5,140	5,140	5,140	5,140					20,560
	OVERHEAD \$	7,710	7,710	7,710	7,710					30,840
OTHER	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOTAL	HOURS	42,630	38,318	65,750	49,000	9,000				205,600
	LABOR \$	457,302	411,234	705,466	525,652	105,154				2,204,408
	OVERHEAD \$	685,953	616,551	1,058,199	788,478	157,731				3,306,912
MATERIAL & SUBCON.		2,140	9,160	19,600	20,976	11,224				63,100
MATERIAL OVERHEAD		107	458	980	1,049	561				3,155
TRAVEL		1,926	2,061	2,940	2,360	1,684				10,971
OTHER										
SUBTOTAL EST. COST		1,147,420	1,039,264	1,787,105	1,338,515	276,354				5,588,746
G & A EXPENSE		137,691	124,712	214,462	160,622	33,162				670,649
TOTAL EST. COST		1,285,119	1,163,976	2,001,647	1,499,137	309,516				6,259,395
GRAND TOTAL		1,285,119	1,163,976	2,001,647	1,499,137	309,516				6,259,395

DATE 19 NOV 77
WBS 1.4.1.7

PROJECT- PCX PROJECT
TITLE- SAFETY MANAGEMENT

DESIGN-TO-COST-FACTOR = 0.00

PAGE 10

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS									
LABOR \$									
OVERHEAD \$									
MFG. HOURS									
LABOR \$									
OVERHEAD \$									
TOOLING HOURS									
LABOR \$									
OVERHEAD \$									
Q&RA HOURS									
LABOR \$									
OVERHEAD \$									
TEST HOURS									
LABOR \$									
OVERHEAD \$									
OTHER HOURS	18,228	27,930	20,972						67,130
LABOR \$	328,164	512,740	377,496						1,208,340
OVERHEAD \$	328,164	512,740	377,496						1,208,340
TOTAL HOURS	18,228	27,930	20,972						67,130
LABOR \$	328,164	512,740	377,496						1,208,340
OVERHEAD \$	328,164	512,740	377,496						1,208,340
MATERIAL & SUBCON.									
MATERIAL OVERHEAD									
TRAVEL	642	1,031	735						2,408
OTHER									
SUBTOTAL EST. COST	656,850	1,036,511	755,727						2,419,088
G & A EXPENSE	78,822	120,781	90,687						290,290
TOTAL EST. COST	735,672	1,127,292	846,414						2,709,378
GRAND TOTAL	735,672	1,127,292	846,414						2,709,378

DATE 19 NOV 77
WBS 1.4.1.8

PROJECT- PCX PROJECT
TITLE- PROJECT DIRECTION

DESIGN-TO-COST-FACTOR = 0.00

PAGE 11

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS									
LABOR \$									
OVERHEAD \$									
MFG. HOURS									
LABOR \$									
OVERHEAD \$									
TOOLING HOURS									
LABOR \$									
OVERHEAD \$									
Q&RA HOURS									
LABOR \$									
OVERHEAD \$									
TEST HOURS									
LABOR \$									
OVERHEAD \$									
OTHER HOURS	4,410	5,880	5,880	5,880	4,410				26,460
LABOR \$	79,380	105,840	105,840	105,840	79,380				476,280
OVERHEAD \$	79,380	105,840	105,840	105,840	79,380				476,280
TOTAL HOURS	4,410	5,880	5,880	5,880	4,410				26,460
LABOR \$	79,380	105,840	105,840	105,840	79,380				476,280
OVERHEAD \$	79,380	105,840	105,840	105,840	79,380				476,280
MATERIAL & SUBCON.									
MATERIAL OVERHEAD									
TRAVEL	321	487	735	393					2,136
OTHER									
SUBTOTAL EST. COST	159,081	212,367	212,415	212,073	158,760				954,696
G & A EXPENSE	19,090	25,484	25,492	25,449	19,351				114,866
TOTAL EST. COST	178,171	237,851	237,905	237,522	177,811				1,069,260
GRAND TOTAL	178,171	237,851	237,905	237,522	177,811				1,069,260

DATE 19 NOV 77
WBS 1.4.1.9

PROJECT- PCX PROJECT
TITLE- CHECKOUT

DESIGN-TO-COST-FACTOR = 0.00

PAGE 12

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS			2,940	3,440					6,380
LABOR \$			43,806	51,256					95,062
OVERHEAD \$			43,806	51,256					95,062
MFG. HOURS									
LABOR \$									
OVERHEAD \$									
TOOLING HOURS									
LABOR \$									
OVERHEAD \$									
Q&RA HOURS	3,352	9,780	13,034	41,689	2,625				70,480
LABOR \$	35,967	124,939	139,855	447,323	28,166				756,250
OVERHEAD \$	53,951	157,409	239,783	670,985	42,249				1,137,377
TEST HOURS				17,400					17,400
LABOR \$				182,526					182,526
OVERHEAD \$				273,789					273,789
OTHER HOURS									
LABOR \$									
OVERHEAD \$									
TOTAL HOURS	3,352	9,780	15,974	62,529	2,625				94,260
LABOR \$	35,967	124,939	183,661	681,105	28,166				1,033,838
OVERHEAD \$	53,951	157,409	253,569	946,030	42,249				1,503,228
MATERIAL & SUBCON.	6,875								6,875
MATERIAL OVERHEAD	344								344
TRAVEL	321	344	735	1,180	842				3,422
OTHER				1,967					1,967
SUBTOTAL EST. COST	97,458	262,692	437,985	1,680,282	71,257				2,549,674
G & A EXPENSE	11,695	31,523	52,558	201,634	8,551				305,961
TOTAL EST. COST	109,153	294,215	490,543	1,881,916	79,808				2,855,635
GRAND TOTAL	109,153	294,215	490,543	1,881,916	79,808				2,855,635

DATE 19 NOV 77 WBS 1.4.2		PROJECT- PCX PROJECT TITLE- SYSTEM ENGINEERING					DESIGN-TO-COST-FACTOR = 0.00			PAGE 13
ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS	148,396	227,288	199,265	153,490	79,116				787,555
	LABOR \$	2,211,101	3,088,591	2,969,048	2,287,001	1,178,828				11,734,569
	OVERHEAD \$	2,211,101	3,088,591	2,969,048	2,287,001	1,178,828				11,734,569
MFG.	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOOLING	HOURS									
	LABOR \$									
	OVERHEAD \$									
Q&RA	HOURS	25,480	45,080	50,960	22,540					144,060
	LABOR \$	273,400	483,708	546,801	241,854					1,545,763
	OVERHEAD \$	410,100	725,562	820,202	362,781					2,318,645
TEST	HOURS	15,324	18,416	15,347	3,668					52,155
	LABOR \$	160,749	193,184	160,990	32,184					547,107
	OVERHEAD \$	241,124	289,777	241,485	48,277					820,663
OTHER	HOURS	6,076	8,604	8,640	5,880	1,764				30,964
	LABOR \$	109,368	154,872	155,520	105,840	31,752				557,352
	OVERHEAD \$	109,368	154,872	155,520	105,840	31,752				557,352
TOTAL	HOURS	195,276	279,388	274,212	184,978	86,880				1,014,734
	LABOR \$	2,754,618	3,920,355	3,832,359	2,666,879	1,210,580				14,384,791
	OVERHEAD \$	2,971,693	4,258,802	4,186,255	2,803,899	1,210,580				15,431,229
MATERIAL & SUBCON.		320,198	141,408	64,006						525,612
MATERIAL OVERHEAD		16,010	7,071	3,200						26,281
TRAVEL		5,184	9,447	9,151	4,975	2,105				30,862
OTHER		457,849	687,841	716,172	463,998	275,750				2,601,610
SUBTOTAL EST. COST		6,525,552	9,024,924	8,811,143	5,939,751	2,699,015				33,000,385
G & A EXPENSE		783,066	1,082,991	1,057,337	712,770	323,082				3,960,046
TOTAL EST. COST		7,308,618	10,107,915	9,868,480	6,652,521	3,022,097				36,960,431
GRAND TOTAL		7,308,618	10,107,915	9,868,480	6,652,521	3,022,097				36,960,431

DATE 19 NOV 77
WBS 1.4.2.1

PROJECT- PCX PROJECT
TITLE- INTEGRATION WITH SHUTTLE

DESIGN-TO-COST-FACTOR = 0.00

PAGE 14

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS	25,284	33,717	28,138	21,640	10,528				119,307
LABOR \$	376,732	522,383	419,256	322,436	156,867				1,777,674
OVERHEAD \$	376,732	522,383	419,256	322,436	156,867				1,777,674
MFG. HOURS									
LABOR \$									
OVERHEAD \$									
TOOLING HOURS									
LABOR \$									
OVERHEAD \$									
Q&RA HOURS									
LABOR \$									
OVERHEAD \$									
TEST HOURS	9,637	11,104	9,254	1,850					31,845
LABOR \$	131,092	116,481	97,874	19,407					334,054
OVERHEAD \$	151,638	174,722	145,611	29,111					501,082
OTHER HOURS	698	1,143	1,161	600	180				3,782
LABOR \$	12,564	20,574	20,898	10,800	3,240				68,076
OVERHEAD \$	12,564	20,574	20,898	10,800	3,240				68,076
TOTAL HOURS	35,619	45,964	38,553	24,090	10,708				154,934
LABOR \$	490,388	639,438	537,228	352,643	160,107				2,179,804
OVERHEAD \$	540,934	697,679	585,765	362,347	160,107				2,346,832
MATERIAL & SUBCON.	212,342	93,776	42,446						348,564
MATERIAL OVERHEAD	10,617	4,689	2,122						17,428
TRAVEL	3,338	4,466	3,822	2,714	1,263				15,603
OTHER	68,266	150,554	103,978	68,880	41,894				383,572
SUBTOTAL EST. COST	1,325,885	1,590,602	1,275,361	786,584	363,371				5,291,803
G & A EXPENSE	159,106	184,872	153,043	94,390	43,605				635,016
TOTAL EST. COST	1,484,991	1,725,474	1,428,404	880,974	406,976				5,926,819
GRAND TOTAL	1,484,991	1,725,474	1,428,404	880,974	406,976				5,926,819

DATE 19 NOV 77
WBS 1.4.2.2

PROJECT- PCX PROJECT
TITLE- ANALYSIS AND INTEGRATION

DESIGN-TO-COST-FACTOR = 0.00

PAGE 15

ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS	123,112	173,571	171,127	131,850	68,588				668,248
	LABOR \$	1,834,369	2,586,208	2,549,792	1,964,565	1,021,941				9,956,895
	OVERHEAD \$	1,834,369	2,586,208	2,549,792	1,964,565	1,021,941				9,956,895
MFG.	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOOLING	HOURS									
	LABOR \$									
	OVERHEAD \$									
Q&RA	HOURS	25,480	45,080	50,960	22,540					144,060
	LABOR \$	273,400	483,708	546,801	241,854					1,545,763
	OVERHEAD \$	410,100	725,562	820,202	362,781					2,318,645
TEST	HOURS	5,687	7,312	6,093	1,218					20,310
	LABOR \$	59,657	76,703	63,916	12,777					213,053
	OVERHEAD \$	89,486	115,055	95,874	19,166					319,581
OTHER	HOURS	5,378	7,461	7,479	5,280	1,584				27,182
	LABOR \$	96,804	134,298	134,622	95,040	28,512				489,276
	OVERHEAD \$	96,804	134,298	134,622	95,040	28,512				489,276
TOTAL	HOURS	159,657	233,424	235,659	160,888	70,172				859,800
	LABOR \$	2,264,230	3,280,917	3,295,131	2,314,236	1,050,473				12,204,967
	OVERHEAD \$	2,430,759	3,561,123	3,600,490	2,441,552	1,050,473				13,084,397
MATERIAL & SUBCON.		107,856	47,632	21,560						177,048
MATERIAL OVERHEAD		5,393	2,382	1,078						8,853
TRAVEL		1,846	4,981	5,329	2,261	842				15,259
OTHER		389,583	587,287	612,194	395,118	233,856				2,218,038
SUBTOTAL EST. COST		5,199,667	7,484,322	7,535,782	5,153,167	2,335,644				27,708,682
G & A EXPENSE		623,960	898,119	904,294	618,380	280,277				3,325,030
TOTAL EST. COST		5,823,627	8,382,441	8,440,076	5,771,547	2,615,921				31,033,712
GRAND TOTAL		5,823,627	8,382,441	8,440,076	5,771,547	2,615,921				31,033,712

DATE 19 NOV 77
NBS 1.4.3

PROJECT- PCX PROJECT
TITLE- PCX VEHICLE

DESIGN-TO-COST-FACTOR = 0.00

PAGE 14

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS	49,577	63,485	63,449	33,648	12,465				219,624
LABOR \$	738,698	945,927	945,389	456,654	185,729				3,272,397
OVERHEAD \$	738,698	945,927	945,389	456,654	185,729				3,272,397
MFG. HOURS	123	3,241	22,683	20,712					46,759
LABOR \$	1,108	29,252	224,374	186,616					421,300
OVERHEAD \$	1,662	43,804	306,563	279,924					631,953
TOOLING HOURS	73	43,643	26,629						70,345
LABOR \$	623	372,276	227,145						600,044
OVERHEAD \$	935	558,416	340,719						900,070
Q&RA HOURS	942	6,237	7,718	8,629					23,526
LABOR \$	10,137	66,924	82,814	92,589					252,434
OVERHEAD \$	15,162	100,387	124,222	138,885					378,656
TEST HOURS	980	5,344	3,590	3,528					13,442
LABOR \$	10,280	56,159	37,659	37,009					141,007
OVERHEAD \$	15,420	84,190	56,489	55,514					211,513
OTHER HOURS	392	392	392						1,176
LABOR \$	7,056	7,056	7,056						21,168
OVERHEAD \$	7,056	7,056	7,056						21,168
TOTAL HOURS	57,587	122,342	124,461	63,517	12,465				374,872
LABOR \$	767,872	1,477,444	1,504,437	772,868	185,729				4,708,350
OVERHEAD \$	778,933	1,739,680	1,780,438	930,977	185,729				5,415,757
MATERIAL & SUBCON.	141,603	511,582	246,356	53,172					942,713
MATERIAL OVERHEAD	7,080	25,279	12,317	2,659					47,135
TRAVEL	1,749	3,572	3,822	2,143	842				12,120
OTHER	119,908	129,810	107,201	84,704	68,397				510,020
SUBTOTAL EST. COST	1,817,145	3,877,167	3,654,571	1,846,523	440,697				11,636,103
G & A EXPENSE	218,058	465,260	438,549	221,583	52,885				1,396,335
TOTAL EST. COST	2,035,203	4,342,427	4,093,120	2,068,106	493,582				13,032,438
GRAND TOTAL	2,035,203	4,342,427	4,093,120	2,068,106	493,582				13,032,438

DATE 19 NOV 77 WBS 1.4.3.1		PROJECT- PCX PROJECT TITLE- STRUCTURAL SYSTEM		DESIGN-TO-COST-FACTOR = 0.00						PAGE 17
ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS	49,577	63,485	63,449	30,648	12,465				219,624
	LABOR \$	738,698	945,927	945,389	456,654	185,729				3,272,397
	OVERHEAD \$	738,698	945,927	945,389	456,654	185,729				3,272,397
MFG.	HOURS	123	3,241	22,683	20,712					46,759
	LABOR \$	1,108	29,202	204,374	186,616					421,300
	OVERHEAD \$	1,662	43,804	326,563	279,924					631,933
TOOLING	HOURS	73	43,643	26,629						70,345
	LABOR \$	623	372,276	227,145						600,044
	OVERHEAD \$	935	558,416	340,719						900,070
Q&RA	HOURS	942	6,237	7,718	8,629					23,524
	LABOR \$	10,107	66,924	82,814	92,589					252,434
	OVERHEAD \$	15,162	122,387	124,222	138,885					378,656
TEST	HOURS	980	5,344	3,590	3,528					13,442
	LABOR \$	10,280	56,559	37,659	37,009					141,007
	OVERHEAD \$	15,420	84,690	56,489	55,514					211,513
OTHER	HOURS	392	392	392						1,176
	LABOR \$	7,056	7,056	7,056						21,168
	OVERHEAD \$	7,056	7,056	7,056						21,168
TOTAL	HOURS	52,087	122,342	124,461	63,517	12,465				374,872
	LABOR \$	767,872	1,477,444	1,504,437	772,868	185,729				4,708,350
	OVERHEAD \$	778,933	1,739,680	1,780,438	930,977	185,729				5,415,757
MATERIAL & SUBCON.		141,603	501,582	246,356	53,172					942,713
MATERIAL OVERHEAD		7,080	25,279	12,317	2,659					47,135
TRAVEL		1,749	3,572	3,822	2,143	842				12,128
OTHER		119,908	129,810	107,201	84,704	68,397				510,020
SUBTOTAL EST. COST		1,817,145	3,877,167	3,654,571	1,846,523	440,697				11,636,103
G & A EXPENSE		218,058	465,260	438,549	221,583	52,885				1,396,335
TOTAL EST. COST		2,035,203	4,342,427	4,093,120	2,068,106	493,582				13,032,438
GRAND TOTAL		2,035,203	4,342,427	4,093,120	2,068,106	493,582				13,032,438

DATE 19 NOV 77
WBS 1.4.3.1.1

PROJECT- PCX PROJECT
TITLE- PROPELLANT TANKS

DESIGN-TO-COST-FACTOR = 0.00

PAGE 10

ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS	10,547	12,270	11,096	9,016	1,568				40,297
	LABOR \$	157,150	182,823	177,250	59,838	23,363				400,424
	OVERHEAD \$	157,150	182,823	177,250	59,838	23,363				400,424
MFG.	HOURS		560	9,023	9,162					18,745
	LABOR \$		5,546	81,297	82,550					168,893
	OVERHEAD \$		7,569	121,946	123,825					253,340
TOOLING	HOURS		9,674	6,216						15,890
	LABOR \$		82,519	53,022						135,541
	OVERHEAD \$		123,779	79,533						203,312
Q&RA	HOURS	478	1,435	3,636	4,018					9,567
	LABOR \$	5,129	15,398	39,014	43,113					102,654
	OVERHEAD \$	7,694	23,597	58,521	64,670					153,982
TEST	HOURS		1,194	3,590	3,528					8,312
	LABOR \$		12,525	37,659	37,009					87,193
	OVERHEAD \$		18,788	56,489	55,514					130,791
OTHER	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOTAL	HOURS	11,025	25,133	34,361	20,724	1,568				92,811
	LABOR \$	162,279	298,311	388,242	222,510	23,363				1,094,705
	OVERHEAD \$	164,844	356,656	493,739	353,847	23,363				1,341,849
MATERIAL & SUBCON.		683	292,322	164,943						457,948
MATERIAL OVERHEAD		34	14,616	8,247						22,897
TRAVEL										
OTHER		23,818	31,705	26,534	27,872	22,813				132,742
SUBTOTAL EST. COST		351,650	993,610	1,081,705	554,229	69,639				3,050,141
G & A EXPENSE		42,199	119,161	129,805	66,507	8,345				366,017
TOTAL EST. COST		393,857	1,112,771	1,211,510	620,736	77,884				3,416,158
GRAND TOTAL		393,857	1,112,771	1,211,510	620,736	77,884				3,416,158

DATE 19 NOV 77
WBS 1.9.3.1.2

PROJECT- PCX PROJECT
TITLE- THRUST STRUCTURE

DESIGN-TO-COST-FACTOR = 0.00

PAGE 19

ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS	8,663	7,255	6,762	2,719	1,369				28,768
	LABOR \$	129,079	118,100	100,754	40,513	20,398				398,844
	OVERHEAD \$	129,079	118,100	100,754	40,513	20,398				398,844
MFG.	HOURS		174	2,809	2,853					5,836
	LABOR \$		1,568	25,309	25,706					52,583
	OVERHEAD \$		2,352	37,964	38,559					78,875
TOOLING	HOURS		1,567	1,009						2,576
	LABOR \$		13,367	8,607						21,974
	OVERHEAD \$		20,051	12,911						32,962
Q&RA	HOURS	199	598	1,515	1,675					3,987
	LABOR \$	2,135	6,417	16,256	17,973					42,781
	OVERHEAD \$	3,203	9,626	24,384	26,960					64,173
TEST	HOURS		186							186
	LABOR \$		1,951							1,951
	OVERHEAD \$		2,927							2,927
OTHER	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOTAL	HOURS	8,862	9,780	12,095	7,247	1,369				39,363
	LABOR \$	131,214	131,403	150,926	84,192	20,398				518,133
	OVERHEAD \$	132,282	143,656	176,013	106,032	20,398				577,781
MATERIAL & SUBCON.		47,348	44,097	11,547	8,556					111,548
MATERIAL OVERHEAD		2,367	2,205	577	428					5,577
TRAVEL										
OTHER		16,146	21,606	18,485	19,783	15,826				91,846
SUBTOTAL EST. COST		329,357	342,367	357,548	218,991	56,622				1,304,885
G & A EXPENSE		39,523	41,084	42,906	26,279	6,795				156,587
TOTAL EST. COST		368,880	383,451	400,454	245,270	63,417				1,461,472
GRAND TOTAL		368,880	383,451	400,454	245,270	63,417				1,461,472

DATE 19 NOV 77
WBS 1.4.3.1.3

PROJECT- PCX PROJECT
TITLE- MAIN SHELL

DESIGN-TO-COST-FACTOR = 0.00

PAGE 20

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS	9,373	11,740	11,348	5,106	1,640				39,207
LABOR \$	139,658	174,926	169,085	76,079	24,436				584,184
OVERHEAD \$	139,658	174,926	169,085	76,079	24,436				584,184
MFG. HOURS		413	6,663	6,766					13,842
LABOR \$		3,721	60,034	60,962					124,717
OVERHEAD \$		5,582	90,051	91,443					187,076
TOOLING HOURS		8,420	5,423						13,843
LABOR \$		71,823	46,258						118,081
OVERHEAD \$		107,735	69,387						177,122
Q&RA HOURS	265	794	2,012	2,233					5,304
LABOR \$	2,843	8,520	21,589	23,960					56,912
OVERHEAD \$	4,265	12,780	32,384	35,940					85,369
TEST HOURS		1,122							1,122
LABOR \$		11,770							11,770
OVERHEAD \$		17,655							17,655
OTHER HOURS									
LABOR \$									
OVERHEAD \$									
TOTAL HOURS	9,638	22,489	25,446	14,105	1,640				73,318
LABOR \$	142,501	270,760	296,966	161,001	24,436				895,664
OVERHEAD \$	143,923	318,678	360,907	203,462	24,436				1,051,406
MATERIAL & SUBCON.	42,494	91,085	23,799	24,811					182,189
MATERIAL OVERHEAD	2,125	4,554	1,190	1,241					9,110
TRAVEL									
OTHER	20,159	26,965	23,079	24,699	19,824				114,726
SUBTOTAL EST. COST	351,202	712,542	705,941	415,214	68,696				2,253,095
G & A EXPENSE	42,144	85,445	84,713	49,826	8,244				270,372
TOTAL EST. COST	393,346	797,487	790,654	465,040	76,940				2,523,467
GRAND TOTAL	393,346	797,487	790,654	465,040	76,940				2,523,467

DATE 19 NOV 77 WBS 1.9.3.1.4		PROJECT- PCX PROJECT TITLE- ORBITER INTERFACE STRUCTURES					DESIGN-TO-COST-FACTOR = 0.00			PAGE 21
ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS	3,962	6,894	4,038	2,008	612				17,514
	LABOR \$	59,034	102,721	60,166	29,919	9,119				240,959
	OVERHEAD \$	59,034	102,721	60,166	29,919	9,119				240,959
MFG.	HOURS		118	2,181	1,931					4,230
	LABOR \$		1,663	19,651	17,398					38,112
	OVERHEAD \$		1,595	29,477	26,097					57,169
TOOLING	HOURS		21,624	13,927						35,551
	LABOR \$		184,453	118,797						303,250
	OVERHEAD \$		276,680	178,196						454,876
Q&RA	HOURS		3,410	312						3,722
	LABOR \$		36,589	3,348						39,937
	OVERHEAD \$		54,884	5,022						59,906
TEST	HOURS		2,842							2,842
	LABOR \$		29,813							29,813
	OVERHEAD \$		44,720							44,720
OTHER	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOTAL	HOURS	3,962	34,888	20,458	3,939	612				63,859
	LABOR \$	59,034	354,639	201,962	47,317	9,119				672,071
	OVERHEAD \$	59,034	480,600	272,861	56,016	9,119				877,630
MATERIAL & SUBCON.		18,380	39,124	35,524	19,362					112,390
MATERIAL OVERHEAD		919	1,956	1,776	968					5,619
TRAVEL										
OTHER		5,040	6,733	5,770	6,175	4,967				28,685
SUBTOTAL EST. COST		142,407	883,052	517,893	129,838	23,205				1,696,395
G & A EXPENSE		17,089	105,966	62,147	15,581	2,785				203,568
TOTAL EST. COST		159,496	989,018	580,040	145,419	25,990				1,899,963
GRAND TOTAL		159,496	989,018	580,040	145,419	25,990				1,899,963

DATE 19 NOV 77
WBS 1.4.3.1.5

PROJECT- PCX PROJECT
TITLE- MICROMETEOROID PROTECTION

DESIGN-TO-COST-FACTOR = 0.00

PAGE 22

ELEMENTS OF COST		FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR.	HOURS	2,215	1,847	2,299	490	392				7,243
	LABOR \$	33,604	27,520	34,255	7,301	5,841				107,921
	OVERHEAD \$	33,004	27,520	34,255	7,301	5,841				107,921
MFG.	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOOLING	HOURS									
	LABOR \$									
	OVERHEAD \$									
Q&RA	HOURS									
	LABOR \$									
	OVERHEAD \$									
TEST	HOURS	980								980
	LABOR \$	10,280								10,280
	OVERHEAD \$	15,420								15,420
OTHER	HOURS									
	LABOR \$									
	OVERHEAD \$									
TOTAL	HOURS	3,195	1,847	2,299	490	392				8,223
	LABOR \$	43,284	27,520	34,255	7,301	5,841				118,201
	OVERHEAD \$	48,424	27,520	34,255	7,301	5,841				123,341
MATERIAL & SUBCON.		5,499	4,936	4,961						15,396
MATERIAL OVERHEAD		275	247	248						770
TRAVEL										
OTHER		24,250	6,733	5,770	6,175	4,967				47,895
SUBTOTAL EST. COST		121,732	66,956	79,489	20,777	16,449				305,403
G & A EXPENSE		14,608	8,035	9,539	2,493	1,998				36,673
TOTAL EST. COST		136,340	74,991	89,028	23,270	18,447				342,076
GRAND TOTAL		136,340	74,991	89,028	23,270	18,447				342,076

DATE 19 NOV 77
RBS 1,4,3,1,6

PROJECT- PCX PROJECT
TITLE- INTEGRATION

DESIGN-TO-COST-FACTOR = 0.00

PAGE 23

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88	TOTAL
ENGR. HOURS	14,817	23,479	27,186	16,309	6,884				88,595
LABOR \$	220,773	349,837	403,879	243,004	102,572				1,320,065
OVERHEAD \$	220,773	349,837	403,879	243,004	102,572				1,320,065
MFG. HOURS	123	1,976	2,007						4,106
LABOR \$	1,108	17,804	18,083						36,995
OVERHEAD \$	1,662	26,736	27,125						55,493
TOOLING HOURS	73	2,358	54						2,485
LABOR \$	623	23,114	461						21,198
OVERHEAD \$	935	30,171	692						31,798
Q&RA HOURS			243	703					946
LABOR \$			2,607	7,543					10,150
OVERHEAD \$			3,911	11,315					15,226
TEST HOURS									
LABOR \$									
OVERHEAD \$									
OTHER HOURS	392	392	392						1,176
LABOR \$	7,056	7,056	7,056						21,168
OVERHEAD \$	7,056	7,056	7,056						21,168
TOTAL HOURS	15,405	28,205	29,802	17,012	6,884				97,308
LABOR \$	229,560	394,811	432,086	250,547	102,572				1,409,576
OVERHEAD \$	230,426	413,770	442,663	254,319	102,572				1,443,750
MATERIAL & SUBCON.	27,199	30,518	5,582	443					63,242
MATERIAL OVERHEAD	1,360	1,501	279	22					3,162
TRAVEL	1,749	3,572	3,822	2,143	842				12,128
OTHER	30,495	36,648	27,563						94,706
SUBTOTAL EST. COST	520,789	679,740	911,995	507,474	205,986				3,025,984
G & A EXPENSE	62,495	105,569	109,439	60,897	24,718				363,118
TOTAL EST. COST	583,284	785,309	1,021,434	568,371	230,704				3,389,102
GRAND TOTAL	583,284	785,309	1,021,434	568,371	230,704				3,389,102

ORIGINAL PAGE IS
OF POOR QUALITY

ORIGINAL PAGE IS
OF POOR QUALITY

DATE 19 NOV 77
WBS 1

PROJECT- PCX PROJECT
TITLE-

DESIGN-TO-COST-FACTOR = 0.00

PAGE 1

ESCALATION RATES

ELEMENTS OF COST	FY - 81	FY - 82	FY - 83	FY - 84	FY - 85	FY - 86	FY - 87	FY - 88
MATERIAL & SUBCON.	•000	•000	•000	•000	•000	•000	•000	•000
TRAVEL	•000	•000	•000	•000	•000	•000	•000	•000
OTHER	•000	•000	•000	•000	•000	•000	•000	•000

APPENDIX C

ERROR MESSAGES

52
PAGE INTENTIONALLY BLANK

ERROR MESSAGES

<u>Error Code</u>	<u>Reason for Error</u>	<u>Correction</u>
01	Invalid Transaction Type	Transaction Type Code must be a 10, 20, 30, 40 or 50.
02	Invalid Activity Code	Activity code on 20 card must be ENG, MFG, TLG, QRA, TST, OTH, MAT or GA.
03	Invalid Rate	Labor rate on 20 card must be numeric 99v99 (i.e., 12.50).
04	Invalid Overhead Rate	Overhead rate on 20 card must be numeric 999v9 (i.e., 130.0).
05	Invalid Fiscal Year	Fiscal year on 50 card must be numeric 2 digit (i.e., '77', '78' etc.).
06	Invalid WBS Number	WBS number on 40 & 50 card must be numeric with decimals (i.e. 1.5.2).
07	Invalid - Must be Numeric	Hours for each category on 50 card must be numeric.
08	Invalid Year	Years on 10 card must be numeric 4 digits(i.e. 1977, 1978, ect.)
09	Invalid WBS Title	Title must be present.
10	Invalid Category	Category on 30 card must be MAT, TRV or ODR.
11	Invalid Percentage Factor	Percentage factor on 30 card must be numeric numeric v999 (i.e., 0.020)
12	Invalid Fee Percentage	Contractor Fee % on 10 card must be numeric 2 digit.
13	Invalid D-T-C Factor	Design to cost factor on 10 card must be numeric 3 digits maximum. ex: 105 is 5% increase, 095 is 5% decrease.

<u>Error Code</u>	<u>Reason for Error</u>	<u>Correction</u>
14	More-than-1-Type 10 Card	Only one 10 card allowed.
15	Excessive Type 20 Card	Only eight type 20 cards allowed.
16	Duplicate Act Code on 20 Card	An Activity code can only be used once on 20 card.
17	Duplicate Act code on 30 Card	An Activity code can only be used once on 30 card.
18	Duplicate WBS Number	Duplicate WBS # with same FY are not allowed.
19	FY on 50 card out of range	Fiscal year on 50 card does not match years on 10 card.

APPENDIX D

SENSITIVE RUN PROCEDURE

PRECEDING PAGE BLANK NOT FILMED

56
PAGE INTENTIONALLY BLANK

PROCEDURES FOR PROCESSING SENSITIVE SEB JOBS BY COMPUTER SERVICES OFFICE

PURPOSE

The following paragraphs establish responsibilities and outline procedures for punching of input data and receipt, scheduling, processing, control and disposition of computer jobs, program card decks, and printed materials which pertain to sensitive SEB information processed through the Computer Services Office.

INPUT

Input data will be punched and controlled by the requesting activity.

SCHEDULING COMPUTER TIME

The office requiring sensitive computer runs must contact Mr. C. L. Cozelos, AH23, 453-3347, or Mr. J. T. Felder, AH21, 453-3341. An approximate "Start Time" will be agreed upon for starting the sensitive run. In the event that there is a priority problem, the requesting activity will contact Mr. Clayton McGee, or Mr. John D. Gibbons, AH32, 453-4181, for establishment of priority and definite "Start Time."

DELIVERY TO COMPUTER

The requester will be responsible for the delivery of all necessary program decks, data, and any other material required for processing of sensitive material to the U-9300 remote terminal in Building 4610, Room 303. The requester is to remain at the remote site until the completion of the sensitive run.

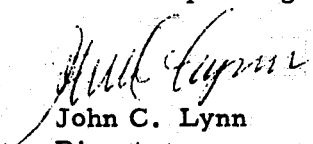
COMPUTER PROCESSING

The requester, upon arrival at the U-9300 remote terminal, will inform the operator that he has a sensitive run. The operator will place an opaque mask over the printer. The operator will remain in the remote terminal room to operate the U-9300 and assist the requester. The operator must not handle the computer printout or otherwise read any of the sensitive data of information. The operator will contact the central computer room and arrange to expedite execution of the sensitive computer job. The mass storage files used in processing of the sensitive run can only be accessed by the requester through the use of read and write security keys which are changed by the requester for each sensitive run. Upon completion of the job, all mass storage files

will be cleared by "FASCLR" and the requester is responsible for assuring that all input material, printouts, and printer ribbons are removed from the terminal area.

In case of emergency program debugging during a production run of sensitive material, contact Mr. Clayton McGee or Mr. John D. Gibbons, AH32, 453-4181, who will contact contractor programmer personnel for corrective action. All reproduction of sensitive outputs will be the responsibility of the requesting activity.

Storage and transportation of sensitive information will be the responsibility of the requesting activity.


John C. Lynn
Director
Computer Services Office

APPROVAL

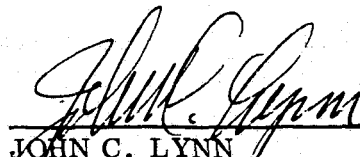
PAGE II

PRICING AND COST ESTIMATING HANDBOOK

Prepared by
Systems Analysis and Integration Laboratory
and
Computer Services Office

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.



JOHN C. LYNN
Director, Computer Services Office



H. E. THOMASON
Director, Systems Analysis and Integration Laboratory