LIFE CYCLE SYSTEM MODEL FOR ESTIMATING CONSTRUCTION EQUIPMENT OWNERSHIP COSTS

By

ROGER HAROLD MILLER

Bachelor of Science
Iowa State University
Ames, Iowa
1958

Master of Business Administration
Oklahoma City University
Oklahoma City, Oklahoma
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Thesis Approved:

Robert L. James
Thesis Adviser

Phillip S. Manke

James B. Jackson

Gerald M. Lage

D. D. Durham
Dean of the Graduate College

PREFACE

The heavy construction contractor has a substantial investment in special purpose equipment per dollar revenue. In general, construction equipment is considered to have an economic life of approximately five years. This means the contracting firm should recover at least 20% of its investment each year. If the sales are twice the investment, then approximately 10% of the firm's revenue is required for the cost of capital wastage.

The heavy construction estimator is faced with the problem of deciding, not only the operating costs and production rates for each project estimated, but also the cost of ownership and a return on the firm's investment. Traditional estimating methods use the predetermined machine-hour rate for owning and operating costs as the basis for estimating project equipment costs.

It is the purpose of this paper to challenge the use of predetermined machine-hour rates as the basis for estimating project equipment costs and to present a theoretically correct alternative.

The author has attempted to give credit to all sources from which material has been taken. He apologizes for any omissions of this type which may, unknowingly, have occurred.

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CHAPTER I

INTRODUCTION

There are many segments which comprise the whole of the construction industry. They range in size and specialties from the single proprietor house builder to the giant design-construct organizations employing many thousands of people. One significant branch of the industry is the heavy construction contractor. As shown in Table I, heavy construction represents nearly 30% of the total new construction industry's volume.[1] The heavy construction contractor's investment in special purpose assets at all operating levels is characteristically high in comparison with revenues. As illustrated in Table II, their investment is many times that of the building contractor per dollar revenue.[2] Table III shows this investment difference to be more than ten times greater at most revenue levels. With this variance in investment, differences in resource requirements can also be noted. These differences in resource inputs are shown in Table IV.

This dissertation will be concerned with the heavy construction contractor and his equipment costs on a project by project basis. The present chapter will outline the nature of problems confronting the heavy construction

TABLE I

DISTRIBUTION OF NEW CONSTRUCTION ACTIVITY,
BY TYPE OF CONSTRUCTION, 1967

Type of Construction	Million Dollars	Percent
Residential buildings	$24,442	32.1
Nonresidential buildings	29,146	38.2
Public utilities, Highways and streets, Water supply and sewer systems, and other public works	22,572	29.7
TOTAL NEW CONSTRUCTION	$76,160	100.0

Source: Peter J. Cassimatis, "Economics of the Construction Industry." A Research Report from the Conference Board. Studies in Business Economics No. 111.

TABLE II

AVERAGE INVESTMENT IN EQUIPMENT PER CONTRACTOR, 1964

Size of Firm by Annual Business Receipts	Only Building Construction	Only Heavy Construction	Building and Heavy
(Millions)		(Thousands)	
Under 2.5	$ 64	$ 916	$ 345
2.5 - 4.9	127	1,738	613
5.0 - 919	187	3,093	959
10.0 - 24.9	241	6,197	3,151
25.0 - 49.9	333	13,933	4,096
50.0 and up	1,210	20,744	10,538

Source: Peter J. Cassimatis, "Economics of the Construction Industry." A Research Report from the Conference Board. Studies in Business Economics No. 111.

TABLE III

CONTRACTOR EQUIPMENT INVESTMENT, 1967

Revenue Levels (in millions)	Under $5	$5 - 9.9	$10 - 14.9	$100 & Over
		(Thousands)		
Building Contractors				
Average per $1 million '67 contracts	40.2	36.4	24.9	12.8
Heavy and Highway Contractors				
Average per $1 million '67 contracts	525.6	348.9	390.9	414.8
Building and Heavy or Highway Contractors				
Average per $1 million '67 contracts	291.9	178.8	110.7	68.3

Source: Construction Methods Magazine (June, 1968), p. 28.

TABLE IV

PERCENT DISTRIBUTION OF INPUTS FOR TYPICAL CONSTRUCTION PROJECTS, 1959-1962

	Average Materials	Average Labor	Average Depreciation	Average Overhead & Profit
Residential buildings	47.0%	25.7%	1.0%	26.3%
Nonresidential buildings	52.1%	31.4%	2.3%	14.2%
Public utilities, highways and streets, water supply and sewer systems, and other public works	41.2%	25.1%	16.5%	17.2%

Source: Peter J. Cassimatis, "Economics of the Construction Industry." A Research Report from the Conference Board. Studies in Business Economics No. 111.

contractor and discuss the specific problem to be dealt with in subsequent chapters.

The Construction Process

Heavy construction is generally accomplished by the contract method. That is, the public agency or contracting authority desiring to construct a facility prepares plans and specifications for the project and advertises for "bidders" in a manner usually prescribed by law. A "bid" is a specific price proposal which sets forth, in a format shown in the specifications, the amount of money a contractor is willing to accept in return for construction of the proposed facility in accordance with the aforementioned plans and specifications. The firm submitting the lowest and adjudged "best" bid among all "bidders" for a project then enters into a contract with the contracting authority and carries out the construction under the continuous inspection of materials and workmanship by representatives of the owner agency.

In general, the contractor moves men, materials, and equipment to the jobsite and combines these resources in the most efficient manner throughout the construction process. Each contracting firm bidding for a project prepares its own estimate of what it expects its costs would be if it were to construct the proposed facility. To this direct cost figure an amount of money is added for general overhead and profit contribution and the total is

the amount of the bid. Quite often there is a wide range in the amounts bid on a given project by the prospective contractors. The causes of this spread in the amounts bid can be generally classified under two headings. The first, and most obvious, is that the higher bidders added the most money for the profit contribution. The second is that the higher bidders estimated the highest costs. Reasons for both categories will be obvious from subsequent discussion in this paper.

The Construction Firm and Its Environmental System

If the contractor's environment is envisioned as being a total system comprised of several subsystems, some relationships can be established. The first subsystem deals with the exogenous variables created by competition in the market place. The second subsystem deals with the endogenous variables of the firm's own operations. A third subsystem provides feedback information for decision making in the other subsystems. The decisions made at the interface of the exogenous and endogenous subsystems provides for the agreement of the two subsystems and determines much of the success or failure of the firm. The objective of the total system is to maximize the present value of the wealth of the firm's owners.

The determinants of the exogenous subsystem are the market prices the firm receives for the different classes of

construction work. These prices are set for the firm by its most efficient competitors. However, the prices bid by a firm's competitors for any given project are generally in direct proportion to the competitor's individual volume-time function.[3] This observation is in keeping with traditional economic theory which would expect a firm's prices to rise and fall in proportion to the demand for its product. The objective of the exogenous system is to obtain, using an optimum bid strategy, the volume of work which maximizes the long run contribution margin. The results of the exogenous system serve as constraints to the endogenous system.

The determinants of the endogenous system are the cash contribution margins recovered from the various projects the firm constructs. The objective of this system is efficiency within the system constraints. To accomplish this objective, the profit residual (contribution margin less depreciation and general overhead expenses) must provide a capital attracting, or at least a capital holding rate of return to the firm's owners.

Most of the research accomplished to date has centered upon the exogenous system and the methodology for obtaining, within the limits of a firm's capacity, the optimum margin volume.[4] This paper is concerned with the endogenous system and will assume the firm can compete successfully in its market place.

All examples used in this paper assume constant price levels and all incomes are before income taxes are deducted.

The Construction Firm and Its Internal System

Using the information shown in Tables III and IV, the endogenous system can be illustrated. A general case might be based upon the following assumptions for under $5 million revenue:

1. An expected work day, 10 hours;
2. An expected work week, 50 hours;
3. An expected work year, 40 weeks, 200 days, 2000 hours;
4. An average expected market price per unit, $0.50;
5. An average expected production rate, 1000 units per hour;
6. Investment per $1,000,000 revenue, from Table III, $525,600; and
7. Equipment depreciation, from Table IV, $165,000.

INCOME STATEMENT FOR ONE YEAR

Total Revenue	$1,000,000	(2000 hr/yr x 1000 units/hr x $0.50/unit)
Less Materials	412,000	(Table IV)
Less Labor	251,000	(Table IV)
Contribution Margin	$ 337,000	(Net Cash Flow, Projects)
Less Depreciation	165,000	
Overhead and Profit	$ 172,000	
Less Overhead	100,000	
NET PROFIT	$ 72,000	

From this example, it can be seen that changes in the firm's operating system can be made by either:

1. Changes in the cost of materials and labor used;
2. Changes in overhead; or
3. Changes in the investment required to produce the same revenue.

These observations illustrate the relationships of the system. Given the revenue, materials, and labor as relatively fixed quantities in the long run, then it can be seen that the contribution margin, overhead, and investment proportions must be maintained in a definite relationship with one another to provide a satisfactory return over time. However, in the short run, overhead and investment remain relatively fixed and the contribution margin tends to vary greatly with changes in revenue. The effect can be short run operating losses even in a well proportioned system.

The effect of the large fixed investment on profits can be demonstrated by reducing the equipment operating hours in a work year or by reducing the production rate units per hour from those used in the previous example. The short term effect of either is to reduce revenue, however, the long run effect of a reduced production rate wears out the equipment while the reduced production hours per year preserves the equipment for future use. Change in the price per unit is a function of the exogenous system and will not be considered here. The effect of reducing operating hours or production rate is shown in the following example.

REDUCED INCOME STATEMENT FOR ONE YEAR

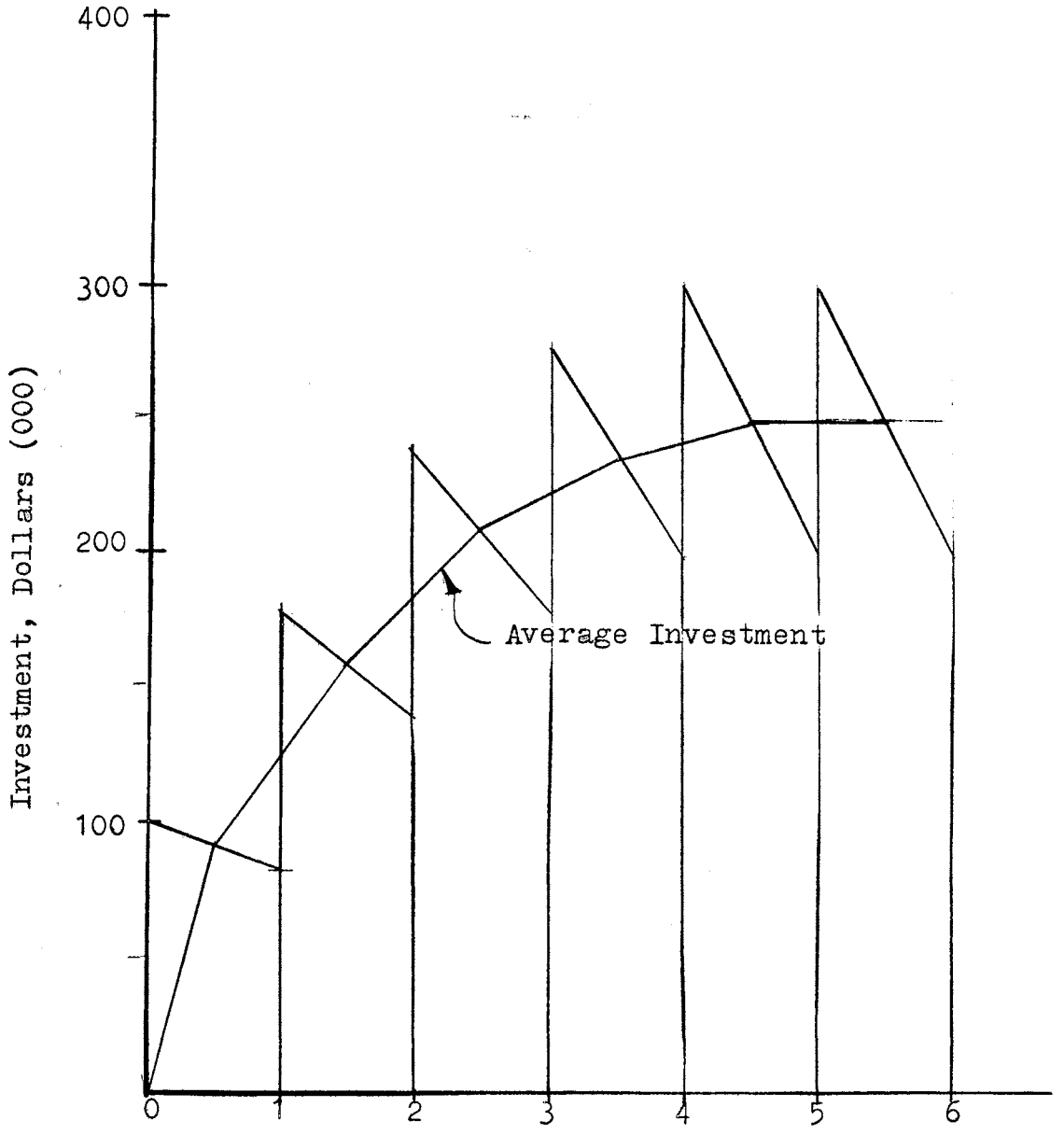
Total Revenue	$750,000	(1500 hr/yr x 1000 units/hr, or 2000 hr/yr x 750 units/hr, x $0.50/unit)
Less Materials	309,000	(Proportion, Table IV)
Less Labor	188,250	(Proportion, Table IV)
Contribution Margin	$252,750	(Net Cash Flow, Projects)
Less Depreciation	165,000	
Overhead and Profit	$ 87,750	
Less Overhead	100,000	
NET PROFIT (Loss)	$(12,250)	

A 25% downward shift in production produced a 25% reduction in revenue. However, the profit residual is reduced by 117% of the "expected volume" profit. Using the data from Tables III and IV corresponding to the non-residential building contractor, the same 25% reduction in revenue would lower the building contractor's profit by 98%.

The most a firm could lose, if it quits business completely, would be its fixed costs. Any contribution above variable costs tends to pay fixed costs. For the heavy contractor, faced with large fixed costs, it is imperative to maintain a volume near capacity. This also helps to explain the wide range of bids received on any given project. When it becomes a firm's "turn" to take additional work in order to maintain volume, the short run contribution margin may substantially be reduced in order to maintain an

equipment use rate near capacity. The contribution margin, at any point before the break-even volume is reached, has no "profit portion," and high fixed costs tend to make the break-even volume high. On a calendar year basis, it may be October or November before the break-even volume is reached and a profit made.

The $72,000 profit is a 14% return on the $525,600 investment and appears to be in line with a survey made in conjunction with the data in Table III which found that nearly one-fourth of those firms involved in heavy construction and nearly one-third of the highway builders realized a return of 20%. One-fourth of all reporting firms, in the building and heavy classification, made less than a 5% return on capital invested in 1967. The information for the survey and tables did not indicate whether the figures were gross investment or whether they recognized depreciation and were net investment. However, when considering the firm's total asset mix, as opposed to an individual piece of equipment, depreciation becomes less important. If the firm has reached a stable size, and its stock of assets has a fairly even age distribution, the amount of annual depreciation expense and unrecovered investment will become relatively stable. For example, if a firm invests $100,000 each year in equipment having a five year life and uses straight line depreciation with no salvage value, the unrecovered investment and amount of depreciation becomes constant as shown in Figure 1. Using a double declining balance rather than a straight line depreciation



Begin Inv.	100,000	180,000	240,000	280,000	300,000	300,000
Depreciation	20,000	40,000	60,000	80,000	100,000	100,000
End Inv.	80,000	140,000	180,000	200,000	200,000	200,000

Figure 1. Average Unrecovered Investment for $100,000 Per Year New Investment, Straight Line Depreciation

schedule, the cycling is between a beginning year investment of $250,000 and an ending year investment of $150,000. This represents a $50,000 lower average book investment with the same $100,000 per year depreciation. For cost estimating purposes, the stability of the investment mix allows the firm to be more general in its estimating the equipment cost for a project because it is generally true that any given equipment spread will contain some older and some newer individual pieces of equipment. The average investment must fit within the system constraints. Except for large and lengthy projects, the task of accounting for depreciation on each piece of equipment at every age level on each project cost estimate would be quite cumbersome.

Traditional Cost Accounting Methods

Methods of cost accounting used by manufacturing firms have evolved into a sophisticated system of standard rates and variances.

> Standard costs are the scientifically predetermined costs of manufacturing a single unit, or a number of units of product, during a specified period in the immediate future. Standard costs are the planned costs of a product under current and/or anticipated operating conditions. They are based on normal or ideal conditions of efficiency and volume, particularly with respect to factory overhead.[5]

Variance, by definition, is simply a deviation from a standard. Variances in direct labor, direct materials, and equipment operating costs, are used in conjunction with the production rate per unit time and indicate operating

efficiencies or inefficiences. In the short run, they are primarily variable cost variances from the planned, or standard cost. Fixed cost variances such as general overhead, insurance, and depreciation, are primarily management concerns and indicate their ability to mate the endogenous and exogenous systems.

The similarities between the manufacturing and construction firm's operations are such that no real variable cost differences should be expected. If one expects, based upon reasonable judgement, to achieve certain production rates and associated operating costs, there should be no reason to expect different percentage unit cost variances from either the manufacturer or the contractor.

However, variances in fixed costs, for short run applications, can be substantially different between manufacturers and contractors. Here again, the exogenous system is assumed to be operating efficiently and an optimum volume of work is available from the endogenous system.

Table V gives the historical weather patterns at Tinker Air Force Base, Oklahoma City, Oklahoma, as published in a recent contract document.[6]

Weather is used in this example because it is the largest single difference between manufacturing a product and constructing a project.[7] If 40,000 units are scheduled to be manufactured this month, the factory's fixed cost variance will have very little relationship to the weather; however, 40,000 units of production for the construction

TABLE V

HISTORICAL WEATHER INFORMATION--TINKER AIR FORCE BASE, OKLAHOMA CITY, OKLAHOMA

Month	Days in Month	Average Rain	No. Days 0.01"	Average No. Days Temp < 32°F	Total Bad Days*	Total Available Work Days*
Jan.	31		6	24	30	1
Feb.	28		7	18	25	3
Mar.	31		7	12	19	12
Apr.	30		8	1	9	21
May	31		11	0	11	20
June	30		9	0	9	21
July	31		7	0	7	24
Aug.	31		6	0	6	25
Sept.	30		6	0	6	24
Oct.	31		6	1	7	24
Nov.	30		4	13	17	13
Dec.	31		5	19	24	7
	365		82	88	170	195

Source: Harold Rothbart, "Investigation and Analysis of Curves of Delay in the Construction Industry," American Society of Civil Engineers, New York, New York Meeting Preprint No. 1368, 1971.

*These columns added by the author.

firm can be postponed due to weather and the full cost of the 40,000 units would be indeterminate.

The purpose of this paper is to provide the construction firm with a method of estimating fixed cost application to construction projects and the use of information obtained from the endogenous system to optimize decision making in the exogenous system.

Estimating Errors Affecting Fixed Costs

There are two possibilities for reduced income at a constant unit revenue. The first is to lower the production rate while holding operating hours constant. This was shown in the previous example by reducing the production rate from 1000 units per hour to 750 units per hour at a constant 2000 operating hours per year. The revenue produced at a price of $0.50 per unit dropped from $1,000,000 per year to $750,000. The effect of this change would be fully accounted for in advance by the firm and a correct project estimate would result if it estimated its fixed costs based upon a predetermined machine hour rate and an expected use of 2000 hours per year. If its depreciation and other fixed costs were $150,000 per year for this equipment, then $150,000 ÷ 2000 hours = $75.00 per operating hour would be the estimated fixed cost portion of the project regardless of the production rate. For example, if the project being considered were to last six months and use 1000 operating

operating hours, then $75.00 per hour times 1000 hours, or $75,000 would be the estimated fixed costs of the project.

In the other case, the income reduction is caused by a reduction in the operating hours. In the previous example, the $250,000 revenue reduction could have been caused by the operating hours being reduced from 2000 hours to 1500 hours. In this case, a predetermined machine hour rate of $75.00 per operating hour would cause the firm to underestimate, or not recover from the project, its fixed cost portion. The $75.00 per hour times 750 hours in six months is only $56,250.

In the two examples given above, these differences are large numerically and could be easily corrected by the experienced and enlightened contractor. Also, during the life of the equipment (generally about five years), these differences tend to be offsetting in that there may be as much over-utilization during the life of the equipment as there is under-utilization.

Most highway contractors bid on several projects let the same day once each month by their respective state highway departments. Because of the exigencies of their work schedules, most of their estimating is done the day before the letting. It is common practice by many firms to estimate the number of machine hours required for a project and multiply this figure by the appropriate "owning and operating" machine hour rate to determine the equipment cost for the project. To this figure, a percentage is added for general overhead and profit contribution and the total is

the amount of the bid. The firm then submits its bids on the several projects it has estimated. It would seem, if the same hourly machine hour rates and the same overhead and profit percentages are added to each project, the profit contributions should consistently be proportionately the same. On the majority of projects this is true, otherwise there could not be many successful contractors. However, failure to identify projects that entail lower or higher machine hour usage per unit of time than some predetermined standard is clearly an estimating error and the result is a built in fixed cost underrun or overrun.

Statement of the Problem

It is possible for the firm, using traditional estimating methods, to underestimate its fixed equipment costs on some projects and be low bidder on these projects and overestimate its fixed equipment costs on other projects and not be low bidder.

Scope of the Investigation

The scope of this investigation was limited to fixed equipment costs. It was the object of this study to develop a correct fixed equipment cost estimating method. The well established discounted cash flow technique for capital investment studies was incorporated as a correct standard guide. Application of this technique to individual construction project estimates was studied.

FOOTNOTES

[1]Peter J. Cassimatis, "Economics of the Construction Industry." A Research Report from the Conference Board. Studies in Business Economics No. 111.

[2]Ibid.

[3]F. H. Griffis, Jr., "A Stochastic Analysis of the Competitive Bidding Problem for Construction Contractors," (unpublished Ph.D. dissertation, Oklahoma State University, 1971).

[4]Ibid.

[5]A. Maty, O. Curvy, and G. Frank, Cost Accounting. Cincinnati, Ohio: Southwestern Publishing Co., 1967, p. 596.

[6]Tinker Air Force Base, Specifications for Steam Tunnel Modifications, July, 1970.

[7]Harold Rothbart, "Investigation and Analysis of Curves of Delay in the Construction Industry," American Society of Civil Engineers, New York, New York Meeting Preprint No. 1368, 1971.

CHAPTER II

LITERATURE REVIEW

There has been very little published in the area directly relating to the application of fixed equipment costs to project cost estimates. Several of the equipment manufacturers have publications which are to be used as guidelines for calculating "O & O," owning and operating equipment costs. These publications are generally accepted as authoritative and are widely used by authors of other publications discussing equipment costs and optimal replacement policies. Before beginning the literature review, a development of a general theory relating to equipment will be discussed.

The Life Cycle System

In general, a firm purchases equipment with the expectation of earning, during the time of ownership and subsequent sale, an amount of money greater than the asset cost. From the operation of a piece of equipment, a cash cost for maintenance, repairs, fuel, operator's wages is incurred. It is assumed that a cash revenue is also produced by operating this equipment. The difference between the cash operating revenue and the cash operating

expense is a cash flow to the firm which owns and operates the asset. The cash flow into the firm is usually referred to as the "cash net of expenses" or net cash flow, "NCF."

The net cash flow consists of two parts. The first part is some portion of the original capital investment which is recovered. The second part is a return on the unrecovered original investment. If the net cash flow was not large enough to provide for both capital recovery and return, in theory, the return on the unrecovered investment balance of the previous period takes precedence and the capital recovered is the residual for that period.

The worth of an earning equipment asset at any time during its useful life must at least be equal to or greater than the present value of the net cash flows through the equipment's remaining life discounted at some rate, such as the firm's cost of capital. The following examples will illustrate this concept.[1]

Given an original investment cost, C, and a pattern of net cash flows NCF_1, ..., and a scrap or trade-in value at the end of the firm's ownership period, s, the internal rate of return, r, may be solved for in the equation:

$$C = \frac{NCF_1}{(1 + r)} + \frac{NCF_2}{(1 + r)^2} + \frac{NCF_3}{(1 + r)^3} + \cdots + \frac{s}{(1 + r)^n} \quad .$$

The development of this equation may be found in any Engineering Economy textbook.[2]

The workings of this system are such that at any point in time, the value of the used machine, assuming other firms operate with equal efficiency, should be the same to the present owner as well as other prospective owners of that same machine. That is, at the end of the first year of use:

$$C_1 = \frac{NCF_2}{(1 + r)} \quad \frac{NCF_3}{(1 + r)^2} + \cdots + \frac{s}{(1 + r)^n} ,$$

and after the second year:

$$C_2 = \frac{NCF_3}{(1 + r)} + \cdots + \frac{s}{(1 + r)^n} .$$

If the firm uses a depreciation schedule for tax purposes which shows a book value which is lower than the unrecovered investment balance computed by the internal rate of return method, the effect is to increase the net cash flow in that year because tax payments are deferred to a later year. However, as was shown in Chapter I, when the firm's total spread of equipment is considered rather than individual items of equipment, the depreciation expense of capital recovered tends to stabilize with the unrecovered investment. The calculations for a $10,000 investment as shown in Tables VI and VII demonstrate the life cycle system. In Table VI, the net cash flows are uniform, while Table VII illustrates the more general case, where operating costs rise and revenues decline with age.

The calculations in Tables VI and VII show a 20% return to the owner on the unrecovered investment. However, because

TABLE VI

LIFE CYCLE SYSTEM, EQUAL ANNUAL NET CASH FLOWS

Year	Investment Begin Year	Net Cash Flow	Return on Investment	Capital Recovered	End of Year Investment
1	$10,000	$4,473	$2,000	$2,473	$7,527
2	7,527	4,473	1,505	2,967	4,560
3	4,560	4,473	914	3,560	1,000
	TOTALS	13,419	- 4,419	= 9,000	
				1,000	Residual* Value
				10,000	

Rate of Return on Unrecovered Investment = 20%.

*"Residual" means resale, or salvage.

TABLE VII

LIFE CYCLE SYSTEM, DECLINING ANNUAL NET CASH FLOWS

Year	Investment Begin Year	Net Cash Flow	Return on Investment	Capital Recovered	End of Year Investment
1	$10,000	$6,000	$2,000	$4,000	$6,000
2	6,000	4,200	1,200	3,000	3,000
3	3,000	2,600	600	2,000	1,000
	TOTALS	12,800	- 3,800	= 9,000	
				1,000	Residual* Value
				10,000	

Rate of Return on Unrecovered Investment = 20%.

*"Residual" means resale, or salvage.

of differences in patterns of net cash flows, the total sum of money returned was greater for the example in Table VI than that in Table VII.

To find the rate of return which satisfies the end conditions of the system (the beginning investment and salvage value), the internal rate of return, r, of the cash flows of Table VII may be solved for in the previously presented equation:

$$\$10,000 = \frac{6,000}{(1 + r)} + \frac{4,200}{(1 + r)^2} + \frac{2,600}{(1 + r)^3} + \frac{1,000}{(1 + r)^4} .$$

The rate of return, r, equals 20%.

The implications of a decision as to the amount of money that should be added to the estimated direct operating cost can be computed at any point during the life of the equipment. If the equipment was just purchased, and a project was being estimated that would require one-half of a production year and yield a cash flow of $2236.50, then it would yield an equivalent annual cash flow of $4473.00, the same as illustrated in Table VI. If the cash flow for that year were repeated for two more years, the life cycle cash flow for the equipment used in Table VI would yield an internal rate of return of 20%. In this manner, a contracting firm can determine the outcome of its decisions on a project by project basis and not rely on a predetermined rental rate for its ownership cost estimating. Thus, it would seem desirable to utilize the life cycle for estimating fixed equipment costs.

Current Methods of Estimating

The Catepillar Tractor Company has published their suggested method for estimating the operating and ownership costs of construction equipment.[3] A wealth of material is supplied through charts and tables for each piece of equipment manufactured by this company. Equipment operating costs include such items as tires, repairs, fuel, and lubricants. The charts and tables are set up to compute the costs in terms of an operating hour. This approach appears to be sound because a machine wears out and its revenue producing capability can be measured by the hour. Thus, hourly operating costs can be accurately predetermined. A 50 gallon tank of fuel will be used in, say, 10 hours. Therefore, the machine burns five gallons of fuel per hour on the average. Tires that last 3000 hours and cost $3000 each will, therefore, have an average cost of $1.00 per operating hour. All equipment manufacturers have tested their machines and supply this type of data for them.

Repairs, however, present a somewhat different problem in averaging because of their stairstep type pattern with respect to operating hours. Usually, minor repairs are required on a new machine and these repairs become more extensive as the machine gets older. In between, a pattern of major repairs are generally required at fairly regular intervals. The "Cat" Handbook recommends averaging repair costs over the life of the equipment. The total cost of

repairs may be as great as the first cost of the machine and averaging these costs results in a "repair reserve" fund which is built up for use in later years. The effect of this intentional distortion must be considered because one has to contemplate the practical aspects estimating costs using an increasing repairs allowance.

Ownership costs are listed as depreciation, insurance, and taxes. For estimating these costs, the handbook again recommends averaging. One of the arguments for averaging is that both depreciation and repairs are about the same total dollar amount and one decreases while the other increases with age, thus, the total cost at any point in time is the same as the average of the two. A graph representing the two costs and an average is shown in Figure 2 for a new machine costing $100,000 and having a lifetime total repair cost of $90,000. The average cost of repairs on a per hour basis for the equipment of Figure 2 is listed in Table VIII.

In the earlier years, the contractor is over-costing the projects being estimated by as much as 13% of the cost of the equipment and in later years, under-costing projects by as much as 12%. If this equipment can produce a $200,000 revenue in a year, the projects will be over- and under-costed by approximately +6.5% and -6%. The average cost of depreciation on a per hour basis for the equipment of Figure 2 is listed in Table IX.

A similar observation may be made analyzing the data in Table IX as for the data in Table VIII except for its

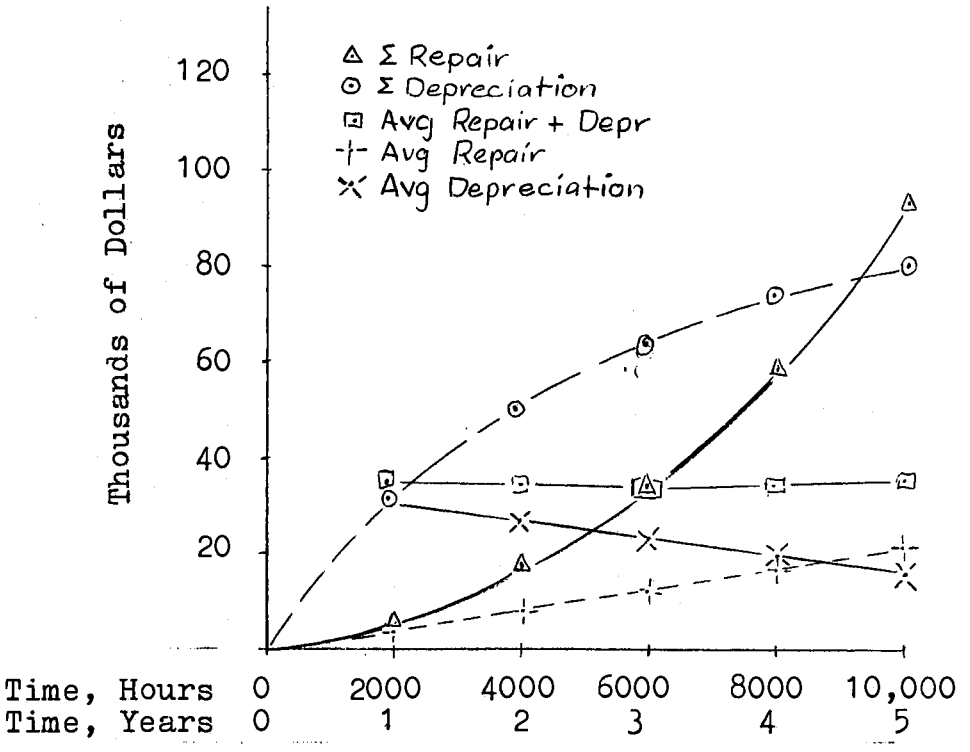


Figure 2. Lifetime Average Versus Repair and Depreciation Expenses Graph

TABLE VIII

LIFETIME AVERAGE VERSUS PERIOD REPAIR EXPENSE

Year	Σ Operating Hours	Est. Period Repair Cost	Average Repair Cost/Oper. Hr.	Period Charge at Life Average	Period Over (Under) Charge	Σ Repair Reserve Fund
1	2,000	$ 5,000	$2.50	$18,000	$13,000	$13,000
2	4,000	10,000	3.75	18,000	8,000	21,000
3	6,000	20,000	5.83	18,000	(2,000)	19,000
4	8,000	25,000	7.50	18,000	(7,000)	12,000
5	10,000	30,000	9.00	18,000	(12,000)	0
		$90,000		$90,000		

TABLE IX

LIFETIME AVERAGE VERSUS PERIOD DEPRECIATION EXPENSE

Year	Σ Operating Hours	Est. Period Depr. Cost	Avg. Depr. Cost/Oper. Hr.	Period Charge at Life Average	Period Over (Under) Charge	Σ Depr. Reserve Fund
1	2,000	$30,000	$15.00	$16,000	(14,000)	(14,000)
2	4,000	20,000	12.50	16,000	(4,000)	(18,000)
3	6,000	10,000	10.00	16,000	6,000	(12,000)
4	8,000	10,000	8.75	16,000	6,000	(6,000)
5	10,000	10,000	8.00	16,000	6,000	0
		$80,000		$80.000		

TABLE X

LIFETIME AVERAGE VERSUS PERIOD REPAIR AND DEPRECIATION EXPENSES

Year	Σ Operating Hours	Period Over (Under) Charges Repair	Period Over (Under) Charges Depr.	Total Over (Under) Charges	Σ Over (Under) Charges
1	2,000	$13,000	(14,000)	(1,000)	(1,000)
2	4,000	8,000	(4,000)	4,000	3,000
3	6,000	(2,000)	6,000	4,000	7,000
4	8,000	(7,000)	6,000	(1,000)	6,000
5	10,000	(12,000)	6,000	(6,000)	0

having the opposite effect upon the project costing. Table X combined the data to show the net over- or under-costing.

In terms of averaging depreciation and repair charges over the life of a piece of equipment, the two errors tend to be offsetting and allow the firm, in a general sense, to cover its equipment cost of repair and depreciation by this method. However, in the specific area of estimating the ownership costs for a particular project, this method does not give the decision maker the proper information as will be discussed later in this paper.

The International Harvester Company's[4] estimating handbook advocates essentially the same method of estimating. The depreciation is calculated over the full life of the equipment and this dollar amount is divided by the expected service life in hours. Repairs, interest, and taxes are estimated as a percentage of the hourly depreciation cost.

In a Highway Research Board Report,[5] depreciation is discussed in conjunction with obsolescence, the inability of a machine to economically compete with the technological improvements of a newer machine. It is pointed out that ownership costs are incurred on an annual basis and are generally fixed costs. It is suggested that annual costs of major repairs and overhauling be treated as fixed costs because they occur in relatively large amounts at irregular intervals and cannot be charged to specific jobs. The

authors then proceed to develop hourly ownership rental rates by estimating the annual hours of use for the equipment.

The Associated General Contractors of America,[6] in their guidebook regarding contractors' equipment ownership expense, take a somewhat different approach. This publication suggests the calculation of an annual charge for depreciation, overhauling, major repairs, painting, insurance, taxes, storage, and interest, and dividing this annual dollar amount by average number of working months to obtain a monthly charge for ownership expense. A further division of the monthly charges is made by simply dividing by either the average working days per month to obtain a daily rate, or by the average hours per month to obtain an hourly rate.

In this manner, the contracting firm may use an hourly rate, with a minimum daily charge, a minimum weekly charge, and a minimum monthly charge to assure itself of recovering at least the predetermined annual fixed costs. It should be pointed out, however, that an over-utilization of equipment, higher monthly machine hours than standard, could result in under charging unless consideration is given to this possibility. The result would be that the equipment is actually being used up faster than the reserve for replacement is accumulating. Useful economic life varies from contractor to contractor, depending on such things as maintenance programs and type of use.

Summary and Conclusions

The treatment of ownership costs by estimating from the use of lifetime averages as advocated by the equipment manufacturers is rather easy for the estimator to apply. An hourly rental rate can be determined at the time the equipment is acquired and used from that time on until retirement. On the other hand, there can be some expensive mistakes made in estimating specific projects. The predetermined annual use rate may be much greater than the use rate available on a particular project. If rental rates, which assume some particular annual or lifetime use, are employed, then any other use rate creates an estimating error. The assumption made with this method is that the differences will balance in the lifetime average. The fact that the averages will prevail in the long run does not preclude the possibility of making some very costly mistakes in the short term.

The Associated General Contractors' method of equipment costing seems to overcome most of the objectionable features found in the equipment manufacturers' model. Even though a better cost accounting system, this model is still deficient when used in project cost estimating.

All other textbooks, articles, and equipment handbooks available for review adopted one or the other of the estimating procedures discussed in this chapter. None of the methods currently being advocated utilize the life cycle system presented at the beginning of this chapter as an estimating tool. They all ignore the time-value of money.

In the traditional estimating model, given an original investment cost, C, and a pattern of annual hours use, H_1, H_2, ..., and a scrap or trade-in value at the end of the firm's ownership period, S, the hourly rental rate, R, may be solved for in the equation:

$$R = \frac{(C - S)}{H_1 + H_2 + H_3 + \cdots + H_n} .$$

This model might be described as a constant revenue, straight line depreciation, zero rate of interest model. Revenue is not considered and no cash flows can be established with this model.

In the life cycle system model described at the beginning of the chapter, the rental rate, R, may be solved for in the equation:

$$R = \frac{NCF_1 + NCF_2 + NCF_3 + \cdots + NCF_n}{H_1 + H_2 + H_3 + \cdots + H_n} .$$

This model is concerned with the size and timing of cash flows and requires none of the limiting assumptions required by the traditional estimating model.

Chapter III presents a method of estimating fixed costs for each project which provides the estimator with the information needed to view the impact of each of his decision alternatives within the life cycle system.

FOOTNOTES

[1]Edgar O. Edwards and Philip W. Bell, The Theory and Measurement of Business Income, Berkeley and Los Angeles: University of California Press, 1964, p. 176.

[2]Eugene L. Grant and W. G. Ireson, Principles of Engineering Economy, Fourth Edition, New York, New York: Ronald Press, 1964.

[3]Caterpillar Performance Handbook, Caterpillar Tractor Company, Peoria, Illinois, 1970.

[4]Sales Department--International Harvester Company, Chicago, Illinois, "Basic Estimating."

[5]T. S. Dudick and F. I. Ravenscroft, "Development of Uniform Procedures for Establishing Construction Equipment Rental Rates," Highway Research Board, NCHRP Report No. 26, Washington, D. C., 1966.

[6]"Contractor's Equipment Ownership Expense," The Associated General Contractors of America, Washington, D. C., 1966.

CHAPTER III

THE PROBLEM OF ESTIMATING EQUIPMENT FIXED COSTS FOR A SPECIFIC PROJECT

Introduction

The preceding chapters have outlined the problem facing the heavy construction contracting firm with regard to general estimation of its fixed equipment costs. Chapter I gave an overview of the magnitude of equipment costs for the industry as a whole and showed by an example how an individual firm's earnings can be greatly affected by the fixed equipment costs. Chapter II reviewed the life cycle system and the present by used methods of estimating fixed equipment costs. Chapter III will address the problem on an individual project basis and present in detail an analysis which provides an accurate basis for estimating fixed equipment costs.

The Predetermined Machine-Hour Rate

Although there is a variety of techniques for estimating fixed equipment costs, they are all based upon the premise of a predetermined machine-hour rate of capital recovery. This basic method is used in at least five different ways or purposes.

It is used:

1) in capital investment analysis;
2) in equipment replacement studies;
3) in estimating the equipment ownership cost portion of construction project costs;
4) by management as a standard to measure the financial success or failure of individual construction projects; and
5) by owners of construction projects as a standard to make reimbursements to contractors for costs of extra or additional work not contemplated in the original contract.

There are several reasons for widespread use of the predetermined machine-hour rate for estimating project fixed equipment costs. The first reason is that it conforms to accepted "job order" standard cost accounting procedures. A second reason is that of convenience. A rate, once determined, may be used by operating personnel over the entire life of the equipment. Finally, the method is used because its essential correctness in estimating has not been seriously questioned. Because historical cost accounting procedures utilize the method, it has been assumed that it should also be a viable estimating method.

The purpose of this chapter is to analyze the accuracy of the predetermined machine-hour rate for estimating equipment fixed costs on individual projects. In particular, three questions might be asked.

1) How accurately does the predetermined machine-hour rate estimate equipment fixed costs?
2) What factors influence the size and direction of any cost estimating error?
3) What are the implications of these errors in terms of cash flows, return on investment, selection of projects to bid, and the amount to bid on a selected project?

Cost Accounting Versus Estimating

Cost accounting procedures apply all costs, such as direct labor, direct material, depreciation, overhead, and other fixed expenses, to the output of the same time period. Under the normal capacity, or long-range approach, a machine-hour rate is determined in which expenses and production are based upon utilization of the equipment over its economic life in order to level out the highs and lows in the firm's activity. The machine-hour basis for applying fixed costs to output is recognized as legitimate for construction equipment because of its fairly predictable basic machine-hour life. Variances from normal capacity found on specific projects are accounted for at the end of accounting periods by charging or crediting projects according to equipment usage. If the normal capacity usage is based upon an ownership cost portion of $10 per operating hour, 2000 hours per year ($20,000), and the year's cost

accounting charges show 1500 hours at $10 per hour ($15,000), then an additional charge of $5,000 must be prorated among the year's projects because the ownership costs were fixed for the year at $20,000. If the estimator, during the course of the year, used the $10 per hour ownership cost rate to estimate the cost of projects which did not have equivalent annual use rates of 2000 hours, the estimate was in error. Ownership costs which are not recovered from projects by this system are gone forever and cannot be regained except by overutilization in the future. This amounts to a compensating error.

A contracting firm makes its capital investment in equipment. From then on, it is concerned with the equipment's position within the life cycle system, i.e., the present value of the net cash flows through the remaining life of the equipment should be equal to or greater than the unrecovered investment in the machine. If the unrecovered investment at the beginning of the year is $50,000, and the firm's minimum acceptable rate of return on this type of equipment is 20 percent, then the return demanded in the next year will be $50,000 x 20% = $10,000 for this piece of equipment. If the net cash flow was $30,000 the first year, then the unrecovered investment for the following year would be $50,000 - $20,000 = $30,000 = $30,000. The $10,000 is owed to the firm's owners as the return they demanded for their continuing investment. The $20,000 capital recovered applies only to the original investment. In this case,

the $10,000 return might consist of, $6000 of implied interest cost, or the return available in the next best alternative use of the money; and $4000 to cover price level changes, obsolescence, inflation, and a risk premium for investing in special purpose assets which deteriorate rapidly in resale value. A recent study of optimal replacement policies attempted to quantify some 60 explicit and implicit equipment costs.[1]

The overall accounting view of depreciation is to spread the initial cost of a piece of equipment over the economic life of the equipment. Depreciation accounting does not necessarily follow the same pattern as capital recovery. Tax depreciation allows the firm to deduct, as an expense, an amount of money from its revenue to replenish the firm's capital money stock. This is done in order that the firm can replace its equipment with new equipment when the present depreciation does not necessarily follow the pattern of capital recovery. It should be noted, however, that depreciation does affect capital recovery patterns when income taxes and salvage are considered because they are cash flows away from the firm. Depreciation methods that are used affect the timing of cash flows and are important to the analysis of fixed equipment cost estimating. As shown in Chapter I, the impact is generally not as great when considering the firm's complete stock of capital equipment. The net cash flow is generally computed in the following manner:

Operating revenue - Operating expenses = Operating Income

Operating Income - Tax Depreciation = Taxable Income

Taxable Income x (1 - effective tax rate) = Income After Taxes

Income After Taxes + Tax Depreciation = Net Cash Flow

(Working capital changes, and principal and interest payments have been omitted for simplicity.)

Large depreciation charges in earlier years of equipment life reduce taxes and increase net cash flow.

Estimating by the predetermined machine-hour rate assumes a straight line hourly physical depreciation and an accompanying straight line hourly capital recovery. It does not account for the time-value of money. The time-value of money is considered in the discounted cash flow technique of analysis and it is well established in the literature.[2] Its application is quite extensive in the field of capital investment.

If the estimator uses the technique of estimating by predetermined machine-hour rates, equal weight is given to all projects because no distinction is made between the different projects' cash earning ability. Only where the revenues of all the various alternative projects are equal is the alternative which minimizes cost the alternative which maximizes profit.

A Project Estimating Example

To illustrate the differences in the concepts involved, a simple example will be used. A single machine is purchased new for the price of $100,000. It is considered to have no salvage value and a life of five years or 10,000 hours. The firm wants a return on its unrecovered investment of 16 2/3%, and the implied interest cost, or cost of capital is estimated to be 10%. Cash operating costs are estimated to be $15 per operating hour. The machine-hour rental rate then, is $100,000 ÷ 10,000 hours = $10 per hour, or, $100,000 ÷ 5 years = $20,000 per year ÷ 2,000 hours per year = $10 per hour. The total annual estimated costs would be $20,000 for ownership and $15 per hour x 2,000 hours = $30,000 operating costs, a total of $50,000. Based upon straight line depreciation, the average investment for the five year period is $60,000 and a 16 2/3% return on this investment is $10,000 per year. Therefore, costs marked up 20% will yield a 16 2/3% return. Income taxes, working capital investment, and general overhead allocations are not included for the sake of simplicity. The following estimates are based upon the basic machine-hour rate method and the machine-hour rate method adjusted for minimum period charges as discussed in Chapter II. This method will hereafter be called the "direct cost method."

Three projects have been estimated using the machine-hour rate method and the results are tabulated in Table XI.

TABLE XI

BID COMPUTATION USING MACHINE-HOUR RATES

Project	Est. Project Duration in Weeks	Est. Mach. Prod. Hrs.	Est. Oper. Cost/Hr.	Est. Own. Cost/Hr.	Project Est. Cost	20% Profit Contribution	Amount Bid
A	8	333	$15	$10	$8,325	$1,665	$9,990
B	2	100	15	10	2,500	500	3,000
C	4	250	15	10	6,250	1,250	7,500

The assumption here is that the firm is in no better position with any one project except that one project is larger or smaller than another. This assumption is correct as long as each project takes proportionately as much calendar time to complete as the others. Ownership costs have a time dimension which cannot be ignored. The ownership costs per unit time are based upon the unrecovered capital which must be employed in the construction of any project.

Return on investment is a generally accepted standard of a firm's current operating efficiency. The long term counterpart to return on investment is the present value of the stockholders' wealth. The present value concept fits the life cycle system described in Chapter II and takes into account not only current earnings but also the future earnings of the present investment. Capital recovery and return on unrecovered investment are, to a large extent, independent of either physical depreciation or accounting and tax depreciation. Although depreciation accounting is a part of the analysis, the important result for the contracting firm is the pattern of capital recovery and return on unrecovered investment within the life cycle system.

In Table XII, the same projects as shown in Table XI are estimated using the direct cost method.

Project B has an estimated equipment use rate of 50 hours per week. At this weekly rate, 2,000 hours of equipment usage would be expected in the estimated annual

TABLE XII

BIB COMPUTATION USING DIRECT COST BASIS

Project	Est. Project Duration in Weeks	Est. Mach. Prod. Hrs.	Est. Oper. Cost/Hr.	Est. Period Proj. Cost	Project Cost	20% Profit Contribution	Amount Bid
A	8	333	$15	$4,000*	$8,995	$1,800	$10,795
B	2	100	15	1,000**	2,500	500	3,000
C	4	250	15	2,000***	5,750	1,150	6,900

*8 wk/40 wk year x $20,000 per year capital recovery.

**2 wk/40 wk year x $20,000 per year capital recovery.

***4 wk/40 wk year x $20,000 per year capital recovery.

40 week production year. Project A has an estimated usage rate of 42 hours per week, which is equivalent to a 1,667 hour annual rate. Project C has been estimated to use the equipment 63 hours per week, or a 2,500 hour annual rate.

Equivalent Annual Use Rate

For each project, an "equivalent annual use rate" may be defined as the annual hours of equipment operation which would be expected if the project under consideration were repeated as many times as would be required to complete a production year. Project A required eight calendar weeks out of a 40 week production year. Therefore, five projects identical to Project A could be completed in a 40 calendar week production year. These five projects, each using an estimated 333 equipment operating hours generate a total of 1,667 equipment operating hours in a 40 week year. Project A can then be said to have an equivalent annual use rate of 1,667 hours. Project B has an equivalent annual use rate of 2,000 hours while Project C has a 2,500 hour annual rate. Table XIII summarizes the results of Tables XI and XII on an annual basis.

The annual cost error in estimating the cost of Project A by the machine-hour rate method is caused by underutilization of equipment. The five year or 10,000 hour life indicates that there will be a decline in the value of the equipment of at least $20,000 per year whether it has been used 2,000 hours or not. The error might be called one of

TABLE XIII

DIFFERENCE BETWEEN MACHINE-HOUR RATE AND DIRECT COST ESTIMATE

Project	Est. Annual Mach.-Hrs.	Annual Cap. Rec. Mach.-Hrs.	Annual Cap. Rec. Required	Annual Cost Error	Annual Cap. Rec. Dir. Cost	Annual Cost Error
A	1,667	$16,667	$20,000	($3,333)	$20,000	$ 0
B	2,000	20,000	20,000	0	20,000	0
C	2,500	25,000	25,000	0	20,000	($5,000)

omitting the cost of obsolescence. Even though the machine can earn revenue at the rate which was contemplated at the time of purchase, newer models of the machine can earn at an even greater rate.

The annual cost error in estimating the cost of Project C by the direct cost method is caused by overutilization. The error is the same unit magnitude as the error in Project A, except opposite in sign. The annual hours difference is greater for Project C. The machine in Project C is physically being worn out faster than its cost is being recovered on an annual basis.

Equivalent Life Cycle Time in Years

The equivalent life cycle time in years may be found for a particular project by dividing the service life in hours by the equivalent annual use rate for the equipment used on the project. For Project A, the equivalent life cycle would be 10,000 hours divided by 1,667 hours per year, or six years. In this example, it was stated that the firm intends to estimate on the basis of recovering the cost of the equipment in not more than five years. For Project B, the equivalent life cycle is 10,000 hours ÷ 2,000 hours = 5 years; and, for Project C, the equivalent life cycle is 10,000 hours ÷ 2,500 hours = 4 years.

Life Cycle System Computations

In order to use the life cycle system, the equivalent annual net cash flow from each project must be computed. The information is given in Table XIV.

TABLE XIV

ANNUAL CASH FLOWS

Project	Annualized Revenue	Annualized Oper. Cost	Annualized Net Cash Flow	Equivalent Life Cycle
From Table XI -- Machine-Hour Rates				
A	$49,950	$25,005	$24,945	6
B	60,000	30,000	30,000	5
C	75,000	37,500	37,500	4
From Table XII -- Direct Costs				
A	$53,975	$25,005	$28,970	6
B	60,000	30,000	30,000	5
C	69,000	37,500	31,500	4

To determine the order in which the projects should be considered, the life cycle system equation given in Chapter II may be used to solve for the internal rate of return, r:

From Tables XI and XIV -- Machine-Hour Rates

Project A

$$\$100,000 = \frac{\$24,945}{(1+r)} + \frac{\$24,945}{(1+r)^2} + \frac{\$24,945}{(1+r)^3} + \frac{\$24,945}{(1+r)^4} + \frac{\$24,945}{(1+r)^5} + \frac{\$24,945}{(1+r)^6},$$

$$r = 12.90\% ;$$

Project B

$$\$100,000 = \frac{\$30,000}{(1+r)} + \frac{\$30,000}{(1+r)^2} + \frac{\$30,000}{(1+r)^3} + \frac{\$30,000}{(1+r)^4} + \frac{\$30,000}{(1+r)^5},$$

$$r = 15.23\% ;$$

Project C

$$\$100,000 = \frac{\$37,500}{(1+r)} + \frac{\$37,500}{(1+r)^2} + \frac{\$37,500}{(1+r)^3} + \frac{\$37,500}{(1+r)^4},$$

$$r = 18.45\% .$$

From Tables XII and XIV -- Direct Costs

Project A

$$\$100,000 = \frac{\$28,970}{(1+r)} + \frac{\$28,970}{(1+r)^2} + \frac{\$28,970}{(1+r)^3} + \frac{\$28,970}{(1+r)^4} + \frac{\$28,970}{(1+r)^5} + \frac{\$28,970}{(1+r)^6},$$

$$r = 18.52\% ;$$

Project B

$$\$100,000 = \frac{\$30,000}{(1+r)} + \frac{\$30,000}{(1+r)^2} + \frac{\$30,000}{(1+r)^3} + \frac{\$30,000}{(1+r)^4} + \frac{\$30,000}{(1+r)^5},$$

$$r = 15.23\% ;$$

Project C

$$\$100{,}000 = \frac{\$31{,}500}{(1+r)} + \frac{\$31{,}500}{(1+r)^2} + \frac{\$31{,}500}{(1+r)^3} + \frac{\$31{,}500}{(1+r)^4} ,$$

$$r = 9.93\% .$$

Computer solutions for these equations are shown in Appendix A.

Another solution to the problem is to solve the life cycle system equation with the interest rate, or cost of capital, as the discount rate and determine the present value of the net cash flows. If the net cash flows, discounted at the firm's cost of capital, are greater than the first cost of the machine, then the machine's rate of return is greater than the firm's cost of capital. Again, the life cycle system equation may be solved, this time for the initial cost, C, with a minimum rate of return, r, of 10%:

From Table XI -- Machine-Hour Rates

Project A

$$C = \frac{\$24{,}945}{(1.10)} + \frac{\$24{,}945}{(1.10)^2} + \frac{\$24{,}945}{(1.10)^3} + \frac{\$24{,}945}{(1.10)^4} + \frac{\$24{,}945}{(1.10)^5} + \frac{\$24{,}945}{(1.10)^6} ,$$

$$= \$108{,}640 ;$$

Project B

$$C = \frac{\$30{,}000}{(1.10)} + \frac{\$30{,}000}{(1.10)^2} + \frac{\$30{,}000}{(1.10)^3} + \frac{\$30{,}000}{(1.10)^4} + \frac{\$30{,}000}{(1.10)^5} ,$$

$$= \$113{,}721 ;$$

Project C

$$C = \frac{\$37,500}{(1.10)} + \frac{\$37,500}{(1.10)^2} + \frac{\$37,500}{(1.10)^3} + \frac{\$37,500}{(1.10)^4} ,$$

$$= \$118,868 .$$

From Table XII -- Direct Cost

Project A

$$C = \frac{\$28,970}{(1.10)} + \frac{\$28,970}{(1.10)^2} + \frac{\$28,970}{(1.10)^3} + \frac{\$28,970}{(1.10)^4} + \frac{\$28,970}{(1.10)^5} + \frac{\$28,970}{(1.10)^6} ,$$

$$= \$126,170 ;$$

Project B

$$C = \frac{\$30,000}{(1.10)} + \frac{\$30,000}{(1.10)^2} + \frac{\$30,000}{(1.10)^3} + \frac{\$30,000}{(1.10)^4} + \frac{\$30,000}{(1.10)^5} ,$$

$$= \$113,721 ;$$

Project C

$$C = \frac{\$31,500}{(1.10)} + \frac{\$31,500}{(1.10)^2} + \frac{\$31,500}{(1.10)^3} + \frac{\$31,500}{(1.10)^4} ,$$

$$= \$99,849 .$$

If the contracting firm was awarded Project A to build, it would be making a return on its investment at a 12.90% rate for the duration of the project if its bid was based on machine-hour rates, and at an 18.52% rate if its bid was based upon the direct cost method. For Project B, both methods return at a 15.23% rate. As was shown in Table XIII, the reverse of the results for Project A is true for

Project C. In this case, the equipment would last only four calendar years while the direct cost method assumes a five year life. The return rate for the machine-hour rate method bid is 18.45%, while the direct cost method bid would return at a 9.93% rate.

The net cash flow required for a 16 2/3% true rate of return over the five year life figures given for Project B is $31,020 per year. The reason for the rate in the example being 15.23%, rather than 16.67%, is the use of average investment and straight line depreciation in setting up the initial figures for the example.

Summary and Conclusions

It can readily be seen from the solutions of the sample equations that the construction firm could easily be low bidder on financially poor projects and overbid others which could be considerably better. For the firm to treat all projects alike when they are, in fact, not alike, is a grave estimating error.

The solutions to the equations given show either the rate of return or present value of the net cash flows. It is possible, however, to determine the amount which needs to be bid to return a given percentage on the unrecovered investment. This would simply be the common capital recovery factor[3] used in engineering economy studies. The capital recovery factor for a given life in years and a given minimum percentage return on investment multiplied by the

unrecovered present investment will give the estimator the annual net cash flow required. This value divided by the equivalent annual number of projects will be the minimum amount of money the firm should bid on this project.

For the three projects given in the example, Table XV presents bids computed using the life cycle cost system. The bid amounts shown in the table provide the firm with its capital recovery and a return rate of 16 2/3% for each of the projects.

Chapter IV describes the testing program which was used to verify the basic concepts of this system, and to expand and refine the methodology presented in this chapter.

TABLE XV

BID COMPUTATION--LIFE CYCLE COST SYSTEM

Project	Equivalent Life in Years	Equivalent Annual Projects	Annual Cash Flow Required	Project Cash Flow Required	Est. Oper. Cost	Bid Amount
A	6	5	$27,620*	$5,524	$4,995	$10,519
B	5	20	31,020	1,551	1,500	3,051
C	4	10	36,210	3,621	3,750	7,371

*Annual net cash flow = $\frac{r(1 + r)^n}{(1 + r)^n - 1}$, where r = 16.667%, n = equivalent life in years.

FOOTNOTES

[1]James Douglas, "Construction Equipment Policy: The Economic Life of Equipment," Technical Report No. 61, The Construction Institute, Stanford University, Stanford, California, 1966.

[2]Harold Bierman and Seymour Smidt, The Capital Budgeting Decision, Second Edition. New York: The MacMillan Co., 1966.

[3]Eugene L. Grant and W. G. Ireson, Principles of Engineering Economy, Fourth Edition, New York, New York: Ronald Press, 1964.

CHAPTER IV

LIFE CYCLE SYSTEM RESEARCH PROGRAM

Introduction

The previous three chapters have been concerned with the theoretical aspects of estimating project equipment costs. The present chapter will be concerned with the application of life cycle system theory. The purpose of this research was to find the determinants of equipment cost estimating errors, and the direction and magnitude of these errors.

Fixed and Variable Costs

Generally, costs are classified as either variable or fixed. Variable costs are those costs which vary directly with the level of production. Fixed costs are those costs which remain the same at all levels of production. A variable cost dollar amount increases directly with output while the unit variable cost remains constant. A fixed cost dollar amount remains constant while a unit fixed cost decreases with increases in output. All costs are variable in the very long run and fixed in the very short run.

An additional subclassification, semifixed cost, is a cost that is fixed between two increments of production.

For example, a particular payroll clerk may handle the payroll for a certain maximum number of employees. If the level of output requires more employees than one payroll clerk can handle, a second clerk must be hired. In terms of cost, the dollar amount of this particular overhead is fixed between the two levels of output. By definition then, the cost is semifixed.

Production Rate

A contracting firm makes a cost commitment of its resources for some time period, usually one day. In effect, this means that the variable costs such as fuel, oil, grease, and operating labor, are fixed in dollar amount for that day, regardless of the output. This assumes the cost of the resources to the project are identical to the costs for one whole day. The relationship is hyperbolic, $XY = K^*$, where: X is the production rate per unit of time, Y is the unit cost, and K^* is the total cost per unit of time. If an asphalt plant costs \$100 per hour to operate and the output is 100 tons per hour, then the unit cost is:

$$Y = \frac{K^*}{X}$$

$$= \frac{\$100/hr}{100\ ton/hr}$$

$$= \$1.00/ton \quad .$$

Where the output is 75 tons per hour, then:

$$Y = \frac{\$100/hr}{75 \text{ ton/hr}}$$

$$= \$1.33/ton .$$

Where the output is 125 tons per hour, then:

$$Y = \frac{\$100/hr}{125 \text{ ton/hr}}$$

$$= \$0.80/ton .$$

If the output ranges from 75 tons per hour to 200 tons per hour, the unit costs will be distributed as shown in Figure 3. If the firm had estimated its unit cost for this project to be \$1.00 per ton, the penalty for producing 50 tons per hour is \$1.00 per ton, whereas, the bonus for producing 200 tons per hour is only \$0.50 per ton. In terms of utility theory, the estimator would either need to be fairly certain of producing 100 tons per hour, or strive for a balance between the expected penalty and expected bonus.

Elements of the Testing Program

In order to properly account for the interaction between variable and fixed costs and the production rate, a computer simulation was used for testing. In this manner, actual costs could be treated as a random variable. In the first setup of the program, an estimator who works for an Oklahoma based highway contractor was asked to estimate a least likely, most likely, and an optimistic production rate for a particular project, and to express the probability of achieving or exceeding the most likely rate. This proved to

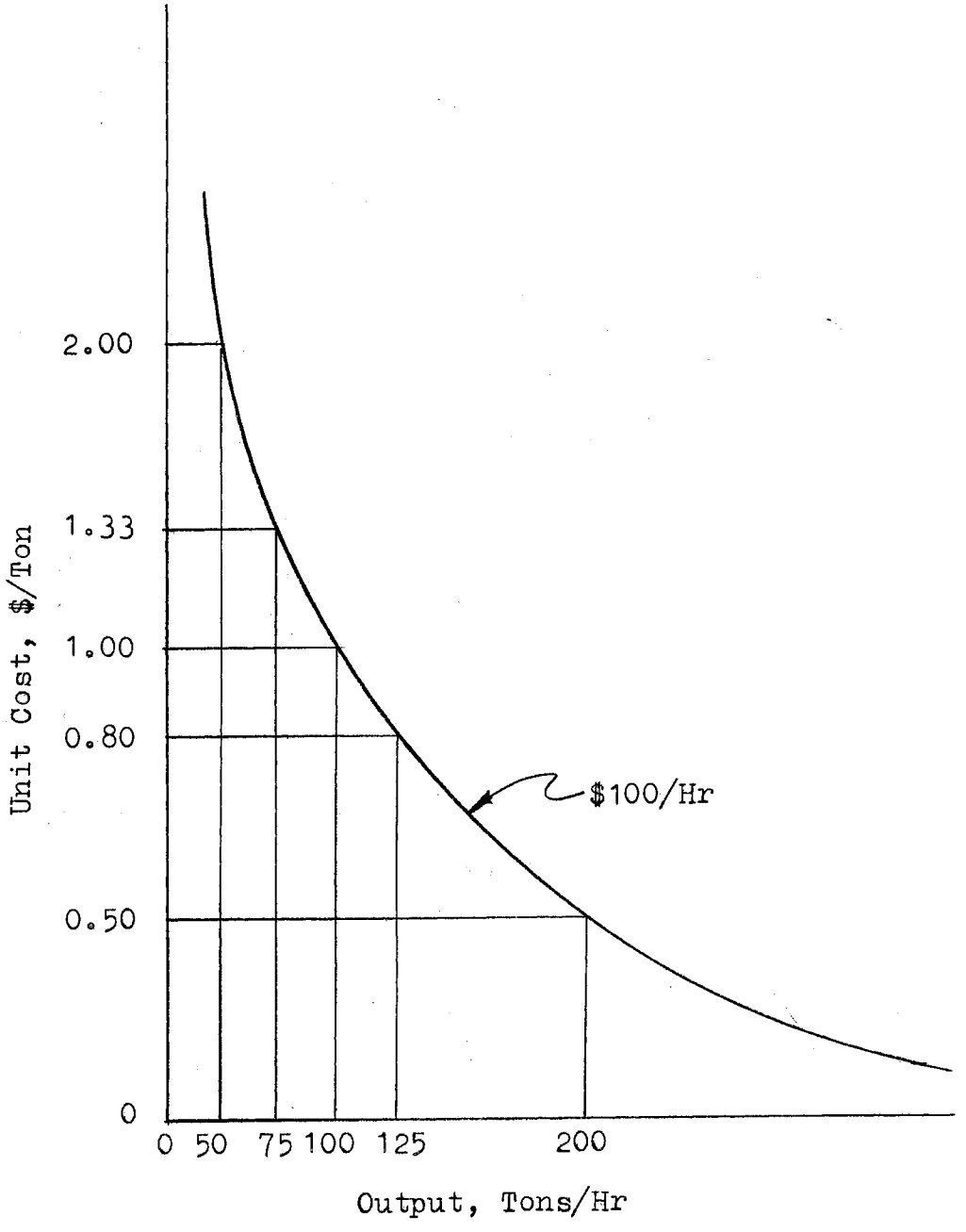


Figure 3. Unit Cost Versus Output

be very difficult. The expression of probability creates confusion in the minds of many estimators. The probability of doing "this well or better" is very hard to define. For this reason, a triangular distribution which required no probability statements was used as the probability density function. From this, a cummulative distribution function was established as shown in Appendix B. A random number between 0.0 and 1.0, selected by the random number generator subprogram, is used by the program as the cummulative probability of that production rate or less.

There are actually three random cost generating variables which are considered by the simulation program. They are:

1) production rate, units per hour;
2) production hours per week; and
3) production weeks per year.

An experienced construction estimator subjectively and objectively accounts for many variables in estimating the cost of a project. Many things might be considered in arriving at the lowest possible, but not probable, the most likely, and the highest possible, but not probable, production hours per week. Labor conditions, climate, site location, etc., would all have a bearing on the estimator's choice of range and values. Almost all possible combinations of variables that effect costs can be considered by combinations of the three variables listed above. They are the basic cost determinants within the production system.

The Simulation Process

The computer program first calculates the estimated cost of a project by using the modal, or most likely values for production rate, hours per week, weeks per year, and the machine-hour rates as derived from the input data. It then "constructs" the project 1000 times via the simulation process. The data obtained regarding the production and costs is stored and analyzed in the remainder of the program. The means and standard deviations are calculated for each variable resource input as well as cost output. All values are discarded that are not within plus or minus two standard deviations from the mean (within the limits of a 95% probability of occurrence). The printouts of two example programs involving asphalt plant production are shown in Appendix D.

Findings of the Research

The program outputs distributions of the fixed and variable resources and their associated costs. A comparison of these distributions provides a comparison of estimating errors between sets of input data.

When the input production distributions were symmetrical, and the equipment use rate was the same as contemplated by the predetermined rental rate method, symmetrical cost distributions were expected. It was found, however, that this was not the case. Subsequent investigation revealed the skewness of estimating error distribution comes from

both the fixed costs and the variable costs. The effect of errors in fixed costs was demonstrated in Chapter III. The source of the variable cost error is shown in Appendix C.

To demonstrate the effect of variable cost errors, a simple example will be used. An asphalt batch plant operation will be used for this example. Production of an average of 100 tons per hour with a 4000 lb batch size plant and 250 tons per hour with a 10,000 lb batch size plant is expected. A full cost comparison as opposed to a variable cost comparison must include both labor and capital because there is no increase in labor cost and only a slight increase in the cost of fuel and repairs for operating the larger plant. The variable unit costs for three levels of output for each plant is shown in Table XVI. The percentage changes in production and unit costs are all equal. However, the actual dollar unit cost change was $2\frac{1}{2}$ times as great for the smaller plant than the larger plant. The significance of this result is that where the production rate is rather large in comparison to the dollar amount of variable costs, the risk of not meeting estimated unit costs (because of lower than contemplated production rates) is much less than at a high ratio of variable costs to production rate.

The risk factor for each example estimate shown in Appendix D is given on the pages entitled "Bid Item Parameters." The risk factor is calculated from the fixed hourly operating cost of equipment, labor and labor taxes, all job overhead, and the probability of the

TABLE XVI

UNIT COST VERSUS OUTPUT, $200/HOUR OPERATING COST

Plant Size	Output Values	Unit Cost	% of Avg. Output	% of Avg. Cost	Marginal Cost
4000 lb	75 tph	$2.67/ton	75%	133%	
					$0.67
4000 lb	100 tph	$2.00/ton	100%	100%	
					$0.40
4000 lb	125 tph	$1.60/ton	125%	80%	
10,000 lb	187 tph	$1.06/ton	75%	133%	
					$0.26
10,000 lb	250 tph	$0.80/ton	100%	100%	
					$0.16
10,000 lb	313 tph	$0.64/ton	125%	80%	

production rate dropping from the expected rate to the least likely rate. In the case of the two asphalt plants, this probability is 0.5 and absolute risk is then double the expected risk. The range of cash costs, shown in the example estimates, verifies the mathematical derivations of Appendix C.

The histograms illustrate the skewness of the costs in contrast to the symmetry of the input production rate factors. The cause of this skewness is that there is a large "underproduction penalty" and a relatively small "overproduction bonus" for deviations from the expected production rate.

The first cost estimate for each plant is based upon using the modal production rate factors to calculate the project's cost. The total amount bid is then based upon the ownership cost described on the pages following the cost estimates. This estimate is essentially a modified machine-hour rate or direct cost estimate.

The second cost estimate for each plant also uses the modal production rate factor values to calculate the costs. The total amount bid is based upon a return on investment approach described on the pages following the second cost estimates.

The third cost estimate is derived from the means of the production rate factors obtained from the simulation process. The amount of contribution margin added to the direct cash costs, however, is obtained from the life cycle

cost system method of estimating illustrated in Chapter III. The net cash flow requirements and equipment lives are converted to months rather than years in order to facilitate the calculations. The net cash flow for the equipment is compared to the risk factor and the larger amount used as the required profit markup. The assumption is that the contractor would not want to risk the loss of cash but would be willing to take a calculated risk on the loss of capital recovered and return. The net cash flows available for equipment capital recovery and return vary considerably for the first two estimates as is demonstrated by the simulation process.

Another estimate entitled "Excavation General," is included as Appendix E to illustrate the variance in the estimating results obtained by a combination using single valued production rate factor values and machine-hour rate or direct cost calculations versus the simulation and life cycle cost estimating method. The range of cash flows available is the difference between the amount bid and the cash costs plus general overhead as the project is "constructed" one thousand times. The rates of return, the net cash flow distributions, and the financial accounting sheets which accompany each estimate verify the quality of the estimates as each estimate is compared to the others.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The state of the art of estimating costs and determining the amounts which should be bid on construction projects involving substantial equipment investment is essentially the use of traditional cost accounting methods as the basis of estimating. This paper has attempted to question the use of such standard rates as an estimating tool. A completely different approach has been offered which uses as its basis the well established discounted cash flow technique of analysis.

Traditional estimating methods result in "overbidding" on some projects and "underbidding" on others. The life cycle system model yields a "theoretically correct" bid on all projects.

Further research should be directed toward the implementation of the life cycle theory. Such standardization would improve the quality of contractor's estimates and, in the long run, be passed on to the consumer in the form of lower prices.

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APPENDIX A

LIFE CYCLE SYSTEM CALCULATIONS

AN INTERNAL RATE OF RETURN OF 12.8984%
APPLIES TO THESE PROJECTED CASH FLOWS:

YEAR	PROJECTED CASH FLOW
0	-100000.00
1	24945.00
2	24945.00
3	24945.00
4	24945.00
5	24945.00
6	24945.00

YEAR	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-100000.00	1.000000	-100000.00	0.0	0.0	0.0	0.0	0.0	100000.00
1	24945.00	0.885752	22095.09	12898.41	12898.41	12046.59	12046.59	24945.00	87953.38
2	24945.00	0.784558	19570.80	11344.59	24242.99	13600.41	25647.01	49890.00	74352.94
3	24945.00	0.694925	17334.89	9590.34	33833.34	15354.66	41001.66	74835.00	58998.34
4	24945.00	0.615532	15354.43	7609.84	41443.18	17335.16	58336.82	99780.00	41663.18
5	24945.00	0.545209	13600.23	5373.89	46817.07	19571.11	77907.88	124725.00	22092.13
6	24945.00	0.482921	12046.45	2849.53	49666.60	22095.46	100003.31	149670.00	-3.31

AN INTERNAL RATE OF RETURN OF 15.2343%
APPLIES TO THESE PROJECTED CASH FLOWS:

YEAR	PROJECTED CASH FLOW
0	-100000.00
1	30000.00
2	30000.00
3	30000.00
4	30000.00
5	30000.00

YEAR	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-100000.00	1.000000	-100000.00	0.0	0.0	0.0	0.0	0.0	100000.00
1	30000.00	0.867797	26033.92	15234.34	15234.34	14765.66	14765.66	30000.00	85234.31
2	30000.00	0.753073	22592.18	12984.88	28219.22	17015.12	31780.78	60000.00	68219.19
3	30000.00	0.653515	19605.44	10392.74	38611.96	19607.26	51388.04	90000.00	48611.96
4	30000.00	0.567118	17013.55	7405.71	46017.67	22594.29	73982.31	120000.00	26017.69
5	30000.00	0.492144	14764.32	3963.62	49981.29	26036.38	100018.69	150000.00	-18.69

AN INTERNAL RATE OF RETURN OF 18.4453%
APPLIES TO THESE PROJECTED CASH FLOWS:

YEAR	PROJECTED CASH FLOW
0	-100000.00
1	37500.00
2	37500.00
3	37500.00
4	37500.00

YEAR	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-100000.00	1.000000	-100000.00	0.0	0.0	0.0	0.0	0.0	100000.00
1	37500.00	0.844272	31660.21	18445.27	18445.27	19054.73	19054.73	37500.00	80945.25
2	37500.00	0.712796	26729.84	14930.57	33375.85	22569.43	41624.15	75000.00	58375.85
3	37500.00	0.601794	22567.27	10767.59	44143.43	26732.41	68356.56	112500.00	31643.44
4	37500.00	0.508078	19052.91	5836.72	49980.15	31663.28	100019.81	150000.00	-19.81

AN INTERNAL RATE OF RETURN OF 15.2343%
APPLIES TO THESE PROJECTED CASH FLOWS:

YEAR	PROJECTED CASH FLOW
0	-100000.00
1	30000.00
2	30000.00
3	30000.00
4	30000.00
5	30000.00

YEAR	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-100000.00	1.000000	-100000.00	0.0	0.0	0.0	0.0	0.0	100000.00
1	30000.00	0.867797	26033.92	15234.34	15234.34	14765.66	14765.66	30000.00	85234.31
2	30000.00	0.753073	22592.18	12984.88	28219.22	17015.12	31780.78	60000.00	68219.19
3	30000.00	0.653515	19605.44	10392.74	38611.96	19607.26	51388.04	90000.00	48611.96
4	30000.00	0.567118	17013.55	7405.71	46017.67	22594.29	73982.31	120000.00	26017.69
5	30000.00	0.492144	14764.32	3963.62	49981.29	26036.38	100018.69	150000.00	-18.69

AN INTERNAL RATE OF RETURN OF 18.5156%
APPLIES TO THESE PROJECTED CASH FLOWS:

YEAR	PROJECTED CASH FLOW
0	-100000.00
1	28970.00
2	28970.00
3	28970.00
4	28970.00
5	28970.00
6	28970.00

YEAR	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-100000.00	1.000000	-100000.00	0.0	0.0	0.0	0.0	0.0	100000.00
1	28970.00	0.843771	24444.04	18515.59	18515.59	10454.41	10454.41	28970.00	89545.56
2	28970.00	0.711949	20625.17	16579.89	35095.48	12390.11	22844.52	57940.00	77155.44
3	28970.00	0.600722	17402.92	14285.79	49381.27	14684.21	37528.73	86910.00	62471.27
4	28970.00	0.506872	14684.08	11566.92	60948.19	17403.08	54931.81	115880.00	45068.19
5	28970.00	0.427684	12390.00	8344.64	69292.81	20625.36	75557.13	144850.00	24442.88
6	28970.00	0.360867	10454.32	4525.74	73818.50	24444.26	100001.38	173820.00	-1.38

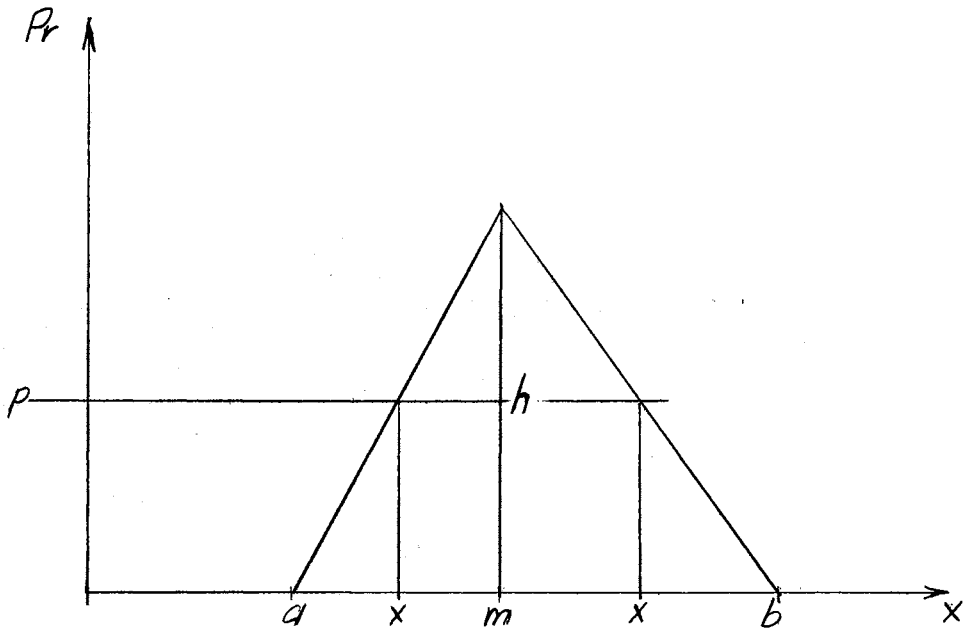
AN INTERNAL RATE OF RETURN OF 9.9297%
APPLIES TO THESE PROJECTED CASH FLOWS:

YEAR	PROJECTED CASH FLOW
0	-100000.00
1	31500.00
2	31500.00
3	31500.00
4	31500.00

YEAR	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-100000.00	1.000000	-100000.00	0.0	0.0	0.0	0.0	0.0	100000.00
1	31500.00	0.909673	28654.68	9929.66	9929.66	21570.34	21570.34	31500.00	78429.63
2	31500.00	0.827505	26066.40	7787.79	17717.45	23712.21	45282.55	63000.00	54717.45
3	31500.00	0.752758	23711.89	5433.25	23150.70	26066.75	71349.25	94500.00	28650.75
4	31500.00	0.684764	21570.07	2844.92	25995.62	28655.08	100004.31	126000.00	-4.31

APPENDIX B

TRIANGULAR PROBABILITY DISTRIBUTION



1) $\frac{p}{h} = \frac{x - a}{m - a}$ $\qquad x < m$

2) $\frac{p}{h} = \frac{b - x}{b - m}$ $\qquad x > m$

1) $p = \frac{h}{m - a}(x - a)$

2) $p = \frac{h}{b - m}(b - x)$

3) $1 = (\frac{1}{2})(h)(b - a)$

$h = \frac{2}{b - a}$

4) $\therefore p(x = pr) = \frac{h}{m - a}(x - a)$

$= \frac{\frac{2}{b - a}}{m - a}(x) - \frac{\frac{2}{b - a}}{m - a}(a)$

$= \frac{2x}{(b-a)(m-a)} - \frac{2a}{(b-a)(m-a)}$ $\qquad a < x < m$

5) $$p(x=pr) = \frac{-2x}{(b-a)(b-m)} + \frac{2b}{(b-a)(b-m)} \qquad m < x < b$$

Let:

$$s_1 = \frac{2}{(b-a)(m-a)} \qquad s_2 = \frac{2}{(b-a)(b-m)}$$

Then:

$$p = s_1 x - s_1 a \qquad a < x < m$$

$$p = -s_2 x + s_2 b \qquad m < x < b$$

Cummulative Probability Density Function

$a < x < m$

6) $$p(x \leq pr) = s_1 \int_a^x (x - a)dx$$

$$= \frac{s_1}{2}(x - a)^2 \Big|_a^x$$

$$= \frac{s_1}{2}(x - a)^2$$

$m < x < b$

7) $$p(x \leq pr) = -s_2 \int_m^x (b - x)dx + p(x \leq m)$$

$$= \frac{-s_2}{2}(b - x)^2 \Big|_m^x + p(x \leq m)$$

$$= \frac{-s_2}{2}(b - x)^2 + \frac{s_2}{2}(b - m)^2 + \frac{s_1}{2}(m - a)^2$$

Substituting in Equation (6)

8) $$p(x \leq pr) = \frac{2(x - a)^2}{2(b - a)(m - a)} \qquad a < x < m$$

Substituting in Equation (7)

$$9) \quad p(x \leq pr) = -\frac{2(b-x)^2}{2(b-a)(b-m)} + \frac{2(b-m)^2}{2(b-a)(b-m)} + \frac{2(m-a)^2}{2(b-a)(m-a)}$$

$$= \frac{-(b-x)^2}{(b-a)(b-m)} + \frac{(b-m)^2}{(b-a)(b-m)} + \frac{(m-a)}{(b-a)}$$

If YFL, a random number, is generated such that $0 < YFL < 1$, then YFL can be the cummulative probability of any x, such that $a \leq x \leq b$.

Substituting in Equation (8)

$$YFL = \frac{(x-a)^2}{(b-a)(m-a)}$$

$$(x-a)^2 = (YFL)(b-a)(m-a)$$

$$x - a = \sqrt{YFL(b-a)(m-a)}$$

$$x = \sqrt{YFL(b-a)(m-a)} + a \qquad a < x < m$$

Substituting in Equation (9)

$$YFL = -\frac{(b-x)^2}{(b-a)(b-m)} + \frac{(b-m)^2}{(b-a)(b-m)} + \frac{(m-a)}{(b-a)}$$

$$\frac{(b-x)^2}{(b-a)(b-m)} = -YFL + \frac{(b-m)^2}{(b-a)(b-m)} + \frac{(m-a)}{(b-a)}$$

$$(b-x)^2 = -YFL(b-a)(b-m) + (b-m)^2 + (m-a)(b-m)$$

$$b - x = \sqrt{-YFL(b-a)(b-m) + (b-m)^2 + (m-a)(b-m)}$$

$$x = b - \sqrt{-YFL(b-a)(b-m) + (b-m)^2 + (m-a)(b-m)}$$

$$m < x < b$$

APPENDIX C

DERIVATION OF THE GRIFFIS-MILLER RISK FACTOR (GMR)

A unit cost of construction consists of two variables. The first is crew cost per unit of time and the second is the production rate. If, y, is defined as the unit cost, x, as the production rate per unit of time, and, k, as the crew cost per unit of time, then:

$$y = \frac{k}{x} . \qquad (1)$$

If the crew cost per unit of time is constant, regardless of the production rate per unit of time, then the relationship is hyperbolic.

If, X, is the random variable associated with the production rate and the distribution, X, is triangular with a range, b - a, and a modal value of, m, as developed in Appendix B, then:

$$P[X=x] = f_X^{(1)}(x) = \frac{2(x-a)}{(b-a)(m-a)} \qquad a \leq x \leq m \qquad (2)$$

and

$$P[X=x] = f_X^{(2)}(x) = \frac{2(b-x)}{(b-a)(b-m)} \qquad m < x < b . \qquad (3)$$

The Cummulative Distribution Function (C.D.F.), of x, is then:

$$\int_{-\infty}^{x} f_X^{(1)}(x)dx = F_X^{(1)}(x) = \frac{(x-a)^2}{(b-a)(m-a)}, \quad a \leq x \leq m , \qquad (4)$$

and,

$$1 - \int_{x}^{\infty} f_X^{(2)}(x)dx = F_X^{(1)}(x) = 1 - \frac{(b-x)^2}{(b-a)(b-m)}\Big|_x^b$$

$$= 1 - \frac{(b-b)^2}{(b-a)(b-m)} + \frac{(b-x)^2}{(b-a)(b-m)}$$

$$= 1 - \frac{(b-x)^2}{(b-a)(b-m)} , \qquad m < x \leq b . \tag{5}$$

Because, $y = k/x$, then the CDF for the random variable, Y, is defined as,

$$P[Y \leq y] = P[Y \leq \frac{k}{x}]$$

$$= P[X \geq \frac{k}{y}]$$

$$= 1 - F_X(x)$$

$$= F_Y(y) . \tag{6}$$

Because the mapping function, k/y, is a one-to-one, monotonic, strictly decreasing function, from Equation (6),

$$F_Y^{(1)}(y) = \frac{(b - \frac{k}{y})^2}{(b-a)(b-m)} , \qquad \frac{k}{b} \leq \frac{k}{y} < \frac{k}{m} \tag{7}$$

and,

$$F_Y^{(2)}(y) = 1 - \frac{(\frac{k}{y} - a)^2}{(b-a)(m-a)} , \qquad \frac{k}{m} < \frac{k}{y} \leq \frac{k}{a} . \tag{8}$$

Therefore, the Probability Density Function (P.D.F.), for the random variable, Y, becomes,

$$\frac{d}{dy} F_Y^{(1)}(y) = \frac{-\frac{2k}{y^2}(b - \frac{k}{y})}{(b-a)(b-m)} ,$$

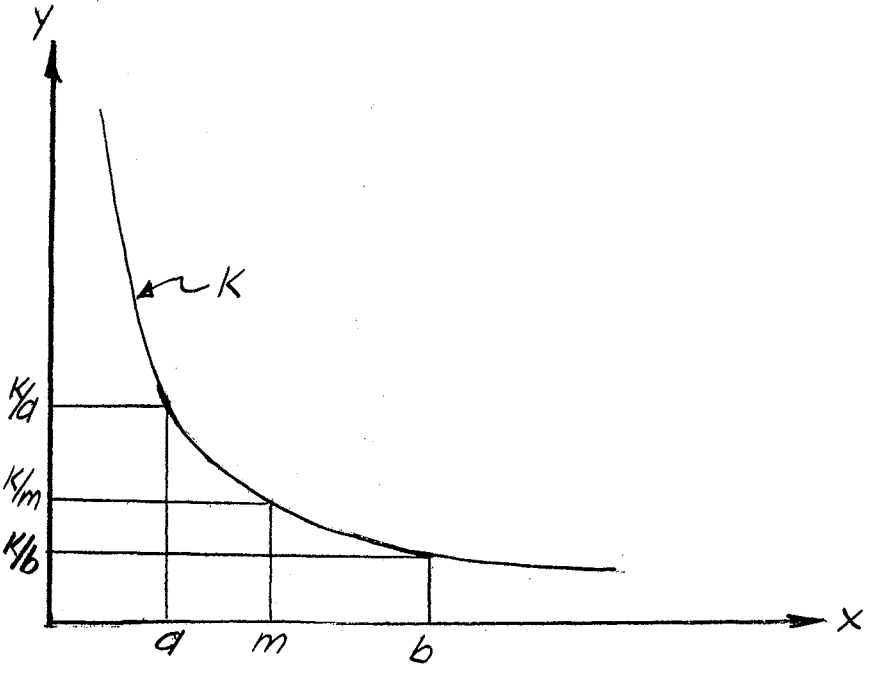
or,

$$f_Y^{(1)}(y) = \frac{2k\left(\frac{k}{y^3} - \frac{b}{y^2}\right)}{(b-a)(b-m)} , \qquad \frac{k}{b} \leq \frac{k}{y} < \frac{k}{m} , \tag{9}$$

and,

$$f_Y^{(2)}(y) = \frac{\left(\frac{k}{y^3} - \frac{a}{y^2}\right)^2}{(b-a)(m-a)} , \qquad \frac{k}{m} < \frac{k}{y} \leq \frac{k}{a} . \tag{10}$$

To find the relationship between the risk distribution and the mapping function, $y = k/x$,



the spread on, y, Δy, is given by,

$$\Delta_y^{(1)} = \frac{k}{m} - \frac{k}{b} = \frac{k(b-m)}{mb} , \tag{11}$$

and

$$\Delta_y^{(2)} = \frac{k}{a} - \frac{k}{m} = \frac{k(m-a)}{am} \quad . \tag{12}$$

The risk portion of the distribution of, y, is associated with the lower than expected production rates. Therefore, the risk function of interest is the linear functional,

$$\Delta_y^{(2)} = \frac{k(m-a)}{am} \quad ,$$

$$= k\left(\frac{1}{a} - \frac{1}{m}\right) \quad . \tag{13}$$

The risk may be defined as the spread above, k/m, times the probability of a having a production rate below the expected rate, m,

$$\text{RISK} \equiv k\left(\frac{1}{a} - \frac{1}{m}\right)p\left(Y \geq \frac{k}{m}\right) \quad ,$$

$$\equiv k\left(\frac{1}{a} - \frac{1}{m}\right)\left(1 - \frac{(m-a)^2}{(b-a)(m-a)}\right) \quad ,$$

$$\equiv k\left(\frac{m-a}{am}\right)p\left(y \geq \frac{k}{m}\right) \quad ,$$

$$\equiv k\left(\frac{m-a}{am}\right)\left(\frac{b-m}{b-a}\right) \quad ,$$

$$\text{GMR} \equiv k\left(\frac{m-a}{am}\right)\left(\frac{b-m}{b-a}\right) \quad . \tag{14}$$

The GMR is the increase in unit cost caused by a production rate decrease from the expected rate, m, to the least likely rate, a (absolute risk), times the probability of the production rate decreasing from, m, to, a (expected risk).

APPENDIX D

ASPHALT PLANT PROJECT ESTIMATES

PROJECT NAME: 4,000LB ASPHALT PLANT

LETTING DATE: 5- 1-1972

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PROJECT ESTIMATE PARAMETERS

****

ESTIMATED GENERAL OVERHEAD COSTS TO BE RECOVERED FROM THIS YEAR'S OPERATIONS

ESTIMATED COST OF MATERIALS OVERHEAD = $	10000.00
ESTIMATED COST OF LABOR OVERHEAD = $	135000.00
ESTIMATED COST OF EQUIPMENT OVERHEAD = $	30000.00
ESTIMATED OTHER OVERHEAD EXPENSES = $	33000.00
TOTAL EST OVERHEAD ALLOCATION, THIS YEAR = $	208000.00

MINIMUM ACCEPTABLE RETURN ON INVESTMENT = $ 20 % PER YEAR BEFORE INCOME TAX

BEGIN PRODUCTION MONTH 6

ESTIMATED VALUE, AT BEGINNING OF YEAR, ALL COMPANY'S PRODUCTIVE EQUIPMENT = $	500000.00
ESTIMATED VALUE, AT BEGINNING OF YEAR, EQUIPMENT SPREAD REQUIRED FOR THIS BID ITEM =$	250000.00
ESTIMATED VALUE OF THIS EQUIPMENT SPREAD WHEN NEW =$	480000.00
AVERAGE ECONOMIC LIFE, DEPRECIATION, CAPITAL RECOVERY PERIOD, IN HRS, FOR THIS SPREAD =	10000
THEREFORE, THE MINIMUM CAPITAL RECOVERY PER OPERATING HOUR = $	48.00

ESTIMATE NO: 0

BID ITEM PARAMETERS

HOURLY DIRECT LABOR COST = $	70.00	(NO FICA, WC, OR FRINGES)
HOURLY EQUIP OPERATING COST = $	90.00	AVG OVER LIFE OF EQUIP-FUEL, OIL, GREASE, TIRES, MAINT, ETC, OPERATING COSTS ONLY
UNIT PRICE, DIRECT MATERIAL = $	3.710	PER TON
OTHER DIRECT ESPENSES = $	8000.00	MOBILIZATION, SIGNS, ETC
LABOR TAXES, % OF DIRECT LABOR =	15 %	(WORKMENS COMP, FICA, UNEMPL, FRINGES)
OTHER, % OF TOTAL COST, ADDON =	5 %	(INSURANCE, BONDS, AGC, ETC)
LABOR INCREASE, OVER EQUIP HOURS =	12 %	
LEAST LIKELY PRODUCTION RATE =	75	TON/HOUR
MOST LIKELY PRODUCTION RATE =	100	TON/HOUR
OPTOMISTIC PRODUCTION RATE =	125	TON/HOUR
LEAST LIKELY PROD WEEK =	40	HOURS
MOST LIKELY PROD WEEK =	50	HOURS
OPTOMISTIC PROD WEEK =	60	HOURS
LEAST LIKELY PROD YEAR =	35	WEEKS
MOST LIKELY PROD YEAR =	40	WEEKS
OPTOMISTIC PROD YEAR =	45	WEEKS
JOB OVERHEAD LABOR =	360.00	PER WEEK
JOB OVERHEAD OTHER =	200.00	PER WEEK
TIME INTERVAL, IF KNOWN =	0	WEEKS, IF DIFFERENT FROM PRODUCTION PERIOD

ESTIMATE NO: 0

RISK FACTOR ANALYSIS

CASH COST/HR =	206.43
UNIT COST PENALTY =	0.34
GMR TOTAL =	34404.50

ITEM COST ESTIMATES
****

EXPECTED COSTS BASED UPON THE 'MOST LIKELY' RATES OF PRODUCTION
****

CODE	ITEM	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL	SUMMARY	UNIT COST
700	TYPE C ASPHALT	TON					
	DIRECT MATERIAL	TON	3.710	100000	370999.88		3.7100
	DIRECT LABOR	HR	70.00	1119	89494.88		0.8949
	EQUIPMENT OPERATION	HR	90.00	1000	90000.00		0.9000
	JOB OVERHEAD LABOR	JOB	($ 360.00 X	22 WEEKS) =	7920.00		0.0792
	OTHER JOB OVERHEAD	JOB	($ 200.00 X	22 WEEKS) =	4400.00		0.0440
	SUBCONTRACT	JOB	0.0		0.0		0.0
	OTHER DIRECT	LS			8000.00		0.0800
	PAYROLL TAXES, ETC	JOB	(15 % X $	97414.88	14612.23		0.1461
	INS, BONDS, AGC, ETC	%	(5 % X ($	746255.88 - 35829.04)=	35829.04		0.3583
	TOTAL DIRECT CASH COST					621255.94	6.2126
	EQUIPMENT RENTAL, (DEPR)	HR	(1000 HRS X $	48.00/HR) =	48000.00		0.4800
	TOTAL DIRECT COST					669255.94	6.6926
	GEN OH ALLOCATION	JOB	(50 % X 50 % = 25 % X $	208000.00)=	52000.00		0.5200
	TOTAL COST INCLUDING OVERHEAD ALLOCATION					721255.94	7.2126
	PROFIT = $	JOB			25000.00		0.2500
	BID =					746255.88	7.4626

THE OVERHEAD ALLOCATION IS:

8.4 % OF DIRECT CASH COST

7.8 % OF TOTAL DIRECT COST AND DEPR

7.2 % OF TOTAL COST AND OH

6.9 % OF AMOUNT BID

THE RETURN ON INVESTMENT PROFIT IS:

4.0 % OF DIRECT CASH COST

3.7 % OF TOTAL DIRECT COST AND DEPR

3.5 % OF TOTAL COST AND OH

3.4 % OF AMOUNT BID

ESTIMATE NO: 1

ITEM COST ESTIMATE BASIS

CALCULATION OF PRODUCTION TIME IS BASED UPON A PRODUCTION
RATE OF 100 TON PER HOUR 50 HOURS PER WEEK, = 5000 TON PER WEEK.
THE TOTAL 100000 TON DIVIDED BY 5000 TON PER WEEK = 20 WEEKS PRODUCTION TIME.
THIS ITEM SHOULD START MONTH 6 AND END, MONTH 12 .

CALCULATION OF THE GENERAL OVERHEAD ALLOCATION TO THIS BID ITEM
IS BASED UPON ITS REQUIRING 20 WEEKS PRODUCTION TIME OUT OF A TOTAL OF 40 WEEKS PRODUCTION
TIME FOR THE YEAR, OR, 50 % OF A PRODUCTION YEAR. FURTHERMORE, $ 250000.00 OF THE COMPANY'S
TOTAL $ 500000.00 PRODUCTIVE EQUIPMENT INVESTMENT, OR 50 % WILL BE USED ON THIS BID ITEM.
THEREFORE, 50 % OF THE COMPANY'S CURRENT EQUIPMENT INVESTMENT WILL BE USED ON THIS BID
ITEM 50 % OF A YEAR. 50 % X 50 % = 25 % OF THE GENERAL OVERHEAD SHOULD BE ALLOCATED TO THIS ITEM.

PROFIT = 20 % X $ 250000.00 = $ 50000.00 / YEAR X 50 % OF YEAR =$ 25000.00
OR OWNERSHIP COST = $ 50000.00 /2000 HRS/YR= $ 25.00 /HR X 1000 HOURS = $ 24999.98

ESTIMATE NO: 1

AN INTERNAL RATE OF RETURN OF 7.3125 % APPLIES TO THE FOLLOWING CASH FLOWS:

MONTH	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-480000.00	1.000000	-480000.00	0.0	0.0	0.0	0.0	0.0	480000.00
1	9725.48	0.993944	9666.58	2925.00	2925.00	6800.48	6800.48	9725.48	473199.50
2	9725.48	0.987925	9608.05	2883.56	5808.55	6841.93	13642.41	19450.97	466357.56
3	9725.48	0.981942	9549.86	2841.86	8650.41	6883.62	20526.03	29176.45	459473.94
4	9725.48	0.975997	9492.04	2799.92	11450.33	6925.57	27451.59	38901.94	452548.38
5	9725.48	0.970086	9434.56	2757.71	14208.04	6967.77	34419.36	48627.42	445580.63
6	9725.48	0.964212	9377.43	2715.25	16923.29	7010.23	41429.59	58352.91	438570.38
7	9725.48	0.958373	9320.64	2672.54	19595.83	7052.95	48482.54	68078.38	431517.44
8	9725.48	0.952570	9264.20	2629.56	22225.38	7095.93	55578.46	77803.81	424421.50
9	9725.48	0.946801	9208.10	2586.32	24811.70	7139.17	62717.63	87529.25	417282.31
10	9725.48	0.941068	9152.34	2542.81	27354.50	7182.67	69900.25	97254.69	410099.75
11	9725.48	0.935369	9096.92	2499.04	29853.54	7226.44	77126.69	106980.13	402873.31
12	9725.48	0.929706	9041.84	2455.01	32308.55	7270.48	84397.13	116705.56	395602.88
13	9725.48	0.924076	8987.09	2410.70	34719.25	7314.78	91711.88	126431.00	388288.13
14	9725.48	0.918481	8932.66	2366.13	37085.37	7359.36	99071.19	136156.44	380928.81
15	9725.48	0.912918	8878.57	2321.28	39406.65	7404.20	106475.38	145881.88	373524.63
16	9725.48	0.907391	8824.81	2276.16	41682.81	7449.32	113924.69	155607.31	366075.31
17	9725.48	0.901895	8771.37	2230.77	43913.58	7494.71	121419.38	165332.75	358580.63
18	9725.48	0.896434	8718.25	2185.10	46098.68	7540.38	128959.75	175058.19	351040.25
19	9725.48	0.891005	8665.46	2139.15	48237.82	7586.33	136546.06	184783.63	343453.94
20	9725.48	0.885611	8613.00	2092.92	50330.74	7632.56	144178.63	194509.06	335821.38
21	9725.48	0.880247	8560.83	2046.41	52377.15	7679.07	151857.69	204234.50	328142.31
22	9725.48	0.874917	8508.99	1999.62	54376.76	7725.87	159583.50	213959.94	320416.50
23	9725.48	0.869619	8457.46	1952.54	56329.30	7772.95	167356.44	223685.38	312643.56
24	9725.48	0.864354	8406.26	1905.17	58234.46	7820.31	175176.75	233410.81	304823.25
25	9725.48	0.859119	8355.34	1857.51	60091.98	7867.97	183044.69	243136.25	296955.31
26	9725.48	0.853917	8304.75	1809.57	61901.54	7915.91	190960.56	252861.69	289039.44
27	9725.48	0.848746	8254.46	1761.33	63662.88	7964.15	198924.69	262587.13	281075.31
28	9725.48	0.843607	8204.48	1712.80	65375.68	8012.68	206937.31	272312.56	273062.69
29	9725.48	0.838499	8154.80	1663.97	67039.63	8061.51	214998.81	282038.00	265001.19
30	9725.48	0.833421	8105.42	1614.85	68654.44	8110.63	223109.44	291763.44	256890.56
31	9725.48	0.828374	8056.33	1565.43	70219.81	8160.06	231269.44	301488.88	248730.56
32	9725.48	0.823358	8007.55	1515.70	71735.50	8209.78	239479.19	311214.31	240520.81
33	9725.48	0.818372	7959.06	1465.67	73201.13	8259.81	247738.94	320939.75	232261.06
34	9725.48	0.813416	7910.87	1415.34	74616.44	8310.14	256049.06	330665.19	223950.94
35	9725.48	0.808491	7862.96	1364.70	75981.13	8360.78	264409.81	340390.63	215590.19
36	9725.48	0.803595	7815.35	1313.75	77294.88	8411.73	272821.50	350116.06	207178.50
37	9725.48	0.798729	7768.02	1262.49	78557.31	8462.99	281284.44	359841.50	198715.56
38	9725.48	0.793892	7720.98	1210.92	79768.19	8514.56	289799.00	369566.94	190201.00
39	9725.48	0.789084	7674.22	1159.04	80927.19	8566.45	298365.44	379292.38	181634.56
40	9725.48	0.784306	7627.76	1106.83	82034.00	8618.65	306984.06	389017.81	173015.94
41	9725.48	0.779557	7581.57	1054.31	83088.31	8671.17	315655.19	398743.25	164344.81
42	9725.48	0.774836	7535.66	1001.48	84089.75	8724.01	324379.19	408468.69	155620.81
43	9725.48	0.770144	7490.02	948.31	85038.06	8777.17	333156.31	418194.13	146843.69
44	9725.48	0.765481	7444.67	894.83	85932.88	8830.66	341986.94	427919.56	138013.06
45	9725.48	0.760845	7399.59	841.02	86773.88	8884.46	350871.38	437645.00	129128.63
46	9725.48	0.756238	7354.78	786.88	87560.75	8938.61	359809.94	447370.44	120190.06
47	9725.48	0.751659	7310.24	732.41	88293.13	8993.07	368803.00	457095.88	111197.00
48	9725.48	0.747108	7265.98	677.61	88970.69	9047.88	377850.88	466821.31	102149.13
49	9725.48	0.742583	7221.98	622.47	89593.13	9103.01	386953.88	476546.75	93046.13
50	9725.48	0.738087	7178.25	567.00	90160.06	9158.48	396112.31	486272.19	83887.69
51	9725.48	0.733617	7134.78	511.19	90671.25	9214.29	405326.56	495997.63	74673.44
52	9725.48	0.729175	7091.58	455.04	91126.25	9270.44	414597.00	505723.06	65403.00
53	9725.48	0.724759	7048.63	398.55	91524.75	9326.93	423923.88	515448.50	56076.13
54	9725.48	0.720370	7005.95	341.71	91866.44	9383.77	433307.63	525173.94	46692.38
55	9725.48	0.716008	6963.52	284.53	92150.94	9440.95	442748.56	534899.38	37251.44
56	9725.48	0.711673	6921.36	227.00	92377.94	9498.48	452247.00	544624.81	27753.00
57	9725.48	0.707363	6879.44	169.12	92547.00	9556.36	461803.31	554350.25	18196.69
58	9725.48	0.703080	6837.79	110.89	92657.88	9614.60	471417.88	564075.69	8582.13
59	9725.48	0.698822	6796.38	52.30	92710.13	9673.18	481091.00	573801.13	-1091.00

ESTIMATE NO: 1

BEGINNING BALANCE SHEET

WORKING CAPITAL, CASH		61539.97
GROSS EQUIP, THIS BID ITEM	480000.00	
CAPITAL RECOVERED, (ACCUM DEPREC)	230000.00	
NET EQUIP, THIS BID ITEM		250000.00
OTHER CO. EQUIP (AT PRESENT VALUE)		250000.00
TOTAL EQUIPMENT INVESTMENT		500000.00
TOTAL ASSETS		561539.94
TAXES PAYABLE, RESERVE		0.0
NET WORTH		561539.94
TOTAL LIABILITIES AND NET WORTH		561539.94

INCOME STATEMENT

SALES		752409.88
DIRECT CASH OUTLAYS		
LABOR	112027.06	
MATERIALS	370999.88	
EQUIPMENT	90000.00	
SUBCONTRACT	0.0	
OTHER	48229.04	
TOTAL DIRECT CASH COST		621255.94
GROSS MARGIN, CASH CONTRIBUTION		131153.94

APPLIED PERIOD COST (INDIRECT MTL, LAB, EQUIP)		52000.00
CAPITAL RECOVERED (DEPRECIATION)		48000.00
NET PROFIT		31153.94

ENDING BALANCE SHEET
****

CASH (WORKING CAPITAL + CASH INCOME)		192693.88
GROSS EQUIPMENT	480000.00	
CAPITAL RECOVERED (ACCUM DEPREC)	278000.00	
NET EQUIPMENT		202000.00
OTHER CO. EQUIP		250000.00
TOTAL EQUIP		452000.00
TOTAL ASSETS		644693.88
TAXES PAYABLE RESERVE (AT 50% OF NET INCOME)		15576.97
NET WORTH		629116.88
TOTAL LIABILITIES AND NET WORTH		644693.88

ESTIMATE NO: 1

ITEM COST ESTIMATES

****

EXPECTED COSTS BASED UPON THE 'MOST LIKELY' RATES OF PRODUCTION

****

CODE	ITEM	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL	SUMMARY	UNIT COST
7CC	TYPE C ASPHALT	TON					
	DIRECT MATERIAL	TON	3.710	100000	370999.88		3.7100
	DIRECT LABOR	HR	70.00	1119	112027.06		0.8949
	EQUIPMENT OPERATION	HR	90.00	1000	90000.00		0.9000
	JOB OVERHEAD LABOR	JOB	($ 360.00	X 22 WEEKS) =	7920.00		0.0792
	OTHER JOB OVERHEAD	JOB	($ 200.00	X 22 WEEKS) =	4400.00		0.0440
	SUBCONTRACT	JOB	0.0		0.0		0.0
	OTHER DIRECT	LS			8000.00		0.0800
	PAYROLL TAXES, ETC	JOB	(15 % X $	97414.88	14612.23		0.1461
	INS, BONDS, AGC, ETC	%	(5 % X ($	752409.88 - 48229.04)=	48229.04		0.3583
	TOTAL DIRECT CASH COST					621255.94	6.2126
	CAPITAL RECOVERY, (DEPR)	HR	(1000 HRS X $	48.00/HR) =	48000.00		0.4800
	TOTAL DIRECT COST					669255.94	6.6926
	GEN OH ALLOCATION	JOB	(50 % X 50 % = 25 % X $ 208000.00)=		52000.00		0.5200
	TOTAL COST INCLUDING OVERHEAD ALLOCATION					721255.94	7.2126
	RETURN ON INVESTMENT, PROFIT	JOB			31153.98		0.3115
	TOTAL FULL COST, MIN BID REQ'D FOR A 20 % RET ON INV =					752409.88	7.5241

THE OVERHEAD ALLOCATION IS:

8.4 % OF DIRECT CASH COST

7.8 % OF TOTAL DIRECT COST AND DEPR

7.2 % OF TOTAL COST AND OH

6.9 % OF AMOUNT BID

THE RETURN ON INVESTMENT PROFIT IS:

5.0 % OF DIRECT CASH COST

4.7 % OF TOTAL DIRECT COST AND DEPR

4.3 % OF TOTAL COST AND OH

4.1 % OF AMOUNT BID

ESTIMATE NO: 2

ITEM COST ESTIMATE BASIS
****

CALCULATION OF PRODUCTION TIME IS BASED UPON A PRODUCTION
RATE OF 100 TON PER HOUR 50 HOURS PER WEEK, = 5000 TON PER WEEK.
THE TOTAL 100000 TON DIVIDED BY 5000 TON PER WEEK = 20 WEEKS PRODUCTION TIME.
THIS ITEM SHOULD START MONTH 6 AND END, MONTH 12 .

****

CALCULATION OF THE GENERAL OVERHEAD ALLOCATION TO THIS BID ITEM
IS BASED UPON ITS REQUIRING 20 WEEKS PRODUCTION TIME OUT OF A TOTAL OF 40 WEEKS PRODUCTION
TIME FOR THE YEAR, OR, 50 % OF A PRODUCTION YEAR. FURTHERMORE, $ 250000.00 OF THE COMPANY'S
TOTAL $ 500000.00 PRODUCTIVE EQUIPMENT INVESTMENT, OR 50 % WILL BE USED ON THIS BID ITEM.
THEREFORE, 50 % OF THE COMPANY'S CURRENT EQUIPMENT INVESTMENT WILL BE USED ON THIS BID
ITEM 50 % OF A YEAR. 50 % X 50 % = 25 % OF THE GENERAL OVERHEAD SHOULD BE ALLOCATED TO THIS ITEM.

****

ESTIMATED WORKING CAPITAL REQUIREMENTS ARE FOUR WEEKS PAYROLL PLUS 10% OF ONE MONTH'S
DIRECT MATERIAL AND EQUIPMENT OPERATING COSTS, A TOTAL, $ 61539.97 FOR THIS ITEM
THE MINIMUM ACCEPTABLE RETURN ON INVESTMENT, OR PROFIT, FOR THIS ITEM IS THE 20 % ANNUAL
RETURN REQUIRED TIMES THE SUM OF THE $ 61539.97 WORKING CAPITAL AND THE $ 250000.00
CURRENT EQUIPMENT INVESTMENT TIMES 50 % OF A PROD YEAR = THE REQUIRED PROFIT, $ 31153.98.

****

ESTIMATE NO: 2

AN INTERNAL RATE OF RETURN OF 11.3437 % APPLIES TO THE FOLLOWING CASH FLOWS:

MONTH	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-480000.00	1.000000	-480000.00	0.0	0.0	0.0	0.0	0.0	480000.00
1	10672.21	0.990636	10572.27	4537.49	4537.49	6134.71	6134.71	10672.21	473865.25
2	10672.21	0.981360	10473.27	4479.50	9016.99	6192.71	12327.42	21344.41	467672.56
3	10672.21	0.972170	10375.20	4420.96	13437.95	6251.25	18578.67	32016.62	461421.31
4	10672.21	0.963067	10278.05	4361.87	17799.82	6310.34	24889.01	42688.83	455110.94
5	10672.21	0.954049	10181.80	4302.21	22102.04	6369.99	31259.00	53361.04	448741.00
6	10672.21	0.945116	10086.47	4242.00	26344.03	6430.21	37689.21	64033.24	442310.75
7	10672.21	0.936265	9992.02	4181.21	30525.24	6491.00	44180.21	74705.44	435819.75
8	10672.21	0.927498	9898.45	4119.85	34645.09	6552.36	50732.56	85377.63	429267.44
9	10672.21	0.918814	9805.77	4057.91	38703.01	6614.29	57346.86	96049.81	422653.13
10	10672.21	0.910210	9713.95	3995.39	42698.39	6676.82	64023.67	106722.00	415976.31
11	10672.21	0.901687	9622.98	3932.27	46630.66	6739.93	70763.56	117394.19	409236.44
12	10672.21	0.893244	9532.88	3868.56	50499.22	6803.65	77567.19	128066.38	402432.81
13	10672.21	0.884879	9443.61	3804.24	54303.46	6867.96	84435.13	138738.56	395564.88
14	10672.21	0.876594	9355.20	3739.32	58042.78	6932.89	91368.00	149410.75	388632.00
15	10672.21	0.868385	9267.59	3673.78	61716.56	6998.42	98366.38	160082.94	381633.63
16	10672.21	0.860254	9180.80	3607.63	65324.19	7064.58	105430.94	170755.13	374569.06
17	10672.21	0.852198	9094.83	3540.84	68865.00	7131.36	112562.25	181427.31	367437.75
18	10672.21	0.844218	9009.67	3473.43	72338.38	7198.77	119761.00	192099.50	360239.00
19	10672.21	0.836313	8925.30	3405.38	75743.75	7266.82	127027.81	202771.69	352972.19
20	10672.21	0.828482	8841.73	3336.69	79080.38	7335.52	134363.31	213443.88	345636.69
21	10672.21	0.820724	8758.93	3267.34	82347.69	7404.86	141768.13	224116.06	338231.88
22	10672.21	0.813040	8676.93	3197.34	85545.00	7474.86	149242.94	234788.25	330757.06
23	10672.21	0.805426	8595.67	3126.68	88671.63	7545.52	156788.44	245460.44	323211.56
24	10672.21	0.797884	8515.18	3055.36	91726.94	7616.85	164405.25	256132.63	315594.75
25	10672.21	0.790413	8435.45	2983.35	94710.25	7688.85	172094.06	266804.81	307905.94
26	10672.21	0.783012	8356.46	2910.67	97620.88	7761.54	179855.56	277477.00	300144.44
27	10672.21	0.775680	8278.21	2837.30	100458.13	7834.91	187690.44	288149.19	292309.56
28	10672.21	0.768416	8200.69	2763.24	103221.31	7908.97	195599.38	298821.38	284400.63
29	10672.21	0.761221	8123.91	2688.47	105909.75	7983.73	203583.06	309493.56	276416.94
30	10672.21	0.754093	8047.84	2613.00	108522.75	8059.20	211642.25	320165.75	268357.75
31	10672.21	0.747031	7972.47	2536.82	111059.56	8135.39	219777.63	330837.94	260222.38
32	10672.21	0.740036	7897.82	2459.91	113519.44	8212.29	227989.88	341510.13	252010.13
33	10672.21	0.733107	7823.87	2382.28	115901.69	8289.93	236279.75	352182.31	243720.25
34	10672.21	0.726242	7750.61	2303.92	118205.56	8368.29	244648.00	362854.50	235352.00
35	10672.21	0.719442	7678.03	2224.81	120430.31	8447.39	253095.38	373526.69	226904.63
36	10672.21	0.712705	7606.14	2144.96	122575.25	8527.25	261622.63	384198.88	218377.38
37	10672.21	0.706031	7534.91	2064.35	124639.56	8607.86	270230.44	394871.06	209769.56
38	10672.21	0.699420	7464.36	1982.98	126622.50	8689.23	278919.63	405543.25	201080.38
39	10672.21	0.692871	7394.46	1900.84	128523.31	8771.37	287690.94	416215.44	192309.06
40	10672.21	0.686383	7325.22	1817.92	130341.19	8854.29	296545.19	426887.63	183454.81
41	10672.21	0.679956	7256.63	1734.22	132075.38	8937.98	305483.13	437559.81	174516.88
42	10672.21	0.673589	7188.68	1649.73	133725.06	9022.48	314505.56	448232.00	165494.44
43	10672.21	0.667281	7121.36	1564.44	135289.50	9107.77	323613.31	458904.19	156386.69
44	10672.21	0.661033	7054.68	1478.34	136767.81	9193.86	332807.13	469576.38	147192.88
45	10672.21	0.654843	6988.62	1391.43	138159.19	9280.77	342087.88	480248.56	137912.13
46	10672.21	0.648712	6923.18	1303.70	139462.88	9368.51	351456.38	490920.75	128543.63
47	10672.21	0.642637	6858.35	1215.14	140678.00	9457.07	360913.44	501592.94	119086.56
48	10672.21	0.636619	6794.13	1125.74	141803.69	9546.46	370459.88	512265.13	109540.13
49	10672.21	0.630657	6730.50	1035.50	142839.13	9636.71	380096.56	522937.31	99903.44
50	10672.21	0.624753	6667.49	944.40	143783.50	9727.81	389824.31	533609.50	90175.69
51	10672.21	0.618902	6605.05	852.44	144635.94	9819.77	399644.06	544281.69	80355.94
52	10672.21	0.613107	6543.21	759.61	145395.50	9912.59	409556.63	554953.88	70443.38
53	10672.21	0.607366	6481.93	665.91	146061.38	10006.30	419562.88	565626.06	60437.13
54	10672.21	0.601679	6421.24	571.32	146632.69	10100.89	429663.75	576298.25	50336.25
55	10672.21	0.596045	6361.11	475.83	147108.50	10196.37	439860.06	586970.44	40139.94
56	10672.21	0.590463	6301.54	379.45	147487.94	10292.76	450152.81	597642.63	29847.19
57	10672.21	0.584935	6242.54	282.15	147770.06	10390.05	460542.81	608314.81	19457.19
58	10672.21	0.579458	6184.09	183.93	147953.94	10488.27	471031.06	618987.00	8968.94
59	10672.21	0.574031	6126.18	84.78	148038.69	10587.42	481618.44	629659.19	-1618.44

ESTIMATE NO: 2

BEGINNING BALANCE SHEET

WORKING CAPITAL, CASH		61539.97
GROSS EQUIP, THIS BID ITEM	480000.00	
CAPITAL RECOVERED, (ACCUM DEPREC)	230000.00	
NET EQUIP, THIS BID ITEM		250000.00
OTHER CO. EQUIP (AT PRESENT VALUE)		250000.00
TOTAL EQUIPMENT INVESTMENT		500000.00
TOTAL ASSETS		561539.94
TAXES PAYABLE, RESERVE		0.0
NET WORTH		561539.94
TOTAL LIABILITIES AND NET WORTH		561539.94

INCOME STATEMENT

SALES		752409.88
DIRECT CASH OUTLAYS		
LABOR	112027.06	
MATERIALS	370999.88	
EQUIPMENT	90000.00	
SUBCONTRACT	0.0	
OTHER	60629.04	
TOTAL DIRECT CASH COST		621255.94
GROSS MARGIN, CASH CONTRIBUTION		131153.94

APPLIED PERIOD COST (INDIRECT MTL, LAB, EQUIP)	52000.00
CAPITAL RECOVERED (DEPRECIATION)	48000.00
NET PROFIT	31153.94

ENDING BALANCE SHEET

CASH (WORKING CAPITAL + CASH INCOME)		192693.88
GROSS EQUIPMENT	480000.00	
CAPITAL RECOVERED (ACCUM DEPREC)	278000.00	
NET EQUIPMENT		202000.00
OTHER CO. EQUIP		250000.00
TOTAL EQUIP		452000.00
TOTAL ASSETS		644693.88
TAXES PAYABLE RESERVE (AT 50% OF NET INCOME)		15576.97
NET WORTH		629116.88
TOTAL LIABILITIES AND NET WORTH		644693.88

ESTIMATE NO: 2

ESTIMATE FROM SIMULATIONS
****

EXPECTED COSTS BASED UPON THE GENERATED PROD RATE AND COST DISTRIBUTIONS
****

***** NOTE ***** TOTALS AND SUMMARYS ARE DERIVED FROM DISTRIBUTION MEANS AND NOT BY ADDITION

CODE	ITEM	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL	SUMMARY	UNIT COST
700	TYPE C ASPHALT	TON					
	DIRECT MATERIAL	TON	3.710	100000	370999.88		3.7100
	DIRECT LABOR	HR	70.00	1119	88923.50		0.8892
	EQUIPMENT OPERATION	HR	90.00	1000	90000.00		0.9000
	JOB OVERHEAD LABOR	JOB	($ 360.00 X 22 WEEKS) =		7920.00		0.0792
	OTHER JOB OVERHEAD	JOB	($ 200.00 X 22 WEEKS) =		4400.00		0.0440
	SUBCONTRACT	JOB	0.0		0.0		0.0
	OTHER DIRECT	LS			8000.00		0.0800
	PAYROLL TAXES, ETC	JOB	(15 % X $ 96843.50		14526.52		0.1453
	INS, BONDS, AGC, ETC	%	(5 % X ($ 751718.19 - 35988.35)=		35988.35		0.3599
	TOTAL DIRECT CASH COST					622428.13	6.2076
	GEN OH ALLOCATION	JOB	(52 % X 50 % = 26 % X $ 208000.00)=		54421.74		0.5442
	TOTAL COST INCLUDING OVERHEAD ALLOCATION					676849.81	6.7685
	CAPITAL RECOVERY & RETURN	JOB			74868.38		0.7487
	TOTAL BID REQUIRED					751718.19	7.5172

THE OVERHEAD ALLOCATION IS:

8.8 % OF DIRECT CASH COST

8.1 % OF TOTAL DIRECT COST AND DEPR

7.5 % OF TOTAL COST AND OH

7.2 % OF AMOUNT BID

THE RETURN ON INVESTMENT PROFIT IS:

12.0 % OF DIRECT CASH COST

11.2 % OF TOTAL DIRECT COST AND DEPR

11.1 % OF TOTAL COST AND OH

10.0 % OF AMOUNT BID

ESTIMATE NO: 3

ITEM COST ESTIMATE BASIS

****

***** THE FOLLOWING IS BASED UPON A RUN OF 1000 SIMULATIONS *****

CALCULATION OF PRODUCTION TIME IS BASED UPON A PRODUCTION

RATE OF 100 TON PER HOUR 49 HOURS PER WEEK, = 4900 TON PER WEEK.

THE TOTAL 100000 TON DIVIDED BY 4900 TON PER WEEK = 20 WEEKS PRODUCTION TIME.

THIS ITEM SHOULD START MONTH 6 AND END, MONTH 12 .

****

CALCULATION OF THE GENERAL OVERHEAD ALLOCATION TO THIS BID ITEM

IS BASED UPON ITS REQUIRING 20 WEEKS PRODUCTION TIME OUT OF A TOTAL OF 39 WEEKS PRODUCTION

TIME FOR THE YEAR, OR, 52 % OF A PRODUCTION YEAR. FURTHERMORE, $ 250000.00 OF THE COMPANY'S

TOTAL $ 500000.00 PRODUCTIVE EQUIPMENT INVESTMENT, OR 50 % WILL BE USED ON THIS BID ITEM.

THEREFORE, 50 % OF THE COMPANY'S CURRENT EQUIPMENT INVESTMENT WILL BE USED ON THIS BID

ITEM 52 % OF A YEAR. 50 % X 52 % = 26 % OF THE GENERAL OVERHEAD SHOULD BE ALLOCATED TO THIS ITEM.

****

ESTIMATED WORKING CAPITAL REQUIREMENTS ARE FOUR WEEKS PAYROLL PLUS 10% OF ONE MONTH'S

DIRECT MATERIAL AND EQUIPMENT OPERATING COSTS, A TOTAL, $ 61259.97 FOR THIS ITEM

THE MINIMUM ACCEPTABLE RETURN ON INVESTMENT, OR PROFIT, FOR THIS ITEM IS THE 20 % ANNUAL

RETURN REQUIRED TIMES THE SUM OF THE $ 61259.97 WORKING CAPITAL AND THE $ 250000.00

CURRENT EQUIPMENT INVESTMENT TIMES 52 % OF A PROD YEAR = THE REQUIRED PROFIT, $ 74868.38.

****

AN INTERNAL RATE OF RETURN OF 14.1562 % APPLIES TO THE FOLLOWING CASH FLOWS:

MONTH	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-480000.00	1.000000	-480000.00	0.0	0.0	0.0	0.0	0.0	480000.00
1	11230.26	0.988342	11099.33	5662.49	5662.49	5567.77	5567.77	11230.26	474432.19
2	11230.26	0.976820	10969.94	5596.81	11259.30	5633.45	11201.21	22460.52	468798.75
3	11230.26	0.965432	10842.05	5530.36	16789.66	5699.90	16901.11	33690.77	463098.88
4	11230.26	0.954177	10715.66	5463.11	22252.77	5767.14	22668.26	44921.03	457331.69
5	11230.26	0.943054	10590.74	5395.08	27647.85	5835.18	28503.44	56151.29	451496.56
6	11230.26	0.932060	10467.27	5326.24	32974.09	5904.02	34407.45	67381.50	445592.50
7	11230.26	0.921193	10345.24	5256.59	38230.69	5973.66	40381.12	78611.75	439618.88
8	11230.26	0.910455	10224.64	5186.12	43416.81	6044.14	46425.25	89842.00	433574.69
9	11230.26	0.899840	10105.44	5114.82	48531.63	6115.44	52540.69	101072.25	427459.25
10	11230.26	0.889350	9987.63	5042.68	53574.30	6187.58	58728.27	112302.50	421271.69
11	11230.26	0.878982	9871.20	4969.68	58543.99	6260.57	64988.85	123532.75	415011.13
12	11230.26	0.868736	9756.12	4895.83	63439.82	6334.43	71323.25	134763.00	408676.75
13	11230.26	0.858608	9642.39	4821.10	68260.88	6409.16	77732.38	145993.25	402267.63
14	11230.26	0.848599	9529.98	4745.50	73006.31	6484.76	84217.13	157223.50	395782.88
15	11230.26	0.838705	9418.87	4669.00	77675.25	6561.26	90778.38	168453.75	389221.63
16	11230.26	0.828928	9309.07	4591.59	82266.81	6638.66	97417.00	179684.00	382583.00
17	11230.26	0.819264	9200.54	4513.28	86780.06	6716.98	104133.94	190914.25	375866.06
18	11230.26	0.809713	9093.29	4434.04	91214.06	6796.22	110930.13	202144.50	369069.88
19	11230.26	0.800273	8987.28	4353.87	95567.88	6876.39	117806.50	213374.75	362193.50
20	11230.26	0.790944	8882.50	4272.75	99840.56	6957.51	124764.00	224605.00	355236.00
21	11230.26	0.781724	8778.96	4190.67	104031.19	7039.59	131803.56	235835.25	348196.44
22	11230.26	0.772610	8676.61	4107.63	108138.81	7122.63	138926.19	247065.50	341073.81
23	11230.26	0.763603	8575.46	4023.60	112162.38	7206.65	146132.81	258295.75	333867.19
24	11230.26	0.754701	8475.49	3938.59	116100.94	7291.67	153424.44	269526.00	326575.56
25	11230.26	0.745903	8376.68	3852.57	119953.50	7377.69	160802.13	280756.25	319197.88
26	11230.26	0.737207	8279.02	3765.53	123719.00	7464.72	168266.81	291986.50	311733.19
27	11230.26	0.728613	8182.51	3677.47	127396.44	7552.78	175819.56	303216.75	304180.44
28	11230.26	0.720119	8087.12	3588.38	130984.81	7641.88	183461.44	314447.00	296538.56
29	11230.26	0.711724	7992.84	3498.23	134483.00	7732.03	191193.44	325677.25	288806.56
30	11230.26	0.703427	7899.66	3407.01	137890.00	7823.24	199016.63	336907.50	280983.38
31	11230.26	0.695226	7807.57	3314.72	141204.69	7915.53	206932.13	348137.75	273067.88
32	11230.26	0.687121	7716.55	3221.34	144426.00	8008.91	214941.00	359368.00	265059.00
33	11230.26	0.679111	7626.59	3126.87	147552.81	8103.39	223044.38	370598.25	256955.63
34	11230.26	0.671194	7537.68	3031.27	150584.06	8198.98	231243.31	381828.50	248756.69
35	11230.26	0.663369	7449.80	2934.55	153518.56	8295.71	239539.00	393058.75	240461.00
36	11230.26	0.655636	7362.96	2836.69	156355.19	8393.57	247932.56	404289.00	232067.44
37	11230.26	0.647993	7277.12	2737.67	159092.81	8492.59	256425.13	415519.25	223574.88
38	11230.26	0.640439	7192.29	2637.48	161730.25	8592.77	265017.88	426749.50	214982.13
39	11230.26	0.632972	7108.43	2536.12	164266.31	8694.14	273712.00	437979.75	206288.00
40	11230.26	0.625593	7025.57	2433.55	166699.81	8796.70	282508.69	449210.00	197491.31
41	11230.26	0.618300	6943.66	2329.78	169029.56	8900.48	291409.13	460440.25	188590.88
42	11230.26	0.611092	6862.71	2224.78	171254.31	9005.48	300414.56	471670.50	179585.44
43	11230.26	0.603968	6782.71	2118.55	173372.81	9111.71	309526.25	482900.75	170473.75
44	11230.26	0.596927	6703.64	2011.06	175383.81	9219.20	318745.44	494131.00	161254.56
45	11230.26	0.589968	6625.49	1902.30	177286.06	9327.96	328073.38	505361.25	151926.63
46	11230.26	0.583090	6548.25	1792.26	179078.31	9438.00	337511.38	516591.50	142488.63
47	11230.26	0.576292	6471.91	1680.92	180759.19	9549.34	347060.69	527821.75	132939.31
48	11230.26	0.569574	6396.46	1568.27	182327.44	9661.99	356722.63	539052.00	123277.38
49	11230.26	0.562934	6321.89	1454.29	183781.69	9775.97	366498.56	550282.25	113501.44
50	11230.26	0.556371	6248.19	1338.96	185120.63	9891.29	376389.81	561512.50	103610.19
51	11230.26	0.549885	6175.35	1222.28	186342.88	10007.98	386397.75	572742.75	93602.25
52	11230.26	0.543475	6103.36	1104.21	187447.06	10126.04	396523.75	583973.00	83476.25
53	11230.26	0.537139	6032.21	984.76	188431.81	10245.50	406769.19	595203.25	73230.81
54	11230.26	0.530877	5961.89	863.89	189295.69	10366.36	417135.50	606433.50	62864.50
55	11230.26	0.524688	5892.38	741.60	190037.25	10488.65	427624.13	617663.75	52375.88
56	11230.26	0.518571	5823.69	617.87	190655.06	10612.39	438236.50	628894.00	41763.50
57	11230.26	0.512526	5755.79	492.68	191147.69	10737.58	448974.06	640124.25	31025.94
58	11230.26	0.506551	5688.70	366.01	191513.69	10864.25	459838.25	651354.50	20161.75
59	11230.26	0.500645	5622.38	237.85	191751.50	10992.41	470830.63	662584.75	9169.38
60	11230.26	0.494809	5556.83	108.17	191859.63	11122.09	481952.69	673815.00	-1952.69

BEGINNING BALANCE SHEET

WORKING CAPITAL, CASH		61259.97
GROSS EQUIP, THIS BID ITEM	480000.00	
CAPITAL RECOVERED, (ACCUM DEPREC)	230000.00	
NET EQUIP, THIS BID ITEM		250000.00
OTHER CO. EQUIP (AT PRESENT VALUE)		250000.00
TOTAL EQUIPMENT INVESTMENT		500000.00
TOTAL ASSETS		561259.94
TAXES PAYABLE, RESERVE		0.0
NET WORTH		561259.94
TOTAL LIABILITIES AND NET WORTH		561259.94

INCOME STATEMENT

SALES		751718.19
DIRECT CASH OUTLAYS		
LABOR	111370.00	
MATERIALS	370999.88	
EQUIPMENT	90000.00	
SUBCONTRACT	0.0	
OTHER	48388.35	
TOTAL DIRECT CASH COST		622428.13
GROSS MARGIN, CASH CONTRIBUTION		129290.06

APPLIED PERIOD COST (INDIRECT MTL, LAB, EQUIP)		54421.74
CAPITAL RECOVERED (DEPRECIATION)		48000.00
NET PROFIT		26868.31

ENDING BALANCE SHEET
****

CASH (WORKING CAPITAL + CASH INCOME)		190550.00
GROSS EQUIPMENT	480000.00	
CAPITAL RECOVERED (ACCUM DEPREC)	278000.00	
NET EQUIPMENT		202000.00
OTHER CO. EQUIP		250000.00
TOTAL EQUIP		452000.00
TOTAL ASSETS		642550.00
TAXES PAYABLE RESERVE (AT 50% OF NET INCOME)		13434.16
NET WORTH		629115.81
TOTAL LIABILITIES AND NET WORTH		642550.00

ESTIMATE NO: 3

PROBABILITY STATEMENTS

THE FOLLOWING PROBABILITY STATEMENTS ARE BASED UPON THE RESULTS OF THE SIMULATION PROCESS.

VARIABLE NAME	LOWEST PROBABLE VALUE	PROBABLE AVERAGE VALUE	HIGHEST PROBABLE VALUE	PROBABILITY OF VALUE GREATER THAN THE AVERAGE
PRODUCTION RATE	80 TON/HR	100 TON/HR	120 TON/HR	53.0 %
HOURS PER WEEK	43 HOURS	49 HOURS	59 HOURS	61.0 %
WEEKS PER YEAR	35 WEEKS	39 WEEKS	43 WEEKS	65.0 %
DIRECT CASH COST	$ 572774.63	$ 622428.13	$ 672081.56	46.0 %
TOTAL DIRECT COST	$ 618247.94	$ 670765.81	$ 730411.06	46.0 %
TOTAL COST AND OH	$ 618036.75	$ 676549.88	$ 738073.00	45.0 %
TOTAL COST AND PROFIT	$ 697141.81	$ 757818.88	$ 821122.81	45.0 %

**** NOTE ***** THERE IS A 95% PROBABILITY THAT ALL VALUES WILL LIE BETWEEN THE HIGH AND LOW VALUES SHOWN.

ESTIMATE NO: 3

CUMULATIVE PROBABILITY DISTRIBUTION, ONE THOUSAND SIMULATIONS

PRODUCTION RATE, UNITS/HOUR

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	75	100	123	10	
75.00					99.80 %
79.00					97.90 %
83.00					94.20 %
87.00					87.50 %
91.00					78.80 %
95.00					68.30 %
99.00					53.60 %
103.00					38.00 %
107.00					24.80 %
111.00					16.30 %
115.00					8.50 %
119.00					2.00 %

PRODUCTION HOURS/ WEEK

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	40	49	59	3	
40.00					99.80 %
41.58					98.60 %
43.17					93.60 %
44.75					89.30 %
46.33					76.40 %
47.92					69.70 %
49.50					52.60 %
51.08					32.40 %
52.67					23.50 %
54.25					13.30 %
55.83					7.80 %
57.42					2.00 %

PRODUCTION WEEKS/YEAR

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	35	39	44	2	
35.00					97.10 %
35.75					97.10 %
36.50					89.60 %
37.25					78.70 %
38.00					65.90 %
38.75					65.90 %
39.50					48.90 %
40.25					31.30 %
41.00					16.10 %
41.75					16.10 %
42.50					7.00 %
43.25					1.90 %

ESTIMATE NO: 3

TOTAL DIRECT CASH COST

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	578935.94	622428.13	695463.06	24826.72	
578935.94					99.90 %
588646.50					94.40 %
598357.13					83.00 %
608067.69					70.80 %
617778.31					53.80 %
627488.88					36.90 %
637199.50					25.00 %
646910.06					16.40 %
656620.69					9.50 %
666331.25					5.50 %
676041.88					2.70 %
685752.44					1.10 %

TOTAL AMOUNT OF BID

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	697141.81	757818.88	854713.69	31652.00	
697141.81					99.90 %
710272.75					96.30 %
723403.75					86.30 %
736534.75					73.40 %
749665.75					57.40 %
762796.75					39.40 %
775927.69					25.80 %
789058.69					16.20 %
802189.69					9.70 %
815320.69					5.20 %
828451.69					2.20 %
841582.63					0.70 %

NET CASH FLOW, EQUIP, EXPECTED VALUES

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	-33589.44	63215.61	123982.31	30773.95	
-33589.44					99.90 %
-20458.46					99.30 %
-7327.48					97.80 %
5803.49					94.80 %
18934.47					90.30 %
32065.44					83.80 %
45196.38					74.20 %
58327.38					60.60 %
71458.38					42.60 %
84589.31					26.60 %
97720.31					13.70 %
110851.25					3.70 %

ESTIMATE NO: 3

NET CASH FLOW EQUIP, ROI APPROACH

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	-27435.44	69369.31	130136.31	30775.48	
-27435.44					99.90 %
-14304.46					99.30 %
-1173.48					97.80 %
11957.49					94.80 %
25088.47					90.30 %
38219.44					83.80 %
51350.38					74.20 %
64481.38					60.60 %
77612.38					42.60 %
90743.31					26.60 %
103874.31					13.70 %
117005.25					3.70 %

NET CASH FLOW, EQUIP, LIFE CYCLE SYSTEM

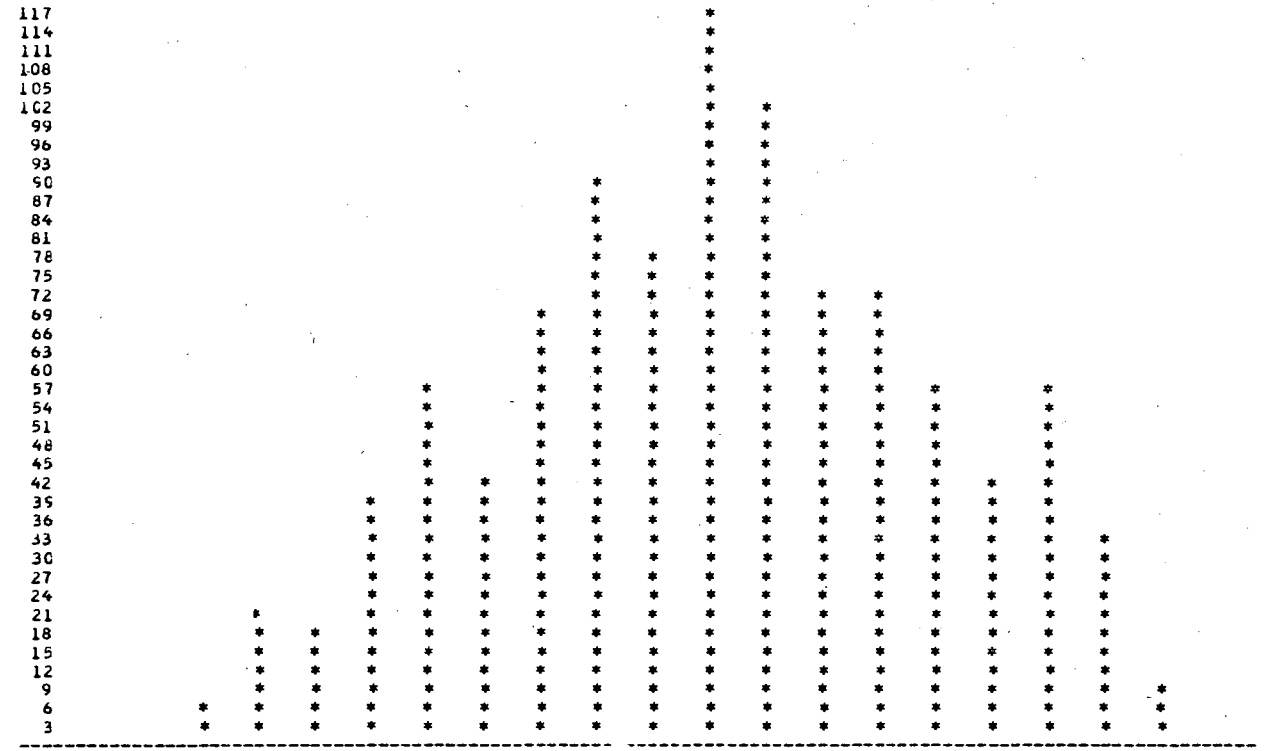
NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	-76471.31	20337.93	81100.44	30767.45	
-76471.31					99.90 %
-63340.34					99.30 %
-50209.36					97.80 %
-37078.38					94.80 %
-23947.41					90.30 %
-10816.44					83.80 %
2314.50					74.20 %
15445.50					60.60 %
28576.50					42.60 %
41707.44					26.60 %
54838.44					13.70 %
67969.38					3.70 %

ESTIMATE NO: 3

HISTOGRAM 1

FREQUENCY	0	8	21	19	39	57	44	70	91	79	117	103	74	73	59	44	57	34	10	1

EACH * EQUALS 3 POINTS



INTERVAL CLASS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

TOTAL = 100324.00 AVERAGE = 100.324 STANDARD DEVIATION = 10.327 MINIMUM = 75.000 MAXIMUM = 123.000

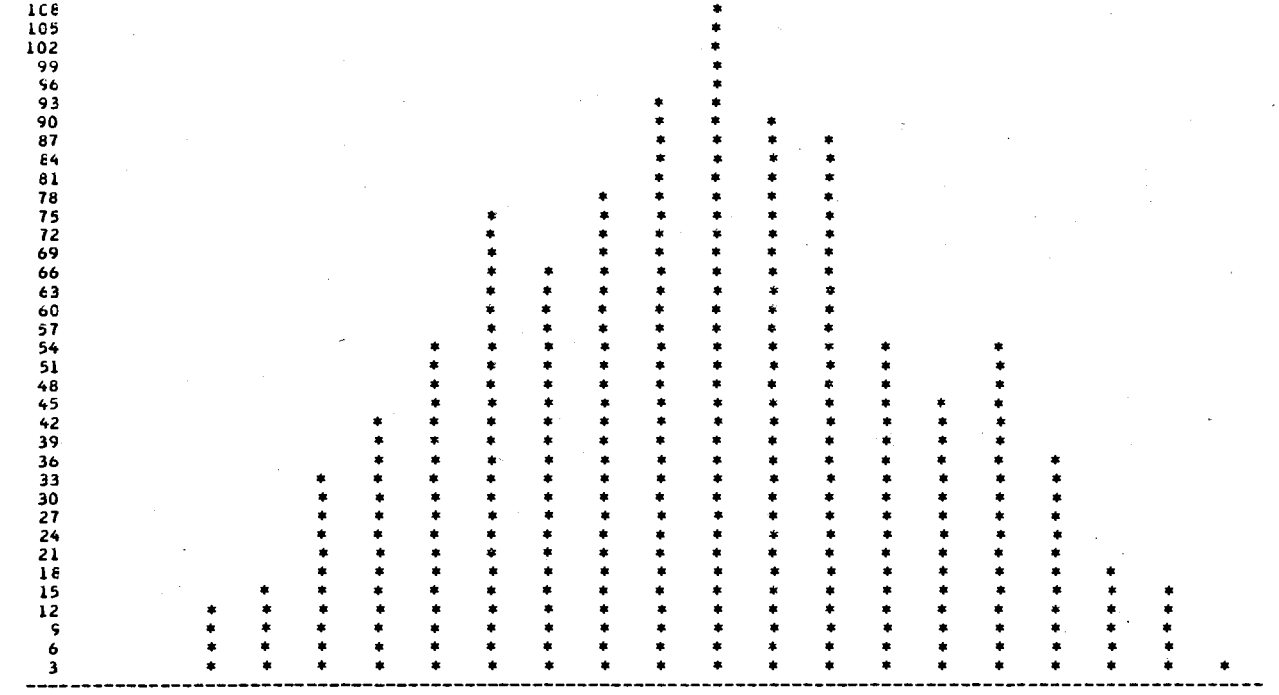
PRODUCTION RATE, UNITS/HOUR

ESTIMATE NO: 3

HISTOGRAM 2

FREQUENCY 0 14 16 34 43 54 75 67 78 93 110 92 89 56 46 55 38 20 15 5

EACH * EQUALS 3 POINTS



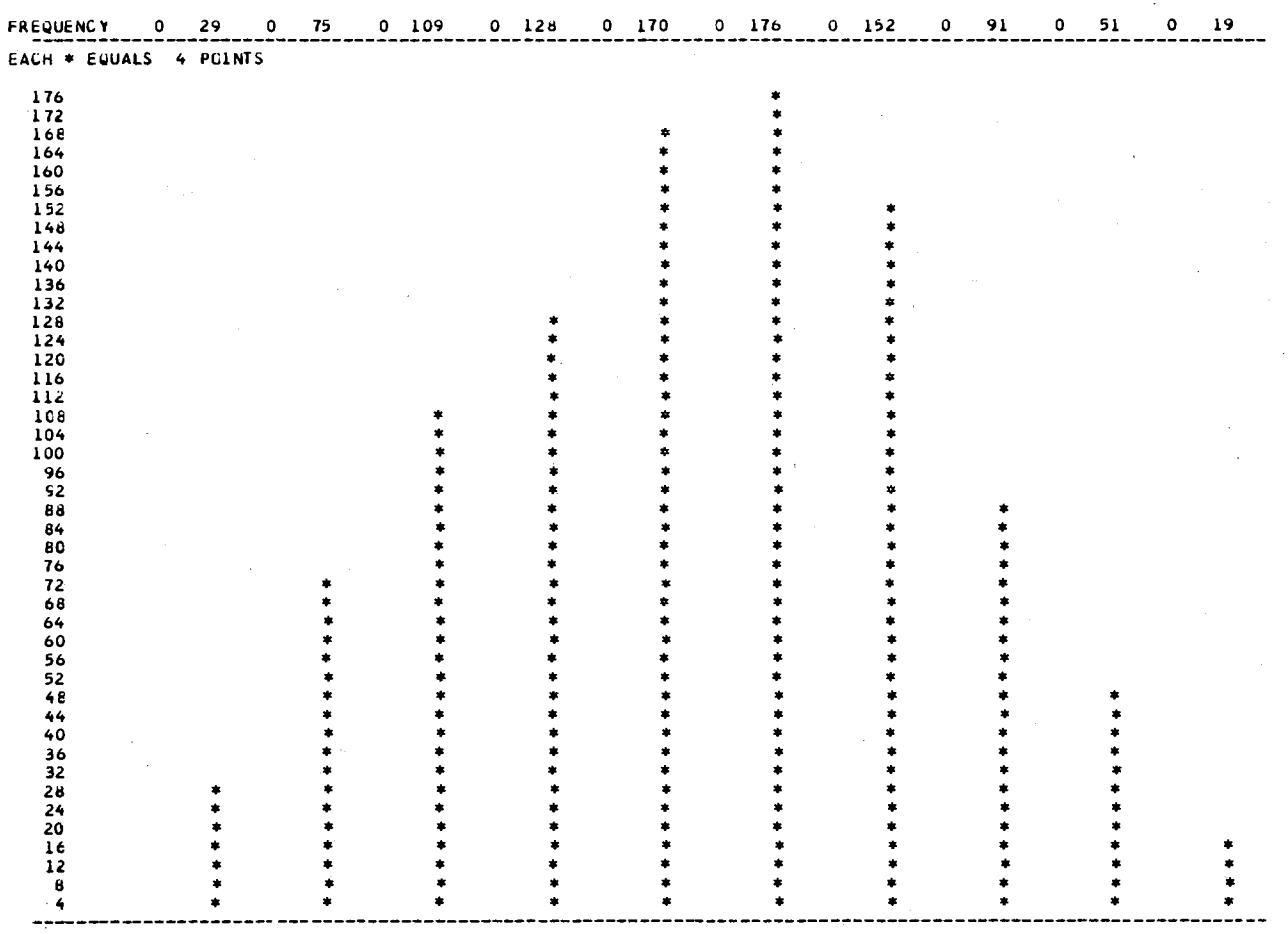
INTERVAL CLASS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

TOTAL = 49658.00 AVERAGE = 49.658 STANDARD DEVIATION = 3.955 MINIMUM = 40.000 MAXIMUM = 59.000

PRODUCTION HOURS/ WEEK

ESTIMATE NO: 3

HISTOGRAM 3

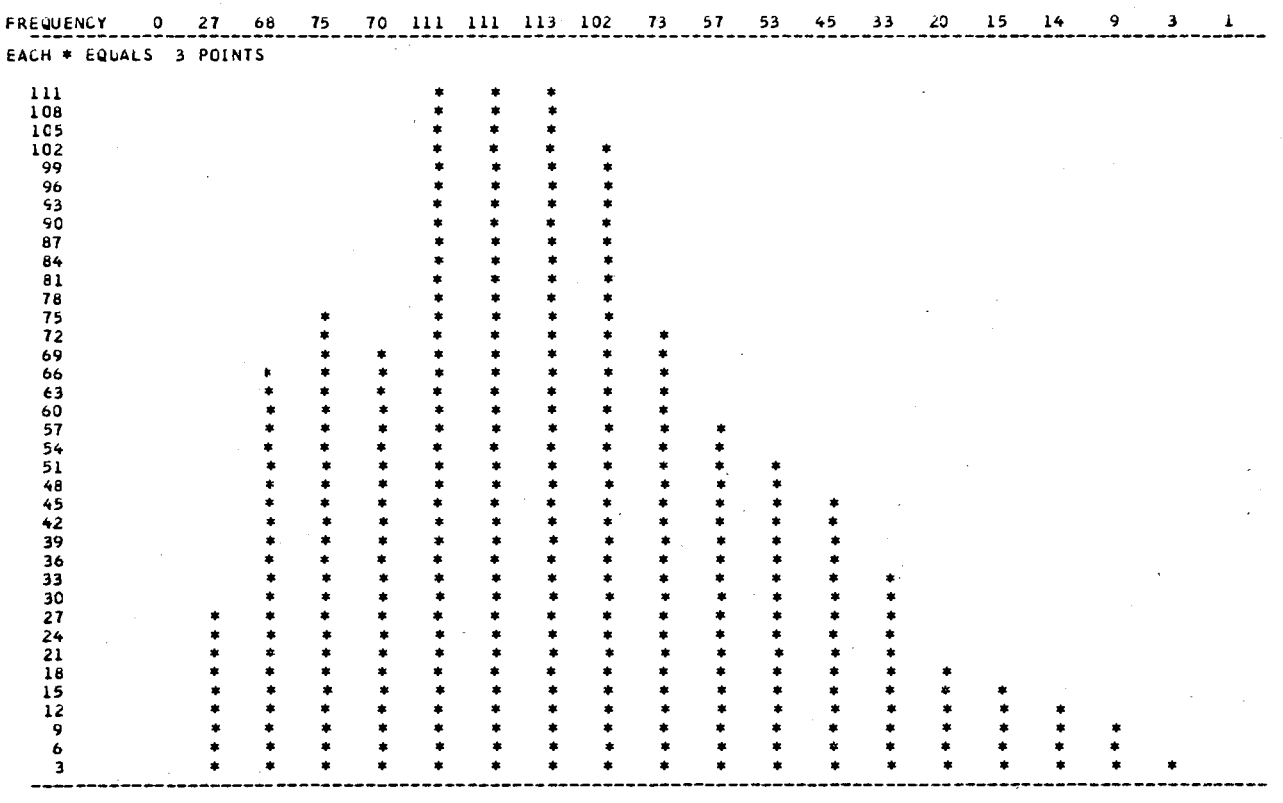


TOTAL = 39365.00 AVERAGE = 39.365 STANDARD DEVIATION = 2.114 MINIMUM = 35.000 MAXIMUM = 44.000

PRODUCTION WEEKS/YEAR

ESTIMATE NO: 3

HISTOGRAM 4

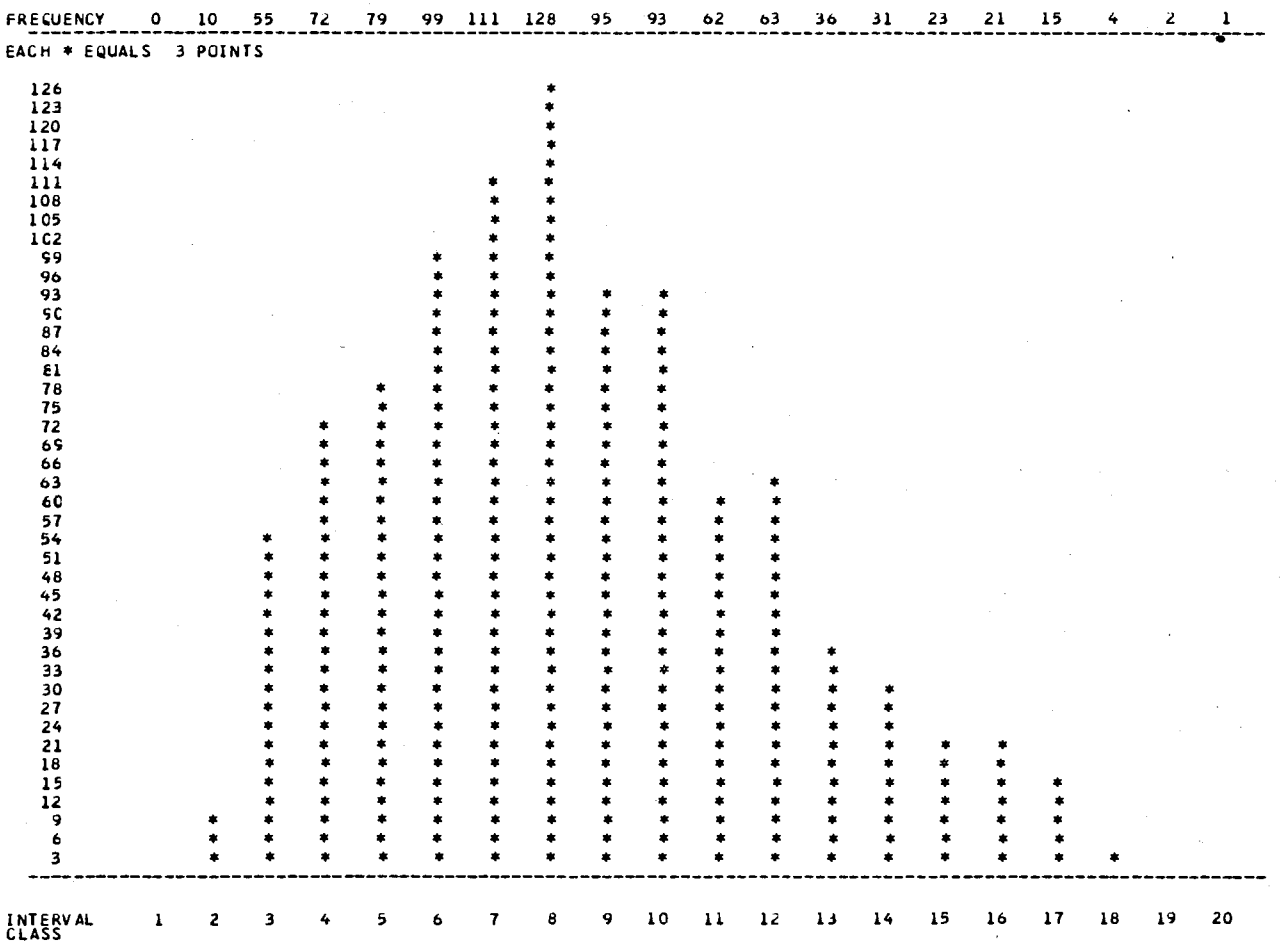


TOTAL = 622428160.00 AVERAGE =622428.125 STANDARD DEVIATION = 24843.781 MINIMUM =578935.938 MAXIMUM =695463.063

TOTAL DIRECT CASH COST

ESTIMATE NO: 3

HISTOGRAM 5



TOTAL = 757818880.00 AVERAGE =757818.875 STANDARD DEVIATION = 31671.320 MINIMUM =697141.813 MAXIMUM =854713.688

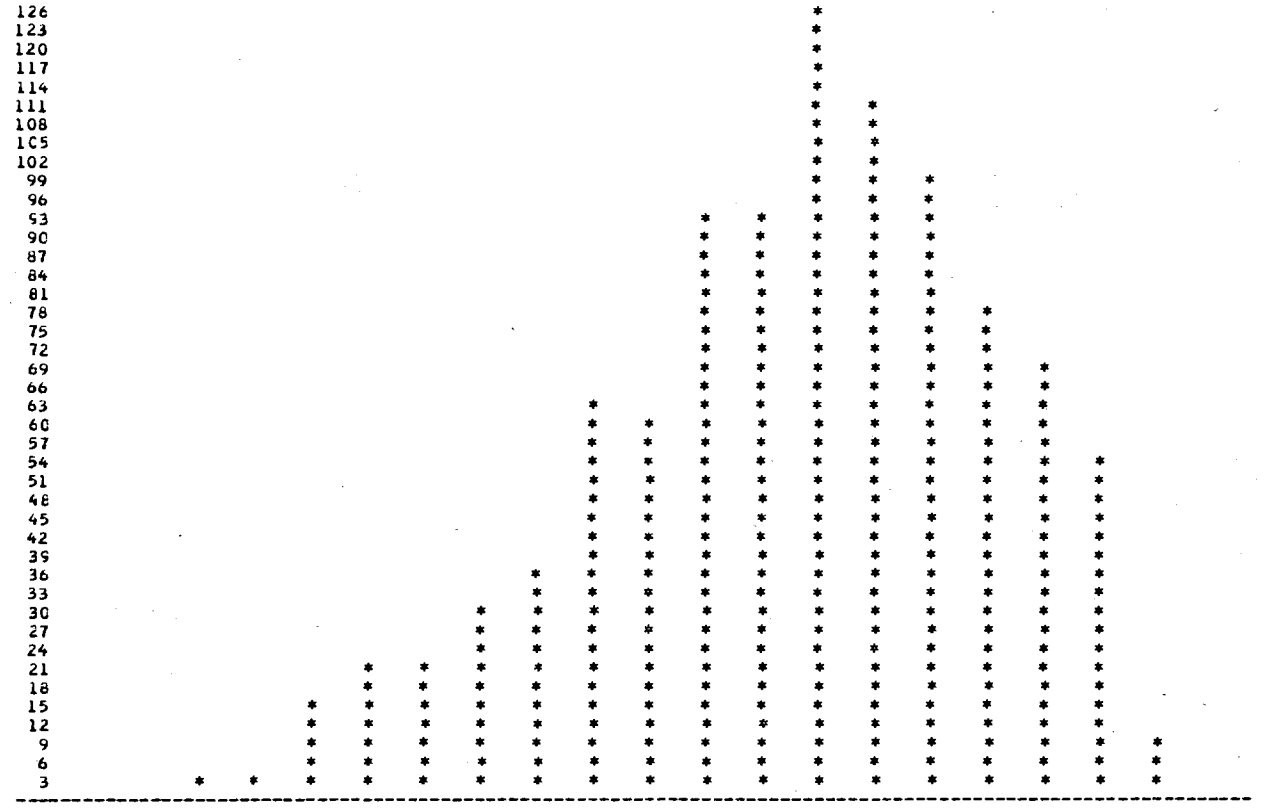
TOTAL AMOUNT OF BID

ESTIMATE NO: 3

HISTOGRAM 6

FREQUENCY	0	3	4	15	21	23	31	36	63	62	93	95	128	111	99	79	71	56	9	1

EACH * EQUALS 3 POINTS



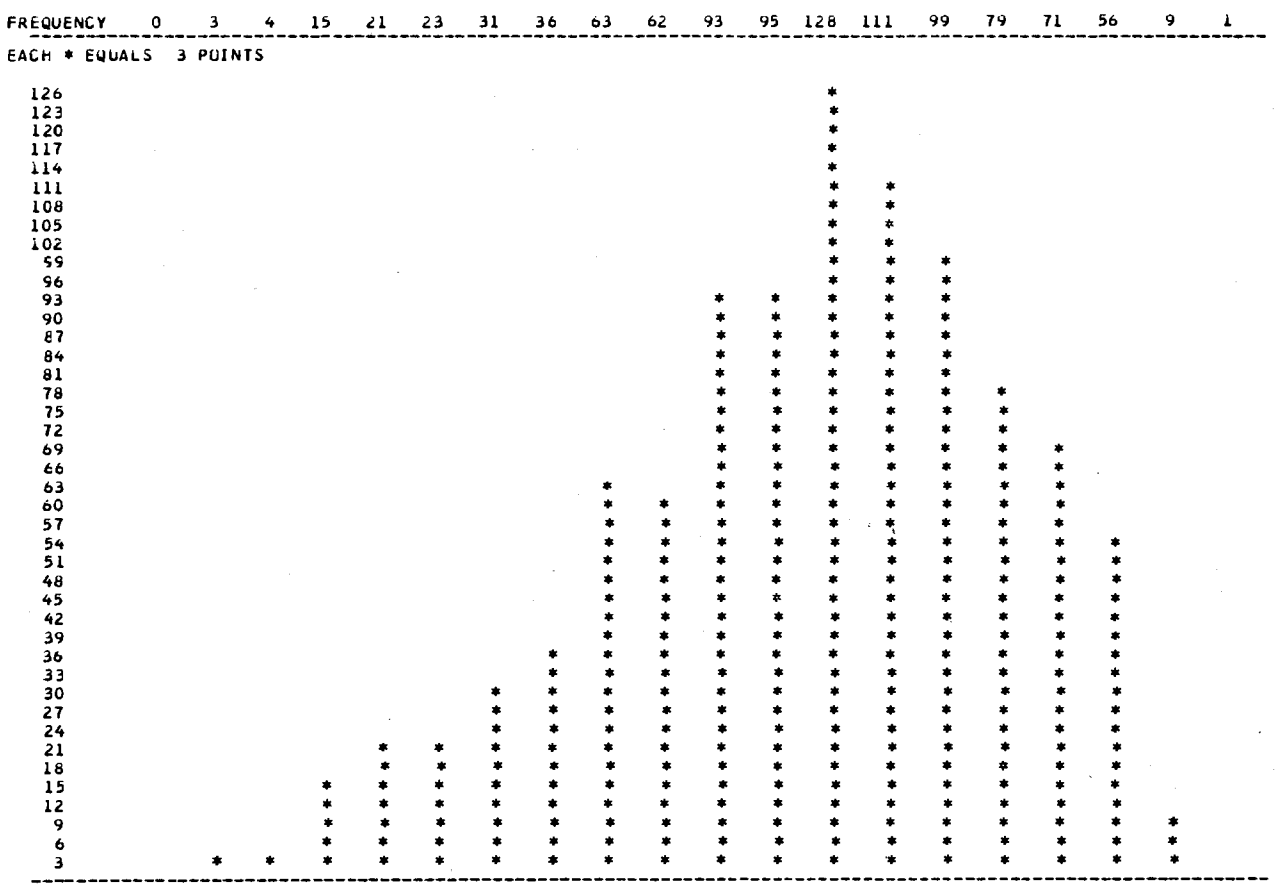
INTERVAL CLASS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

TOTAL = 63215616.00 AVERAGE = 63215.613 STANDARD DEVIATION = 30789.348 MINIMUM =-33589.438 MAXIMUM =123982.313

NET CASH FLOW, EQUIP, EXPECTED VALUES

ESTIMATE NO: 3

HISTOGRAM 7

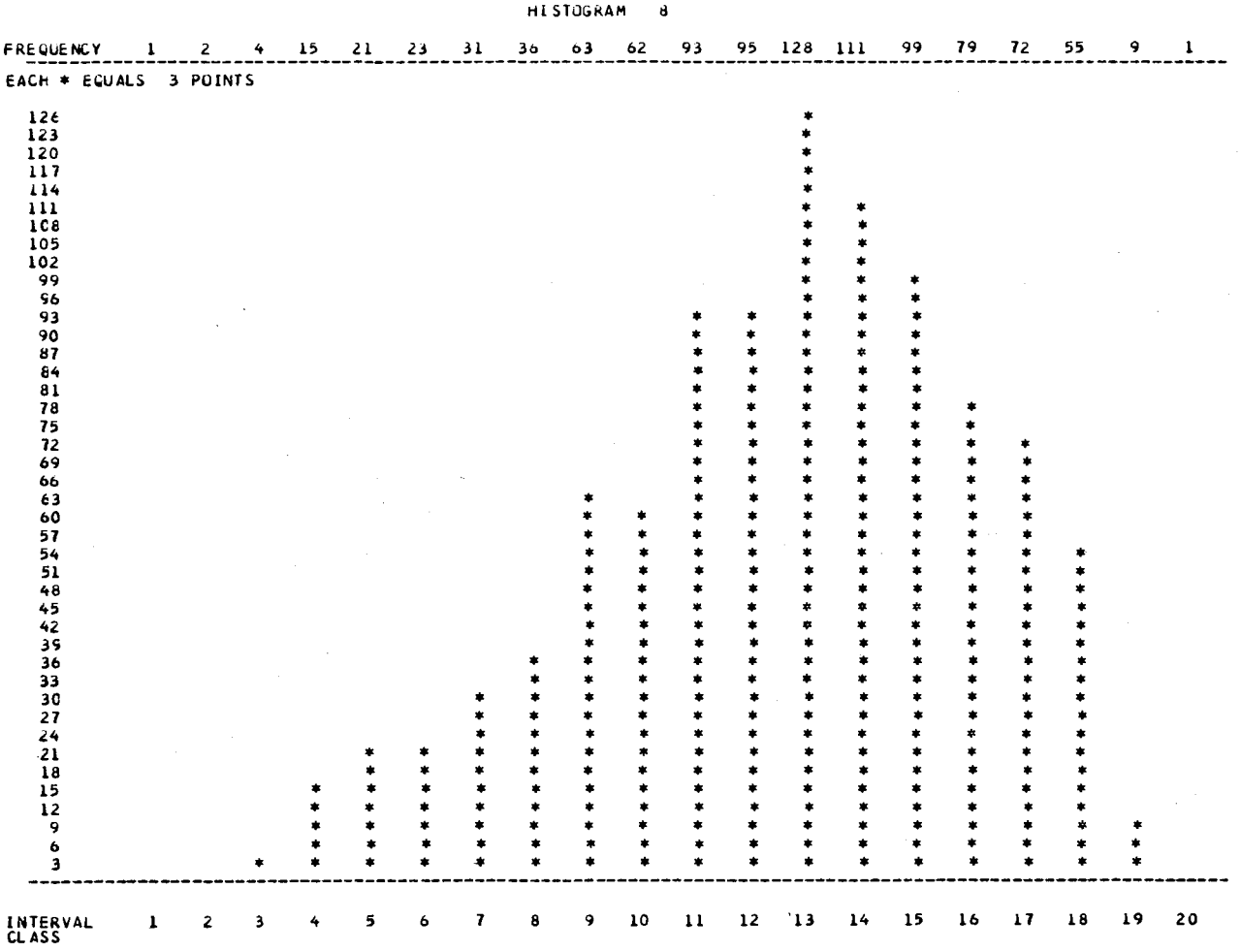


TOTAL = 69369344.00 AVERAGE = 69369.313 STANDARD DEVIATION = 30790.879 MINIMUM =-27435.438 MAXIMUM =130136.313

NET CASH FLOW EQUIP, ROI APPROACH

ESTIMATE NO: 3

HISTOGRAM 8



TOTAL = 20337936.00 AVERAGE = 20337.934 STANDARD DEVIATION = 30782.844 MINIMUM =-76471.313 MAXIMUM = 81100.438

NET CASH FLOW, EQUIP, LIFE CYCLE SYSTEM

ESTIMATE NO: 3

BID ITEM PARAMETERS

HOURLY DIRECT LABOR COST = $	70.00	(NO FICA, WC, OR FRINGES)
HOURLY EQUIP OPERATING COST = $	90.00	AVG OVER LIFE OF EQUIP-FUEL, OIL, GREASE, TIRES, MAINT, ETC, OPERATING COSTS ONLY
UNIT PRICE, DIRECT MATERIAL = $	3.710	PER TUN
OTHER DIRECT ESPENSES = $	8000.00	MOBILIZATION, SIGNS, ETC
LABOR TAXES, % OF DIRECT LABOR =	15 %	(WORKMENS COMP, FICA, UNEMPL, FRINGES)
OTHER, % OF TOTAL COST, ADDON =	5 %	(INSURANCE, BONDS, AGC, ETC)
LABOR INCREASE, OVER EQUIP HOURS =	12 %	
LEAST LIKELY PRODUCTION RATE =	187	TON/HOUR
MOST LIKELY PRODUCTION RATE =	250	TON/HOUR
OPTOMISTIC PRODUCTION RATE =	313	TON/HOUR
LEAST LIKELY PROD WEEK =	40	HOURS
MOST LIKELY PROD WEEK =	50	HOURS
OPTOMISTIC PROD WEEK =	60	HOURS
LEAST LIKELY PROD YEAR =	35	WEEKS
MOST LIKELY PROD YEAR =	40	WEEKS
OPTOMISTIC PROD YEAR =	45	WEEKS
JOB OVERHEAD LABOR =	360.00	PER WEEK
JOB OVERHEAD OTHER =	200.00	PER WEEK
TIME INTERVAL, IF KNOWN =	0	WEEKS, IF DIFFERENT FROM PRODUCTION PERIOD

ESTIMATE NO: 0

RISK FACTOR ANALYSIS

CASH COST/HR =	208.09
UNIT COST PENALTY =	0.14
GMR TOTAL =	14020.89

PROJECT NAME: 10000LB ASPHALT PLANT

LETTING DATE: 5- 1-1972

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PROJECT ESTIMATE PARAMETERS

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ESTIMATED GENERAL OVERHEAD COSTS TO BE RECOVERED FROM THIS YEAR'S OPERATIONS

ESTIMATED COST OF MATERIALS OVERHEAD = $	10000.00
ESTIMATED COST OF LABOR OVERHEAD = $	135000.00
ESTIMATED COST OF EQUIPMENT OVERHEAD = $	30000.00
ESTIMATED OTHER OVERHEAD EXPENSES = $	33000.00
TOTAL EST OVERHEAD ALLOCATION, THIS YEAR = $	208000.00

MINIMUM ACCEPTABLE RETURN ON INVESTMENT = $ 20 % PER YEAR BEFORE INCOME TAX

BEGIN PRODUCTION MONTH 6

ESTIMATED VALUE, AT BEGINNING OF YEAR, ALL COMPANY'S PRODUCTIVE EQUIPMENT = $	800000.00
ESTIMATED VALUE, AT BEGINNING OF YEAR, EQUIPMENT SPREAD REQUIRED FOR THIS BID ITEM =$	400000.00
ESTIMATED VALUE OF THIS EQUIPMENT SPREAD WHEN NEW =$	750000.00
AVERAGE ECONOMIC LIFE, DEPRECIATION, CAPITAL RECOVERY PERIOD, IN HRS, FOR THIS SPREAD =	10000
THEREFORE, THE MINIMUM CAPITAL RECOVERY PER OPERATING HOUR = $	75.00

ESTIMATE NO: 0

ITEM COST ESTIMATES
****

EXPECTED COSTS BASED UPON THE 'MOST LIKELY' RATES OF PRODUCTION
****

CODE	ITEM	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL	SUMMARY	UNIT COST
7CC	TYPE C ASPHALT	TON					
	DIRECT MATERIAL	TON	3.710	100000	370999.88		3.7100
	DIRECT LABOR	HR	70.00	447	35735.00		0.3573
	EQUIPMENT OPERATION	HR	90.00	400	36000.00		0.3600
	JOB OVERHEAD LABOR	JOB	($ 360.00 X 10 WEEKS) =		3600.00		0.0360
	OTHER JOB OVERHEAD	JOB	($ 200.00 X 10 WEEKS) =		2000.00		0.0200
	SUBCONTRACT	JOB	0.0		0.0		0.0
	OTHER DIRECT	LS			8000.00		0.0800
	PAYROLL TAXES, ETC	JOB	(15 % X $ 39335.00		5900.25		0.0590
	INS, BONDS, AGC, ETC	%	(5 % X ($ 555598.94 - 26564.02)=		26564.02		0.2656
	TOTAL DIRECT CASH COST					488799.06	4.8880
	EQUIPMENT RENTAL, (DEPR)	HR	(400 HRS X $ 75.00/HR) =		30000.00		0.3000
	TOTAL DIRECT COST					518799.06	5.1880
	GEN OH ALLOCATION	JOB	(19 % X 50 % = 9 % X $ 208000.00)=		20799.99		0.2080
	TOTAL COST INCLUDING OVERHEAD ALLOCATION					539599.00	5.3960
	PROFIT = $	JOB			15999.98		0.1600
	BID =					555598.94	5.5560

THE OVERHEAD ALLOCATION IS:

4.3 % OF DIRECT CASH COST

4.0 % OF TOTAL DIRECT COST AND DEPR

3.9 % OF TOTAL COST AND OH

3.7 % OF AMOUNT BID

THE RETURN ON INVESTMENT PROFIT IS:

3.3 % OF DIRECT CASH COST

3.1 % OF TOTAL DIRECT COST AND DEPR

3.0 % OF TOTAL COST AND OH

2.9 % OF AMOUNT BID

ESTIMATE NO: 1

AN INTERNAL RATE OF RETURN OF 10.8750 % APPLIES TO THE FOLLOWING CASH FLOWS:

MONTH	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-750000.00	1.000000	-750000.00	0.0	0.0	0.0	0.0	0.0	750000.00
1	16471.77	0.991020	16323.84	6796.87	6796.87	9674.90	9674.90	16471.77	740325.06
2	16471.77	0.982120	16177.25	6709.19	13506.05	9762.58	19437.48	32943.53	730562.50
3	16471.77	0.973301	16031.98	6620.71	20126.77	9851.05	29288.53	49415.30	720711.44
4	16471.77	0.964560	15888.00	6531.44	26658.21	9940.33	39228.86	65887.06	710771.13
5	16471.77	0.955898	15745.32	6441.36	33099.56	10030.41	49259.27	82358.81	700740.69
6	16471.77	0.947314	15603.93	6350.45	39450.02	10121.31	59380.58	98830.56	690619.38
7	16471.77	0.938808	15463.82	6258.73	45708.75	10213.04	69593.56	115302.31	680406.44
8	16471.77	0.930376	15324.94	6166.18	51874.92	10305.59	79899.13	131774.06	670100.88
9	16471.77	0.922021	15187.32	6072.78	57947.70	10398.98	90298.06	148245.81	659701.94
10	16471.77	0.913742	15050.93	5978.54	63926.25	10493.22	100791.25	164717.56	649208.75
11	16471.77	0.905537	14915.79	5883.45	69809.69	10588.32	111379.56	181189.31	638620.44
12	16471.77	0.897404	14781.82	5787.49	75597.13	10684.27	122063.81	197661.06	627936.19
13	16471.77	0.889345	14649.08	5690.66	81287.75	10781.10	132844.88	214132.81	617155.13
14	16471.77	0.881358	14517.53	5592.96	86880.69	10878.80	143723.63	230604.56	606276.38
15	16471.77	0.873445	14387.18	5494.37	92375.00	10977.39	154701.00	247076.31	595299.00
16	16471.77	0.865600	14257.96	5394.89	97769.88	11076.88	165777.88	263548.06	584222.13
17	16471.77	0.857827	14129.92	5294.51	103064.38	11177.26	176955.13	280019.81	573044.88
18	16471.77	0.850123	14003.03	5193.21	108257.56	11278.55	188233.63	296491.56	561766.38
19	16471.77	0.842490	13877.29	5091.00	113348.56	11380.77	199614.38	312963.31	550385.63
20	16471.77	0.834924	13752.67	4987.86	118336.38	11483.90	211098.25	329435.06	538901.75
21	16471.77	0.827426	13629.16	4883.79	123220.13	11587.98	222686.19	345906.81	527313.81
22	16471.77	0.819996	13506.77	4778.77	127998.88	11692.99	234379.13	362378.56	515620.88
23	16471.77	0.812632	13385.48	4672.81	132671.63	11798.96	246178.06	378850.31	503821.94
24	16471.77	0.805334	13265.28	4565.88	137237.50	11905.89	258083.94	395322.06	491916.06
25	16471.77	0.798102	13146.15	4457.98	141695.44	12013.78	270097.69	411793.81	479902.31
26	16471.77	0.790935	13028.10	4349.11	146044.50	12122.66	282220.31	428265.56	467779.69
27	16471.77	0.783833	12911.11	4239.25	150283.69	12232.52	294452.81	444737.31	455547.19
28	16471.77	0.776793	12795.15	4128.39	154412.06	12343.38	306796.19	461209.06	443203.81
29	16471.77	0.769817	12680.25	4016.53	158428.56	12455.23	319251.38	477680.81	430748.63
30	16471.77	0.762904	12566.38	3903.66	162332.19	12568.11	331819.44	494152.56	418180.56
31	16471.77	0.756055	12453.55	3789.76	166121.94	12682.01	344501.44	510624.31	405498.56
32	16471.77	0.749264	12341.70	3674.83	169796.75	12796.94	357298.38	527096.06	392701.63
33	16471.77	0.742535	12230.87	3558.85	173355.56	12912.91	370211.25	543567.81	379788.75
34	16471.77	0.735867	12121.03	3441.83	176797.38	13029.93	383241.13	560039.56	366758.88
35	16471.77	0.729259	12012.19	3323.75	180121.06	13148.02	396389.13	576511.31	353610.88
36	16471.77	0.722710	11904.31	3204.60	183325.63	13267.17	409656.25	592983.06	340343.75
37	16471.77	0.716220	11797.40	3084.36	186409.94	13387.40	423043.63	609454.81	326956.38
38	16471.77	0.709788	11691.46	2963.04	189372.94	13508.72	436552.31	625926.56	313447.69
39	16471.77	0.703415	11586.49	2840.62	192213.50	13631.15	450183.44	642398.31	299816.56
40	16471.77	0.697097	11482.42	2717.08	194930.56	13754.68	463938.06	658870.06	286061.94
41	16471.77	0.690838	11379.31	2592.43	197522.94	13879.33	477817.38	675341.81	272182.63
42	16471.77	0.684634	11277.12	2466.65	199989.56	14005.11	491822.44	691813.56	258177.56
43	16471.77	0.678486	11175.86	2339.73	202329.25	14132.03	505954.44	708285.31	244045.56
44	16471.77	0.672392	11075.49	2211.66	204540.88	14260.10	520214.50	724757.06	229785.50
45	16471.77	0.666354	10976.03	2082.43	206623.25	14389.34	534603.81	741228.81	215396.19
46	16471.77	0.660370	10877.46	1952.03	208575.25	14519.74	549123.50	757700.56	200876.50
47	16471.77	0.654441	10779.79	1820.44	210395.69	14651.32	563774.81	774172.31	186225.19
48	16471.77	0.648563	10682.98	1687.66	212083.31	14784.10	578558.88	790644.06	171441.13
49	16471.77	0.642739	10587.04	1553.68	213636.94	14918.08	593476.94	807115.81	156523.06
50	16471.77	0.636967	10491.96	1418.49	215055.38	15053.27	608530.19	823587.56	141469.81
51	16471.77	0.631247	10397.75	1282.07	216337.44	15189.70	623719.88	840059.31	126280.13
52	16471.77	0.625579	10304.38	1144.41	217481.81	15327.35	639047.19	856531.06	110952.81
53	16471.77	0.619960	10211.84	1005.51	218487.31	15466.25	654513.44	873002.81	95486.56
54	16471.77	0.614393	10120.14	865.35	219352.63	15606.42	670119.81	889474.56	79880.19
55	16471.77	0.608876	10029.26	723.91	220076.50	15747.85	685867.63	905946.31	64132.38
56	16471.77	0.603408	9939.20	581.20	220657.69	15890.57	701758.19	922418.06	48241.81
57	16471.77	0.597989	9849.94	437.19	221094.88	16034.57	717792.75	938889.81	32207.25
58	16471.77	0.592619	9761.48	291.88	221386.75	16179.89	733972.63	955361.56	16027.38
59	16471.77	0.587298	9673.83	145.25	221531.94	16326.52	750299.13	971833.31	-299.13

ITEM COST ESTIMATE BASIS

****

CALCULATION OF PRODUCTION TIME IS BASED UPON A PRODUCTION
RATE OF 250 TON PER HOUR 50 HOURS PER WEEK, = 12500 TON PER WEEK.
THE TOTAL 100000 TON DIVIDED BY 12500 TON PER WEEK = 8 WEEKS PRODUCTION TIME.
THIS ITEM SHOULD START MONTH 6 AND END, MONTH 8 .

****

CALCULATION OF THE GENERAL OVERHEAD ALLOCATION TO THIS BID ITEM
IS BASED UPON ITS REQUIRING 8 WEEKS PRODUCTION TIME OUT OF A TOTAL OF 40 WEEKS PRODUCTION
TIME FOR THE YEAR, OR, 19 % OF A PRODUCTION YEAR. FURTHERMORE, $ 400000.00 OF THE COMPANY'S
TOTAL $ 800000.00 PRODUCTIVE EQUIPMENT INVESTMENT, OR 50 % WILL BE USED ON THIS BID ITEM.
THEREFORE, 50 % OF THE COMPANY'S CURRENT EQUIPMENT INVESTMENT WILL BE USED ON THIS BID
ITEM 19 % OF A YEAR. 50 % X 19 % = 9 % OF THE GENERAL OVERHEAD SHOULD BE ALLOCATED TO THIS ITEM.

****

PROFIT = 20 % X $ 400000.00 = $ 79999.94 / YEAR X 19 % OF YEAR =$ 15999.98
OR OWNERSHIP COST = $ 79999.94 /2000 HRS/YR= $ 40.00 /HR X 400 HOURS = $ 15999.98

ESTIMATE NO: 1

BEGINNING BALANCE SHEET

WORKING CAPITAL, CASH		56139.97
GROSS EQUIP, THIS BID ITEM	750000.00	
CAPITAL RECOVERED, (ACCUM DEPREC)	350000.00	
NET EQUIP, THIS BID ITEM		400000.00
OTHER CO. EQUIP (AT PRESENT VALUE)		400000.00
TOTAL EQUIPMENT INVESTMENT		800000.00
TOTAL ASSETS		856139.94
TAXES PAYABLE, RESERVE		0.0
NET WORTH		856139.94
TOTAL LIABILITIES AND NET WORTH		856139.94

INCOME STATEMENT

SALES		557844.56
DIRECT CASH OUTLAYS		
LABOR	45235.25	
MATERIALS	370999.88	
EQUIPMENT	36000.00	
SUBCONTRACT	0.0	
OTHER	36564.02	
TOTAL DIRECT CASH COST		488799.06
GROSS MARGIN, CASH CONTRIBUTION		69045.50

APPLIED PERIOD COST (INDIRECT MTL, LAB, EQUIP)		20799.99
CAPITAL RECOVERED (DEPRECIATION)		30000.00
NET PROFIT		18245.51

ENDING BALANCE SHEET

CASH (WORKING CAPITAL + CASH INCOME)		125185.44
GROSS EQUIPMENT	750000.00	
CAPITAL RECOVERED (ACCUM DEPREC)	380000.00	
NET EQUIPMENT		370000.00
OTHER CO. EQUIP		400000.00
TOTAL EQUIP		770000.00
TOTAL ASSETS		895185.44
TAXES PAYABLE RESERVE (AT 50% OF NET INCOME)		9122.75
NET WORTH		886062.63
TOTAL LIABILITIES AND NET WORTH		895185.44

ESTIMATE NO: 1

ITEM COST ESTIMATES
****

EXPECTED COSTS BASED UPON THE 'MOST LIKELY' RATES OF PRODUCTION
****

CODE	ITEM	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL	SUMMARY	UNIT COST
7CC	TYPE C ASPHALT	TON					
	DIRECT MATERIAL	TON	3.710	100000	370999.88		3.7100
	DIRECT LABOR	HR	70.00	447	45235.25		0.3573
	EQUIPMENT OPERATION	HR	90.00	400	36000.00		0.3600
	JOB OVERHEAD LABOR	JOB	($ 360.00 X 10 WEEKS) =		3600.00		0.0360
	OTHER JOB OVERHEAD	JOB	($ 200.00 X 10 WEEKS) =		2000.00		0.0200
	SUBCONTRACT	JOB	0.0		0.0		0.0
	OTHER DIRECT	LS			8000.00		0.0800
	PAYROLL TAXES, ETC	JOB	(15 % X $ 39335.00		5900.25		0.0590
	INS, BONDS, AGC, ETC	%	(5 % X ($ 557844.56 - 36564.02)=		36564.02		0.2656
	TOTAL DIRECT CASH COST					488799.06	4.8880
	CAPITAL RECOVERY, (DEPR)	HR	(400 HRS X $ 75.00/HR) =		30000.00		0.3000
	TOTAL DIRECT COST					518799.06	5.1880
	GEN OH ALLOCATION	JOB	(19 % X 50 % = 9 % X $ 208000.00)=		20799.99		0.2080
	TOTAL COST INCLUDING OVERHEAD ALLOCATION					539599.00	5.3960
	RETURN ON INVESTMENT, PROFIT	JOB			18245.59		0.1825
	TOTAL FULL COST, MIN BID REQ'D FOR A 20 % RET ON INV =					557844.56	5.5784

THE OVERHEAD ALLOCATION IS:

4.3 % OF DIRECT CASH COST

4.0 % OF TOTAL DIRECT COST AND DEPR

3.9 % OF TOTAL COST AND OH

3.7 % OF AMOUNT BID

THE RETURN ON INVESTMENT PROFIT IS:

3.7 % OF DIRECT CASH COST

3.5 % OF TOTAL DIRECT COST AND DEPR

3.4 % OF TOTAL COST AND OH

3.3 % OF AMOUNT BID

ESTIMATE NO: 2

ITEM COST ESTIMATE BASIS

CALCULATION OF PRODUCTION TIME IS BASED UPON A PRODUCTION
RATE OF 250 TON PER HOUR 50 HOURS PER WEEK, = 12500 TON PER WEEK.
THE TOTAL 100000 TON DIVIDED BY 12500 TON PER WEEK = 8 WEEKS PRODUCTION TIME.
THIS ITEM SHOULD START MONTH 6 AND END, MONTH 8 .

CALCULATION OF THE GENERAL OVERHEAD ALLOCATION TO THIS BID ITEM
IS BASED UPON ITS REQUIRING 8 WEEKS PRODUCTION TIME OUT OF A TOTAL OF 40 WEEKS PRODUCTION
TIME FOR THE YEAR, OR, 19 % OF A PRODUCTION YEAR. FURTHERMORE, $ 400000.00 OF THE COMPANY'S
TOTAL $ 800000.00 PRODUCTIVE EQUIPMENT INVESTMENT, OR 50 % WILL BE USED ON THIS BID ITEM.
THEREFORE, 50 % OF THE COMPANY'S CURRENT EQUIPMENT INVESTMENT WILL BE USED ON THIS BID
ITEM 19 % OF A YEAR. 50 % X 19 % = 9 % OF THE GENERAL OVERHEAD SHOULD BE ALLOCATED TO THIS ITEM.

ESTIMATED WORKING CAPITAL REQUIREMENTS ARE FOUR WEEKS PAYROLL PLUS 10% OF ONE MONTH'S
DIRECT MATERIAL AND EQUIPMENT OPERATING COSTS, A TOTAL, $ 56139.97 FOR THIS ITEM
THE MINIMUM ACCEPTABLE RETURN ON INVESTMENT, OR PROFIT, FOR THIS ITEM IS THE 20 % ANNUAL
RETURN REQUIRED TIMES THE SUM OF THE $ 56139.97 WORKING CAPITAL AND THE $ 400000.00
CURRENT EQUIPMENT INVESTMENT TIMES 19 % OF A PROD YEAR = THE REQUIRED PROFIT, $ 18245.59.

AN INTERNAL RATE OF RETURN OF 13.1250 % APPLIES TO THE FOLLOWING CASH FLOWS:

MONTH	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-750000.00	1.000000	-750000.00	0.0	0.0	0.0	0.0	0.0	750000.00
1	17335.48	0.989182	17147.93	8203.12	8203.12	9132.36	9132.36	17335.48	740867.63
2	17335.48	0.978481	16962.43	8103.23	16306.35	9232.24	18364.60	34670.95	731635.38
3	17335.48	0.967895	16778.92	8002.25	24308.61	9333.22	27697.82	52006.43	722302.13
4	17335.48	0.957424	16597.41	7900.17	32208.78	9435.30	37133.13	69341.88	712866.81
5	17335.48	0.947067	16417.86	7796.97	40005.75	9538.50	46671.63	86677.31	703328.31
6	17335.48	0.936822	16240.25	7692.65	47698.40	9642.83	56314.46	104012.75	693685.50
7	17335.48	0.926687	16064.56	7587.18	55285.58	9748.30	66062.75	121348.19	683937.25
8	17335.48	0.916662	15890.77	7480.56	62766.14	9854.92	75917.63	138683.63	674082.38
9	17335.48	0.906746	15718.86	7372.77	70138.88	9962.71	85880.31	156019.06	664119.69
10	17335.48	0.896936	15548.82	7263.80	77402.63	10071.68	95951.94	173354.50	654048.06
11	17335.48	0.887233	15380.60	7153.64	84556.25	10181.83	106133.75	190689.94	643866.25
12	17335.48	0.877635	15214.21	7042.28	91598.50	10293.20	116426.94	208025.38	633573.06
13	17335.48	0.868141	15049.63	6929.70	98528.19	10405.78	126832.69	225360.81	623167.31
14	17335.48	0.858749	14886.82	6815.89	105344.06	10519.59	137352.25	242696.25	612647.75
15	17335.48	0.849459	14725.78	6700.83	112044.88	10634.65	147986.88	260031.69	602013.13
16	17335.48	0.840270	14566.47	6584.51	118629.38	10750.96	158737.81	277367.13	591262.19
17	17335.48	0.831180	14408.90	6466.93	125096.25	10868.55	169606.31	294702.56	580393.69
18	17335.48	0.822188	14253.02	6348.05	131444.25	10987.43	180593.69	312038.00	569406.31
19	17335.48	0.813293	14098.83	6227.88	137672.13	11107.60	191701.25	329373.44	558298.75
20	17335.48	0.804495	13946.31	6106.39	143778.50	11229.09	202930.31	346708.88	547069.69
21	17335.48	0.795792	13795.44	5983.57	149762.06	11351.91	214282.19	364044.31	535717.81
22	17335.48	0.787183	13646.20	5859.41	155621.44	11476.07	225758.25	381379.75	524241.75
23	17335.48	0.778667	13498.57	5733.89	161355.31	11601.59	237359.81	398715.19	512640.19
24	17335.48	0.770244	13352.54	5607.00	166962.25	11728.48	249088.25	416050.63	500911.75
25	17335.48	0.761911	13208.09	5478.72	172440.94	11856.76	260945.00	433386.06	489055.00
26	17335.48	0.753668	13065.20	5349.04	177789.94	11986.44	272931.44	450721.50	477068.56
27	17335.48	0.745515	12923.86	5217.93	183007.81	12117.54	285048.94	468056.94	464951.06
28	17335.48	0.737450	12784.05	5085.40	188093.19	12250.08	297299.00	485392.38	452701.00
29	17335.48	0.729473	12645.75	4951.41	193044.56	12384.06	309683.06	502727.81	440316.94
30	17335.48	0.721581	12508.95	4815.96	197860.50	12519.52	322202.56	520063.25	427797.44
31	17335.48	0.713775	12373.63	4679.03	202539.50	12656.45	334859.00	537398.69	415141.00
32	17335.48	0.706053	12239.77	4540.60	207080.06	12794.88	347653.88	554734.13	402346.13
33	17335.48	0.698415	12107.36	4400.66	211480.69	12934.82	360588.69	572069.56	389411.31
34	17335.48	0.690860	11976.38	4259.18	215739.81	13076.29	373664.94	589405.00	376335.06
35	17335.48	0.683386	11846.81	4116.16	219855.94	13219.32	386884.25	606740.44	363115.75
36	17335.48	0.675993	11718.66	3971.58	223827.50	13363.90	400248.13	624075.88	349751.88
37	17335.48	0.668680	11591.89	3825.41	227652.88	13510.07	413758.19	641411.31	336241.81
38	17335.48	0.661446	11466.48	3677.64	231330.50	13657.83	427416.00	658746.75	322584.00
39	17335.48	0.654291	11342.44	3528.26	234858.75	13807.21	441223.19	676082.19	308776.81
40	17335.48	0.647212	11219.73	3377.24	238235.94	13958.23	455181.38	693417.63	294818.63
41	17335.48	0.640211	11098.36	3224.58	241460.50	14110.90	469292.25	710753.06	280707.75
42	17335.48	0.633285	10978.29	3070.24	244530.69	14265.23	483557.44	728088.50	266442.56
43	17335.48	0.626434	10859.52	2914.21	247444.88	14421.26	497978.69	745423.94	252021.31
44	17335.48	0.619657	10742.05	2756.48	250201.31	14578.99	512557.63	762759.38	237442.38
45	17335.48	0.612954	10625.85	2597.02	252798.31	14738.45	527296.06	780094.81	222703.94
46	17335.48	0.606323	10510.89	2435.82	255234.13	14899.65	542195.69	797430.25	207804.31
47	17335.48	0.599764	10397.19	2272.86	257506.94	15062.62	557258.25	814765.69	192741.75
48	17335.48	0.593276	10284.71	2108.11	259615.00	15227.36	572485.56	832101.13	177514.44
49	17335.48	0.586858	10173.45	1941.56	261556.56	15393.91	587879.44	849436.56	162120.56
50	17335.48	0.580509	10063.39	1773.19	263329.75	15562.28	603441.69	866772.00	146558.31
51	17335.48	0.574229	9954.52	1602.98	264932.69	15732.50	619174.13	884107.44	130825.88
52	17335.48	0.568017	9846.84	1430.91	266363.56	15904.57	635078.69	901442.88	114921.31
53	17335.48	0.561872	9740.32	1256.95	267620.50	16078.52	651157.19	918778.31	98842.81
54	17335.48	0.555793	9634.94	1081.09	268701.56	16254.38	667411.56	936113.75	82588.44
55	17335.48	0.549781	9530.71	903.31	269604.81	16432.16	683843.69	953449.19	66156.31
56	17335.48	0.543833	9427.61	723.58	270328.38	16611.89	700455.56	970784.62	49544.44
57	17335.48	0.537950	9325.62	541.89	270870.25	16793.58	717249.13	988120.06	32750.88
58	17335.48	0.532130	9224.73	358.21	271228.44	16977.26	734226.38	1005455.50	15773.63
59	17335.48	0.526373	9124.93	172.52	271400.94	17162.95	751389.31	1022790.94	-1389.31

BEGINNING BALANCE SHEET

WORKING CAPITAL, CASH		56139.97
GROSS EQUIP, THIS BID ITEM	750000.00	
CAPITAL RECOVERED, (ACCUM DEPREC)	350000.00	
NET EQUIP, THIS BID ITEM		400000.00
OTHER CO. EQUIP (AT PRESENT VALUE)		400000.00
TOTAL EQUIPMENT INVESTMENT		800000.00
TOTAL ASSETS		856139.94
TAXES PAYABLE, RESERVE		0.0
NET WORTH		856139.94
TOTAL LIABILITIES AND NET WORTH		856139.94

INCOME STATEMENT

SALES		557844.56
DIRECT CASH OUTLAYS		
LABOR	45235.25	
MATERIALS	370999.88	
EQUIPMENT	36000.00	
SUBCONTRACT	0.0	
OTHER	46564.02	
TOTAL DIRECT CASH COST		488799.06
GROSS MARGIN, CASH CONTRIBUTION		69045.50

APPLIED PERIOD COST (INDIRECT MTL, LAB, EQUIP)		20799.99
CAPITAL RECOVERED (DEPRECIATION)		30000.00
NET PROFIT		18245.51

ENDING BALANCE SHEET
****

CASH (WORKING CAPITAL + CASH INCOME)		125185.44
GROSS EQUIPMENT	750000.00	
CAPITAL RECOVERED (ACCUM DEPREC)	380000.00	
NET EQUIPMENT		370000.00
OTHER CO. EQUIP		400000.00
TOTAL EQUIP		770000.00
TOTAL ASSETS		895185.44
TAXES PAYABLE RESERVE (AT 50% OF NET INCOME)		9122.75
NET WORTH		886062.63
TOTAL LIABILITIES AND NET WORTH		895185.44

ESTIMATE NO: 2

ESTIMATE FROM SIMULATIONS
****

EXPECTED COSTS BASED UPON THE GENERATED PROD RATE AND COST DISTRIBUTIONS
****
***** NOTE ***** TOTALS AND SUMMARYS ARE DERIVED FROM DISTRIBUTION MEANS AND NOT BY ADDITION

CODE	ITEM	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL	SUMMARY	UNIT COST
7CC	TYPE C ASPHALT	TON					
	DIRECT MATERIAL	TON	3.710	100000	370999.88		3.7100
	DIRECT LABOR	HR	70.00	446	35446.94		0.3545
	EQUIPMENT OPERATION	HR	90.00	398	35820.00		0.3582
	JOB OVERHEAD LABOR	JOB	($ 360.00 X	10 WEEKS) =	3600.00		0.0360
	OTHER JOB OVERHEAD	JOB	($ 200.00 X	10 WEEKS) =	2000.00		0.0200
	SUBCONTRACT	JOB	0.0		0.0		0.0
	OTHER DIRECT	LS			8000.00		0.0800
	PAYROLL TAXES, ETC	JOB	(15 % X $	39046.94	5857.04		0.0586
	INS, BONDS, AGC, ETC	%	(5 % X ($	557270.31 - 26613.13)=	26613.13		0.2661
	TOTAL DIRECT CASH COST					488795.63	4.8834
	GEN OH ALLOCATION	JOB	(20 % X 50 % = 10 % X $	208000.00)=	21681.97		0.2168
	TOTAL COST INCLUDING OVERHEAD ALLOCATION					510477.56	5.1048
	CAPITAL RECOVERY & RETURN	JOB			46792.76		0.4679
	TOTAL BID REQUIRED					557270.31	5.5727

THE OVERHEAD ALLOCATION IS:

4.4 % OF DIRECT CASH COST

4.2 % OF TOTAL DIRECT COST AND DEPR

4.0 % OF TOTAL COST AND OH

3.9 % OF AMOUNT BID

THE RETURN ON INVESTMENT PROFIT IS:

9.6 % OF DIRECT CASH COST

9.0 % OF TOTAL DIRECT COST AND DEPR

9.2 % OF TOTAL COST AND OH

8.4 % OF AMOUNT BID

ESTIMATE NO: 3

ITEM COST ESTIMATE BASIS
****

***** THE FOLLOWING IS BASED UPON A RUN OF 1000 SIMULATIONS *****
****

CALCULATION OF PRODUCTION TIME IS BASED UPON A PRODUCTION
RATE OF 251 TON PER HOUR 49 HOURS PER WEEK, = 12299 TON PER WEEK.
THE TOTAL 100000 TON DIVIDED BY 12299 TON PER WEEK = 8 WEEKS PRODUCTION TIME.
THIS ITEM SHOULD START MONTH 6 AND END, MONTH 8 .

CALCULATION OF THE GENERAL OVERHEAD ALLOCATION TO THIS BID ITEM
IS BASED UPON ITS REQUIRING 8 WEEKS PRODUCTION TIME OUT OF A TOTAL OF 39 WEEKS PRODUCTION
TIME FOR THE YEAR, OR, 20 % OF A PRODUCTION YEAR. FURTHERMORE, $ 400000.00 OF THE COMPANY'S
TOTAL $ 800000.00 PRODUCTIVE EQUIPMENT INVESTMENT, OR 50 % WILL BE USED ON THIS BID ITEM.
THEREFORE, 50 % OF THE COMPANY'S CURRENT EQUIPMENT INVESTMENT WILL BE USED ON THIS BID
ITEM 20 % OF A YEAR. 50 % X 20 % = 10 % OF THE GENERAL OVERHEAD SHOULD BE ALLOCATED TO THIS ITEM.

ESTIMATED WORKING CAPITAL REQUIREMENTS ARE FOUR WEEKS PAYROLL PLUS 10% OF ONE MONTH'S
DIRECT MATERIAL AND EQUIPMENT OPERATING COSTS, A TOTAL, $ 55841.97 FOR THIS ITEM
THE MINIMUM ACCEPTABLE RETURN ON INVESTMENT, OR PROFIT, FOR THIS ITEM IS THE 20 % ANNUAL
RETURN REQUIRED TIMES THE SUM OF THE $ 55841.97 WORKING CAPITAL AND THE $ 400000.00
CURRENT EQUIPMENT INVESTMENT TIMES 20 % OF A PROD YEAR = THE REQUIRED PROFIT, $ 46792.76.

AN INTERNAL RATE OF RETURN OF 14.1562 % APPLIES TO THE FOLLOWING CASH FLOWS:

MONTH	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-750000.00	1.000000	-750000.00	0.0	0.0	0.0	0.0	0.0	750000.00
1	17547.29	0.988342	17342.71	8847.65	8847.65	8699.64	8699.64	17547.29	741300.31
2	17547.29	0.976820	17140.54	8745.02	17592.67	8802.27	17501.91	35094.58	732498.06
3	17547.29	0.965432	16940.71	8641.18	26233.85	8906.11	26408.02	52641.87	723591.94
4	17547.29	0.954177	16743.22	8536.11	34769.96	9011.18	35419.20	70189.13	714580.75
5	17547.29	0.943054	16548.04	8429.81	43199.77	9117.48	44536.67	87736.38	705463.31
6	17547.29	0.932060	16355.13	8322.25	51522.03	9225.04	53761.71	105283.63	696238.25
7	17547.29	0.921193	16164.45	8213.43	59735.45	9333.86	63095.57	122830.88	686904.38
8	17547.29	0.910455	15976.01	8103.32	67838.75	9443.97	72539.50	140378.13	677460.50
9	17547.29	0.899840	15789.76	7991.91	75830.63	9555.38	82094.88	157925.38	667905.13
10	17547.29	0.889350	15605.68	7879.18	83709.75	9668.11	91762.94	175472.63	658237.06
11	17547.29	0.878982	15423.76	7765.13	91474.88	9782.16	101545.06	193019.88	648454.94
12	17547.29	0.868736	15243.95	7649.73	99124.56	9897.55	111442.56	210567.13	638557.44
13	17547.29	0.858608	15066.24	7532.97	106657.50	10014.32	121456.88	228114.38	628543.13
14	17547.29	0.848599	14890.60	7414.84	114072.31	10132.45	131589.31	245661.63	618410.69
15	17547.29	0.838705	14717.00	7295.30	121367.56	10251.98	141841.25	263208.88	608158.75
16	17547.29	0.828928	14545.43	7174.36	128541.88	10372.93	152214.13	280756.13	597785.88
17	17547.29	0.819264	14375.86	7052.00	135593.81	10495.29	162709.38	298303.38	587290.63
18	17547.29	0.809713	14208.27	6928.19	142522.00	10619.10	173328.44	315850.63	576671.56
19	17547.29	0.800273	14042.63	6802.91	149324.88	10744.38	184072.81	333397.88	565927.19
20	17547.29	0.790944	13878.92	6676.16	156001.00	10871.13	194943.94	350945.13	555056.06
21	17547.29	0.781724	13717.13	6547.92	162548.88	10999.37	205943.25	368492.38	544056.75
22	17547.29	0.772610	13557.21	6418.16	168967.00	11129.13	217072.38	386039.63	532927.63
23	17547.29	0.763603	13399.16	6286.88	175253.88	11260.41	228332.75	403586.88	521667.25
24	17547.29	0.754701	13242.96	6154.04	181407.88	11393.25	239726.00	421134.13	510274.00
25	17547.29	0.745903	13088.57	6019.63	187427.50	11527.66	251253.63	438681.38	498746.38
26	17547.29	0.737207	12935.98	5883.64	193311.13	11663.65	262917.25	456228.63	487082.75
27	17547.29	0.728613	12785.18	5746.05	199057.13	11801.24	274718.44	473775.88	475281.56
28	17547.29	0.720119	12636.13	5606.83	204663.94	11940.46	286658.88	491323.13	463341.13
29	17547.29	0.711724	12488.82	5465.97	210129.88	12081.32	298740.19	508870.38	451259.81
30	17547.29	0.703427	12343.23	5323.45	215453.31	12223.84	310964.00	526417.63	439036.00
31	17547.29	0.695226	12199.33	5179.25	220632.50	12368.04	323332.00	543964.88	426668.00
32	17547.29	0.687121	12057.11	5033.34	225665.81	12513.95	335845.94	561512.13	414154.06
33	17547.29	0.679111	11916.55	4885.72	230551.50	12661.57	348507.50	579059.38	401492.50
34	17547.29	0.671194	11777.63	4736.35	235287.81	12810.94	361318.44	596606.63	388681.56
35	17547.29	0.663369	11640.32	4585.22	239873.00	12962.07	374280.50	614153.88	375719.50
36	17547.29	0.655636	11504.63	4432.31	244305.25	13114.98	387395.44	631701.13	362604.56
37	17547.29	0.647993	11370.51	4277.59	248582.81	13269.70	400665.13	649248.38	349334.88
38	17547.29	0.640439	11237.96	4121.05	252703.81	13426.23	414091.31	666795.63	335908.69
39	17547.29	0.632972	11106.94	3962.67	256666.44	13584.62	427675.88	684342.88	322324.13
40	17547.29	0.625593	10977.46	3802.41	260468.81	13744.87	441420.69	701890.13	308579.31
41	17547.29	0.618300	10849.48	3640.27	264109.06	13907.02	455327.69	719437.38	294672.31
42	17547.29	0.611092	10723.00	3476.21	267585.25	14071.08	469398.75	736984.63	280601.25
43	17547.29	0.603968	10597.99	3310.22	270895.44	14237.07	483635.81	754531.88	266364.19
44	17547.29	0.596927	10474.45	3142.26	274037.69	14405.02	498040.81	772079.13	251959.19
45	17547.29	0.589968	10352.34	2972.33	277010.00	14574.96	512615.75	789626.38	237384.25
46	17547.29	0.583090	10231.65	2800.39	279810.38	14746.90	527362.63	807173.63	222637.38
47	17547.29	0.576292	10112.36	2626.42	282436.75	14920.86	542283.44	824720.88	207716.56
48	17547.29	0.569574	9994.48	2450.40	284887.13	15096.88	557380.31	842268.13	192619.69
49	17547.29	0.562934	9877.96	2272.31	287159.38	15274.98	572655.25	859815.38	177344.75
50	17547.29	0.556371	9762.80	2092.11	289251.44	15455.18	588110.38	877362.63	161889.63
51	17547.29	0.549885	9648.99	1909.79	291161.19	15637.50	603747.81	894909.88	146252.19
52	17547.29	0.543475	9536.51	1725.32	292886.50	15821.97	619569.75	912457.13	130430.25
53	17547.29	0.537139	9425.33	1538.67	294425.13	16008.62	635578.31	930004.38	114421.69
54	17547.29	0.530877	9315.45	1349.82	295774.94	16197.47	651775.75	947551.63	98224.25
55	17547.29	0.524688	9206.85	1158.74	296933.63	16388.55	668164.25	965098.88	81835.75
56	17547.29	0.518571	9099.52	965.41	297899.00	16581.88	684746.13	982646.13	65253.88
57	17547.29	0.512526	8993.43	769.79	298668.75	16777.50	701523.56	1000193.38	48476.44
58	17547.29	0.506551	8888.59	571.87	299240.56	16975.42	718498.94	1017740.63	31501.06
59	17547.29	0.500645	8784.97	371.61	299612.13	17175.67	735674.56	1035287.88	14325.44
60	17547.29	0.494809	8682.56	169.00	299781.06	17378.29	753052.81	1052835.00	-3052.81

BEGINNING BALANCE SHEET

WORKING CAPITAL, CASH		55841.97
GROSS EQUIP, THIS BID ITEM	750000.00	
CAPITAL RECOVERED, (ACCUM DEPREC)	350000.00	
NET EQUIP, THIS BID ITEM		400000.00
OTHER CO. EQUIP (AT PRESENT VALUE)		400000.00
TOTAL EQUIPMENT INVESTMENT		800000.00
TOTAL ASSETS		855841.94
TAXES PAYABLE, RESERVE		0.0
NET WORTH		855841.94
TOTAL LIABILITIES AND NET WORTH		855841.94

INCOME STATEMENT

SALES		557270.31
DIRECT CASH OUTLAYS		
LABOR	44903.98	
MATERIALS	370999.88	
EQUIPMENT	35820.00	
SUBCONTRACT	0.0	
OTHER	36613.13	
TOTAL DIRECT CASH COST		488795.63
GROSS MARGIN, CASH CONTRIBUTION		68474.69

APPLIED PERIOD COST (INDIRECT MTL, LAB, EQUIP)		21681.97
CAPITAL RECOVERED (DEPRECIATION)		29850.00
NET PROFIT		16942.72

ENDING BALANCE SHEET
****

CASH (WORKING CAPITAL + CASH INCOME)		124316.63
GROSS EQUIPMENT	750000.00	
CAPITAL RECOVERED (ACCUM DEPREC)	379850.00	
NET EQUIPMENT		370150.00
OTHER CO. EQUIP		400000.00
TOTAL EQUIP		770150.00
TOTAL ASSETS		894466.63
TAXES PAYABLE RESERVE (AT 50% OF NET INCOME)		8471.36
NET WORTH		885995.25
TOTAL LIABILITIES AND NET WORTH		894466.63

ESTIMATE NO: 3

PROBABILITY STATEMENTS

THE FOLLOWING PROBABILITY STATEMENTS ARE BASED UPON THE RESULTS OF THE SIMULATION PROCESS.

VARIABLE NAME	LOWEST PROBABLE VALUE	PROBABLE AVERAGE VALUE	HIGHEST PROBABLE VALUE	PROBABILITY OF VALUE GREATER THAN THE AVERAGE
PRODUCTION RATE	201 TON/HR	251 TON/HR	301 TON/HR	52.0 %
HOURS PER WEEK	43 HOURS	49 HOURS	59 HOURS	61.0 %
WEEKS PER YEAR	35 WEEKS	39 WEEKS	43 WEEKS	65.0 %
DIRECT CASH COST	$ 464753.38	$ 488795.63	$ 512837.81	46.0 %
TOTAL DIRECT COST	$ 495558.44	$ 518896.13	$ 548715.44	46.0 %
TOTAL COST AND OH	$ 486364.31	$ 510379.00	$ 538858.31	45.0 %
TOTAL COST AND PROFIT	$ 534719.75	$ 559489.00	$ 588650.50	45.0 %

**** NOTE ***** THERE IS A 95% PROBABILITY THAT ALL VALUES WILL LIE BETWEEN THE HIGH AND LOW VALUES SHOWN.

ESTIMATE NO: 3

CUMULATIVE PROBABILITY DISTRIBUTION, ONE THOUSAND SIMULATIONS
****

PRODUCTION RATE, UNITS/HOUR
****

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	188	251	309	25	
188.00					99.80 %
198.08					98.00 %
208.17					94.50 %
218.25					88.30 %
228.33					79.80 %
238.42					69.90 %
248.50					54.80 %
258.58					39.90 %
268.67					26.10 %
278.75					17.80 %
288.83					9.60 %
298.92					2.30 %

PRODUCTION HOURS/ WEEK
****

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	40	49	59	3	
40.00					99.80 %
41.58					98.60 %
43.17					93.60 %
44.75					89.30 %
46.33					76.40 %
47.92					69.70 %
49.50					52.60 %
51.08					32.40 %
52.67					23.50 %
54.25					13.30 %
55.83					7.80 %
57.42					2.00 %

PRODUCTION WEEKS/YEAR
****

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	35	39	44	2	
35.00					97.10 %
35.75					97.10 %
36.50					89.60 %
37.25					78.70 %
38.00					65.90 %
38.75					65.90 %
39.50					48.90 %
40.25					31.30 %
41.00					16.10 %
41.75					16.10 %
42.50					7.00 %
43.25					1.90 %

ESTIMATE NO: 3

TOTAL DIRECT CASH COST

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	471108.44	488795.63	518091.69	12021.10	
471108.44					99.90 %
475023.69					94.40 %
478938.94					83.30 %
482854.19					71.30 %
486769.50					55.00 %
490684.75					37.40 %
494600.00					25.40 %
498515.31					16.60 %
502430.56					9.60 %
506345.81					5.30 %
510261.13					2.80 %
514176.38					1.00 %

TOTAL AMOUNT OF BID

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	534719.75	559489.00	598247.69	14580.77	
534719.75					99.90 %
540013.69					96.90 %
545307.69					87.20 %
550601.69					74.70 %
555895.69					59.00 %
561189.69					40.50 %
566483.69					26.30 %
571777.69					16.70 %
577071.69					9.70 %
582365.63					5.60 %
587659.63					2.40 %
592953.63					0.70 %

NET CASH FLOW, EQUIP, EXPECTED VALUES

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	4143.99	42826.57	67671.88	12388.38	
4143.99					99.90 %
9437.98					99.30 %
14731.96					97.60 %
20025.95					94.40 %
25319.94					90.30 %
30613.93					83.30 %
35907.92					73.70 %
41201.91					59.50 %
46495.89					41.00 %
51789.88					25.30 %
57083.87					12.80 %
62377.86					3.10 %

ESTIMATE NO: 3

NET CASH FLOW EQUIP, ROI APPROACH

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	6389.61	45072.22	69917.50	12388.01	
6389.61					99.90 %
11683.60					99.30 %
16977.59					97.60 %
22271.58					94.40 %
27565.57					90.30 %
32859.55					83.30 %
38153.54					73.70 %
43447.53					59.50 %
48741.52					41.00 %
54035.51					25.30 %
59329.50					12.80 %
64623.48					3.10 %

NET CASH FLOW, EQUIP, LIFE CYCLE SYSTEM

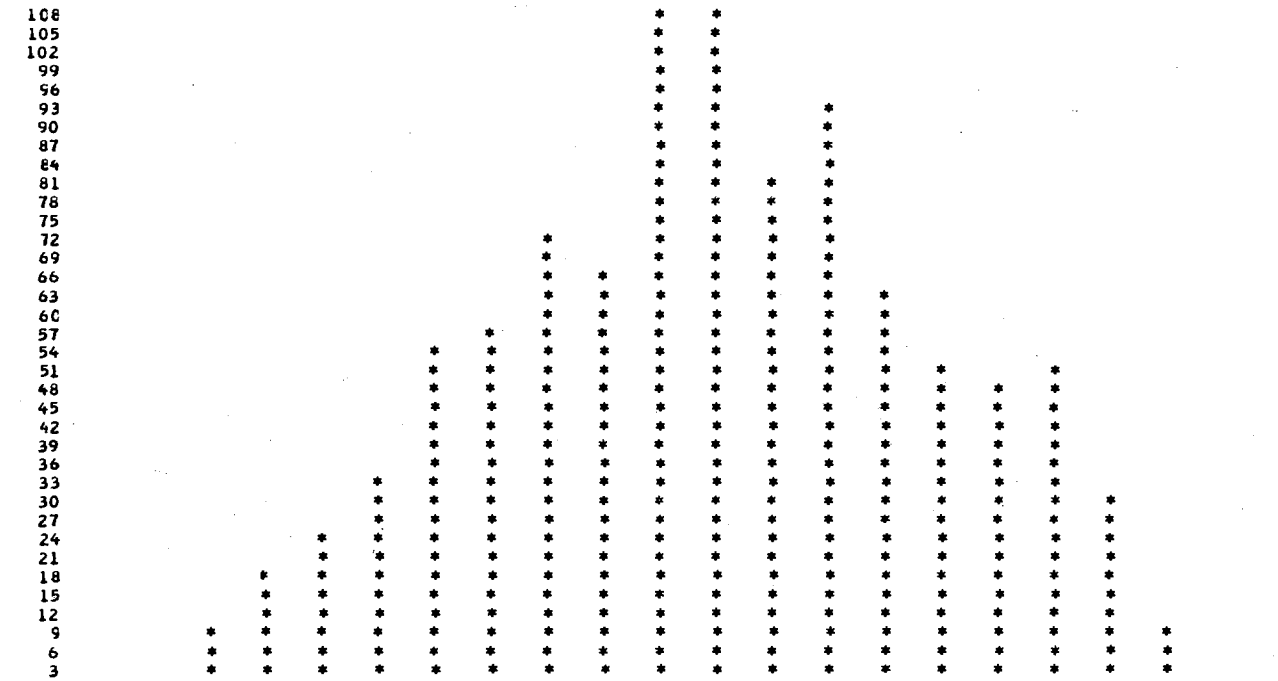
NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	-13956.01	24729.01	49571.94	12385.23	
-13956.01					99.90 %
-8662.02					99.30 %
-3368.02					97.60 %
1925.97					94.40 %
7219.96					90.30 %
12513.95					83.30 %
17807.95					73.70 %
23101.94					59.50 %
28395.93					41.00 %
33689.92					25.30 %
38983.91					12.80 %
44277.91					3.10 %

ESTIMATE NO: 3

HISTOGRAM 1

FREQUENCY	0	10	19	26	34	54	59	72	68	110	109	83	95	64	52	49	53	32	10	1

EACH * EQUALS 3 POINTS



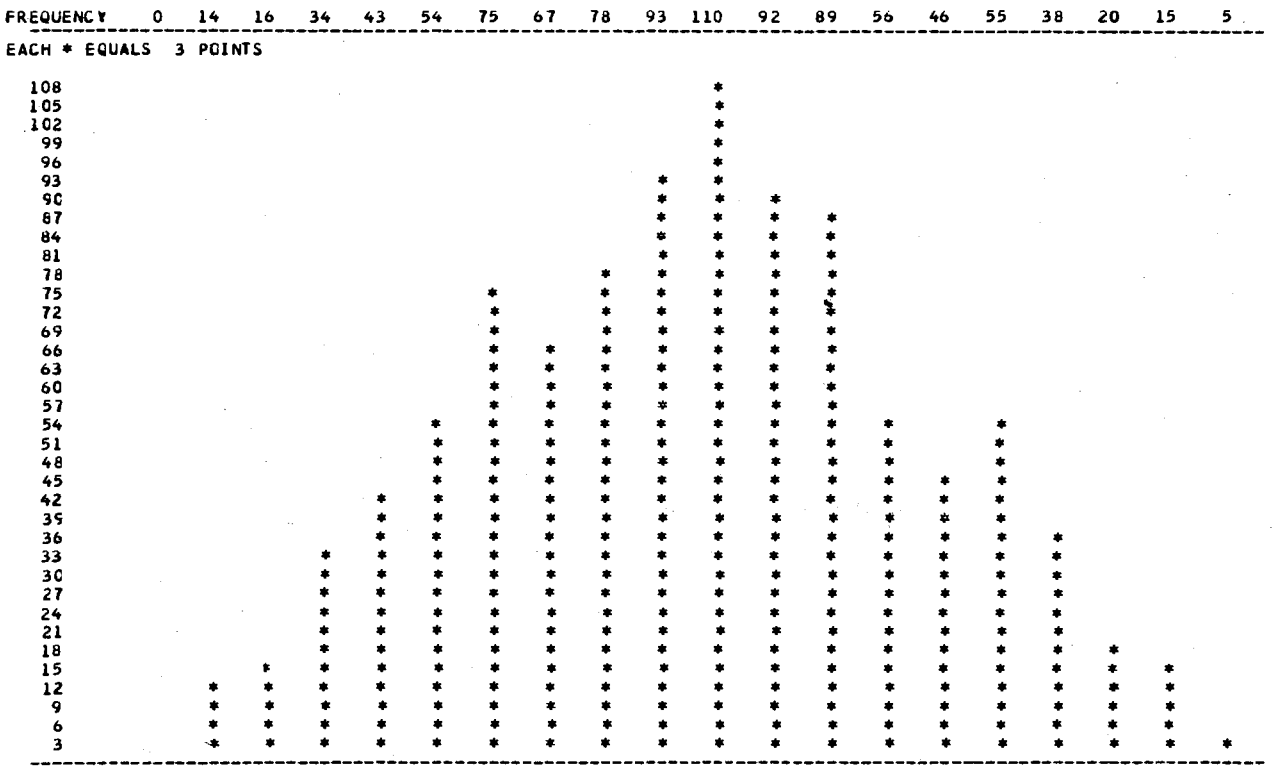
INTERVAL CLASS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

TOTAL = 251601.00 AVERAGE = 251.601 STANDARD DEVIATION = 25.990 MINIMUM = 188.000 MAXIMUM = 309.000

PRODUCTION RATE, UNITS/HOUR

ESTIMATE NO: 3

HISTOGRAM 2

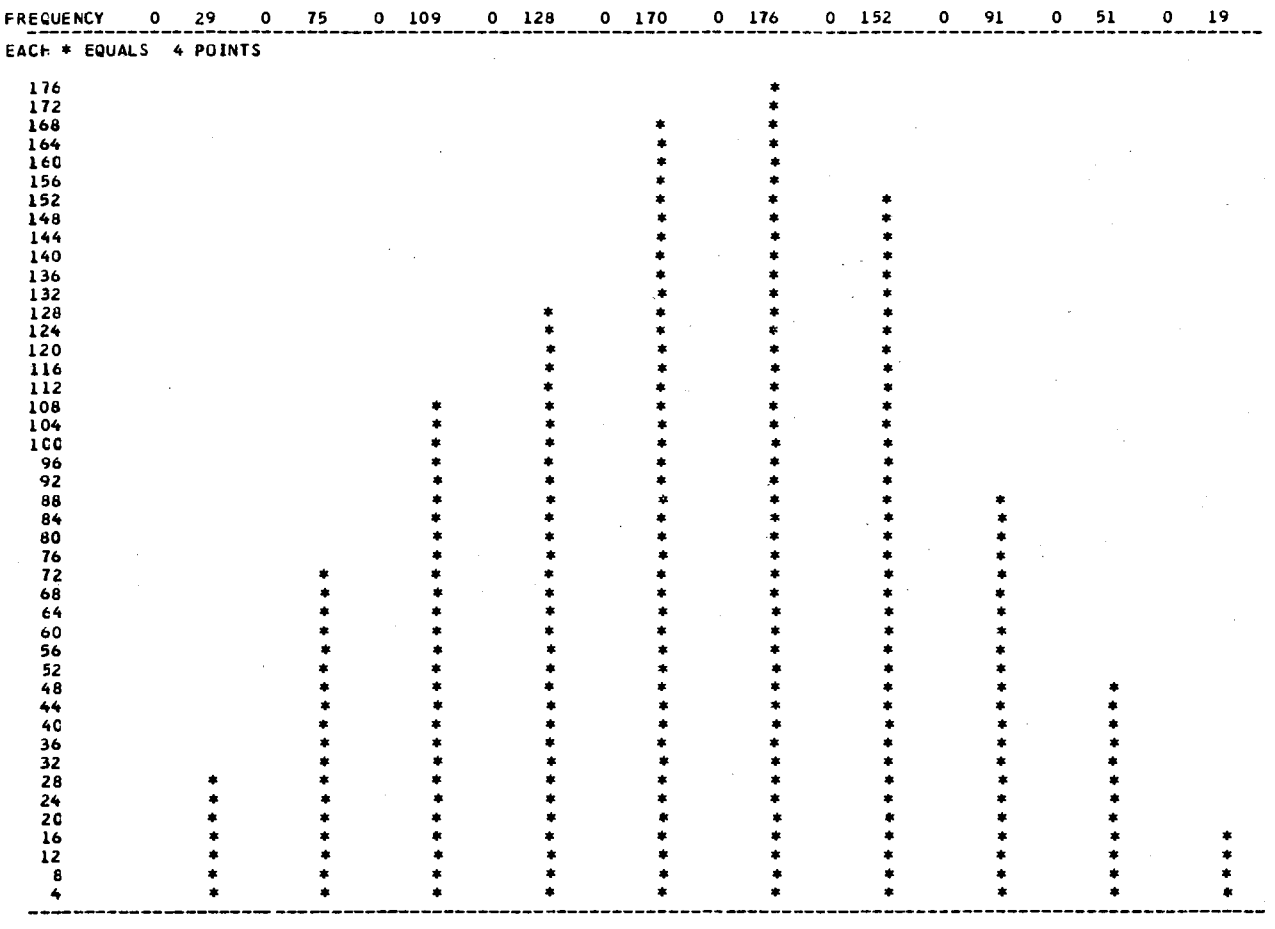


TOTAL = 49658.00 AVERAGE = 49.658 STANDARD DEVIATION = 3.955 MINIMUM = 40.000 MAXIMUM = 59.000

PRODUCTION HOURS/ WEEK

ESTIMATE NO: 3

HISTOGRAM 3

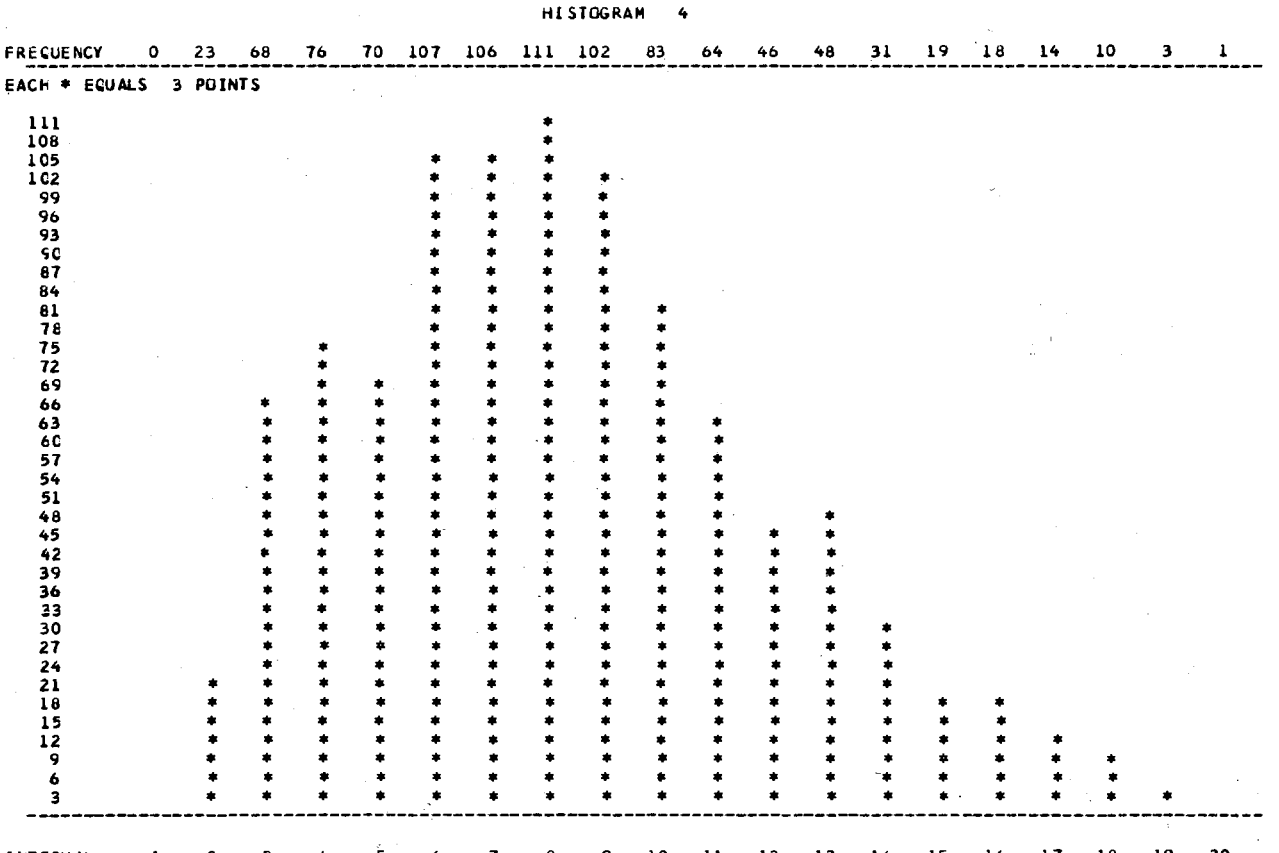


TOTAL = 39365.00 AVERAGE = 39.365 STANDARD DEVIATION = 2.114 MINIMUM = 35.000 MAXIMUM = 44.000

PRODUCTION WEEKS/YEAR

ESTIMATE NO: 3

HISTOGRAM 4

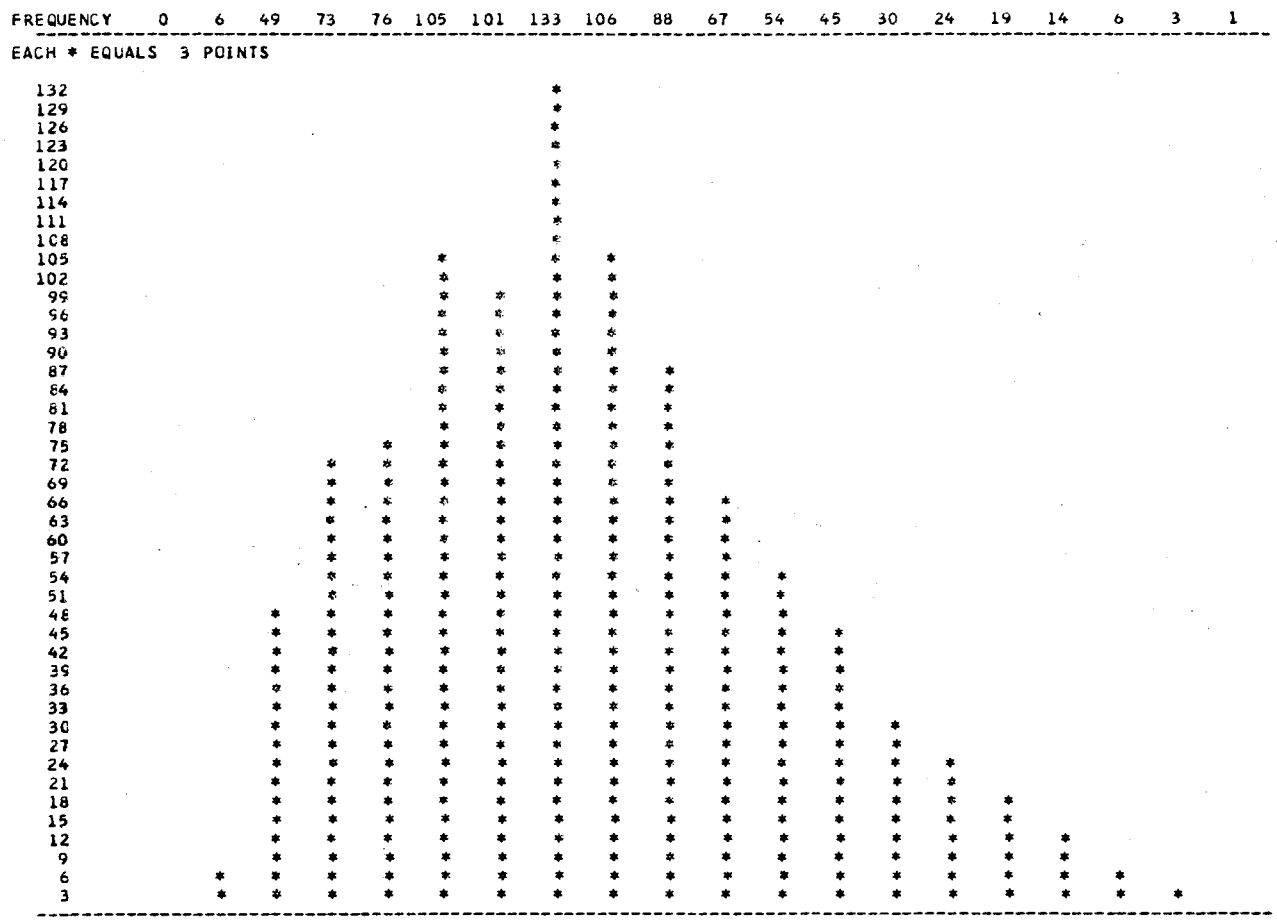


TOTAL = 488795648.00 AVERAGE =488795.625 STANDARD DEVIATION = 12029.016 MINIMUM =471108.438 MAXIMUM =518091.688

TOTAL DIRECT CASH COST

ESTIMATE NO: 3

HISTOGRAM 5

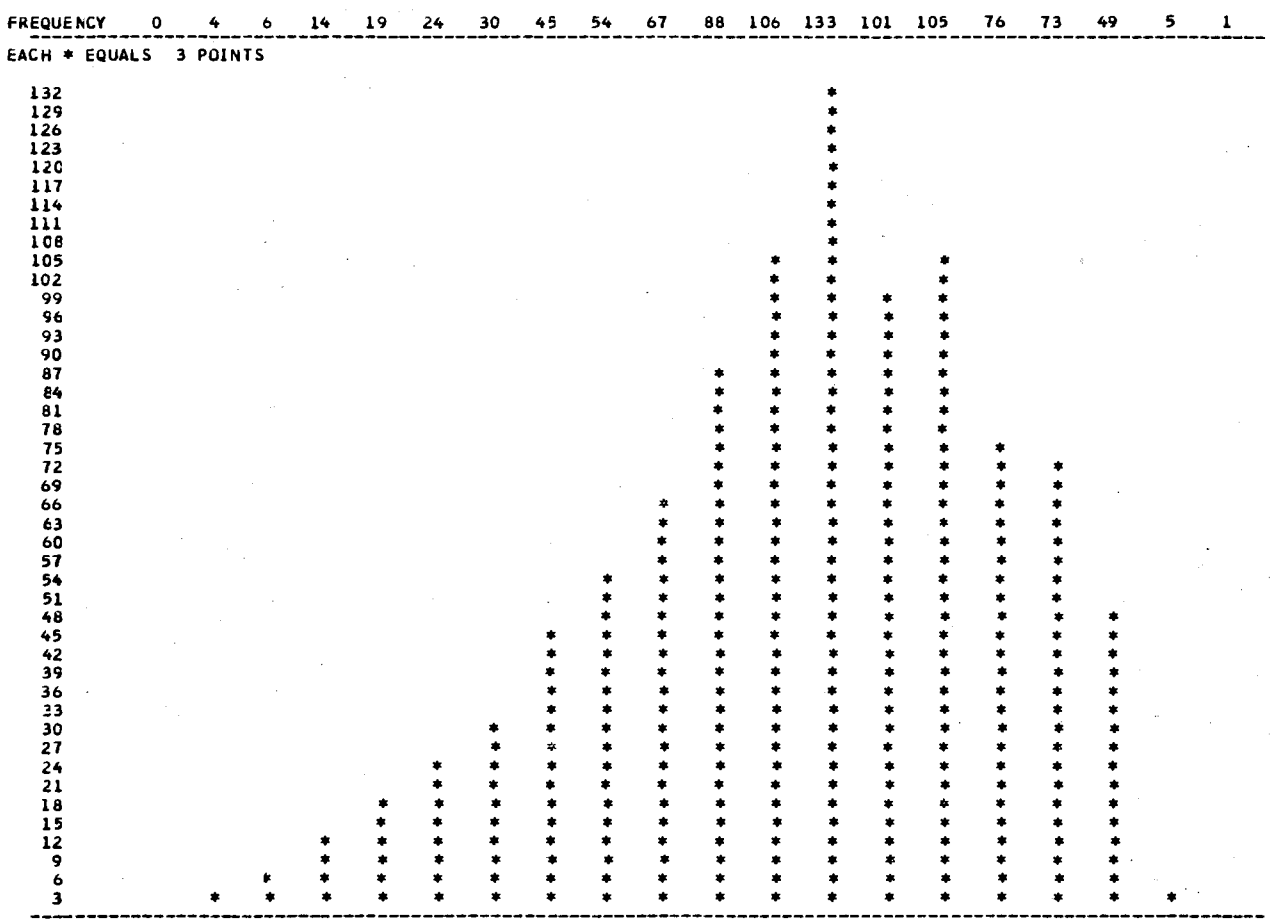


TOTAL = 559489024.00 AVERAGE =559489.000 STANDARD DEVIATION = 14597.340 MINIMUM =534719.750 MAXIMUM =598247.688

TOTAL AMOUNT OF BID

ESTIMATE NO: 3

HISTOGRAM 6

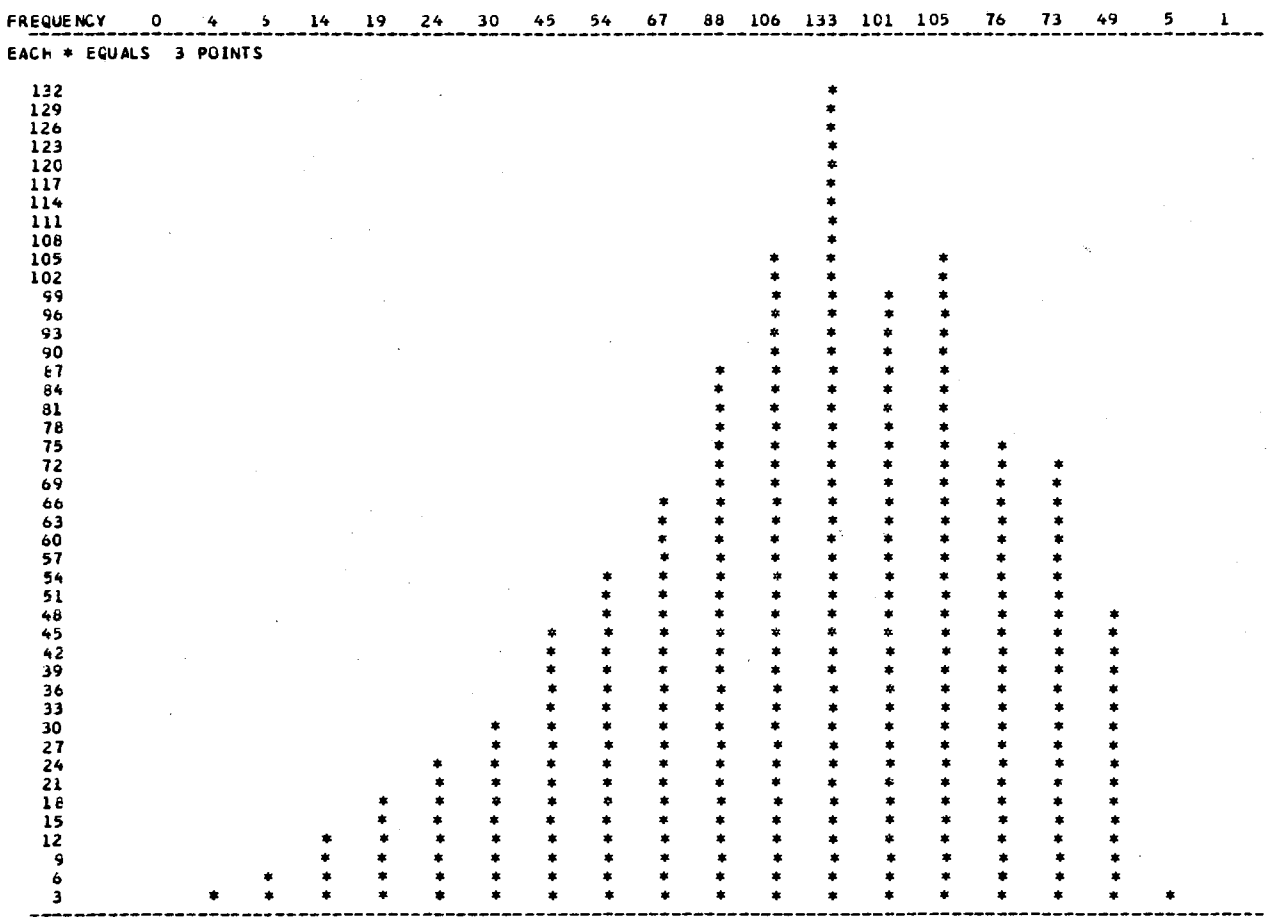


TOTAL = 42826576.00 AVERAGE = 42826.574 STANDARD DEVIATION = 12394.609 MINIMUM = 4143.988 MAXIMUM = 67671.875

NET CASH FLOW, EQUIP, EXPECTED VALUES

ESTIMATE NO: 3

HISTOGRAM 7

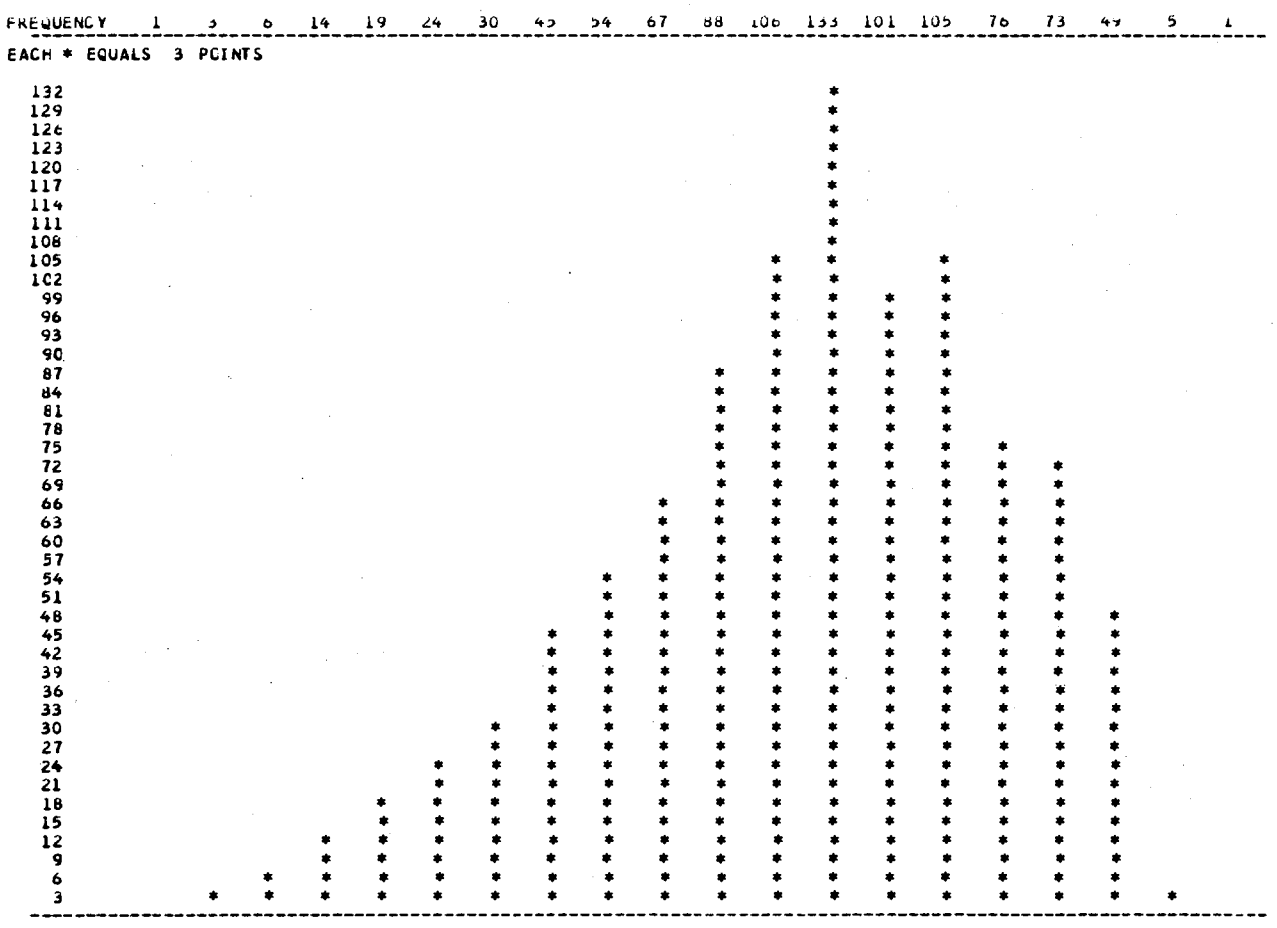


TOTAL = 45072224.00 AVERAGE = 45072.223 STANDARD DEVIATION = 12394.227 MINIMUM = 6389.613 MAXIMUM = 69917.500

NET CASH FLOW EQUIP, ROI APPROACH

ESTIMATE NO: 3

HISTOGRAM 8



TOTAL = 24729008.00 AVERAGE = 24729.008 STANDARD DEVIATION = 12391.430 MINIMUM.=-13956.008 MAXIMUM = 49571.941

NET CASH FLOW, EQUIP, LIFE CYCLE SYSTEM

ESTIMATE NU: 3

APPENDIX E

EXCAVATION PROJECT ESTIMATE

PROJECT NAME: EXCAVATION GENERAL

LETTING DATE: 5- 1-1972

****

PROJECT ESTIMATE PARAMETERS

****

ESTIMATED GENERAL OVERHEAD COSTS TO BE RECOVERED FROM THIS YEAR'S OPERATIONS

ESTIMATED COST OF MATERIALS OVERHEAD = $	12000.00
ESTIMATED COST OF LABOR OVERHEAD = $	55000.00
ESTIMATED COST OF EQUIPMENT OVERHEAD = $	19700.00
ESTIMATED OTHER OVERHEAD EXPENSES = $	11000.00
TOTAL EST OVERHEAD ALLOCATION, THIS YEAR = $	97700.00

MINIMUM ACCEPTABLE RETURN ON INVESTMENT = $ 25 % PER YEAR BEFORE INCOME TAX

BEGIN PRODUCTION MONTH 6

ESTIMATED VALUE, AT BEGINNING OF YEAR, ALL COMPANY'S PRODUCTIVE EQUIPMENT = $	1350000.00
ESTIMATED VALUE, AT BEGINNING OF YEAR, EQUIPMENT SPREAD REQUIRED FOR THIS BID ITEM =$	582000.00
ESTIMATED VALUE OF THIS EQUIPMENT SPREAD WHEN NEW =$	970000.00
AVERAGE ECONOMIC LIFE, DEPRECIATION, CAPITAL RECOVERY PERIOD, IN HRS, FOR THIS SPREAD =	10000
THEREFORE, THE MINIMUM CAPITAL RECOVERY PER OPERATING HOUR = $	97.00

ESTIMATE NO: 0

BID ITEM PARAMETERS

****

HOURLY DIRECT LABOR COST = $	104.00	(NO FICA, WC, OR FRINGES)
HOURLY EQUIP OPERATING COST = $	142.00	AVG OVER LIFE OF EQUIP-FUEL, OIL, GREASE, TIRES, MAINT, ETC, OPERATING COSTS ONLY
UNIT PRICE, DIRECT MATERIAL = $	0.0	PER CY
OTHER DIRECT ESPENSES = $	12000.00	MOBILIZATION, SIGNS, ETC
LABOR TAXES, % OF DIRECT LABOR =	14 %	(WORKMENS COMP, FICA, UNEMPL, FRINGES)
OTHER, % OF TOTAL COST, ADDON =	5 %	(INSURANCE, BONDS, AGC, ETC)
LABOR INCREASE, OVER EQUIP HOURS =	9 %	
LEAST LIKELY PRODUCTION RATE =	800 CY /HOUR	
MOST LIKELY PRODUCTION RATE =	1500 CY /HOUR	
OPTOMISTIC PRODUCTION RATE =	1700 CY /HOUR	
LEAST LIKELY PROD WEEK =	40 HOURS	
MOST LIKELY PROD WEEK =	45 HOURS	
OPTOMISTIC PROD WEEK =	50 HOURS	
LEAST LIKELY PROD YEAR =	40 WEEKS	
MOST LIKELY PROD YEAR =	45 WEEKS	
OPTOMISTIC PROD YEAR =	50 WEEKS	
JOB OVERHEAD LABOR =	365.00	PER WEEK
JOB OVERHEAD OTHER =	210.00	PER WEEK
TIME INTERVAL, IF KNOWN =	0	WEEKS, IF DIFFERENT FROM PRODUCTION PERIOD

ESTIMATE NO: 0

RISK FACTOR ANALYSIS

****

CASH COST/HR =	298.16
UNIT COST PENALTY =	0.04
GMR TOTAL =	38649.89

ITEM COST ESTIMATES
****

EXPECTED COSTS BASED UPON THE 'MOST LIKELY' RATES OF PRODUCTION
****

CODE	ITEM	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL	SUMMARY	UNIT COST
0	UNCL EXCAVATION	CY					
	DIRECT MATERIAL	CY	0.0	1000000	0.0		0.0
	DIRECT LABOR	HR	104.00	726	82441.06		0.0824
	EQUIPMENT OPERATION	HR	142.00	666	94572.00		0.0946
	JOB OVERHEAD LABOR	JOB	($ 365.00 X	16 WEEKS) =	5840.00		0.0058
	OTHER JOB OVERHEAD	JOB	($ 210.00 X	16 WEEKS) =	3360.00		0.0034
	SUBCONTRACT	JOB	0.0		0.0		0.0
	OTHER DIRECT	LS			12000.00		0.0120
	PAYROLL TAXES, ETC	JOB	(14 % X $	88281.06	12359.34		0.0124
	INS, BONDS, AGC, ETC	%	(5 % X ($	354461.44 - 16969.06)=	16969.06		0.0170
	TOTAL DIRECT CASH COST					227541.44	0.2275
	EQUIPMENT RENTAL, (DEPR)	HR	(666 HRS X $	97.00/HR) =	64602.00		0.0646
	TOTAL DIRECT COST					292143.44	0.2921
	GEN OH ALLOCATION	JOB	(32 % X 43 % =	14 % X $ 97700.00)=	13866.51		0.0139
	TOTAL COST INCLUDING OVERHEAD ALLOCATION					306009.94	0.3060
	PROFIT = $	JOB			48451.50		0.0485
	BID =					354461.44	0.3545

THE OVERHEAD ALLOCATION IS:

6.1 % OF DIRECT CASH COST

4.7 % OF TOTAL DIRECT COST AND DEPR

4.5 % OF TOTAL COST AND OH

3.9 % OF AMOUNT BID

THE RETURN ON INVESTMENT PROFIT IS:

21.3 % OF DIRECT CASH COST

16.6 % OF TOTAL DIRECT COST AND DEPR

15.8 % OF TOTAL COST AND OH

13.7 % OF AMOUNT BID

ESTIMATE NO: 1

ITEM COST ESTIMATE BASIS

CALCULATION OF PRODUCTION TIME IS BASED UPON A PRODUCTION
RATE OF 1500 CY PER HOUR 45 HOURS PER WEEK, = 67500 CY PER WEEK.
THE TOTAL 1000000 CY DIVIDED BY 67500 CY PER WEEK = 14 WEEKS PRODUCTION TIME.
THIS ITEM SHOULD START MONTH 6 AND END, MONTH 9 .

CALCULATION OF THE GENERAL OVERHEAD ALLOCATION TO THIS BID ITEM
IS BASED UPON ITS REQUIRING 14 WEEKS PRODUCTION TIME OUT OF A TOTAL OF 45 WEEKS PRODUCTION
TIME FOR THE YEAR, OR, 32 % OF A PRODUCTION YEAR. FURTHERMORE, $ 582000.00 OF THE COMPANY'S
TOTAL $ 1350000.00 PRODUCTIVE EQUIPMENT INVESTMENT, OR 43 % WILL BE USED ON THIS BID ITEM.
THEREFORE, 43 % OF THE COMPANY'S CURRENT EQUIPMENT INVESTMENT WILL BE USED ON THIS BID
ITEM 32 % OF A YEAR. 43 % X 32 % = 14 % OF THE GENERAL OVERHEAD SHOULD BE ALLOCATED TO THIS ITEM.

PROFIT = 25 % X $ 582000.00 = $ 145500.00 / YEAR X 32 % OF YEAR =$ 47901.21
OR OWNERSHIP COST = $ 145500.00 /2000 HRS/YR= $ 72.75 /HR X 666 HOURS = $ 48451.50

ESTIMATE NO: 1

AN INTERNAL RATE OF RETURN OF 3.7500 % APPLIES TO THE FOLLOWING CASH FLOWS:

MONTH	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-970000.00	1.000000	-970000.00	0.0	0.0	0.0	0.0	0.0	970000.00
1	19246.71	0.996885	19186.76	3031.25	3031.25	16215.46	16215.46	19246.71	953784.50
2	19246.71	0.993781	19127.01	2980.57	6011.82	16266.13	32481.59	38493.41	937518.38
3	19246.71	0.990686	19067.45	2929.74	8941.56	16316.96	48798.55	57740.12	921201.44
4	19246.71	0.987601	19008.05	2878.75	11820.31	16367.95	65166.51	76986.81	904833.44
5	19246.71	0.984525	18948.86	2827.60	14647.91	16419.11	81585.56	96233.50	888414.44
6	19246.71	0.981459	18889.85	2776.29	17424.20	16470.41	98055.94	115480.19	871944.06
7	19246.71	0.978403	18831.04	2724.82	20149.02	16521.88	114577.81	134726.88	855422.19
8	19246.71	0.975355	18772.37	2673.19	22822.21	16573.51	131151.31	153973.56	838848.69
9	19246.71	0.972318	18713.92	2621.40	25443.61	16625.30	147776.56	173220.25	822223.44
10	19246.71	0.969290	18655.64	2569.45	28013.05	16677.26	164453.81	192466.94	805546.19
11	19246.71	0.966271	18597.53	2517.33	30530.38	16729.38	181183.19	211713.63	788816.81
12	19246.71	0.963262	18539.62	2465.05	32995.43	16781.66	197964.81	230960.31	772035.19
13	19246.71	0.960262	18481.87	2412.61	35408.04	16834.10	214798.88	250207.00	755201.13
14	19246.71	0.957271	18424.32	2360.00	37768.04	16886.70	231685.56	269453.69	738314.44
15	19246.71	0.954291	18366.96	2307.23	40075.26	16939.48	248625.00	288700.38	721375.00
16	19246.71	0.951318	18309.73	2254.29	42329.55	16992.41	265617.38	307947.06	704382.63
17	19246.71	0.948356	18252.72	2201.19	44530.75	17045.51	282662.88	327193.75	687337.13
18	19246.71	0.945402	18195.88	2147.93	46678.67	17098.78	299761.63	346440.44	670238.38
19	19246.71	0.942458	18139.21	2094.49	48773.16	17152.21	316913.81	365687.13	653086.19
20	19246.71	0.939523	18082.72	2040.89	50814.05	17205.81	334119.63	384933.81	635880.38
21	19246.71	0.936597	18026.40	1987.12	52801.18	17259.58	351379.19	404180.50	618620.81
22	19246.71	0.933680	17970.27	1933.19	54734.36	17313.52	368692.69	423427.19	601307.31
23	19246.71	0.930773	17914.31	1879.08	56613.45	17367.62	386060.25	442673.88	583939.75
24	19246.71	0.927874	17858.51	1824.81	58438.25	17421.89	403482.13	461920.56	566517.88
25	19246.71	0.924984	17802.90	1770.37	60208.62	17476.34	420958.44	481167.25	549041.56
26	19246.71	0.922103	17747.45	1715.75	61924.37	17530.95	438489.38	500413.94	531510.63
27	19246.71	0.919231	17692.17	1660.97	63585.34	17585.73	456075.06	519660.63	513924.94
28	19246.71	0.916369	17637.08	1606.01	65191.35	17640.69	473715.75	538907.31	496284.25
29	19246.71	0.913515	17582.15	1550.89	66742.19	17695.82	491411.56	558154.00	478588.44
30	19246.71	0.910670	17527.39	1495.59	68237.75	17751.12	509162.63	577400.69	460837.38
31	19246.71	0.907834	17472.82	1440.12	69677.81	17806.59	526969.19	596647.38	443030.81
32	19246.71	0.905007	17418.39	1384.47	71062.25	17862.23	544831.38	615894.06	425168.63
33	19246.71	0.902189	17364.16	1328.65	72390.88	17918.05	562749.38	635140.75	407250.63
34	19246.71	0.899379	17310.08	1272.66	73663.50	17974.05	580723.38	654387.44	389276.63
35	19246.71	0.896578	17256.18	1216.49	74879.94	18030.22	598753.56	673634.13	371246.44
36	19246.71	0.893786	17202.43	1160.14	76040.06	18086.56	616840.13	692880.81	353159.88
37	19246.71	0.891001	17148.84	1103.62	77143.63	18143.08	634983.19	712127.50	335016.81
38	19246.71	0.888227	17095.44	1046.93	78190.50	18199.78	653182.94	731374.19	316817.06
39	19246.71	0.885462	17042.22	990.05	79180.50	18256.65	671439.56	750620.88	298560.44
40	19246.71	0.882703	16989.12	933.00	80113.50	18313.70	689753.25	769867.56	280246.75
41	19246.71	0.879955	16936.23	875.77	80989.25	18370.93	708124.13	789114.25	261875.88
42	19246.71	0.877214	16883.48	818.36	81807.56	18428.34	726552.44	808360.94	243447.56
43	19246.71	0.874482	16830.90	760.77	82568.31	18485.93	745038.31	827607.63	224961.69
44	19246.71	0.871759	16778.48	703.00	83271.31	18543.70	763582.00	846854.31	206418.00
45	19246.71	0.869044	16726.23	645.06	83916.31	18601.65	782183.63	866101.00	187816.38
46	19246.71	0.866338	16674.14	586.93	84503.19	18659.78	800843.38	885347.69	169156.63
47	19246.71	0.863640	16622.23	528.61	85031.75	18718.09	819561.44	904594.38	150438.56
48	19246.71	0.860949	16570.44	470.12	85501.81	18776.59	838338.00	923841.06	131662.00
49	19246.71	0.858269	16518.84	411.44	85913.25	18835.26	857173.25	943087.75	112826.75
50	19246.71	0.855596	16467.39	352.58	86265.81	18894.12	876067.31	962334.44	93932.69
51	19246.71	0.852931	16416.12	293.54	86559.31	18953.16	895020.44	981581.12	74979.56
52	19246.71	0.850275	16364.99	234.31	86793.56	19012.39	914032.81	1000827.81	55967.19
53	19246.71	0.847627	16314.02	174.90	86968.44	19071.81	933104.56	1020074.50	36895.44
54	19246.71	0.844987	16263.22	115.30	87083.69	19131.41	952235.94	1039321.19	17764.06
55	19246.71	0.842356	16212.57	55.51	87139.19	19191.19	971427.13	1058567.00	-1427.13

ESTIMATE NO: 1

BEGINNING BALANCE SHEET

WORKING CAPITAL, CASH		29637.20
GROSS EQUIP, THIS BID ITEM	970000.00	
CAPITAL RECOVERED, (ACCUM DEPREC)	388000.00	
NET EQUIP, THIS BID ITEM		582000.00
OTHER CO. EQUIP (AT PRESENT VALUE)		768000.00
TOTAL EQUIPMENT INVESTMENT		1350000.00
TOTAL ASSETS		1379637.00
TAXES PAYABLE, RESERVE		0.0
NET WORTH		1379637.00
TOTAL LIABILITIES AND NET WORTH		1379637.00

INCOME STATEMENT

SALES		356350.38
DIRECT CASH OUTLAYS		
LABOR	100640.38	
MATERIALS	0.0	
EQUIPMENT	94572.00	
SUBCONTRACT	0.0	
OTHER	32329.06	
TOTAL DIRECT CASH COST		227541.44
GROSS MARGIN, CASH CONTRIBUTION		128808.94

APPLIED PERIOD COST (INDIRECT MTL, LAB, EQUIP)		13866.51
CAPITAL RECOVERED (DEPRECIATION)		64602.00
NET PROFIT		50340.38

ENDING BALANCE SHEET
****

CASH (WORKING CAPITAL + CASH INCOME)		158446.13
GROSS EQUIPMENT	970000.00	
CAPITAL RECOVERED (ACCUM DEPREC)	452602.00	
NET EQUIPMENT		517398.00
OTHER CO. EQUIP		768000.00
TOTAL EQUIP		1285398.00
TOTAL ASSETS		1443844.00
TAXES PAYABLE RESERVE (AT 50% OF NET INCOME)		25170.19
NET WORTH		1418673.00
TOTAL LIABILITIES AND NET WORTH		1443844.00

ESTIMATE NO: 1

ITEM COST ESTIMATES
****

EXPECTED COSTS BASED UPON THE 'MOST LIKELY' RATES OF PRODUCTION
****

CODE	ITEM	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL	SUMMARY	UNIT COST
0	UNCL EXCAVATION	CY					
	DIRECT MATERIAL	CY	0.0	1000000	0.0		0.0
	DIRECT LABOR	HR	104.00	726	100640.38		0.0824
	EQUIPMENT OPERATION	HR	142.00	666	94572.00		0.0946
	JOB OVERHEAD LABOR	JOB	($ 365.00 X	16 WEEKS) =	5840.00		0.0058
	OTHER JOB OVERHEAD	JOB	($ 210.00 X	16 WEEKS) =	3360.00		0.0034
	SUBCONTRACT	JOB	0.0		0.0		0.0
	OTHER DIRECT	LS			12000.00		0.0120
	PAYROLL TAXES, ETC	JOB	(14 % X $	88281.06	12359.34		0.0124
	INS, BONDS, AGC, ETC	%	(5 % X ($	356350.38 - 32329.06)=	32329.06		0.0170
	TOTAL DIRECT CASH COST					227541.44	0.2275
	CAPITAL RECOVERY, (DEPR)	HR	(666 HRS X $	97.00/HR) =	64602.00		0.0646
	TOTAL DIRECT COST					292143.44	0.2921
	GEN OH ALLOCATION	JOB	(32 % X 43 % =	14 % X $ 97700.00)=	13866.51		0.0139
	TOTAL COST INCLUDING OVERHEAD ALLOCATION					306009.94	0.3060
	RETURN ON INVESTMENT, PROFIT	JOB			50340.48		0.0503
	TOTAL FULL COST, MIN BID REQ'D FOR A 25 % RET ON INV =					356350.38	0.3564

THE OVERHEAD ALLOCATION IS:

6.1 % OF DIRECT CASH COST

4.7 % OF TOTAL DIRECT COST AND DEPR

4.5 % OF TOTAL COST AND OH

3.9 % OF AMOUNT BID

THE RETURN ON INVESTMENT PROFIT IS:

22.1 % OF DIRECT CASH COST

17.2 % OF TOTAL DIRECT COST AND DEPR

16.5 % OF TOTAL COST AND OH

14.1 % OF AMOUNT BID

ESTIMATE NO: 2

ITEM COST ESTIMATE BASIS

CALCULATION OF PRODUCTION TIME IS BASED UPON A PRODUCTION
RATE OF 1500 CY PER HOUR 45 HOURS PER WEEK, = 67500 CY PER WEEK.
THE TOTAL 1000000 CY DIVIDED BY 67500 CY PER WEEK = 14 WEEKS PRODUCTION TIME.
THIS ITEM SHOULD START MONTH 6 AND END, MONTH 9 .

CALCULATION OF THE GENERAL OVERHEAD ALLOCATION TO THIS BID ITEM
IS BASED UPON ITS REQUIRING 14 WEEKS PRODUCTION TIME OUT OF A TOTAL OF 45 WEEKS PRODUCTION
TIME FOR THE YEAR, OR, 32 % OF A PRODUCTION YEAR. FURTHERMORE, $ 582000.00 OF THE COMPANY'S
TOTAL $ 1350000.00 PRODUCTIVE EQUIPMENT INVESTMENT, OR 43 % WILL BE USED ON THIS BID ITEM.
THEREFORE, 43 % OF THE COMPANY'S CURRENT EQUIPMENT INVESTMENT WILL BE USED ON THIS BID
ITEM 32 % OF A YEAR. 43 % X 32 % = 14 % OF THE GENERAL OVERHEAD SHOULD BE ALLOCATED TO THIS ITEM.

ESTIMATED WORKING CAPITAL REQUIREMENTS ARE FOUR WEEKS PAYROLL PLUS 10% OF ONE MONTH'S
DIRECT MATERIAL AND EQUIPMENT OPERATING COSTS, A TOTAL, $ 29637.20 FOR THIS ITEM
THE MINIMUM ACCEPTABLE RETURN ON INVESTMENT, OR PROFIT, FOR THIS ITEM IS THE 25 % ANNUAL
RETURN REQUIRED TIMES THE SUM OF THE $ 29637.20 WORKING CAPITAL AND THE $ 582000.00
CURRENT EQUIPMENT INVESTMENT TIMES 32 % OF A PROD YEAR = THE REQUIRED PROFIT, $ 50340.48.

ESTIMATE NO: 2

AN INTERNAL RATE OF RETURN OF 4.7812 % APPLIES TO THE FOLLOWING CASH FLOWS:

MONTH	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-970000.00	1.000000	-970000.00	0.0	0.0	0.0	0.0	0.0	970000.00
1	19713.74	0.996032	19635.52	3864.83	3864.83	15848.90	15848.90	19713.74	954151.06
2	19713.74	0.992081	19557.62	3801.69	7666.52	15912.05	31760.95	39427.48	938239.00
3	19713.74	0.988145	19480.03	3738.29	11404.80	15975.45	47736.40	59141.21	922263.56
4	19713.74	0.984225	19402.76	3674.64	15079.44	16039.10	63775.50	78854.94	906224.44
5	19713.74	0.980321	19325.79	3610.73	18690.16	16103.01	79878.50	98568.63	890121.50
6	19713.74	0.976431	19249.11	3546.57	22236.73	16167.17	96045.63	118282.31	873954.38
7	19713.74	0.972558	19172.75	3482.15	25718.88	16231.58	112277.19	137996.00	857722.81
8	19713.74	0.968700	19096.70	3417.48	29136.36	16296.25	128573.44	157709.69	841426.56
9	19713.74	0.964857	19020.94	3352.55	32488.91	16361.18	144934.56	177423.38	825065.44
10	19713.74	0.961029	18945.47	3287.36	35776.27	16426.38	161360.94	197137.06	808639.06
11	19713.74	0.957216	18870.31	3221.91	38998.18	16491.82	177852.75	216850.75	792147.25
12	19713.74	0.953419	18795.45	3156.20	42154.39	16557.53	194410.25	236564.44	775589.75
13	19713.74	0.949637	18720.89	3090.23	45244.62	16623.50	211033.75	256278.13	758966.25
14	19713.74	0.945870	18646.63	3024.00	48268.61	16689.74	227723.44	275991.81	742276.56
15	19713.74	0.942118	18572.66	2957.50	51226.11	16756.23	244479.63	295705.50	725520.38
16	19713.74	0.938380	18498.98	2890.74	54116.85	16823.00	261302.63	315419.19	708697.38
17	19713.74	0.934657	18425.59	2823.71	56940.56	16890.03	278192.63	335132.88	691807.38
18	19713.74	0.930950	18352.50	2756.41	59696.97	16957.32	295149.94	354846.56	674850.06
19	19713.74	0.927256	18279.68	2688.85	62385.82	17024.89	312174.81	374560.25	657825.19
20	19713.74	0.923578	18207.17	2621.02	65006.83	17092.72	329267.50	394273.94	640732.50
21	19713.74	0.919914	18134.94	2552.91	67559.69	17160.82	346428.31	413987.63	623571.69
22	19713.74	0.916264	18062.98	2484.54	70044.19	17229.20	363657.50	433701.31	606342.50
23	19713.74	0.912630	17991.34	2415.89	72460.06	17297.85	380955.31	453415.00	589044.69
24	19713.74	0.909009	17919.97	2346.97	74807.00	17366.77	398322.06	473128.69	571677.94
25	19713.74	0.905404	17848.89	2277.77	77084.75	17435.96	415758.00	492842.38	554242.00
26	19713.74	0.901811	17778.06	2208.30	79293.00	17505.43	433263.38	512556.06	536736.63
27	19713.74	0.898233	17707.54	2138.55	81431.50	17575.18	450838.50	532269.75	519161.50
28	19713.74	0.894670	17637.28	2068.53	83500.00	17645.21	468483.69	551983.44	501516.31
29	19713.74	0.891121	17567.32	1998.22	85498.19	17715.51	486199.19	571697.13	483800.81
30	19713.74	0.887586	17497.63	1927.64	87425.81	17786.10	503985.25	591410.81	466014.75
31	19713.74	0.884065	17428.22	1856.77	89282.56	17856.96	521842.19	611124.50	448157.81
32	19713.74	0.880558	17359.08	1785.62	91068.13	17928.11	539770.25	630838.19	430229.75
33	19713.74	0.877064	17290.21	1714.19	92782.31	17999.54	557769.75	650551.88	412230.25
34	19713.74	0.873585	17221.62	1642.48	94424.75	18071.26	575841.00	670265.56	394159.00
35	19713.74	0.870119	17153.29	1570.47	95995.19	18143.26	593984.25	689979.25	376015.75
36	19713.74	0.866668	17085.26	1498.18	97493.31	18215.55	612199.75	709692.94	357800.25
37	19713.74	0.863229	17017.48	1425.61	98918.88	18288.13	630487.88	729406.63	339512.13
38	19713.74	0.859804	16949.95	1352.74	100271.56	18361.00	648848.81	749120.31	321151.19
39	19713.74	0.856394	16882.71	1279.58	101551.13	18434.15	667282.94	768834.00	302717.06
40	19713.74	0.852997	16815.75	1206.14	102757.25	18507.60	685790.50	788547.69	284209.50
41	19713.74	0.849613	16749.04	1132.39	103889.63	18581.34	704371.81	808261.38	265628.19
42	19713.74	0.846242	16682.59	1058.36	104947.94	18655.38	723027.19	827975.06	246972.81
43	19713.74	0.842884	16616.40	984.03	105931.94	18729.71	741756.88	847688.75	228243.13
44	19713.74	0.839540	16550.48	909.40	106841.31	18804.33	760561.19	867402.44	209438.81
45	19713.74	0.836210	16484.83	834.48	107675.75	18879.25	779440.44	887116.13	190559.56
46	19713.74	0.832893	16419.44	759.26	108435.00	18954.48	798394.88	906829.81	171605.13
47	19713.74	0.829589	16354.30	683.74	109118.69	19030.00	817424.88	926543.50	152575.13
48	19713.74	0.826298	16289.43	607.92	109726.56	19105.82	836530.69	946257.19	133469.31
49	19713.74	0.823020	16224.80	531.79	110258.31	19181.95	855712.63	965970.88	114287.38
50	19713.74	0.819755	16160.44	455.36	110713.63	19258.38	874971.00	985684.56	95029.00
51	19713.74	0.816502	16096.31	378.63	111092.25	19335.11	894306.06	1005398.25	75693.94
52	19713.74	0.813264	16032.47	301.59	111393.81	19412.14	913718.19	1025111.94	56281.81
53	19713.74	0.810038	15968.87	224.25	111618.00	19489.49	933207.63	1044825.63	36792.38
54	19713.74	0.806823	15905.50	146.59	111764.56	19567.14	952774.75	1064539.00	17225.25
55	19713.74	0.803623	15842.42	68.63	111833.19	19645.11	972419.81	1084252.00	-2419.81

ESTIMATE NO: 2

BEGINNING BALANCE SHEET

WORKING CAPITAL, CASH		29637.20
GROSS EQUIP, THIS BID ITEM	970000.00	
CAPITAL RECOVERED, (ACCUM DEPREC)	388000.00	
NET EQUIP, THIS BID ITEM		582000.00
OTHER CO. EQUIP (AT PRESENT VALUE)		768000.00
TOTAL EQUIPMENT INVESTMENT		1350000.00
TOTAL ASSETS		1379637.00
TAXES PAYABLE, RESERVE		0.0
NET WORTH		1379637.00
TOTAL LIABILITIES AND NET WORTH		1379637.00

INCOME STATEMENT

SALES		356350.38
DIRECT CASH OUTLAYS		
LABOR	100640.38	
MATERIALS	0.0	
EQUIPMENT	94572.00	
SUBCONTRACT	0.0	
OTHER	47689.06	
TOTAL DIRECT CASH COST		227541.44
GROSS MARGIN, CASH CONTRIBUTION		128808.94

APPLIED PERIOD COST (INDIRECT MTL, LAB, EQUIP)		13866.51
CAPITAL RECOVERED (DEPRECIATION)		64602.00
NET PROFIT		50340.38

ENDING BALANCE SHEET
****

CASH (WORKING CAPITAL + CASH INCOME)		158446.13
GROSS EQUIPMENT	970000.00	
CAPITAL RECOVERED (ACCUM DEPREC)	452602.00	
NET EQUIPMENT		517398.00
OTHER CO. EQUIP		768000.00
TOTAL EQUIP		1285398.00
TOTAL ASSETS		1443844.00
TAXES PAYABLE RESERVE (AT 50% OF NET INCOME)		25170.19
NET WORTH		1418673.00
TOTAL LIABILITIES AND NET WORTH		1443844.00

ESTIMATE NO: 2

ESTIMATE FROM SIMULATIONS
****

EXPECTED COSTS BASED UPON THE GENERATED PROD RATE AND COST DISTRIBUTIONS
****

***** NOTE ***** TOTALS AND SUMMARYS ARE DERIVED FROM DISTRIBUTION MEANS AND NOT BY ADDITION

CODE	ITEM	UNIT	UNIT PRICE	NO. OF UNITS	TOTAL	SUMMARY	UNIT COST
0	UNCL EXCAVATION	CY					
	DIRECT MATERIAL	CY	0.0	1000000	0.0		0.0
	DIRECT LABOR	HR	104.00	809	91109.13		0.0911
	EQUIPMENT OPERATION	HR	142.00	742	105364.00		0.1054
	JOB OVERHEAD LABOR	JOB	($ 365.00 X 18 WEEKS) =		6570.00		0.0066
	OTHER JOB OVERHEAD	JOB	($ 210.00 X 18 WEEKS) =		3780.00		0.0038
	SUBCONTRACT	JOB	0.0		0.0		0.0
	OTHER DIRECT	LS			12000.00		0.0120
	PAYROLL TAXES, ETC	JOB	(14 % X $ 97679.13		13675.07		0.0137
	INS, BONDS, AGC, ETC	%	(5 % X ($ 385068.44 - 18966.13)=		18966.13		0.0190
	TOTAL DIRECT CASH COST					257369.44	0.2515
	GEN OH ALLOCATION	JOB	(38 % X 43 % = 16 % X $ 97700.00)=		16151.41		0.0162
	TOTAL COST INCLUDING OVERHEAD ALLOCATION					273520.81	0.2735
	CAPITAL RECOVERY & RETURN	JOB			111547.63		0.1115
	TOTAL BID REQUIRED					385068.44	0.3851

THE OVERHEAD ALLOCATION IS:

6.4 % OF DIRECT CASH COST

5.0 % OF TOTAL DIRECT COST AND DEPR

4.8 % OF TOTAL COST AND OH

4.1 % OF AMOUNT BID

THE RETURN ON INVESTMENT PROFIT IS:

43.3 % OF DIRECT CASH COST

33.7 % OF TOTAL DIRECT COST AND DEPR

40.8 % OF TOTAL COST AND OH

29.0 % OF AMOUNT BID

ESTIMATE NO: 3

ITEM COST ESTIMATE BASIS

***** THE FOLLOWING IS BASED UPON A RUN OF 1000 SIMULATIONS *****

CALCULATION OF PRODUCTION TIME IS BASED UPON A PRODUCTION
RATE OF 1347 CY PER HOUR 44 HOURS PER WEEK, = 59268 CY PER WEEK.
THE TOTAL 1000000 CY DIVIDED BY 59268 CY PER WEEK = 16 WEEKS PRODUCTION TIME.
THIS ITEM SHOULD START MONTH 6 AND END, MONTH 10 .

CALCULATION OF THE GENERAL OVERHEAD ALLOCATION TO THIS BID ITEM
IS BASED UPON ITS REQUIRING 16 WEEKS PRODUCTION TIME OUT OF A TOTAL OF 44 WEEKS PRODUCTION
TIME FOR THE YEAR, OR, 38 % OF A PRODUCTION YEAR. FURTHERMORE, $ 582000.00 OF THE COMPANY'S
TOTAL $ 1350000.00 PRODUCTIVE EQUIPMENT INVESTMENT, OR 43 % WILL BE USED ON THIS BID ITEM.
THEREFORE, 43 % OF THE COMPANY'S CURRENT EQUIPMENT INVESTMENT WILL BE USED ON THIS BID
ITEM 38 % OF A YEAR. 43 % X 38 % = 16 % OF THE GENERAL OVERHEAD SHOULD BE ALLOCATED TO THIS ITEM.

ESTIMATED WORKING CAPITAL REQUIREMENTS ARE FOUR WEEKS PAYROLL PLUS 10% OF ONE MONTH'S
DIRECT MATERIAL AND EQUIPMENT OPERATING COSTS, A TOTAL, $ 30300.39 FOR THIS ITEM
THE MINIMUM ACCEPTABLE RETURN ON INVESTMENT, OR PROFIT, FOR THIS ITEM IS THE 25 % ANNUAL
RETURN REQUIRED TIMES THE SUM OF THE $ 30300.39 WORKING CAPITAL AND THE $ 582000.00
CURRENT EQUIPMENT INVESTMENT TIMES 38 % OF A PROD YEAR = THE REQUIRED PROFIT, $ 111547.63.

ESTIMATE NO: 3

AN INTERNAL RATE OF RETURN OF 14.3437 % APPLIES TO THE FOLLOWING CASH FLOWS:

MONTH	NCF	DISC FACT	DISC NCF	ROI	CUM ROI	CAP REC	CUM CR	CUM NCF	UNREC INV
0	-970000.00	1.000000	-970000.00	0.0	0.0	0.0	0.0	0.0	970000.00
1	23596.61	0.988189	23317.91	11594.52	11594.52	12002.09	12002.09	23596.61	957997.87
2	23596.61	0.976518	23042.51	11451.06	23045.58	12145.55	24147.65	47193.23	945852.31
3	23596.61	0.964984	22770.36	11305.88	34351.46	12290.73	36438.38	70789.81	933561.56
4	23596.61	0.953587	22501.43	11158.97	45510.43	12437.64	48876.03	94386.38	921123.94
5	23596.61	0.942324	22235.66	11010.30	56520.72	12586.32	61462.34	117982.94	908537.63
6	23596.61	0.931195	21973.05	10859.85	67380.56	12736.76	74199.06	141579.50	895800.94
7	23596.61	0.920197	21713.54	10707.61	78088.13	12889.00	87088.06	165176.06	882911.94
8	23596.61	0.909329	21457.07	10553.55	88641.63	13043.07	100131.13	188772.63	869868.88
9	23596.61	0.898589	21203.65	10397.64	99039.25	13198.97	113330.06	212369.19	856669.94
10	23596.61	0.887976	20953.22	10239.87	109279.06	13356.74	126686.75	235965.75	843313.25
11	23596.61	0.877488	20705.75	10080.22	119359.25	13516.39	140203.13	259562.31	829796.88
12	23596.61	0.867125	20461.21	9918.66	129277.88	13677.96	153881.06	283158.88	816118.94
13	23596.61	0.856883	20219.53	9755.16	139033.00	13841.45	167722.50	306755.44	802277.50
14	23596.61	0.846763	19980.73	9589.71	148622.69	14006.90	181729.38	330352.00	788270.63
15	23596.61	0.836762	19744.75	9422.29	158044.94	14174.32	195903.69	353948.56	774096.31
16	23596.61	0.826879	19511.54	9252.86	167297.75	14343.75	210247.44	377545.13	759752.56
17	23596.61	0.817113	19281.10	9081.41	176379.13	14515.21	224762.63	401141.69	745237.38
18	23596.61	0.807462	19053.37	8907.91	185287.00	14688.71	239451.31	424738.25	730548.69
19	23596.61	0.797925	18828.33	8732.33	194019.31	14864.28	254315.56	448334.81	715684.44
20	23596.61	0.788501	18605.96	8554.66	202573.94	15041.96	269357.50	471931.38	700642.50
21	23596.61	0.779189	18386.21	8374.86	210948.75	15221.75	284579.25	495527.94	685420.75
22	23596.61	0.769986	18169.05	8192.91	219141.63	15403.70	299982.94	519124.50	670017.06
23	23596.61	0.760892	17954.48	8008.79	227150.38	15587.82	315570.75	542721.06	654429.25
24	23596.61	0.751905	17742.41	7822.46	234972.81	15774.15	331344.88	566317.63	638655.13
25	23596.61	0.743024	17532.86	7633.92	242606.69	15962.70	347307.56	589914.19	622692.44
26	23596.61	0.734249	17325.78	7443.11	250049.75	16153.50	363461.06	613510.75	606538.94
27	23596.61	0.725577	17121.16	7250.03	257299.75	16346.59	379807.63	637107.31	590192.38
28	23596.61	0.717007	16918.95	7054.64	264354.38	16541.98	396349.56	660703.88	573650.44
29	23596.61	0.708538	16719.11	6856.91	271211.25	16739.71	413089.25	684300.44	556910.75
30	23596.61	0.700170	16521.65	6656.82	277868.06	16939.80	430029.00	707897.00	539971.00
31	23596.61	0.691901	16326.53	6454.33	284322.38	17142.28	447171.25	731493.56	522828.75
32	23596.61	0.683729	16133.69	6249.43	290571.75	17347.18	464518.38	755090.13	505481.63
33	23596.61	0.675654	15943.14	6042.08	296613.81	17554.54	482072.88	778686.69	487927.13
34	23596.61	0.667674	15754.84	5832.25	302446.00	17764.37	499837.19	802283.25	470162.81
35	23596.61	0.659788	15568.76	5619.91	308065.88	17976.70	517813.88	825879.81	452186.13
36	23596.61	0.651996	15384.89	5405.03	313470.88	18191.58	536005.44	849476.38	433994.56
37	23596.61	0.644295	15203.17	5187.59	318658.44	18409.03	554414.44	873072.94	415585.56
38	23596.61	0.636686	15023.62	4967.54	323625.94	18629.07	573043.50	896669.50	396956.50
39	23596.61	0.629166	14846.18	4744.86	328370.75	18851.75	591895.25	920266.06	378104.75
40	23596.61	0.621735	14670.83	4519.53	332890.25	19077.09	610972.31	943862.63	359027.69
41	23596.61	0.614392	14497.56	4291.50	337181.69	19305.12	630277.38	967459.19	339722.63
42	23596.61	0.607135	14326.33	4060.74	341242.38	19535.87	649813.19	991055.75	320186.81
43	23596.61	0.599965	14157.14	3827.23	345069.56	19769.38	669582.56	1014652.31	300417.44
44	23596.61	0.592879	13989.93	3590.92	348660.44	20005.69	689588.25	1038248.88	280411.75
45	23596.61	0.585876	13824.68	3351.79	352012.19	20244.82	709833.06	1061845.00	260166.94
46	23596.61	0.578957	13661.41	3109.81	355121.94	20486.80	730319.81	1085441.00	239680.19
47	23596.61	0.572119	13500.07	2864.92	357986.81	20731.69	751051.50	1109037.00	218948.50
48	23596.61	0.565361	13340.61	2617.12	360603.88	20979.50	772030.94	1132633.00	197969.06
49	23596.61	0.558684	13183.05	2366.35	362970.19	21230.27	793261.19	1156229.00	176738.81
50	23596.61	0.552085	13027.34	2112.58	365082.75	21484.03	814745.19	1179825.00	155254.81
51	23596.61	0.545565	12873.48	1855.78	366938.50	21740.83	836486.00	1203421.00	133514.00
52	23596.61	0.539122	12721.44	1595.91	368534.38	22000.70	858486.69	1227017.00	111513.31
53	23596.61	0.532754	12571.20	1332.93	369867.25	22263.68	880750.31	1250613.00	89249.69
54	23596.61	0.526462	12422.72	1066.81	370934.00	22529.80	903280.06	1274209.00	66719.94
55	23596.61	0.520244	12276.00	797.51	371731.50	22799.10	926079.13	1297805.00	43920.88
56	23596.61	0.514100	12131.01	524.99	372256.44	23071.62	949150.69	1321401.00	20849.31
57	23596.61	0.508028	11987.73	249.21	372505.63	23347.40	972498.06	1344997.00	-2498.06

ESTIMATE NO: 3

BEGINNING BALANCE SHEET

****

WORKING CAPITAL, CASH		30300.39
GROSS EQUIP, THIS BID ITEM	970000.00	
CAPITAL RECOVERED, (ACCUM DEPREC)	388000.00	
NET EQUIP, THIS BID ITEM		582000.00
OTHER CO. EQUIP (AT PRESENT VALUE)		768000.00
TOTAL EQUIPMENT INVESTMENT		1350000.00
TOTAL ASSETS		1380300.00
TAXES PAYABLE, RESERVE		0.0
NET WORTH		1380300.00
TOTAL LIABILITIES AND NET WORTH		1380300.00

INCOME STATEMENT

****

SALES		385068.44
DIRECT CASH OUTLAYS		
LABOR	111354.19	
MATERIALS	0.0	
EQUIPMENT	105364.00	
SUBCONTRACT	0.0	
OTHER	34746.13	
TOTAL DIRECT CASH COST		257369.44
GROSS MARGIN, CASH CONTRIBUTION		127699.00

APPLIED PERIOD COST (INDIRECT MTL, LAB, EQUIP)		16151.41
CAPITAL RECOVERED (DEPRECIATION)		71974.00
NET PROFIT		39573.56

ENDING BALANCE SHEET
****

CASH (WORKING CAPITAL + CASH INCOME)		157999.38
GROSS EQUIPMENT	970000.00	
CAPITAL RECOVERED (ACCUM DEPREC)	459974.00	
NET EQUIPMENT		510026.00
OTHER CO. EQUIP		768000.00
TOTAL EQUIP		1278026.00
TOTAL ASSETS		1436025.00
TAXES PAYABLE RESERVE (AT 50% OF NET INCOME)		19786.78
NET WORTH		1416238.00
TOTAL LIABILITIES AND NET WORTH		1436025.00

ESTIMATE NO: 3

PROBABILITY STATEMENTS

THE FOLLOWING PROBABILITY STATEMENTS ARE BASED UPON THE RESULTS OF THE SIMULATION PROCESS.

VARIABLE NAME	LOWEST PROBABLE VALUE	PROBABLE AVERAGE VALUE	HIGHEST PROBABLE VALUE	PROBABILITY OF VALUE GREATER THAN THE AVERAGE
PRODUCTION RATE	963 CY /HR	1347 CY /HR	1683 CY /HR	56.0 %
HOURS PER WEEK	42 HOURS	44 HOURS	49 HOURS	69.0 %
WEEKS PER YEAR	40 WEEKS	44 WEEKS	48 WEEKS	65.0 %
DIRECT CASH COST	$ 177947.06	$ 257369.44	$ 336791.81	38.0 %
TOTAL DIRECT COST	$ 262176.88	$ 330959.31	$ 434674.38	38.0 %
TOTAL COST AND OH	$ 218014.19	$ 273610.75	$ 358411.25	38.0 %
TOTAL COST AND PROFIT	$ 331542.63	$ 388113.63	$ 474977.25	38.0 %

**** NOTE ***** THERE IS A 95% PROBABILITY THAT ALL VALUES WILL LIE BETWEEN THE HIGH AND LOW VALUES SHOWN.

ESTIMATE NO: 3

CUMULATIVE PROBABILITY DISTRIBUTION, ONE THOUSAND SIMULATIONS

PRODUCTION RATE, UNITS/HOUR

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	814	1347	1683	192	
814.00					99.90 %
886.42					98.50 %
958.83					96.20 %
1031.25					92.30 %
1103.67					86.30 %
1176.08					79.40 %
1248.50					71.10 %
1320.92					60.30 %
1393.33					46.90 %
1465.75					32.60 %
1538.17					17.60 %
1610.58					5.60 %

PRODUCTION HOURS/ WEEK

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	40	44	49	1	
40.00					98.60 %
40.75					98.60 %
41.50					93.60 %
42.25					83.90 %
43.00					69.70 %
43.75					69.70 %
44.50					52.60 %
45.25					32.40 %
46.00					17.90 %
46.75					17.90 %
47.50					7.80 %
48.25					2.00 %

PRODUCTION WEEKS/YEAR

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	40	44	49	2	
40.00					97.10 %
40.75					97.10 %
41.50					89.60 %
42.25					78.70 %
43.00					65.90 %
43.75					65.90 %
44.50					48.90 %
45.25					31.30 %
46.00					16.10 %
46.75					16.10 %
47.50					7.00 %
48.25					1.90 %

ESTIMATE NO: 3

TOTAL DIRECT CASH COST

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	204073.88	257369.44	407444.44	39711.21	
204073.88					99.90 %
221021.38					83.90 %
237968.94					60.50 %
254916.50					41.50 %
271864.06					28.10 %
288811.56					19.70 %
305759.13					13.30 %
322706.69					7.90 %
339654.25					4.90 %
356601.75					3.00 %
373549.31					1.60 %
390496.88					0.40 %

TOTAL AMOUNT OF BID

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	331542.63	388113.63	551532.19	43431.82	
331542.63					99.90 %
349875.06					82.70 %
368207.50					58.90 %
386540.00					40.70 %
404872.44					27.20 %
423204.88					19.10 %
441537.38					13.10 %
459869.81					7.90 %
478202.31					5.10 %
496534.75					2.90 %
514867.19					1.50 %
533199.69					0.40 %

NET CASH FLOW, EQUIP, EXPECTED VALUES

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	-85523.13	77842.19	134466.31	43108.79	
-85523.13					99.90 %
-67190.63					99.60 %
-48858.22					98.50 %
-30525.77					97.10 %
-12193.31					94.90 %
6139.13					92.10 %
24471.56					86.90 %
42804.00					80.90 %
61136.50					72.80 %
79468.94					59.30 %
97801.38					41.10 %
116133.81					17.30 %

ESTIMATE NO: 3

NET CASH FLOW EQUIP, ROI APPROACH

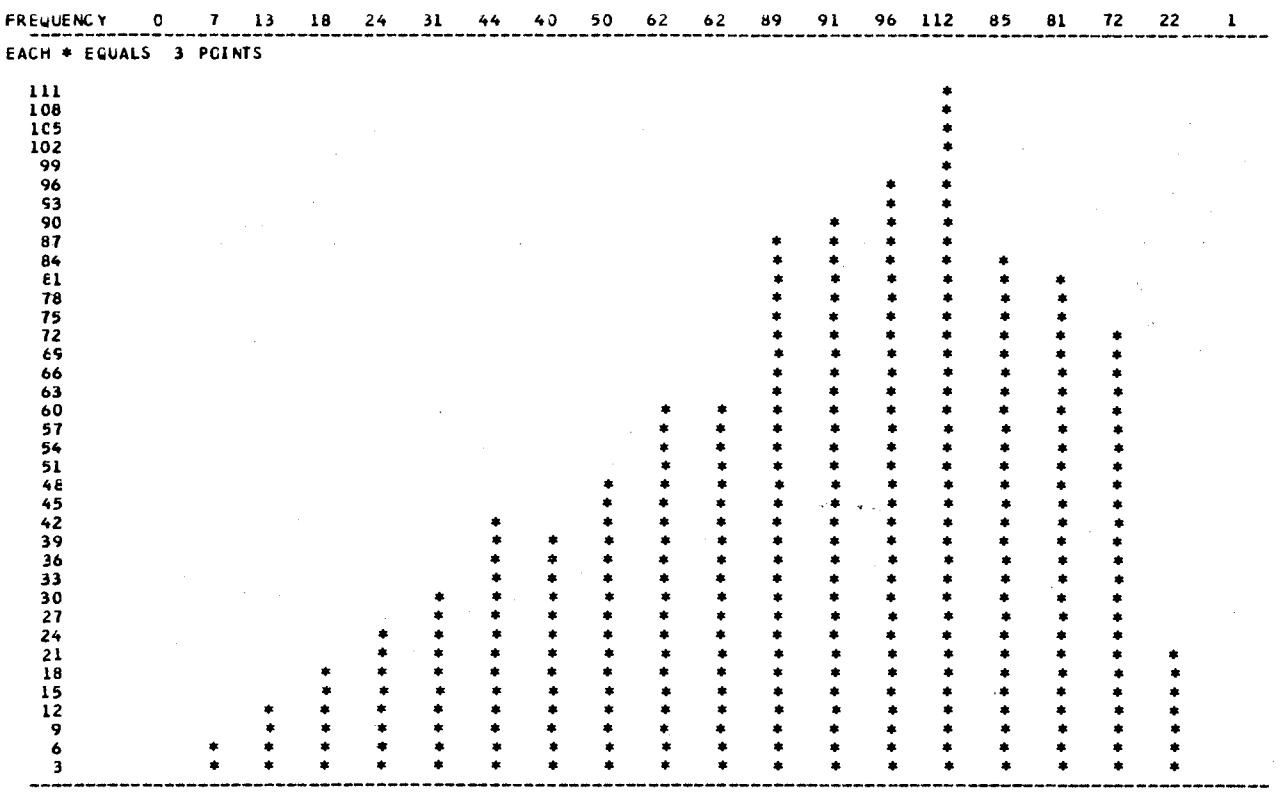
NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	-83634.19	79731.06	136355.25	43109.17	
-83634.19					99.90 %
-65301.73					99.60 %
-46969.28					98.50 %
-28636.83					97.10 %
-10304.38					94.90 %
8028.06					92.10 %
26360.50					86.90 %
44692.94					80.90 %
63025.44					72.80 %
81357.88					59.30 %
99690.31					41.10 %
118022.75					17.30 %

NET CASH FLOW, EQUIP, LIFE CYCLE SYSTEM

NUMBER	MINIMUM	MEAN	MAXIMUM	STD DEVIATION	PROB OF GREATER NO.
	-109258.19	54108.11	110731.25	43104.35	
-109258.19					99.90 %
-90925.69					99.60 %
-72593.25					98.50 %
-54260.83					97.10 %
-35928.38					94.90 %
-17595.94					92.10 %
736.50					86.90 %
19068.94					80.90 %
37401.44					72.80 %
55733.88					59.30 %
74066.31					41.10 %
92398.75					17.30 %

ESTIMATE NO: 3

HISTOGRAM 1

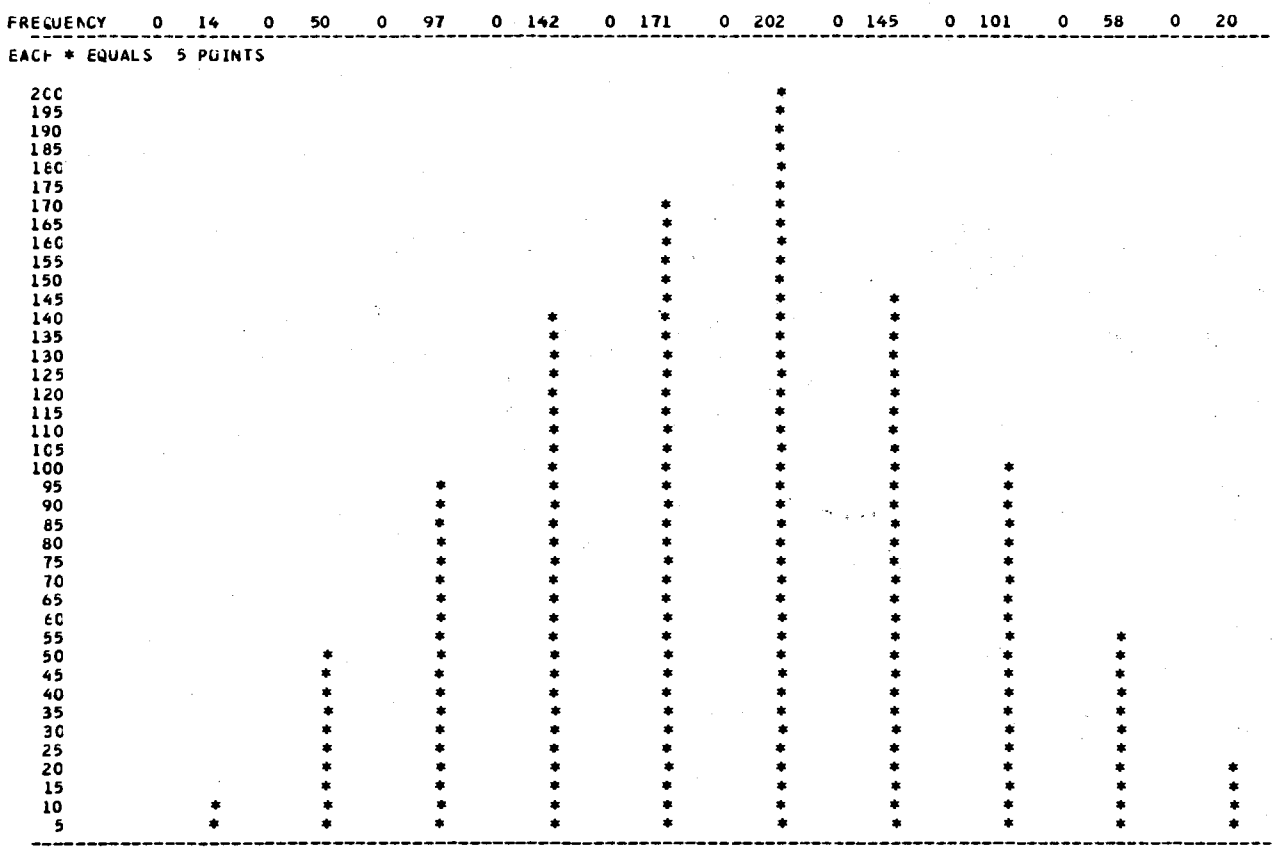


TOTAL = 1347799.00 AVERAGE = 1347.799 STANDARD DEVIATION = 192.697 MINIMUM = 814.000 MAXIMUM = 1683.000

PRODUCTION RATE, UNITS/HOUR

ESTIMATE NO: 3

HISTOGRAM 2



TOTAL = 44585.00 AVERAGE = 44.585 STANDARD DEVIATION = 1.996 MINIMUM = 40.000 MAXIMUM = 49.000

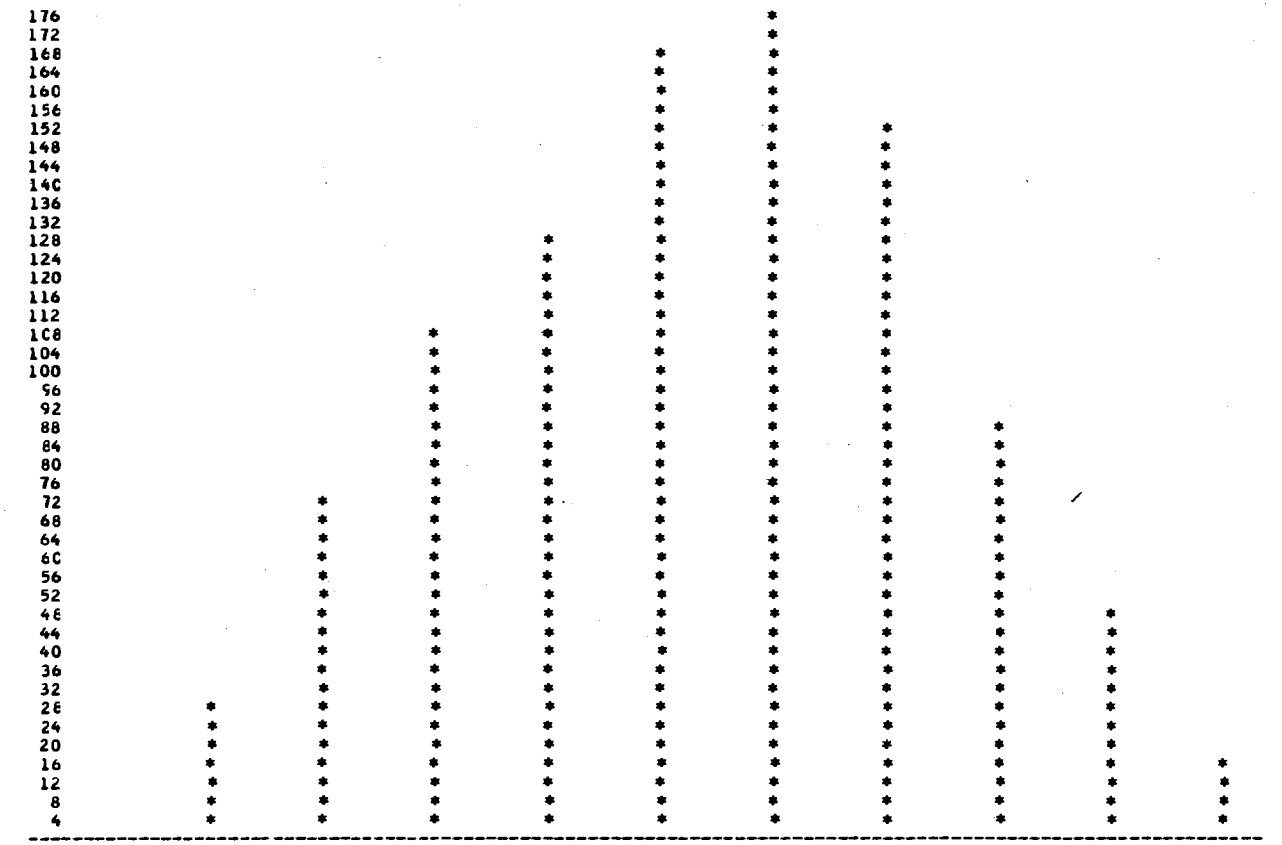
PRODUCTION HOURS/ WEEK

ESTIMATE NO: 3

HISTOGRAM 3

FREQUENCY	0	29	0	75	0	109	0	128	0	170	0	176	0	152	0	91	0	51	0	19

EACH * EQUALS 4 POINTS



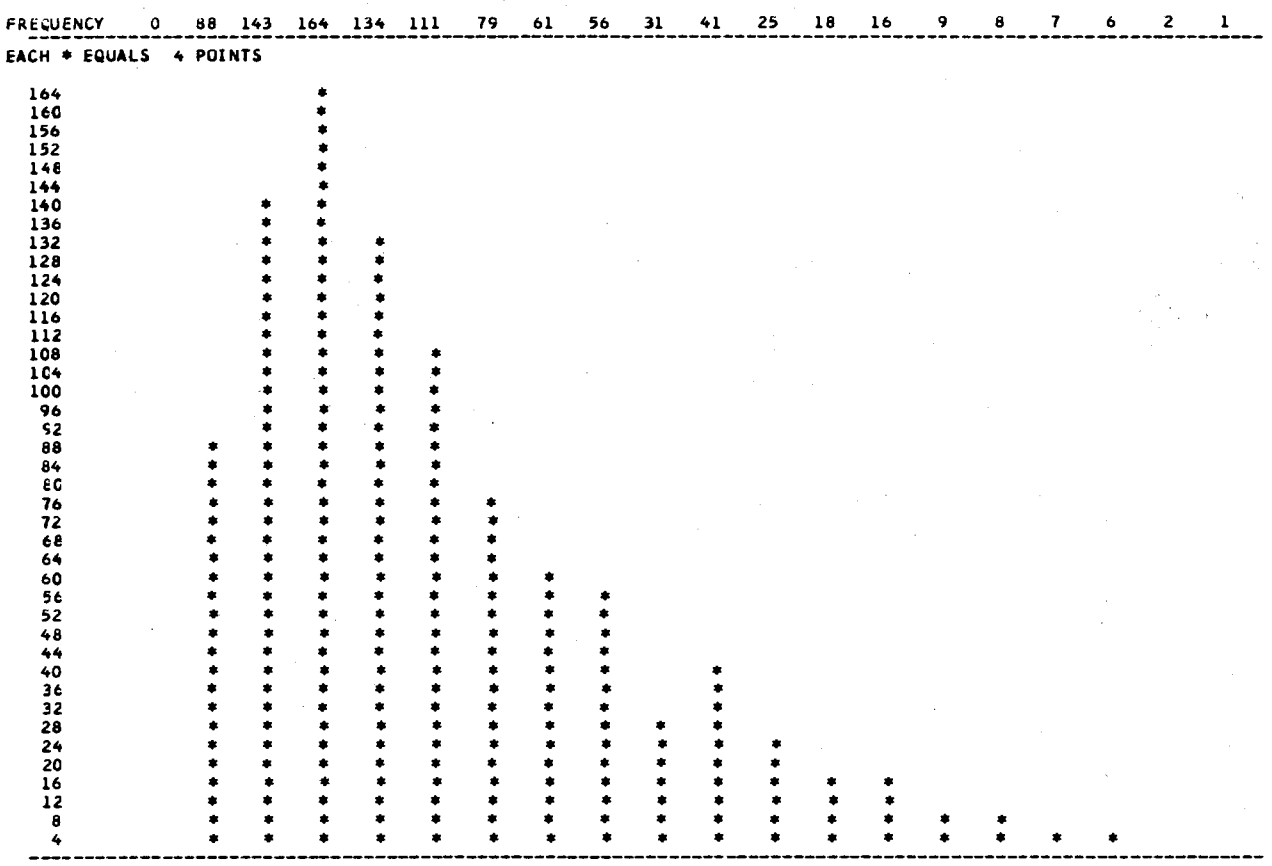
INTERVAL CLASS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

TOTAL = 44365.00 AVERAGE = 44.365 STANDARD DEVIATION = 2.114 MINIMUM = 40.000 MAXIMUM = 49.000

PRODUCTION WEEKS/YEAR

ESTIMATE NO: 3

HISTOGRAM 4



TOTAL = 257369488.00 AVERAGE =257369.438 STANDARD DEVIATION = 39730.793 MINIMUM =204073.875 MAXIMUM =407444.438

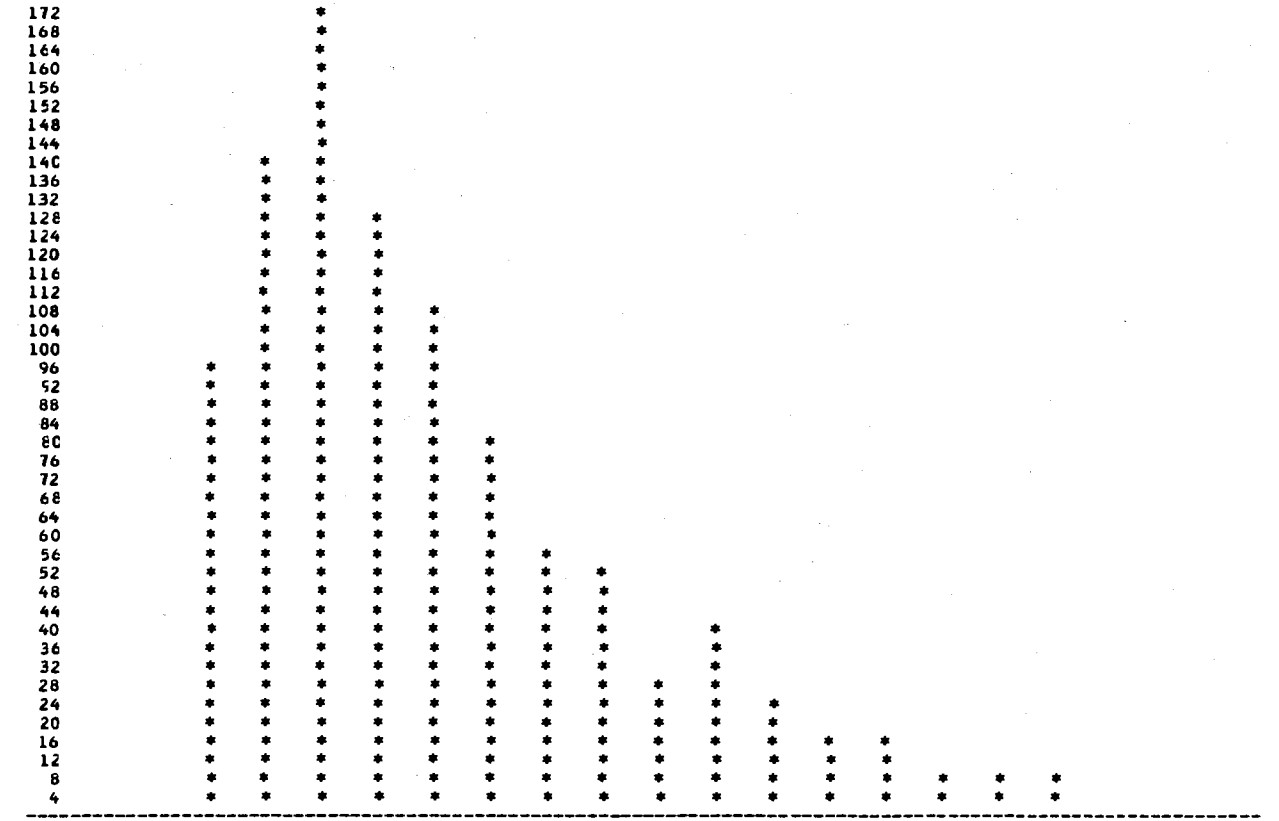
TOTAL DIRECT CASH COST

ESTIMATE NO: 3

HISTOGRAM 5

FREQUENCY	0	97	140	174	129	108	80	56	55	30	40	24	16	18	9	9	8	3	3	1
INTERVAL CLASS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

EACH * EQUALS 4 POINTS



TOTAL = 388113664.00 AVERAGE =388113.625 STANDARD DEVIATION = 43453.434 MINIMUM =331542.625 MAXIMUM =551532.188

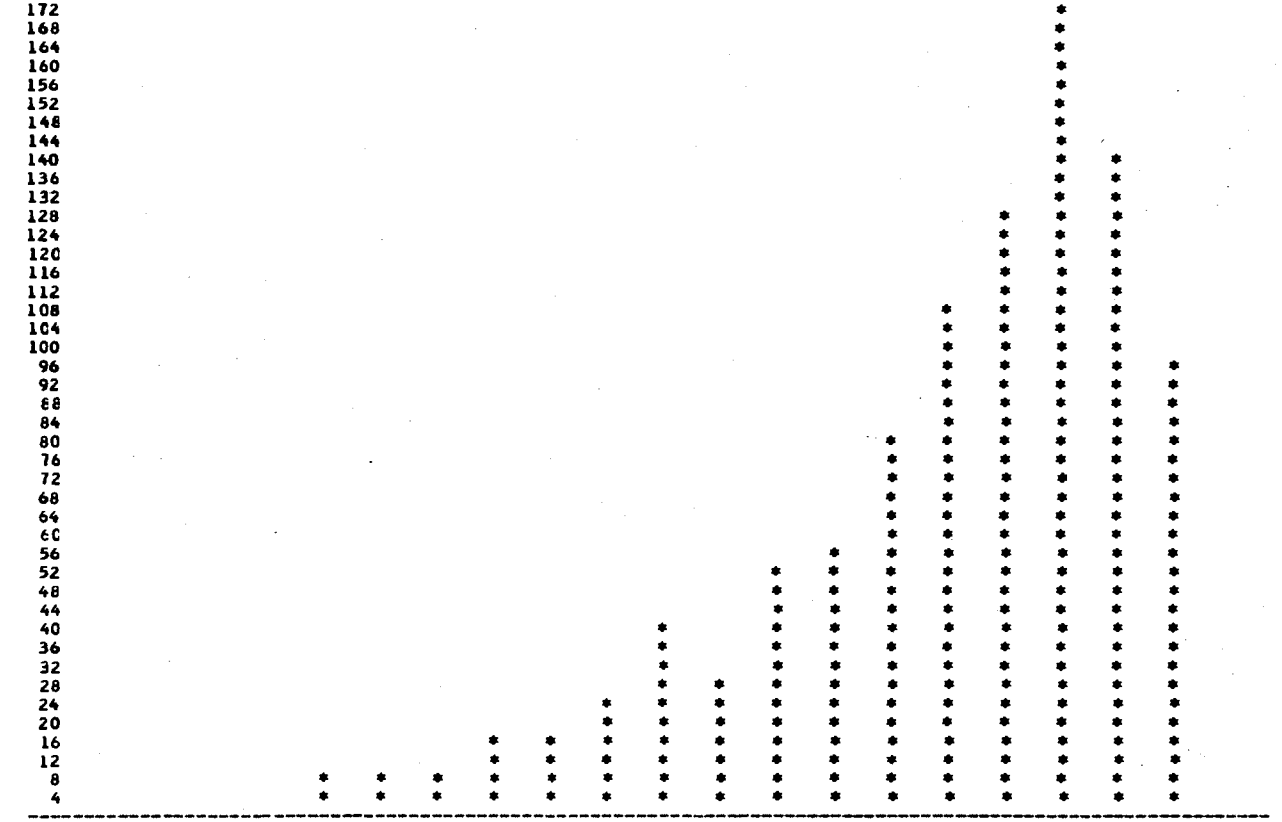
TOTAL AMOUNT OF BID

ESTIMATE NO: 3

HISTOGRAM 6

FREQUENCY 1 3 3 8 9 9 18 16 24 40 30 55 56 80 108 129 174 140 96 1

EACH * EQUALS 4 POINTS



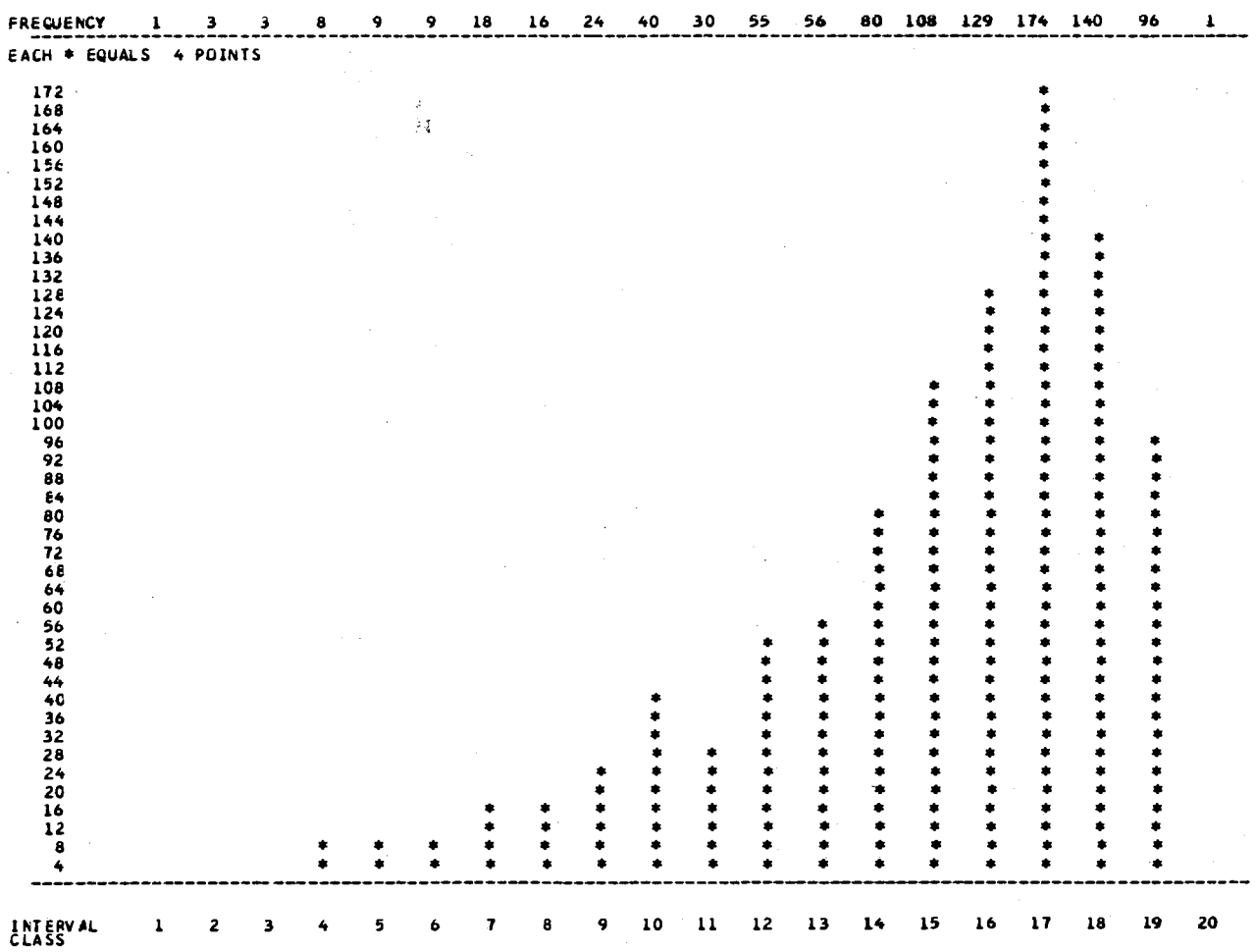
INTERVAL CLASS 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

TOTAL = 77842192.00 AVERAGE = 77842.188 STANDARD DEVIATION = 43130.402 MINIMUM =-85523.125 MAXIMUM =134466.313

NET CASH FLOW, EQUIP, EXPECTED VALUES

ESTIMATE NO: 3

HISTOGRAM 7

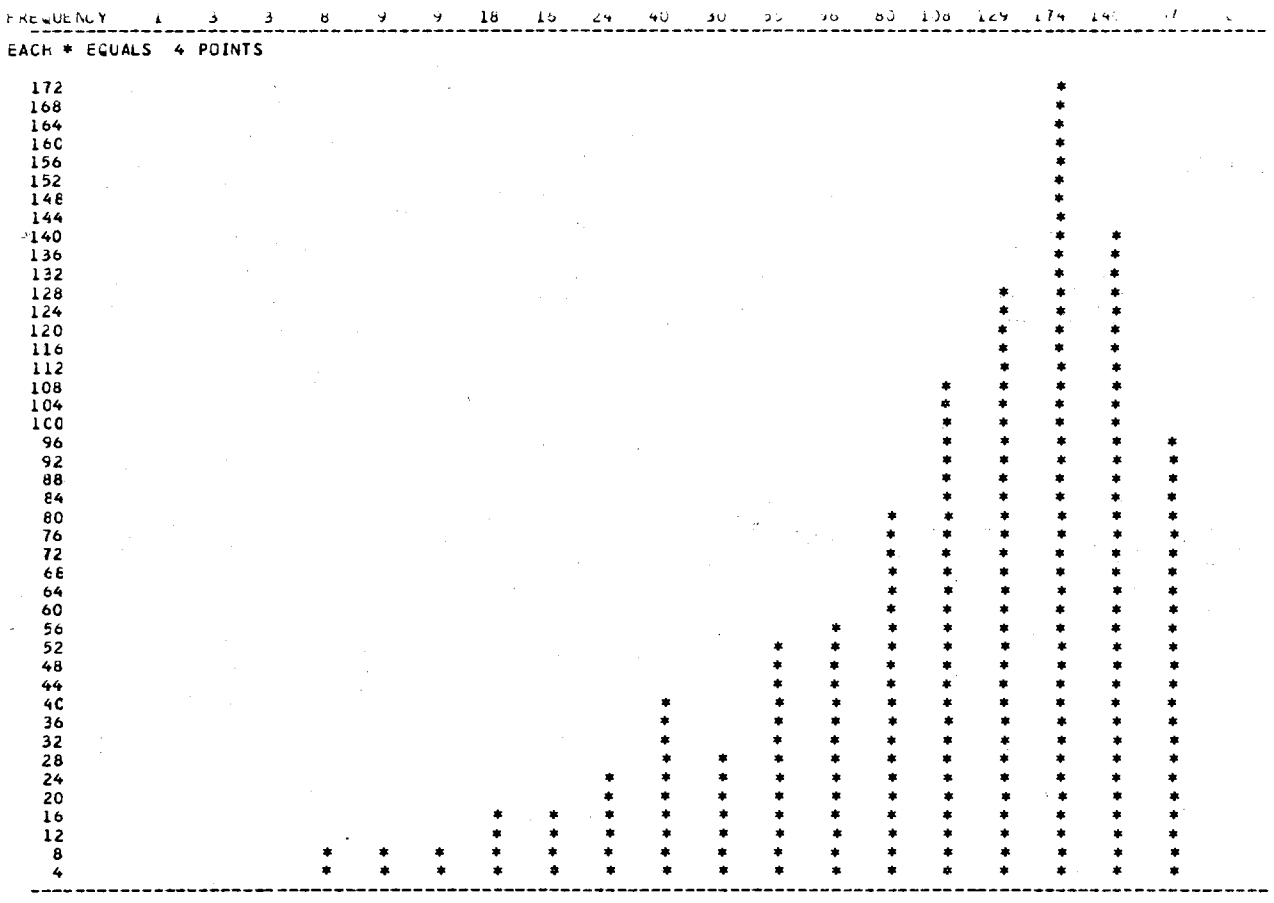


TOTAL = 79731088.00 AVERAGE = 79731.063 STANDARD DEVIATION = 43130.707 MINIMUM =-83634.188 MAXIMUM =136355.250

NET CASH FLOW EQUIP, ROI APPROACH

ESTIMATE NO: 3

HISTOGRAM



TOTAL = 54108112.00 AVERAGE = 54108.109 STANDARD DEVIATION = 43125.957 MINIMUM =********** MAXIMUM =110731.250

NET CASH FLOW, EQUIP, LIFE CYCLE SYSTEM

ESTIMATE NO: 3

VITA

Roger Harold Miller

Candidate for the Degree of

Doctor of Philosophy

Thesis: LIFE CYCLE SYSTEM MODEL FOR ESTIMATING CONSTRUCTION EQUIPMENT OWNERSHIP COSTS

Major Field: Engineering

Biographical:

Personal Data: Born in Vinton, Iowa, October 5, 1935, the son of Harold W. and Marietta S. Miller.

Education: Attended all grades and graduated from the Vinton High School in 1953; received the Bachelor of Science in Civil Engineering from Iowa State University in 1958; received the Master of Business Administration from Oklahoma City University in 1968; completed requirements for the Doctor of Philosophy degree in May, 1973.

Professional Experience: Employed by the Iowa State Highway Department from June, 1958, to January, 1959, as a bridge designer; by the U. S. Army Corps of Engineers, Tulsa District, from January, 1959, to August, 1959, as a planning engineer; by Chicago Bridge and Iron Company from August, 1959, to May, 1963, as a design engineer; by Hallett Construction Company from May, 1963, to January, 1969, as area engineer-manager; by Roger Miller Construction Company from November, 1969, to present, as President; by Kerns and Miller Asphalt Company from January, 1970, to present, as Vice President; by Construction Data Systems, Inc., from November, 1971, to present, as President; by Oklahoma State University from September, 1971, to present, as Instructor of Civil Engineering, Construction Engineering and Management Group.

Professional Activities: Registered Professional Engineer, Oklahoma; Member of: American Society of Civil Engineers; National Association of Construction Cost Consultants; Chi Epsilon; National Society of Professional Engineers; American Association of Cost Engineers.