ECONOMIC ANALYSIS HANDBOOK

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Naval Facilities Engineering Command
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FOREWORD

This handbook has been developed in the Naval Facilities Engineering Command and is issued with the concurrence of the OPNAV Controllers Office for use in the economic documentation of proposed Military Construction line items. It applies to and is issued for the information and guidance of all personnel concerned with the financial management of construction of the Naval Shore Establishment financed by the Military Construction Appropriation of the Department of the Navy.

ECONOMIC ANALYSIS HANDBOOK

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I. GENERAL CONCEPTS

a. Navy Policy for Economic Analysis. Economic analyses techniques have gained increasingly widespread support within the Department of Defense in recent years. SECNAVINST 7000.14 of 30 January 1970 outlines the policies and procedures to be followed in the Navy for preparation and submission of economic analyses supporting proposed Military Construction Investments.

NAVFACINST 11010.53 is written to implement and supplement SECNAVINST 7000.14 with specific references to Military Construction Investments.

b. Economic Analysis - General. It is through economic analysis procedures that available investment proposals are presented to decision makers and ranked in some order of attractiveness for inclusion in the capital budget.

The essence of an economic analysis is the comparison of investment costs against the benefits which are expected to result or the comparison of costs and benefits of various investment alternatives. The investment and the resulting benefits are measured in terms of dollars. Most analyses are complex, involving the comparison of several proposals and the expenditure of resources in the future as well as at the present time.

Before any analysis of a proposed investment can proceed, a certain amount of data must be generated and arranged in a logical pattern. The estimated costs of the proposal, including one-time investment costs, annual costs, and net increases in working capital, form the project cash outflows. Cash inflows may consist of sale of assets or residual values attributable to the project. These cash flows are discussed in greater depth in Part IV, Section d.

c. Classes of Economic Analyses. Economic Analyses may be classified as either PRIMARY or SECONDARY as follows:

1. Primary: A PRIMARY economic analysis is one employed to help determine whether an existing situation or procedure should be changed in some way to

take advantage of dollar savings available through some other situation or set of procedures (A sample PRIMARY economic analysis is contained in Part V of this handbook.). This analysis would discuss the basic need for some change to present conditions - the basic reason. Examples of PRIMARY economic analyses might be the following:

(a) Expansion of utility systems at berthing piers to allow in-port ships to secure internal power plants.

(b) Modernization of Naval Air Rework Facility (NARF) overhaul facilities to speed overhaul work, thereby decreasing the aircraft "pipeline" inventory requirements.

(c) Connection to municipal utility systems in lieu of continuing to operate on-base utility systems (when no significant increase in utility capacity is required).

(d) Replace existing high maintenance cost facilities or equipment with new facilities of similar capacity.

2. Secondary: A SECONDARY economic analysis is one which is used once a deficiency or changed requirement has been identified to determine which of two (or more) alternatives would most economically satisfy the deficiency. (A sample SECONDARY economic analysis is contained in Part V of this handbook.) This type of analysis does not concern itself with the basic need for the construction project but with the choice of alternative ways to satisfy a previously stated basic need or deficiency. Examples of such alternatives might be:

(a) Meet an increased base utility requirement by enlarging present Government plant versus connection to commercial source.

(b) Correct existing deficiencies through new construction versus rehabilitation of existing facilities.

(c) Provide new construction by one of several different design concepts or by use of one of several different types of construction materials.

3. Primary vs. Secondary Analysis. Additional discussion of the basic differences between primary and secondary economic analyses is necessary to assure that budget submissions reflect those differences. Primary economic analyses are those which involve proposed savings over an existing mode of operation. Investments justified on the basis of a primary economic analysis must promise absolute cost savings over the present method of accomplishing a task.

Secondary economic analysis, on the other hand, refers to a method of selection of the most economical alternative from a group of alternatives all designed to perform a function or satisfy a mission which is not justified on the basis of dollar savings. For example, expansion of a utility requirement is justified due to expanded mission of an activity. The method of providing the additional utility requirement is selected through the secondary economic analysis. In this case, the selected alternative does not result in an absolute cost saving, but the selected alternative should represent the least cost alternative relative to other proposed alternatives.

Another way of stating the difference between primary and secondary analysis is to point out the differing impact on the Navy's expense cash flow. Secondary economic analyses are used to justify investments which initiate the expense stream, whereas primary economic analyses justify investments intended to reduce an already existent expense cash flow.

The difference between projects resulting in absolute cost savings and those resulting in increased cost levels but which represent relatively less costly solutions is significant in the Navy budgeting system. NAVFACINST 11010.32B of 2 December 1969 specifies the different methods for reporting the results of a primary or secondary economic analysis on the DD Form 1391.

II. ANALYTIC TECHNIQUES USED IN ECONOMIC ANALYSES

Through the years, a number of methods for analyzing the costs and benefits for investment decision making have been developed and written about. They range in complexity from the simple payback analysis to the more sophisticated discounted cash flow methods. Four techniques of analysis will be discussed in this paper: payback period, Internal Rate of Return (IRR) or yield, the Present Value (PV), and Savings Investment Ratio (SIR).

a. The Payback Method. The payback method is a simple expression of the period of time estimated to recover the investment cost of the project through the incremental cash flows attributable to the project. More specifically in the government, the payback period is a way of stating the number of years by which future savings will match the added investment cost.

The critical shortcoming of the payback method is its failure to consider cash flows after the period of recovery of and above the dollar values of the investment. For this reason it is not a measure of the profitability of a potential investment and should seldom be used to choose between several projects.

It is, however, sometimes desirable to express the results of an economic analysis in terms of the "payback period", particularly if addressing persons not familiar with economic analysis terminology. Later in this paper, a mechanism for converting SIR to "payback period" is presented for this purpose.

b. Present Value Analysis.

1. Concept. Since both benefits and costs usually accrue at varying points in time, the most meaningful comparison between the two can be made when each are summed to a common point in time. The point in time normally selected for cost/benefit comparison is the present. This relationship between the value of payments received at different dates is of fundamental importance in the present value, the IRR, and the SIR methods of economic analysis.

Because money is productive, and because there is a strong preference for having a dollar today as compared with having a dollar at some future time, payment of interest is required for the use of money. The interest rate is a convenient tool for converting costs and benefits occurring at different points in time to equivalent costs and benefits occurring at a single prescribed point in time, usually the present.

(a) Future Value of Money Invested. Suppose that if we have a dollar today we can lend it and be sure of being repaid a year hence with interest at six percent. If we lent the money we would get $1.06 a year from now. It is clear that $1 today can be exchanged for $1.06 a year for now, and is its equivalent in value. It is conventional to speak of $1.06 as the "future worth" of $1 for one year at six percent.

In general case, with interest rate "i" per year, the future worth (F_1) of an initial or present sum (P) after one year is given by

$$F_1 = P+(P \times i)$$

where (P+i) is the value of the interest accrued in one year. Factoring we find

$$F_1 = P(1 + i).$$

This equation shows that the future worth is equal to the initial amount times the factor (1+i). For a present amount equal to $100 and an interest rate equal to six percent,

$$F_1 = \$100\ (1 + .06)$$

$$= \$100\ (1.06)$$

$$F_1 = \$106$$

If the $100 amount is left on deposit for five years at six percent interest, to what amount will it have grown at the end of that period? Returning to the general case, the future value F_1 at the end of year 1 can be reinvested at the same interest rate. Thus

$$F_2 = F_1 (1 + i) = P (1 + i) (1 + i)$$

$$F_2 = P(1 + i)^2$$

$$F_2 = 100 (1.06)^2$$

where F_2 is the future worth of the amount F_1 after one year, or the future worth of P after two years.

Similarly, F_3, the balance after three years, is found as

$$F_3 = F_2 (1 + i) = P(1 + i)^2 (1 + i)$$

$$F_3 = P (1 + i)^3$$

In general, F_n, the future (or "compound") amount at the end of the year n is found to be

$$F_n = P (1 + i)^n \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Thus, with an interest rate of six percent, the future value of $100 at the end of five years is

$$F_5 = \$100 (1.06)^5 = \$100 (1.34) = \$134.$$

A more detailed example is the following: If an individual were to deposit $0.75 in a savings account drawing ten percent per annum compound interest, the growth of his investment would be as follows:

Time	Interest for One Year	Value
Present		$0.75 (=P)
One Year	$0.08	.83 = $75(1+.10)^1$
Two Years	.08	.91 = $75(1+.10)^2$
Three Years	.09	1.00 = $75(1+.10)^3$

(b) Present Value of Future Money (One-Time receipt). To evaluate a future dollar in terms of its present value, we must reverse the process described above. That is, if F_n is an amount of money spent or received at the end of ^{n}years from the present, then its present value P with respect to interest rate i is given by

$$P = \frac{F_n}{(1+i)^n} = F_n \left[\frac{1}{(1+i)^n}\right] \quad \ldots\ldots\ldots (2)$$

which states that the present value of a future amount n years from now is equal to that future amount, F_n, times the discount factor $\frac{1}{(1+i)}$. In other words, the present value of a future dollar is the amount which, if invested today at the specified interest rate, would accumulate to the future dollar value at the future time specified. For example, at an interest rate of ten percent, the present value of $1 to be received three years in the future is $0.75, since it can be seen from the paragraph above that $0.75 invested at the present time at a compound interest rate of ten percent per annum will result in accumulation to $1 at the end of three years.

The above calculations assume that cash flows (receipts or expenditures) occur at the end of each year. Since, in actuality, cash flows are usually staggered throughout the year (by week, month, or quarter) some adjustments must be made to our calculations to reflect this situation. Table A in Appendix B of this Handbook provides factors used to calculate the present value of a single dollar to be received over future periods of up to 30 years, for a discount rate of ten percent, with adjustments for the staggered cash flows. That is, by applying the factors in Table A Appendix B to our assumed end of year cash flows the present value of the cash flow is calculated as though the cash flow had occurred throughout the year.

The present value of receiving $1 three years from now at a discount rate equal to ten percent is

$$P = (\$1)\ (\text{Present Value Factor})$$

$$P = \$1\left[\frac{1}{(1+i)^3}\right] = \$1\left[\frac{1}{(1+.10)^3}\right] = \$1\ (.751) = \$.75$$

This calculation assumes a year end cash flow of $1 in the third year. Using Table A, Appendix B assumes the $1 cash flow is staggered throughout the third year, and the present value factor is adjusted such that

$$P = \$1\ (\text{Adjusted Present value factor})$$
$$P = \$1\ (0.788)*$$
$$P = \$0.79$$

Thus for our purposes, the present value of $1 flowing in the third year is $0.79.

* The factor 0.788 is taken from Table A, Appendix B for n = three years, i = ten percent.

(c) Present Value of Future Money (received annually for succeeding years). One special case is the annual receipt (or savings) year after year of a constant amount of money. The computation of the present value of $1 to be received annually for a period of three consecutive years could be calculated as follows, using Table A, Appendix B.

End of Year	Dollars Received	Present Value Factor (Table A)	Present Value of this year's cash flow
1	$1	0.954	$0.95
2	1	0.867	0.87
3	1	0.788	0.79

Sum of present value of Annual Cash Flows = $2.61

Alternatively, we may use Table B, Appendix B to make the same calculation. Table B contains factors used to calculate the present value of a single dollar flowing annually for n years where n goes from 1 to 25 years discounting at an annual interest rate equal to ten percent. Thus the present value of a series of three $1 cash flows occurring at the end of years 1-3 may be calculated as:

where P =(R)x (Present Value factor for an annual series of cash flows for n years discounted at ten percent)

R = the value of the constant annual cash flow, and the present value factor is taken from Table B, Appendix B:

P = $1 x (2.61)* = $2.61

2. Net Present Value (NPV).

Method of Analysis. To implement the present value approach, simply find the present value of the expected net cash flow of an investment discounted at the appropriate interest rate, (ten percent for most Navy investments as required by SECNAVINST 7000.14) and subtract from it the initial cost outlay of the project. If the net present value is positive; the project should be accepted; if negative, it should be rejected. If two projects are mutually exclusive, the one with the higher net present value should be chosen.

* Taken from Table B, Appendix B with i = ten percent, n = three years

The formula for the net present value is

$$NPV = \sum_{t=1}^{N} \frac{R_t}{(1+i)^t} - C \qquad \text{.....(3)}$$

where $\sum_{t=1}^{N}$ represents the sum of the expression from values of t=1 through t=N, i is the interest rate (ten percent for Navy investments), t is the year of the cash flow, R_t is the amount of the cash flow in year t, N is the economic life of the project and C is the initial investment cost.

The net present values of two projects, A and B, are calculated in Table 1. Project A has a NPV of $132 while B's NPV is $472. On this basis both would be accepted if they are independent, but B should be the one chosen if they are mutually exclusive.

Table 1. Calculating the Net Present Value (NPV) of Projects with $1,000 Initial Cost

	Project A			Project B		
Year	Net Cash Flow	Discount Factor (10%)	PV of Cash Flow	Net Cash Flow	Discount Factor (10%)	PV of Cash Flow
1	$500	.954	$477	$100	.954	$ 95
2	400	.867	347	200	.867	173
3	300	.788	236	300	.788	236
4	100	.717	72	400	.717	287
5				500	.652	326
				600	.592	355
	PV of Inflows		$1132			$1472
	Less Initial Cost		-1000			-1000
	NPV		$ 132			$ 472

3. Internal Rate of Return Method. The internal rate of return (IRR) is defined as the interest rate that equates the present value of the expected future receipts to the cost of the investment outlay. The equation for calculating the IRR is:

$$C = \sum_{t=1}^{N} \frac{Rt}{(1+i)^t} \quad \text{.....(4)}$$

where i is the interest rate, t indexes the year of cash flow, Rt is the amount of the cash flow in year t, N is the last year of the project and C is the initial investment cost.

Some value of i will cause the sum of the discounted net cash flows to equal the initial cost of the project and that value of i is defined to be the internal rate of return. The IRR must be found by trial and error and is thus somewhat burdensome.

The IRR method (or "yield" method as it is sometimes called) is especially useful in businesses where the internal rate of return may be compared with the firm's cost of capital to determine the economic desirability of the project. Except in certain special cases the IRR method will result in the same go or no go decision as the present value method and will rank projects in the same order of economic desirability.

The IRR method is discussed to provide the planner a familiarily with the terms (so often used in investment parlance) rather than to suggest its use for evaluating government investments.

4. Savings/Investment Ratio (SIR) Method. The SIR method is the technique which is preferred for use in selecting acceptable projects for inclusion in the Navy's capital budget. The savings/investment ratio (previously termed benefit/cost ratio) is calculated by dividing the present value of future savings (discounted at the prescribed interest rate (10%)) by the required investment outlay.

$$SIR = \frac{PV\ (Savings)}{(Investment\ Cost)}$$

If costs are incurred over more than one year, the present value of investment costs is used in the denominator of the ratio

$$SIR = \frac{PV \quad (Savings)}{PV \quad (Investment\ Cost)} \quad \ldots\ldots\ldots\ldots (5)$$

Normally, independent projects should be accepted whenever SIR is greater than 1.0. In the previous example Projects A and B each cost $1000 and have a present value of returns equal to $1080 and $1400 respectively; therefore the SIRs are 1.08 for A and 1.40 for B.

The term "future savings" implies that the alternative under consideration is not the least investment cost alternative but rather one which requires some incremental initial investment cost (over the least cost alternative) with the promise of future cost savings. In the simple case where an alternative, with investment equal to $1000 and savings equal to $2000, is compared with the present condition, to go to the alternative involves an incremental investment cost of $1000, with the expected return of $2000 in future cost savings. Therefore,

$$SIR = \frac{\text{Present Value (Future cost savings)}}{\text{Incremental Investment Cost}} =$$

$$\frac{\$2000}{\$1000} = 2.0$$

This example illustrated the kind of investment justified by a primary economic analysis. The investment of $1000 promised to return an absolute cost savings of $2000 resulting in a SIR equal to 2.0 and justification of the investment.

If, however, two alternatives A and B are the only two alternatives available to fulfill the mission, with investment costs of $1000 and $2000 respectively, and furthermore either A or B must be selected, then a SIR may be calculated only for alternative B. Assuming the present value of operating costs of B are $1800 less than those of A,

$$SIR_B = \frac{\$1800}{(\$2000 - \$1000)} = 1.8$$

Since the SIR is greater than 1.0, the additional investment for alternative B is justified. This example illustrates a case where both A and B involve incurring additional costs, but where the additional investment cost of B ($1000) results in an $1800 relative savings. Had the savings of B over A only been $800 the SIR would have been 0.8. Alternative B would then not be justified, and alternative A should be selected. This illustration of the selection of the most economical alternative to perform a mission justified on other than economic grounds is an example of a secondary economic analysis. After the Savings/Investment Ratio has been used to select the most economical alternative for a given project, it is no longer meaningful in justifying the inclusion of this project in the capital budget.

In any situation involving multiple alternatives, the alternatives should be arrayed in ascending order of initial investment cost with SIR based on a comparison with the least investment cost alternative. The alternative with the highest SIR should then be selected.

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ECONOMIC EVALUATION OF MILITARY CONSTRUCTION INVESTMENTS

CALCULATION OF SAVINGS/INVESTMENT RATIOS

(All cost data shown in thousands)

		B	C	D	E
1.	Least Investment Cost Alternative: A				
2.	Test Alternatives:				
3.	Net Investment Cost for Test Alternatives:	$ 450	$ 500	$ 600	$ 700
4.	Net Investment Cost for Least Investment Alternative:	$ 100	$ 100	$ 100	$ 100
5.	Differential Investment for Test Alternatives: (Line 3 minus Line 4)	$ 350	$ 400	$ 500	$ 600
6.	Annual Costs (PV) for Test Alternatives:	$1,532	$1,277	$1,149	$1,233
7.	Terminal Value (PV) for Test Alternatives:	N E G L I G I B L E			
8.	Net Future Costs (PV) for Test Alternatives: (Line 6 minus Line 7)	$1,532	$1,277	$1,149	$1,233
9.	Annual Costs (PV) for Least Investment Alternative:	$1,915	$1,915	$1,915	$1,915
10.	Terminal Value (PV) for Least Investment Alternative:	N E G L I G I B L E			
11.	Net Future Costs (PV) for Least Investment Alternative: (Line 9 minus Line 10)	$1,915	$1,915	$1,915	$1,915
12.	Differential Savings for Test Alternatives: (Line 11 minus Line 8)	$ 383	$ 638	$ 766	$ 682
13.	Savings/Investment Ratios: (Line 12 - Line 5)	1.09	1.60	1.53	1.14

The display on the preceding page shows the SIR calculation for such a multiple alternative case. The least cost alternative (A) has an investment cost equal to $100,000. In this example, alternative C has the highest SIR; which is also greater than 1.0, and should be selected. Had the SIR for all alternatives been less than 1.0, then the least investment cost alternative, A, should be selected.

Further examples are cited in Part V of this handbook as well as the rationale for selecting among competive investments in Part III. SECNAVINST 7000.14 prescribes procedures and format for developing the SIR.

Relationship between Savings/Investment Ratio and Payback Period. Another way of expressing the relationship between an investment and future savings generated by the investment is to state the number of years by which the future savings will match the added investment cost. This is the number of years to the "break-even" point or the "payback period". It is sometimes more meaningful to express the results of an economic analysis in terms of the "payback period", particularly if addressing persons not familiar with economic analysis terminology. Appendix B of this Handbook contains Table C which can be used to convert a given Savings/Investment Ratio to the cost break-even point in years (discounted payback period) for the particular case when future savings accumulate in equal amounts each year and the interest rate is ten percent. If future savings are not the same each year, or nearly the same, or the interest rate is not ten percent the table in Appendix B should not be used, and a statement of the present value of future savings and the net investment should replace the payback period where prescribed.

NOTE: When the Savings/Investment ratio of Economic Life involved in a specific economic analysis does not exactly match the figures shown in the table, straight-line interpolation/extrapolation may be used to determine the investment pay-back period.

III. RATIONALE FOR POLICY CONCERNING ECONOMIC CHOICE AMONG SEVERAL ALTERNATIVES

1. The most obvious policy statement for making an economic choice between several equivalent competing alternatives would be something similar to the following: "When alternative investment proposals for achieving a given mission/objective have the same level of expected benefits, the alternative with the lowest discounted cost should be preferred."

2. The above statement is true when no more than two alternatives are under consideration. Consider, however, the following hypothetical summary of discounted costs for five possible mission-equivalent alternatives:

Alternative:	A	B	C	D	E
Investment*	100	450	500	600	700
Annual Costs* (present value)	1915	1532	1277	1149	1233
Total Present Value Cost*	2015	1982	1777	1749	1933

The schedule of investment opportunities shown above displays the same alternative investments discussed in the example of Part II, Section 4. In that example, alternative C had the highest SIR (1.60) relative to the least cost investment and was thus selected. The policy statement of (1) above, however, would dictate selection of alternative D since it represents the lowest present value total cost of all alternatives considered. The purpose of this section is to study the rationale for policy concerning economic choice among several alternatives in order to resolve this apparent contradiction.

3. Consider the "profitability" or savings/investment ratio for each of the higher investment alternatives (B, C, D and E) as compared with the least investment cost Alternative (A):

a. Compare Alternative B to Alternative A:

Investment B = 450	P.V. annual costs Alt. A=	1915
Investment A = 100	P.V. annual costs Alt. B=	1532
Net Investment B/A = 350	P.V. savings Alt. B=	383

Savings/Investment Ratio B/A=383/350=1.09

* (All costs in $ thousands)

b. Compare Alternative C to Alternative A:

Investment C=500		P.V. annual costs Alt. A=1915	
Investment A=100		P.V. annual costs Alt. C=1277	
Net Investment C/A=400		P.V. savings Alt. C= 638	

Savings/Investment Ratio C/A=638/400=1.60

c. Compare Alternative D to Alternative A:

Investment D=600		P.V. annual costs Alt. A=1915	
Investment A=100		P.V. annual costs Alt. D=1149	
Net Investment D/A=500		P.V. savings Alt. D= 766	

Savings/Investment Ratio D/A=766/500=1.53

d. Compare Alternative E to Alternative A:

Investment E=700		P.V. annual costs Alt. A=1915	
Investment A=100		P.V. annual costs Alt. E=1233	
Net Investment E/A=600		P.V. savings Alt. E= 682	

Savings/Investment Ratio E/A=682/600=1.14

4. Consider an "incremental" savings/investment ratio analysis:

a. Incremental investment for B:A 450 - 100=350
Incremental savings for B:A 1915 - 1532=383

Incremental savings/investment ratio=383/350=1.09

b. Incremental investment for C:B 500 - 450= 50
Incremental savings for C:B 1532 - 1277=255

Incremental savings/investment ratio=225/50=5.10

c. Incremental investment for D:C 600 - 500=100
Incremental savings for D:C 1277 - 1149=128

Incremental savings/investment ratio=128/100=1.28

d. Incremental investment for E:D 700 - 600=100
Incremental savings for E:D 1149 - 1233=-84

Incremental investment does not produce savings - disregard

5. An analysis of this data leads to the following observation:

a. Alternatives B, C, D and E are all "profitable" in the sense that their added total investment over that required for Alternative A will return future savings (discounted) that exceed the added investment costs. All these alternatives are a better economic choice than A.

b. From the review of the "incremental" savings/investment calculations, it is evident that Alternative E should not be pursued, since the incremental investment to go from Alternative D to Alternative E does not return at least an equal amount of savings. In fact, the expenditure of an additional $100,000 results in a net increase in annual costs of $84,000. Do not choose E.

c. From additional review of the "incremental" analysis, it is observed that the additional investment to go from Alternative B to Alternative C results in a much larger return than the incremental step in going from Alternative A to Alternative B (a prerequisite to the increment from Alternative B to C). This means that Alternative C is preferred to Alternative B, since it serves to greatly improve the usefulness of the investment used to arrive at the Alternative B cost. Alternative C is preferred over Alternative B.

d. The incremental investment to reach Alternative D is "profitable" in the sense that it contributes savings at least equal to the added investment, but the rate of "profitability" has markedly decreased (1.28 vs. 5.10). Note that the total savings/investment ratio comparing Alternative D against A is less than the comparison of C against A (1.53 vs. 1.60). This reflects the decreased "profitability" of D as compared to C. If investment funds were not limited in availability, Alternative D would be recommended in order to take advantage of the cost savings (even though small) that would result. In view of the historical constraints, however, on investment funding (particularly MCON) availability, the decision as to whether to proceed with Alternative D requires a policy decision, preferably one which directly advises whether or not the incremental savings/investment ratio of 1.28 is high enough to be competitive with other investment opportunities available to the DOD.

6. The basic management problem is that investment funding is generally limited; i.e., there are more "profitable" places to apply investment funding than there are investment funds. Certainly it is important, then, to place our investment funds where they generate the greatest return. The most specific policy statement which could be provided would be similar to the following: "Disregard any incremental investments which do not provide a savings/investment ratio of at least (some number)." If such a policy decision can be published, either from DOD or SECNAV, then it is recommended that the analysis procedure for multiple investment alternatives proceed along the lines outlined with investment decisions based on that stated level of incremental "profitability" which must be reached. It is doubtful, however, whether such a specific policy statement could be agreed to and perhaps it is not actually required. Another alternative rationale for choice exists which would improve the economic choice policy over that originally stated (paragraph 1).

7. It seems clear that the "optimum" investment for the case stated in paragraph 2 would be Alternative C. This alternative provides the most savings for the investment required. Although the additional $100,000 required to go from Alternative C to Alternative D would be profitable (S/I ratio = 1.28), the chances are that within the DOD that additional $100,000 could be used in some other investment proposal where the return would be greater than 1.28. The suggestion exists that if each individual investment proposal is optimized, then perhaps the total DOD investment program would be optimized. With this concept in mind, it is recommended that the criterion for economic selection from among several alternatives be the following: "The economic choice shall be the alternative which provides the highest savings/investment ratio in comparison to the alternative of least initial investment cost." Adoption of this policy would result in implementation of Alternative C in lieu of Alternative D.

8. CAVEAT. This policy (as with most others) must be used with a little caution and common sense. For example, an Alternative F for the case stated in paragraph 2 might be assumed which would have an investment cost of $100,001 and result in savings of $10. This results in a savings/investment ratio of 10.0, which would be the economic

choice in accordance with the recommended policy of paragraph 7. However, this choice would only reduce the total discounted cost figure by $9, whereas Alternative C reduces this total cost figure by $238,000. Obviously Alternative C would seem to be a more realistic choice.

IV. PROCEDURES FOR ECONOMIC ANALYSIS IN NAVFAC

a. General. Although no two individual analyses are likely to ever be identical, the basic procedures and formats can be prescribed which will fit most situations. A simplified procedure for comparing two alternatives is provided by SECNAVINST 7000.14. The general procedural steps which have been identified are as follows:

1. State the investment problem under consideration and describe each alternative proposal which will provide a satisfactory solution. The "status quo" will be normally included as one of the alternatives, although the "status quo" may also require some investment to make it an acceptable alternative.

2. Individually for each stated satisfactory alternative, determine the estimated net initial investment costs and future annual or recurring costs of operating and maintaining the investment during its useful life. It is helpful to list these alternatives in order of ascending net initial investment cost.

3. Compute the Savings/Investment Ratio for each alternative, comparing each alternative with the alternative of least initial investment. Note that there will be no Savings/Investment Ratio for the least initial investment cost proposal, since it represents the least investment cost solution to the problem. The "profitability" of higher cost investments is the subject under study.

4. If none of the higher investment cost alternatives develops a Savings/Investment Ratio greater than 1.0, then the most economic alternative is the least initial investment cost alternative and no Savings/Investment Ratio will be reported. If one or more of the higher investment cost alternative develops a Savings/Investment Ratio greater than 1.0, then the least initial investment alternative is not the economic choice. The most economic choice will be the alternative which develops the highest Savings/Investment Ratio. If the dollar savings from this alternative are absolute (i.e. the least cost alternative is the status quo-investment cost equal to zero dollars) then this SIR is to be used not only in selecting the alternative but also in justifying the project for inclusion in the capital budget.

If the savings are only relative to some least cost alternative (i.e., the absolute level of expense will increase but the increase is less than with other alternatives) then once the most economic alternative is selected, the SIR is no longer useful or relevant to project justification. For an example of this process see Part III of this Handbook. Formats to be followed in completing the economic analysis procedures are prescribed in SECNAVINST 7000.14.

b. Economic Life.

General. The economic life of a proposal is the period of time over which the benefits to be gained from the proposal may reasonably be expected to accrue to the Department of Defense (See definitions in paragraph A of this Handbook.). Note that there may be a significant period between the time that the investment expenditures begin and the beginning of the period of economic life of the facility. The economic life does not begin until the facility has reached beneficial occupancy and the benefits of its construction can begin to be felt. The economic lives of the various possible project alternatives will govern the time period to be covered by the economic analysis. The analysis should be made using the same base year for all alternatives. The first year in which expenditures will have to be made for any one of the project alternatives. The economic life for an alternative extends through the period during which the proposed investment will provide the service for which the investment will be required. The most common analysis involves the case where the alternative under consideration have the same economic lives. If this is not the case, the analysis requires some minor additional steps to adjust alternative costs so they may be directly compared.

NAVFAC Guidelines. To provide a basis for comparison between competing projects, maximum economic lives are established for the categories of investments listed below even though the equipment or facilities involved may have a physical or technological life for a greater number of years. The economic life figures shown are the maximum allowable, and if they are not used, adequate justification should be provided.

(1) Automatic Data Processing Equipment - 8 years

(2) Buildings

(a) Permanent - 25 years

(b) Semipermanent - 15 years

(c) Temporary - 5 years

(3) Operating Equipment - 10 years

(4) Utilities, Plants and Utility Distribution Systems - 15 years (This category includes investment projects for electricity, water, gas, telephone and similar utilities.)

c. Interest Rate.

General. Interest is the cost of money and is normally expressed as an "Interest Rate" which expresses the annual cost of money as a percentage of the amount borrowed or used. Historically, the interest cost of Government funds has received little consideration as a part of an investment analysis, probably since the Government usually invests money received as direct payment from taxes instead of borrowing in the commercial sense. Recently, however, it has been more generally understood that the amount of Government funds available for investment is severely limited and any money invested in capital improvements could have been used for other purposes as well. The cost of not being able to take advantage of other investment opportunities (due to limited resources) is just as real as a specific stated interest rate to be paid to a banker.

Specific. A specific interest rate quantifies the cost of money to an organization and, in the concept of present value, specifically expresses that organization's preference for a present dollar versus the future dollar. SECNAVINST 7000.14 states that future financial benefits and costs will be discounted at an annual rate of ten percent. Use of another interest or discount rate must be accompanied by detailed and specific justification including the results of the analysis utilizing the ten percent rate. Present value tables for an interest rate of ten percent are contained in Appendix B of this Handbook. Present value tables for other interest rates are contained in standard references on the subject

of economic analysis such as Principles of Engineering Economy by Grant and Ireson.

d. Cost Data

1. One-time Cost Element.

(a) Investment Costs. Investment costs are those costs associated with the acquisition of equipment, real property, nonrecurring services, nonrecurring operations and maintenance (start-up costs and other one-time investment costs). Investment costs need not all occur in a single year. They include:

(1) The cost of rehabilitation, modification or addition of land, buildings, machinery and equipment.

(2) The costs of rehabilitation, modification or other capital items such as furnishings and fittings required to put the project on a "ready-to-use" basis.

(3) The costs of plant rearrangement and tooling associated with the project.

(4) The costs of freight, foundations and installations required by the project.

(5) The value of nonrecurring services received from others, both internal and external to the DOD, when the cost of such services can be measured. However, it is inappropriate to exclude these costs simply because they may be difficult to measure.

(b) Working Capital Changes, plus or (minus). Working capital represents funds tied up in liquid funds or assets on hand or on order. Generally, working capital is some form of inventory of consumables or similar resources held in readiness for use or in stock. Working capital changes can be plus (representing added funding required) or minus (representing a saving in funding). If changes are minus, ensure that the figures entered are enclosed by parentheses ( ) so that the savings will be subtracted from other investment costs for the alternative. Most military construction line items will have little or no effect on working capital, but for purposes of illustration some examples of possible working capital affected as a result of new construction might be the following:

(1) Conversion of utility plants from coal or fuel to commercial natural gas may allow a reduction in fuel stocks.

(2) Construction of modernized repair shop facilities with new production equipment will increase the capacity of the shop, reducing "pipeline" stocks of end items necessary to be maintained in the "under repair" status.

(3) Construction of a supplemental exchange gasoline filling station due to overcrowding and congestion at the existing service station will require some increased capital investment to stock increased gasoline storage capacity in the new tanks.

(c) Value of Existing Assets Replaced, (plus) or minus. In many investments, the proposed purchase of a new piece of equipment or facility eliminates the need for an existing piece of equipment or facility. If property is redistributed to some other Federal agency, that agency is benefitted even though there may be no reimbursement or cash-flow to the agency which controlled the property initially. The fair market value of these replaced assets (as measured by sale price, scrap value or alternative use) should be treated as a reduction in the required investment for decision-making purposes. In the event the demolition cost of a facility being replaced is an additional cost to the Government, the figure should be indicated as additive rather than deductive.

(d) Value of Existing Assets to be Employed. The investment for a given project may consist of cost of assets to be acquired plus existing assets, i.e., assets already on hand. However, the value of such existing assets will be included in the investment costs only when the existing asset is currently in use (or has an alternative, planned use) on some other project or is intended for sale. That is, when the use of the existing asset will result in a cash outlay which would otherwise not be incurred on some other project or will deprive the Government of the cash planned to be realized by sale. Such existing assets will be included at their fair market value (as measured by market price, scrap value, or alternative use) and the basis for arriving at the estimate will be documented.

(e) Net Total Investment. Net Total Investment is the algebraic sum (plus and minus) of the dollar amounts of one-time cost elements (a) through (d). In the event these investment costs do not occur at about the same point in time, or if the investment costs for an alternative occur at a point in time significantly different from the starting project year, all costs shown must have been converted to the equivalent present value costs for the starting project year.

(f) Future Terminal Value. Future terminal value is an estimate of the value of the proposed investment in the distant future. Some factors affecting this estimate include the probability of the continued need for the facility (for governmental or private use), appreciation, and depreciation (physical and functional). The effect of these factors upon future value cannot normally be estimated with any reasonable degree of accuracy. Moreover, any salvage values realized may be almost, or completely, offset by removal, dismantling or disposal costs. In addition, the present value of the terminal value of an investment (Item 9) after a 25-year economic life span is only nine percent of the estimated terminal value at that time. Hence, terminal values will not ordinarily be included in the analysis of a project. If, however, the terminal value is significant, the terminal value may be included in the cost analysis. If used, the terminal value justification must specifically relate in detail the rationale for the terminal value estimate and the degree of confidence attached to such estimate. Particularly not any assumptions regarding the probable need for the facility beyond the evaluation period.

2. Annual Costs. The following paragraphs ((a) through (d)) discuss the cost of an annual or recurring nature which will be required to enable each alternative to perform its function during its anticipated economic life. Note that costs which will remain the same regardless of which alternative is selected need not be shown or considered. The statement "Same for all alternatives" may be inserted in lieu of cost figures, if appropriate. Standard categories of costs include:

(a) Personnel. This category includes personnel costs (civilian and military) that will result from the implementation of the proposed project:

(1) Civilian. Enter the cost of civilian personnel services involved directly in the work to be performed. The cost of civilian personnel paid at annual rates will be gross pay as shown in current pay tables, plus the Government's contribution (which is 8.75% of base pay) for civilian retirement, disability, health, life insurance and where applicable, social security programs. If labor costs are determined on the basis of direct labor hours applied, the civilian pay rate should be increased 29.6% to cover leave and other benefits of civilian pay. This factor represents the average cost of 20.9% for sick leave taken and annual, holiday and other paid leave accruals, plus 8.7% for average Government contributions for other benefits. The total cost of civilian personnel services will be 129.6% of base pay for direct labor.

(2) Military. Enter the cost of military personnel services involved directly in the work performed. This cost will be computed in accordance with instructions contained in NAVCOMPTINST 7041.2A, Supp-1; and 7041.3A.

(3) Other. The sum of personnel costs which pertain to performance of the function under consideration, and which are not included under items (1) and (2) above, such as travel, per diem and moving expenses, personnel training, etc.

(b) Operating (Itemize). This category covers operating costs (other than labor). Each major sub-category for which costs will be significant should be itemized. Included might be:

(1) Materials, Supplies, Utilities, and Other Services. The costs to the Government of supplies and materials used in providing a product or service. Include in this figure the cost of base transportation which can be directly identified with the function, costs for handling, storage, custody and protection of property, and the cost of utility services including specifically, electric power, gas, water, and communications related to the function. Cost of material and supplies will include consideration for reasonable overruns, spoilage or defective work.

(2) Maintenance and Repair. The cost of maintenance and repair to building, structures, grounds and equipment utilized by the function involved in producing goods or services. Capital improvements should not be included here, but should be included with investment costs. Include only those maintenance and repair expenses directly attributable to the project under analysis.

(c) Overhead (Itemize). Itemize and show estimates of any overhead costs attributable to the project in question, particularly those costs that change as a result of the investment proposal. These may be costs for accounting, legal, local procurement, medical services, receipt, storage and issue of supplies, police, fire and other services. Include also the costs of terminating or cancelling any existing arrangements which will become due as a result of undertaking the project in question.

(d) Other (Itemize). Itemize and show any other annual/recurring costs which may not fit any of the other cost categories provided.

3. Cost Element. The development of acceptable investment cost and cost savings estimates is essential in making proper alternative choices and in gaining acceptance of the analysis by reviewing agencies. Use the best of readily available sources and apply standard estimating techniques as much as possible. Acceptance of estimates will be greatly increased by citing data sources. Data may be derived from estimating factors published in official manuals, extracted from historic operating records, obtained from expert opinion, or reduced by sound logical processes or accepted techniques from other pertinent sources. Data used should be credible, consistent and reflect good judgment. If data must be assumed for lack of authoritative sources, they should clearly be labeled as assumptions; and, if possible, some indication made as to the sensitivity of the final analysis as a result of the assumptions used. The effort in obtaining solid data must obviously be somewhat proportional to the urgency, the availability of the data, the importance of the data to the analysis, and the dollar size and importance of the project.

4. Adjustments for Inflationary Trends. When there is reason to believe that prices or price level changes will significantly affect the choice between alternative investment proposals, the analysis should use the best available data projecting material and labor increases. The source of the data and/or the rate used are to be included as a part of the analysis.

5. Completeness. Cost factors which remain the same regardless of which of two alternatives are selected do not have to be treated in detail in the analysis. A statement to this effect within the appropriate format sections will suffice. All other costs, however, which are affected by the alternative choice considered, must be included in the cost data. For Military Construction submissions, this includes not just the cost of the building but the cost of collateral equipment and furnishings, land, leases, equipment installations, operations, utilities maintenance, disposal or other costs as appropriate. The cost of the collateral equipment should include not only the cost of the equipment funded by the proponent agency, but also the cost of all equipment furnished or funded by other agencies. Operating costs should include costs of affected ships, aircraft, vehicles, etc. to the extent that these operating costs would be affected by the facility under analysis.

6. Intangibles. As stated earlier, the scope of this Guide is limited to considerations of tangible financial costs and savings. No guidance is provided concerning quantification or comparison of benefits which are not of a tangible nature or which do not have specific supporting documentation. Non-tangible benefits or tangible benefits which are difficult to quantify are considered to be "non-economic Considerations". Frequently, economic analyses have been submitted which develop cost savings supported by "This project will result in a ten percent increase in the efficiency of our Administrative personnel" or "The new shop layout will improve production five percent" or similar terminology with no specific documentation in support of these figures or not specific indication that the number of employees will, in fact, be reduced. Such non-specific supporting documentation must be considered as intangible, and not appropriate for consideration as a quantitative part of the economic analysis. Provision for intangible benefits is made through the addition of comments at the end of the economic analysis or in other sections of the Facility Study accompanying the line item submittal.

e. Non-economic Considerations. As previously discussed, secondary economic analyses are performed for construction line items having their justification based on requirements other than economic. In this case, a SIR is not reported (except to document the selection of the most economic alternative) but rather the non-economic factors should be reported as required by facilities planning documents (DOD forms 1390 and 1391) to justify the project.

It is also possible that a particular line item may be based on economic justification, but non-economic considerations may force a choice of alternatives which is less than the most economic as determined through the procedures of the previous section. In this case, the Facility Study accompanying the line item submission should describe the non-economic considerations which have resulted in the choice of an alternative other than the one selected in accordance with the procedures of paragraph 4. above. If the alternative selected, although not resulting in maximum economic benefits, still offers significant savings, the Savings/Investment Ratio calculations and economic analysis will be completed as with any other line item offering significant cost savings.

f. Equivalent Mission Alternatives. Special attention is required to ensure that an analysis compares equivalent mission alternatives in the sense that each alternative considered will provide a satisfactory mission solution. Each one must get the job done to meet at least minimum standards of acceptability. For example, if a barracks requirement is for 150 men, and a present barracks can only provide 100 adequate spaces even when renovated, then additional spaces for 50 men in new construction must be included as a part of the renovation alternative before comparing with an alternative of building all 150 spaces of new construction. If another alternative is leasing of commercial bachelor housing, but the minimum lease available is for 200 spaces, this alternative can be considered but no economic credit is given for the leasing alternative providing 50 spaces more than is required. The equivalent mission alternatives are:

1. Renovate existing barracks for 100 men and build 50 new spaces.

2. Build 150 new spaces and demolish existing inadequate spaces.

3. Lease 200 spaces (50 to remain empty).

g. Explanation of Source/Derivation of Estimates. The general arrangement of data supporting the figures shown in the economic analysis is outlined by the formats of SECNAVINST 7000.14. Other than the broad format recommended there is no specific format especially recommended for all cases, since all economic analyses will vary in content to some extent. It is strongly recommended, however, that the arrangement of supporting data follow as closely as possible the arrangement of data shown in the first sections of the formats, with major headings underlined, so that the reviewer can easily find the supporting data for any particular figure without undue search. The economic analysis will be reviewed by personnel not familiar with details of the local situation, and who will be reviewing from a critical viewpoint. Anything that can be done to make the document more legible or more easily followed and understood will simplify the review effort and improve the receptiveness of the reviewer to the proposal. Extra effort must be made to fully explain any unusual calculations or local irregularities which would not be apparent to a reviewer accustomed to a standard approach. Ensure that calculations for older projects are updated to reflect latest figures. Always double check the figures used in the analysis against any supporting calculations. Occasionally changes are made in the supporting calculations without changing the analysis figures or vice versa. This is especially important when updating data from one year to another.

V. EXAMPLES

1. Sample Present Value Calculations. Part II, Section b. of this Handbook provides a basic discussion of the concept of present value and the nature of its use in the development of economic analyses. To simplify the understanding of this concept and provide illustrations of how Tables A and B may be used in calculating the present value of savings to be received in the future three sample present value problems are provided below:

a. Determine the present value of $100,000 to be received (or saved) ten years from now if the discount rate is ten percent per annum.

Solution: From Table A, the present value of $1 to be received at the end of ten years if the discount rate is ten percent is $0.41. Therefore, the present value of $100,000 to be received at the end of ten years at a discount rate of ten percent is $100,000 x 0.41 = $41,000.

b. Determine the present value of $10,000 to be received (or saved) at the end of each year for a period of ten years if the discount rate is ten percent per annum.

Solution: From Table B, the present value (cumulative) of $1 to be saved each year for ten years at a discount rate of ten percent is $6.44. Therefore, the present value of $10,000 to be saved each year for ten years at a discount rate of ten percent is $10,000 x 6.44 = $64,400. (Note that the present value of $10,000 saved each year for ten years is greater than the present value of $100,000 to be saved during the tenth year.)

c. Determine the present value of the savings to be returned during a five year period at a discount rate of ten percent if the savings over the five year period are as follows:

At end of year #:	Savings are:
1	$20,000
2	15,000
3	10,000
4	10,000
5	10,000

Solution Alt. #1: Use Table A to determine the present value of each year's savings - then total as follows:

Year:	Present Value $1:	Present Value Savings:
1	$0.954	$19,080
2	0.867	13,005
3	0.788	7,880
4	0.717	7,170
5	0.652	6,520
		TOTAL $53,655

Solution Alt. #2: Use Table B to determine the present value of the $10,000 received annually and Table A to add the increased savings received during the first two years as follows:

$10,000 saved for 5 years=$10,000 (3.977)=$39,770
Addn'l $10,000 in first yr=$10,000 (0.954)= 9,540
Addn'l $5,000 in 2nd yr=$5,000 (0.867)= 4,345
TOTAL $53,655

2. Sample "Primary" Economic Analysis. Assume that a Naval Station is investigating the profitability of providing utility services to two existing wharves "Alpha" and "Bravo" in order to allow ships in-port to secure their power plants. Planned in-port loading is 2 LST and 2 DD for 320 ship days/year each. Included would be electrical, steam, salt water and compressed air utilities. Potable water is presently available. A summary of quantitative cost data provided or derived to complete the analysis is shown below:

a. Cost of the line item to provide the necessary utilities to the wharves complete is $600,000.

b. Cost of military labor watchstanders now required to man the four auxiliary ship power plants is estimated at $140,000 per year. (Although these personnel will not be reassigned from their ships if these watches are not required, they will presumably be utilized in other ships work.)

c. Fuel cost for in-port ships based on historical ship days in-port is estimated at $280,000 annually.

d. Cost of cleaning of boiler firesides and overhaul of ship generators attributable to in-port steaming requirements is $220,000 per year.

e. Estimated civilian labor costs to operate new utility plant serving these wharves would be $55,000 per year.

f. Civilian labor to provide ship connections under proposed system is estimated to be $10,000 per year.

g. Fuel and power operating costs of the installed utilities estimated to be $290,000 per year.

h. Maintenance cost of new utilities plant estimated at $105,000 per year. Costs are arrayed in varying degrees of detail (with the Savings/Investment Ratio calculation shown) in Format A-1 recommended by SECNAVINST 7000.14. Non-quantifiable benefits should be itemized in FORMAT B of SECNAVINST 7000.14.

ECONOMIC ANALYSIS - DEPARTMENT OF THE NAVY INVESTMENTS
SUMMARY OF PROJECT COSTS
FORMAT A-1

1. Submitting Department of the Navy Component: Naval Station, Anwhere, USA

2. Date of Submission: 1 July 1970

3. Project Title: Waterfront Utilities for Wharves "Alpha" & "Bravo" (P-800)

4. Description of Project Objectives: The objective of this project is to reduce the overall cost of utilities services to in-port ships considering relative economies of providing shore-based utilities versus maintaining ship-board utility systems in operation.

5a. Present Alternative: A. Continue present operation with no waterfront utilities (except existing potable water) provided at wharves "Alpha" & "Bravo".

b. Proposed Alternative: B. Install permanent waterfront electrical, steam salt water and compressed air utilities at wharves "Alpha" & "Bravo" to allow in-port shutdown of ship power plants.

6a. Economic Life: 25

b. Economic Life: 25

7. Project Year	8. Recurring (Operations) Costs a. A Present Alternative	B Proposed Alternative	9. Differential Cost (A - B)	10. Discount Factor	11. Present Value Of Annual Savings
All Years 1-25					B over A
Personnel	140,000	65,000	75,000		
Operating	280,000	290,000	10,000		
Maintenance	220,000	105,000	115,000		
12. TOTALS	640,000	460,000	180,000	9,524*	$ 1,714,320

* Table B, Appendix B, 25 Years, 10%

ECONOMIC ANALYSIS - DEPARTMENT OF THE NAVY INVESTMENTS
SUMMARY OF PROJECT COSTS
FORMAT A-1

13.	Present Value of New Investment:	
	a. Land and Buildings	600,000
	b. Equipment	0
	c. Other (Identify nature)	0
	d. Working Capital (Change - plus or minus)	0
14.	Total Present Value of New Investment (i.e., Funding Requirements)	$600,000
15.	Less: Present value of existing assets replaced	0
16.	Plus: Value of Existing Assets to be Employed on the Project	0
17.	Net Investment (Line 14 minus Line 15 plus Line 16	$600,000
18.	Present Value of Cost Savings From Operations (Col. 11)	1,714,320
19.	Plus: Present Value of the Cost of Refurbishment or Modification Eliminated	0
20.	Total Present Value of Cost Savings	1,714,320
21.	Savings/Investment Ratio (Payback) (Line 20+Line 17)	2.9

SECNAVINST 7000.14
30 January 1970

Attachment 2 to Encl (2)

ECONOMIC ANALYSIS - DEPARTMENT OF THE NAVY INVESTMENTS
SUMMARY OF PROJECT COSTS
FORMAT A-1 (Cont.)

22. Source/Derivation of Cost Estimates: (use as much space as required)

	A (Itemize Project Costs)	B (Itemize Project Costs)
a. Investment Costs:		
(1) Changes in Working Capital	0	0
(2) Net Terminal Value:	0	0 negligible
b. Recurring Cost (Operations):		
(1) Personnel		
Civilian	0	65,000
Military	140,000	0
(2) Operating		
Operating Costs	280,000	290,000
Maintenance Costs	220,000	105,000
(3) Overhead Costs	NO CHANGE	
c. Other Considerations:		

23. Name and Title of Principal Action Officer	Date

SECNAVINST 7000.14
30 January 1970

Attachment 2 to Encl (2)

3. Sample "Secondary" Economic Analysis. Assume that a Naval Station has a 200-man deficiency in bachelor enlisted housing due to continuing deterioration of a present structure and updated backelor housing adequacy criteria. Two alternative means of satisfying this deficiency are to (1) remove the existing structure and replace with a new barracks or to (2) rehabilitate the existing structure to accommodate the 200 men in conformance with adequacy criteria. If rehabilitation is selected, the line item must also include an addition to the structure to provide quarters for all 200 personnel in accordance with latest criteria. From the standpoint of convenience and appearance, it would be desirable to build a new structure, although this investment cost is greater than rehabilitation. It is necessary to investigate the "profitability" of new construction versus rehabilitation through an economic analysis. Cost data relating to the two alternatives was determined to be the following:

a. Construction cost of new barracks is estimated to be $480,000.

b. Demolition of existing barracks is estimated to cost the Government $10,000.

c. Complete rehabilitation of existing barracks including construction of the new addition is estimated at $295,000.

d. Cost of new furnishings for either alternative is estimated at $75,000.

e. Military and Civilian labor costs will be the same regardless of the alternative selected.

f. Estimated annual fuel/utility costs for the new building are estimated at $21,000.

g. Estimated annual fuel/utility costs for the rehabilitated building with addition are estimated at $10,000.

h. Annual maintenance costs for the new building are estimated at $10,000.

i. Annual maintenance costs for the rehabilitated building are estimated at $19,000.

j. Estimated terminal value of the new building is $100,000 at the end of 25 years. Estimated terminal value of the rehabilitated building would be $50,000 at the end of 25 years. (Terminal value would not normally be considered. It is being considered in this example only for purposes of illustration of use of the formats.)

Note that this analysis is secondary in nature since it does not address the basic need for the line item in question. The basic requirement for this line item is not to save dollars, but to correct physical deficiencies in present bachelor quarters available at the station. Correction of the inadequacy by either alternative will be costly. This economic analysis only measures the "profitability" of the more costly investment as opposed to the lesser investment alternative.

From the given Formats, it is seen that the Savings/ Investment Ratio for the new construction alternative as opposed to rehabilitation is less than unity. This means that the present value of savings anticipated over the first 25 years at a ten percent discount rate fails to match the amount of added initial investment required to construct new barracks. The new construction alternative should perhaps be selected due to considerations of morale, siting flexibility, or other features not relating to economics. If that is the case, then separate treatment of those considerations must be provided within the line item justification.

ECONOMIC EVALUATION OF MILITARY CONSTRUCTION INVESTMENTS

GENERAL INFORMATION

1. Submitting DOD Component: NAVY

2. Name of Activity: Naval Station, Anywhere, USA

3. Date of Submission: 1 July 1970

4. Project Title/Description of Project Objective:

Construction of Bachelor Enlisted Quarters (P-722). The objective of this project is to correct present bachelor enlisted housing deficiencies.

5. Alternatives Available:

Identification	Invest. Year	Economic Life(YRS)	Description
A.	1973	25	Rehabilitate existing 200-man barracks to capacity of 150 men in accordance with improved bachelor housing criteria. Construct 50-man addition to existing structure to obtain full 200-man capacity.
B.	1973	25	Replace present substandard barracks with new 200-man bachelor enlisted quarters. Demolish existing structurel

6. Name & Title of Principal Action Officer: Captain I. B. Leave, Commanding Officer

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ECONOMIC EVALUATION OF MILITARY CONSTRUCTION INVESTMENTS

ONE-TIME COST DATA

		A	B	B minus A
1.	Alternative Identification:			
2.	Investment Cost (Itemize):			
	a. Rehabilitate existing barracks and construct addition	$295,000	$ 0	$(295,000)
	b. Construct new 200-man barracks	0	480,000	480,000
	TOTAL:	295,000	480,000	185,000
3.	Working Capital Changes, plus or (minus):	0	0	0
4.	Less: Value of Existing Assets Replaced, (plus) or minus:	0	0,000	10,000
5.	Plus: Value of Existing Assets to be Employed:	0	0	0
6.	Differential Net Investment:			195,000
7.	Terminal Value of Investment: (included for illustration)	50,000	100,000	50,000
8.	Present Value Factor (Table A):			.097
9.	Present Value of Terminal Value:			$ 4,850

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ECONOMIC EVALUATION OF MILITARY CONSTRUCTION INVESTMENTS

ANNUAL COSTS & SAVINGS/INVESTMENT RATIO

1.	Alternative Identification:	A	B	Savings (A minus B)
2.	Annual Costs:			
	a. Personnel: NO CHANGE			
	b. Operating (Itemize):			
	(1) Fuel/Utility Costs	$28,000	$21,000	$ 7,000
	(2) Maintenance Costs	19,000	10,000	9,000
	c. Overhead (Itemize): NO CHANGE			
3.	Total Annual Savings:			$ 16,000
4.	Present Value Factor (Table B):			9.524
5.	Present Value of Annual Savings:			$152,384
6.	Present Value of Annual Savings and Terminal Value:			$157,234
7.	Differential Net Investment:			$195,000
8.	Savings/Investment Ratio:			0.8

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TAB

DEFINITIONS

Alternative - One of two or more differing techniques or means for providing the capability required to complete a project.

Alternative Life - The period of time, in years, for a specific alternative consisting of the sum of the alternative's Investment Period and the alternative's Economic Life.

Annual Costs - Expenses for personnel, material consumed in use, operating, overhead, support services, and other items incurred on an annual basis.

Discounting - (See Present Value).

Discount Rate - The interest rate used to discount or apply the time value of money to future costs and benefits so as to arrive at their present values. (See also Present Value/Time Value of Future Cash Flows).

Economic Life - The period of time over which the benefits to be gained from an investment may reasonably be expected to accrue to the Department of Defense. (Although economic life is not necessarily the same as physical life or technological life, it is significantly affected by both the obsolescence of the investment itself and the purpose it is designed to achieve.) The economic life of an investment begins in the year in which the investment starts producing benefits. Thus, it is possible that the investment may occur several years prior to the start of an alternative's economic life.

Equipment - Machinery, furniture, vehicles, machines used or capable of use in the manufacture of supplies or in performance of services or for any administrative or general plant purposes.

Investment - The sum of money or capital employed for a given purpose or in a given area; a security or other property right purchased or otherwise acquired or the cost of acquisition thereof. An investment is an acquisition made in the expectation of realizing benefits beyond one year. This includes acquisitions which in aggregate will be financed in more than one year.

Investment Period - The period of time, in years, from the start of investment for an alternative until the investment is completed and the alternative's Economic Life begins.

Physical Life - The estimated number of years that a machine, piece of equipment or building can physically be used by the Department of Defense in accomplishing the function for which it was procured or constructed.

Present Value/Time Value of Future Cash Flows - In every investment, explicit recognition should be given to the fact that a dollar today is worth more than a dollar tomorrow because of the interest cost which is related to all Government expenditures which occur over time. Thus, an annual savings or cash-inflow projected for tomorrow has a present value (PV) less than its undiscounted dollar value. Dollar benefits which accrue in the future cannot be compared directly with investments made in the present because of this time value of money. Discounting is a technique for converting various cash flows occurring over time to equivalent amounts at a common point in time - considering the time value of money - to facilitate a valid comparison.

Project - A planned undertaking to provide a capability, but which may have several alternative means of accomplishment.

Project Year - The time, in years, at which an event occurs as measured from the time at which the earliest investment for any project alternative would be made. For example, if one alternative's investment period starts in 1973, and another mission-equivalent alternative's investment period would not start until 1975, the investment for the second alternative could be said to start in the third project year. The first project year is the first year in which expenditures will have to be made for any one of the project alternatives. The project year for any other event is measured from the date of the first project year.

Real Property - Land and rights therein, utility generation plants and distribution systems, buildings, structures, and improvements thereto.

Savings/Investment Ratio - A numerical ratio, when comparing two separate alternatives, of the differences in present value of future costs for the alternatives divided by the differences in investment costs. The ratio is an indication of the effectiveness of higher investments in producing future cost savings.

Technological Life - The estimated number of years before technology will make available new equipment or facilities which will make the existing or proposed equipment or facilities obsolete.

Terminal Value - The expected value of either existing facilities, or facilities not yet in being, at the end of their useful life.

TAB

PRESENT VALUE TABLES

TABLE A -------- PRESENT VALUE OF $1 (SINGLE AMOUNT)

TABLE B -------- PRESENT VALUE OF $1 (CUMULATIVE UNIFORM SERIES)

TABLE C -------- CONVERSION TABLE - SAVINGS/INVESTMENT RATIO TO DISCOUNTED PAY-BACK PERIOD

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Project Year Discount Factors

Table A

PRESENT VALUE OF $1 (Single Amount - to be used when cash-flows accrue in different amounts each year).

Project Year	10%
1	0.954
2	0.867
3	0.788
4	0.717
5	0.652
6	0.592
7	0.538
8	0.489
9	0.445
10	0.405
11	0.368
12	0.334
13	0.304
14	0.276
15	0.251
16	0.228
17	0.208
18	0.189
19	0.172
20	0.156
21	0.142
22	0.129
23	0.117
24	0.107
25	0.097

Table B

PRESENT VALUE OF $1 (Cumulative Uniform Series - to be used when cash-flows accrue in the same amount each year).

10%
0.954
1.821
2.609
3.326
3.977
4.570
5.108
5.597
6.042
6.447
6.815
7.149
7.453
7.729
7.980
8.209
8.416
8.605
8.777
8.933
9.074
9.203
9.320
9.427
9.524

Note: Table A factors represent an arithmetic average of beginning and end of the year single amount factors found in standard present value tables. Table B factors represent the cumulative sum of the factors contained in Table A through any given project year.

TABLE A

CONVERSION TABLE

SAVINGS/INVESTMENT RATIO TO DISCOUNTED PAY-BACK PERIOD

(Interest @ 10%)

Savings/ Investment Ratio	DISCOUNTED PAY-BACK PERIOD (YRS) FOR ECONOMIC LIFE SHOWN				
	5	10	15	20	25
1.0	5.00	10.00	15.00	20.00	25.00
1.1	4.43	8.58	12.34	15.60	18.30
1.2	3.98	7.53	10.54	12.97	14.82
1.3	3.62	6.71	9.23	11.16	12.57
1.4	3.31	6.06	8.22	9.83	10.97
1.5	3.06	5.53	7.42	8.80	9.75
1.6	2.84	5.08	6.77	7.97	8.79
1.7	2.65	4.71	6.22	7.29	8.01
1.8	2.48	4.38	5.76	6.72	7.36
1.9	2.33	4.10	5.37	6.24	6.82
2.0	2.20	3.85	5.02	5.82	6.35
2.1	2.09	3.63	4.72	5.45	5.94
2.2	1.98	3.44	4.45	5.13	5.58
2.3	1.89	3.26	4.21	4.85	5.27
2.4	1.80	3.10	4.00	4.60	4.99
2.5	1.73	2.96	3.81	4.37	4.73
2.6	1.66	2.83	3.63	4.16	4.51
2.7	1.59	2.71	3.47	3.97	4.30
2.8	1.53	2.60	3.33	3.80	4.11
2.9	1.47	2.50	3.19	3.65	3.94
3.0	1.42	2.40	3.07	3.50	3.78
3.1	1.37	2.32	2.95	3.37	3.63
3.2	1.32	2.24	2.85	3.24	3.50
3.3	1.28	2.16	2.75	3.13	3.37
3.4	1.24	2.09	2.66	3.02	3.26
3.5	1.20	2.03	2.57	2.92	3.15
3.6	1.17	1.96	2.49	2.83	3.05
3.7	1.13	1.91	2.41	2.74	2.95
3.8	1.10	1.85	2.34	2.66	2.86
3.9	1.07	1.80	2.28	2.58	2.78
4.0	1.04	1.75	2.21	2.51	2.70
4.5	.92	1.54	1.94	2.20	2.36
5.0	.83	1.38	1.73	1.96	2.10
5.5	.75	1.24	1.56	1.76	1.89
6.0	.68	1.13	1.42	1.61	1.72
6.5	.63	1.04	1.31	1.47	1.58
7.0	.58	.96	1.21	1.36	1.46
7.5	.54	.90	1.12	1.26	1.35
8.0	.51	.84	1.05	1.18	1.26
8.5	.48	.79	.98	1.11	1.18
9.0	.45	.74	.93	1.04	1.12
9.5	.43	.70	.88	.99	1.05
10.0	.41	.67	.83	.93	1.00

TAB

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