# **Economic Calculations for the ASHRAE Handbook**

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# ECONOMIC ANALYSIS TECHNIQUES

#### **Definitions of terms:**

C <sub>e</sub>	= cost of energy to operate the system for one period	ITC	= investment tax credit for energy efficiency improvements, if applicable
$C_{s,assess}$	= initial assessed system value	j	= general inflation rate per period
$C_{s,salv}$	= system salvage value at the end of its	j <sub>e</sub>	= general energy rate per period
	useful life in constant dollars	k	= end if period(s) in which
C <sub>s,init</sub>	= initial system cost		replacement(s), repair(s), depreciation, or interest is calculated
$C_y$	= annualized system cost in constant dollars	М	= periodic maintenance cost
D <sub>k,sl</sub> or D <sub>k,SD</sub>	= amount of depreciation at the end of period k depending on the type of	n	= number of period(s) under consideration
D <sub>k</sub> ,SD	depreciation schedule used, where $D_{k,sl}$ is the straight line depreciation method and $D_{k,SD}$ represents the sum-of-digits	Р	= a sum of money at the present time, <i>i.e.</i> , its present value
	depreciation method in constant dollars	$P_k$	= outstanding principle of the loan for
F	= future value of a sum of money		$C_{s,init}$ at the end of period k in current dollars
i <sub>d</sub>	= discount rate	$R_k$	= net replacement(s), repair cost(s), or
i <sub>m</sub>	= market mortgage rate (real rate + general inflation rate)	ti đe	disposals at the end of period $k$ in constant dollars
$i_m P_k$	= interest charge at the end of period $k$	T <sub>inc</sub>	= (state tax rate + federal tax rate) -
<i>i'</i>	= $(i_d - j)/(1+j)$ = effective discount rate adjusted for energy inflation <i>j</i> , sometimes called the real discount rate		(state tax rate X federal tax rate) where tax rates are based on the last dollar earned, <i>i. e.</i> , the marginal rates
i″	= $(i_d - j_e)/(1 + j_e)$ = effective discount rate	$T_{prop}$	= property tax rate
	adjusted for energy inflation $j_e$	$T_{salv}$	= tax rate applicable to salvage value of
Ι	= annual insurance costs		the system

For any proposed capital investment, the capital and interest costs, salvage costs,

replacement costs, energy costs, taxes, maintenance costs, insurance costs, interest deductions,

depreciation allowances, and other factors must be weighed against the value of the services provided by the system.

## **Single Payment**

A common method for analyzing the impact of a future payment is to reduce it to its present value or present worth. The primary underlying principle is that all monies (those paid now and in the future) should be evaluated according to their present purchasing power. This approach is known as discounting.

The future value F of a present sum of money P over n periods with compound interest rate i is:

$$F = P(1+i)^n \tag{1}$$

The present value or present worth P or a future sum of money F is given by:

$$P = F / (1+i)^n = F \times \text{PWF}(i,n)$$
<sup>(2)</sup>

where PWF(*i*,*n*) the worth factor, is defined by:

$$PWF(i,n) = 1/(1+i)^{n}$$
(3)

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**Example 2:** Calculate the future value of a system presently valued at \$10,000, in 10 years, at 10% interest.

$$F = P(1+i)^n = \$10,000 \times (1+0.10)^{10} = \$10,000 \times 2.593742 = \$25,937.42$$

**Example 3:** Using the present worth factor

PWF(i = 0.10, n = 10), calculate the present value of a future sum of money valued at \$10,000.

$$P = F \times PWF(i, n) = 10,000 \times 1/(1+0.1)^{10} = $3,855.43$$

## **Accounting for Varying Inflation Rates**

Inflation, which accounts for the rise in costs of a commodity over time, is a separate issue from the time value of money – the basis for discounting. Inflation must often be accounted for in

an economic evaluation. Further complexities are added when one considers that different economic goods inflate at different rates. One way to account for this is to use effective interest rates that account for varying rates of inflation.

The effective interest rate i', sometimes called the real rate, accounts for the general inflation rate j and the discount rate  $i_d$ , and can be expressed as follows (Kreith and Kreider 1978, Kreider and Kreith 1982):

$$i' = \frac{1+i_d}{1+j} - 1 = \frac{(i_d - j)}{(1+j)}$$
(4)

Such an expression can be adapted to account for energy inflation by considering the general discount rate  $i_d$  and the energy inflation rate  $j_e$ , thus:

$$i'' = \frac{1+i_d}{1+j_e} - 1 = \frac{(i_d - j_e)}{(1+j_e)}$$
(5)

The discount equations(1) through (3) can be revised to consider the effects of varying inflation rates. The future value F, using constant currency of an invested sum P with a discount rate  $i_d$  under inflation j during n periods now becomes:

$$F = P[1+i_d/1+j]^n = P(1+i')^n$$
(6)

The present worth P, in constant dollars, of a future sum of money F with discount rate  $i_d$ under inflation rate j during n periods is then expressed as:

$$P = F / \left[ (1 + i_d) / (1 + j) \right]^n$$
(7)

In constant currency, the present worth P of a sum of money F can be expressed with an effective interest rate i' which is adjusted for inflation by:

$$P = F / (1+i')^n = F \times \text{PWF}(i',n)$$
(8)

where the effective present worth factor is given by:

$$PWF(i',n) = 1/(1+i')^{n}$$
(9)

**Example 4:** Calculate the effective interest rate taking into consideration a discount rate  $i_d$  of 10% and a general inflation rate j of 5%.

$$i' = (i_d - j) = (1 + j) = (0.1 - 0.05) / (1 + 0.05) = 0.04762 = 4.62\%$$

**Example 5:** Using the effective interest rate in **Example 4**, calculate the future value of \$10,000 10 years from now.

$$F = P(1+i')^n = \$10,000(1+0.04762)^{10} = \$15,923.47 \text{ (constant dollars)}$$

## **Recovering Capital as a Series of Payments**

Another important economic concept is the recovery or acquisition of capital as a series of uniform payments – the capital recovery factor. The capital recovery factor is commonly used to describe periodic uniform mortgage or loan payments. It is the ratio of the periodic payment to the total sum being repaid. The discounted sum S of such an annual series of payments  $P_{ann}$  invested over *n* periods with interest rate *i* is given by:

$$S = P_{ann} \left[ 1 - \left( 1 + i \right)^{-n} \right] / i$$
(10)

This series of uniform annual payments  $P_{ann}$  over *n* periods is equivalent to the present value sum *S* divided by the capital recovery factor, with interest rate *i* expressed as:  $P_{ann} = S_{i} \left[ \left[ 1 - (1 - i)^{-n} \right] \right]$ (11)

$$P_{ann} = Si / \left[ 1 - (1+i)^{-n} \right]$$
(11)

This multiplier is the capital recovery CRF(*i*,*n*), which can be expressed as:  $CRF(i,n) = i / \left[1 - (1+i)^{-n}\right] = i(1+i)^n / \left[(1+i)^n - 1\right]$ (12)

**Example 6:** Calculate the discounted sum of ten periodic payments of \$1,000 with a discount rate of 10%.

$$S = P_{ann}S = P_{ann} \left[ 1 - (1+i)^{-n} \right] / i = 1000 \left[ 1 - (1+0.10)^{-10} \right] / 0.10 = \$6144.57$$

Example 7: Calculate the capital recovery factor for Example 6.  $CRF(i,n) = i / [1 - (1+i)^{-n}] = 0.10 / 1 - (1+0.10)^{-10} = 0.162745$ 

# **Annualized Costs**

The economic analysis methods presented to this point have included only single cash flows or a simple series of payments that were adjusted for inflation. A detailed cash flow analysis of a mechanical system should consider all positive and negative cash flow through the life of the system, including single payments, series of payments, and increasing or decreasing payments, and must also consider varying inflation rates. Such analysis should take into account taxes, tax credits, mortgage payments, and all other costs associated with a particular system. One convenient way of accomplishing this is to use annualized system costs as presented by Kreith and Kreider (1978, 1982) and Kreider (1979).

Total annualized mechanical system costs depend on initial investments, salvage values, replacement costs, energy costs, property taxes, property tax deductions, interest tax deductions, maintenance costs, replacement costs, and insurance costs. Such a representation lends itself to optimization of system costs and can be applied to residential and commercial systems.

Annualized mechanical system owning, operating, and maintenance costs (for a profitmaking firm) can be expressed in constant currency as:

 $C_y = -$  capital and interest + salvage value - replacements (or disposals) - operating energy - property tax - maintenance - insurance + interest tax deduction + depreciation (for commercial systems) (13)

where

$$\begin{array}{ll} \left( \operatorname{CRF}_{s,init} - \operatorname{ITC} \right) \operatorname{CRF}(i',n) & = \operatorname{capital} \text{ and interest} \\ C_{s,salv} \operatorname{PWF}(i',n) \operatorname{CRF}(i',n)(1 - T_{salv}) & = \operatorname{salvage} \operatorname{value} \\ \sum_{k=1}^{n} \left[ R_k \operatorname{PWF}(i',k) \right] \operatorname{CRF}(i',n)(1 - T_{inc}) & = \operatorname{replacements} \operatorname{or} \operatorname{disposals} \\ C_e \left[ \operatorname{CRF}(i',n) / \operatorname{CRF}(i'',n) \right] (1 - T_{inc}) & = \operatorname{operating} \operatorname{energy} \\ C_{s,assess} T_{prop}(1 - T_{inc}) & = \operatorname{property} \operatorname{tax} \\ M(1 - T_{inc}) & = \operatorname{maintenance} \\ I(1 - T_{inc}) & = \operatorname{insurance} \\ T_{inc} \sum_{k=1}^{n} \left[ i_m P_{k-1} \operatorname{PWF}(i_d,k) \right] \operatorname{CRF}(i',n) & = \operatorname{interest} \operatorname{tax} \operatorname{deduction} \\ T_{inc} \sum_{k=1}^{n} \left[ D_k \operatorname{PWF}(i_d,k) \right] \operatorname{CRF}(i',n) & = \operatorname{depreciation} (for \operatorname{commercial} systems) \\ \end{array}$$

The outstanding principle  $P_k$  during year k at market mortgage rate  $i_m$  is given by:

$$P_{k} = \left(C_{s,init} - \text{ITC}\right) \left[ \left(1 + i_{m}\right)^{k-1} + \frac{\left(1 + i_{m}\right)^{k-1} - 1}{\left(1 + i_{m}\right)^{-n} - 1} \right]$$
(14)

Note:  $P_k$  is in current dollars and must, therefore, be discounted by the discount rate  $i_d$  not i'.

Likewise, the summation term for interest deduction can be expressed as:

$$\sum_{k=1}^{n} \left[ i_m P_k / (1+i_d)^k \right] = \left[ \frac{\operatorname{CRF}(i_m, n)}{\operatorname{CRF}(i_d, n)} + \frac{1}{(1+i_m)} \frac{i_m - \operatorname{CRF}(i_m, n)}{\operatorname{CRF}(i_d - i_m) / (1+i_m), n} \right] \times \left( C_{s, init} - \operatorname{ITC} \right)$$
(15)

and if  $i_d = i_m$ ,

$$\sum_{k=1}^{n} \left[ i_m P_k / (1+i_d)^k \right] = \left[ 1 + \frac{n}{(1+i_m)} \left[ i_m - \text{CRF}(i_m, n) \right] \right] \left( C_{s,init} - \text{ITC} \right)$$
(16)

Depreciation terms commonly used include depreciation calculated by the straight line depreciation method, which is:

$$D_{k,SL} = \left(C_{s,init} - C_{s,salv}\right)/n \tag{17}$$

and the sum-of-digits depreciation method:

$$D_{k,SD} = (C_{s,init} - C_{s,salv}) [2(n-k+1)] / n(n+1)$$
(18)

Riggs (1977) and Grant *et al.* (1982) present further information on advanced depreciation methods. Certified accountants may also be consulted for information regarding accelerated methods allowed by the IRS.

**Example 8:** Calculate the annualized system costs using constant dollars for a \$10,000 system considering the following factors: a 5-year life, a salvage value of \$1,000 at the end of the 5 years, ignore investment tax credits, a \$500 replacement in year 3, a discount rate  $i_d$  of 10%, a general inflation rate j of 5%, a fuel inflation rate  $j_e$  of 8%, a market mortgage rate  $i_m$  of 10%, an annual operating cost for energy of \$500, a \$100 annual maintenance cost, a \$50 annual insurance cost, straight line depreciation, an income tax rate of 50%, a property tax rate of 1% of assessed value, an assessed system value equal to 40% of the initial system value, and a salvage tax rate of 50%.

## Effective interest rate i'

$$i' = (i_d - j) / (1 + j) = (0.10 - 0.05) / (1 + 0.05) = 0.047619$$

Effective interest rate i"

$$i'' = (i_d - j_e) / (1 + j_e) = (0.10 - 0.08) / (1 + 0.08) = 0.018519$$

Capital recovery factor CRF(*i'*,*n*) CRF(*i'*,*n*) = *i'* /  $\left[1 - (1 + i')^{-n}\right] = 0.047619 / \left[1 - (1.047619)^{-5}\right] = 0.229457$ 

Capital recovery factor CRF(*i*",*n*) CRF(*i*",*n*) = *i*" /  $\left[1 - (1 + i^{"})^{-n}\right] = 0.018519 / \left[1 - (0.018519)^{-5}\right] = 0.211247$ 

Capital recovery factor CRF $(i_m, n)$ CRF $(i_m, n) = i_m / \left[1 - (1 + i_m)^{-n}\right] = 0.10 / \left[1 - (1.10)^{-5}\right] = 0.263797$ 

**Present worth factor**  $PWF(i_d, years 1 \text{ to } 5)$ 

 $PWF(i_d, 1) = 1/(1.10)^1 = 0.909091$  $PWF(i_d, 2) = 1/(1.10)^2 = 0.826446$  $PWF(i_d, 3) = 1/(1.10)^3 = 0.751315$  $PWF(i_d, 4) = 1/(1.10)^4 = 0.683013$  $PWF(i_d, 5) = 1/(1.10)^5 = 0.620921$ 

**Present worth factor** PWF(i', years 1 to 5)

 $PWF(i', 1) = 1/(1.047619)^{1} = 0.954545$  $PWF(i', 2) = 1/(1.047619)^{2} = 0.911157$  $PWF(i', 3) = 1/(1.047619)^{3} = 0.869741$  $PWF(i', 4) = 1/(1.047619)^{4} = 0.830207$  $PWF(i', 5) = 1/(1.047619)^{5} = 0.792471$ 

**Capital and interest** 

$$(C_{s,init} - ITC)CRF(i', n) = (\$10,000 - \$0)0.0229457 = \$2,294.57$$

Salvage value

$$C_{s,salv}$$
PWF $(i',n)$ CRF $(i',n)(1 - T_{salv}) = $1,000 \times 0.792471 \times 0.229457 \times 0.5 = $90.92$ 

**Replacements or disposals** 

$$\sum_{k=1}^{n} \left[ R_k \text{PWF}(i',k) \right] \text{CRF}(i',n) (1 - T_{inc}) = \$500 \times 0.869741 \times 0.229457 \times 0.5 = \$49.89$$

**Operating energy** 

$$C_{e}[\operatorname{CRF}(i',n) / \operatorname{CRF}(i'',n)](1 - T_{inc}) = 500[0.229457 / 0.211247]0.5 = \$271.55$$

**Property tax** 

$$C_{s,assess}T_{prop}(1-T_{inc}) = $10,000 \times 0.40 \times 0.01 \times 0.05 = $20.00$$

Maintenance

$$M(1 - T_{inc}) = 100(1 - .5) = $50$$

Insurance

$$I(1-T_{inc}) = 50(1-.5) = $25$$

Interest tax deduction

$$T_{inc}\sum_{k=1}^{n} \left[i_m P_{k-1} \text{PWF}(i_d, k)\right] \text{CRF}(i', n) = \dots$$

		Table	e 5 Interest	Deduction S	ummary		
Year	Payment	Interest	Principal	Outstanding	PWF(i,k)	Disco	ounted
	Amount	Payment	Payment	Principal		Interest	Payment
	(Current \$)	(Current \$)	(Current \$)	(Current \$)		(discou	inted \$)
0				\$10,000			
1	2637.97	1000.00	1637.97	8362.02	0.909091	909.09	2398.17
2	2637.97	836.20	1801.77	6560.26	0.826446	691.07	2180.14
3	2637.97	656.03	1981.95	4578.31	0.751315	492.89	1981.95
4	2637.97	457.83	2180.14	2398.17	0.683013	312.70	1801.77
5	2637.97	239.82	2398.17	0	0.620921	148.91	1637.97
Total		3189.88	10,000.00			2554.66	10.000.00

Table 5 Interest Deduction Summary

Annual payment amounts, interest payments, principal payments, outstanding principal payments, present worth factor  $PWF(i_{a}k)$ , discounted interest, and discounted payment are shown in table 5. Annual payments are the product of the initial system costs  $C_{s,init}$  and the capital recovery factor  $CRF(i_m, 5)$ .

Note: Equation (15) can be used to calculate the total discounted interest deduction directly.

Next, apply the capital recovery factor CRF(i',5) and tax rate  $T_{inc}$  to the total of the discounted interest sum.

 $2554.66 \operatorname{CRF}(i',5)T_{inc} = 2554.66 \times 0.229457 \times 0.05 = 293.09$ 

Depreciation

$$T_{inc}\sum_{k=1}^{n} [D_k PWF(i_d,k)]CRF(i',n) \dots$$

Use the straight line depreciation method to calculate depreciation.

$$D_{k,SL} = (C_{s,init} - C_{s,salv}) / n = (\$10,000 - \$1,000) / 5 = \$1800.00$$

Next, discount the depreciation.

Year	$D_{k,SL}$	PWF( <i>i</i> <sub>d</sub> ,k	Discounted Depreciation
1	\$1800.00	0.909091	\$1636.36
2	\$1800.00	0.826446	\$1487.60
3	\$1800.00	0.751315	\$1353.37
4	\$1800.00	0.683013	\$1229.42
5	\$1800.00	0.620921	\$1117.66
Total			\$6823.42

Finally, the capital recovery factor and tax are applied.

$$6823.42 \text{ CRF}(i',n)T_{inc} = 6823.42 \times 0.229457 \times 0.05 = 782.84$$

Summary of terms:

Capital and interest	-\$2294.57
Salvage value	+\$90.92
Replacements or disposal	-\$49.89
Operating costs	-\$271.55
Property tax	-\$20.00
Maintenance	-\$50.00
Insurance	-\$25.00
Interest deduction	+\$293.09
Depreciation deduction	+782.84
Total annualized cost	-\$1544.00

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TC1.8 HANDBOOK EX #1 WALUES												
VALUES       Amount       Payment       Princ       Inter       Payment         System Cost       \$10,000       \$10,200       \$500,200       \$500,200       \$500,200         Invest Tax Credit=       \$10,000       \$2,638       \$1,000       \$500,200       \$500,200         Salvage Year =       \$1,000       \$2,638       \$1,000       \$500,200       \$2,738         Replacement/fighosal       \$2,638       \$52,638       \$52,638       \$500,000       \$30         gis       \$2,638       \$500       \$00,0000       \$00       \$30       \$30         gis       \$50       \$50       \$50       \$50       \$50       \$30       \$30         gis       \$50       \$50       \$50       \$50       \$50       \$50       \$50         Propris												
VALUES       Amount       Payment       Princ       Inter       Payment         System Cost       \$10,000       \$10,250       \$10,000       \$500,252       \$2,030       \$10,200         Invest law Credits       \$10,000       \$2,638       \$1,000       \$500,252       \$2,024       \$2,030       \$4,522       \$2,030       \$4,526       \$500,252       \$2,024       \$2,030       \$4,526       \$500,250       \$2,024       \$2,030       \$4,526       \$500,250       \$2,024       \$2,030       \$4,526       \$500,500       \$4,526       \$500,500       \$4,526       \$500,500       \$4,526       \$500,500       \$50 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>1</td> <td></td> <td></td>										1		
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invest.Tax Credit:       50         life:       50         ife:       51,000         salvag value:       \$1,000         ide:       \$2,000         ig:       \$2,000         ide:       \$2,000         ig:       \$2,000		0	Allount	ayment	ayment			Incer	rayment			
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Salvage Year = 5 Replacement/disposal Yr 5 1d= 5 1d= 7 1d= 7			\$2,638			\$6,560						
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Replace/disposal Yr       3       6       \$0       \$0       \$0       \$0       \$0         j=       35       8       \$0       \$0       \$0       \$0       \$0       \$0         j==       10       \$0       \$0       \$0       \$0       \$0       \$0       \$0         He       10       \$0       \$0       \$0       \$0       \$0       \$0       \$0         He       500       10       \$0       \$0       \$0       \$0       \$0       \$0         Depreciation =       \$500       10       \$0       \$0       \$0       \$2,555       \$10,000         Salvage Tax       500       50       \$0.000       \$2,555       \$10,000       \$0         Salvage Tax       500       50       \$0.000       \$2,555       \$10,000       \$0         Cart aply the capital recovery factor & tax rate to total discounted int.sum.       \$275       \$27.       \$27.         X of system cost:       400       \$1,800       \$27.       \$27.       \$27.         Salvage Tax       \$27.       \$27.       \$27.       \$27.       \$27.         VF(1d,1) =       0.2256       \$1,800       \$27.       \$27.       \$27.					\$2,100							
i=       5%       8       50       \$0       \$0       0.0000       \$0       \$0         i==       8%       9       \$0       \$0       \$0       \$0       \$0         i==       8%       9       \$0       \$0       \$0       \$0       \$0         Fuels       \$500       10       \$0       \$0       \$0       \$0       \$0         Heintenance=       \$500       TOTAL       \$3,190       \$10,000       \$2,255       \$10,000         Insurance=       \$500       TOTAL       \$3,190       \$10,000       \$2,255       \$10,000         Insurance=       \$500       TOTAL       \$3,190       \$10,000       \$2,255       \$10,000         Salvage Tax=       500       Calculate the depreciationfirst calculate depreciation       \$293       \$20         CALCULATIONS												
j==         8X         9         S0         S0         S0         S0         S0         S0           Fuel=         \$500           Maintenance=         \$500           Depreciation =         \$510           Depreciation =         \$500           A of system cost         \$600           Salvage Tax=         5000           CALCULATIONS		% 7										
ime         10x         10         \$0         \$0         \$0         \$0         \$0         \$0           Maintenance=         \$100         TOTAL         \$3,190         \$10,000         \$2,555         \$10,000           Depreciation =         \$100         \$2,555         \$10,000         \$2,555         \$10,000           Prop.Tax=         \$100         \$293         \$2												
Fuel=       \$500         Insurance=       \$500         Depreciation =       \$1.2         Inc.Tax=       \$500         Prop.Tax=       11         Starvage Tax=       \$500         CALQUATIONS												
Maintenance=       \$100         Insurance=       \$50         Depreciation =       \$100         Next apply the capital recovery factor & tax rate to total discounted int.sum.         Inc.Tax=       500         Prop.Tax=       100         Salvage Tax=       500         CALCULATIONS			\$0	\$0	\$0	\$0	0.0000	\$0	\$0			
Insurance=       \$50         Depreciation = S.L. Inc.Tax=       Next apply the capital recovery factor & tax rate to total discounted int.sum.         Yoo,Tax=       10         X of system cost=       400         X of system cost=       500         CALULATIONS				\$3,190	\$10,000			\$2.555	\$10,000			
Inc. tax=       50%         X of system cost=       1%         X of system cost=       40%         Salvage tax=       50%         Calculate the depreciationfirst calculate depreciation         Effective int.(i')=       0.0476         Effective int.(i')=       0.0476         Effective int.(i')=       0.0476         CRF(i,n)=       0.2295         CRF(i,n)=       0.2216         VPKF(id,1)=       0.9091         PVKf(id,2)=       0.8264         PVKf(id,5)=       0.6300         PVKf(id,5)=       0.6209         4 \$1,800       0.0901 \$1,636         Calculate the depreciation and sum         Year       Dk,SL         PVKf(id,5)=       0.6309         Year       Dk,SL         PVKf(id,5)=       0.6209         Year       St,800       0.7513         Year       St,800       0.6303       \$1,229         Operating Costs =       (\$272)         PVKf(id,7)=       0.5455       5       50         Year       Sta00       Sta00       Sta00       Sta00         PVKf(id,7)=       0.4264       8       50       0.0000       Stanapee				457175	010,000			+=,	+10/000			
Prop.Tax=       11/2         X of system cost=       500         Salvage Tax=       500         CALCULATIONS			y the capi	ital reco	very facto	or & tax r	ate to to	tal disco	ounted int	.sum.		
X of system cost=       407         Salvage Tax=       50%         CALCULATIONS-       50%         CALCULATIONS-       50%         Effective int.(i')=       0.0476         Effective int.(i')=       0.0476         Effective int.(i')=       0.0476         Effective int.(i')=       0.0476         CRF(i',n)=       0.2295         CRF(i',n)=       0.211         Verid,51 =       0.6204         PWF(id,51 =       0.6209         Yeif (d,52) =       0.6209         Yeif (d,52) =       0.6209         Yeif (d,52) =       0.6209         Yeif (d,51) =       0.6209         Yeif (d,52) =       0.6209         Yeif (d,51) =       0.6209         Yeif (d,52) =       0.6209         Yeif (d,51) =       0.0000         Yeif (d,51) =       0.0000         Yeif (d,51) =       0.0000         Yeif (d,51) =       0.6200												
Salvage Tax= 50% Calculations												
CALCULATIONS			the depre	eciation.	. first ca	lculate d	epreciati	on				
Effective int.(i'')=       0.0185         CRF(i',n) =       0.2295         CRF(i',n) =       0.2212         PWF(id,1) =       0.2633         PuF(id,2) =       0.8264         PuF(id,3) =       0.7513         2 \$1,800       0.8264 \$1,488         Salvage value =       \$91         PWF(id,4) =       0.6830         3 \$1,800       0.7513         9 WF(id,5) =       0.62645         5 \$1,800       0.6209         9 WF(id,6) =       0.5645         6 \$10<0000		-		Joracron		itoutute u		•				
CRF(i',n) =       0.2295         CRF(i',n) =       0.2112         CRF(i',n) =       0.2638         PWF(id,1) =       0.9091         PWF(id,2) =       0.8264         PWF(id,4) =       0.6303         2 \$1,800       0.9091 \$1,635         CRF(i',n) =       0.7513         2 \$1,800       0.8264 \$1,488         Summarize the terms       \$91         PWF(id,4) =       0.6303         3 \$1,800       0.7513 \$1,352         Replacements       (\$50)         PWF(id,6) =       0.5645         5 \$1,800       0.6209 \$1,118         Property tax =       (\$20)         PWF(id,6) =       0.5645         7 \$0       0.0000       \$0         PWF(id,6) =       0.5645         7 \$0       0.0000       \$0         PWF(id,6) =       0.4261         8 \$0       0.0000       \$0         PWF(id,10) =       0.3855       9       0.0000       \$0         PWF(if,10) =       0.9545       10       \$0       0.0000       \$0         PWF(if,5) =       0.7564       \$783       \$783       \$783         PWF(if,7) =       0.62892       \$79												
CRF(i'r,n) =       0.2112         CRF(im,n) =       0.2638         PWF(id,1) =       0.9091         PWF(id,2) =       0.8264         1       \$1,800       0.9091         PWF(id,3) =       0.7513         2       \$1,800       0.8264         9WF(id,5) =       0.6830         3       \$1,800       0.8264         9WF(id,6) =       0.5645         5       \$1,800       0.6209         9WF(id,6) =       0.5645       \$1,800       0.6209         9WF(id,7) =       0.5132       6       \$0       0.0000         PWF(id,6) =       0.5645       5       \$1,800       0.6209         PWF(id,6) =       0.5645       5       \$1,800       0.6209         9WF(id,7) =       0.4665       7       \$0       0.0000       \$0         PWF(id,10) =       0.3655       9       \$0       0.0000       \$0         PWF(i',1) =       0.9545       10       \$0       0.0000       \$0         PWF(i',2) =       0.7525       9       \$0       0.0000       \$0         PWF(i',6) =       0.7564       7       \$0       0.0000       \$0         PWF(i'				denneste								
CRF(im,n) =       0.2638       Year       Dk,SL       PWF(id,k)Disc.Depr       Summarize the terms         PWF(id,2) =       0.8264       1       \$1,800       0.9091       \$1,636       Capital & Interest =       (\$2,295)         PWF(id,4) =       0.6820       3       \$1,800       0.7513       \$1,352       Replacements       (\$50)         PWF(id,5) =       0.6209       4       \$1,800       0.6931       \$1,220       Operating Costs =       (\$2,20)         PWF(id,6) =       0.5645       5       \$1,000       0.6020       \$1,118       Property tax =       (\$20)         PWF(id,0) =       0.5132       6       \$0       0.0000       \$0       Insurance =       (\$25)         PWF(id,0) =       0.3855       9       \$0       0.0000       \$0       Insurance =       \$273         PWF(id,10) =       0.3855       9       \$0       0.0000       \$0       Insurance =       \$273         PWF(id,2) =       0.9112        TOTAL       \$6,823       ************************************			scount the	deprecia	tion and s	um						
PuF(id,1) =       0.9091         PuF(id,2) =       0.8264         PuF(id,3) =       0.7513         2 \$1,800       0.8264         9uF(id,4) =       0.6830         3 \$1,800       0.7513         2 \$1,800       0.8264         9uF(id,5) =       0.6209         4 \$1,800       0.7513         9uF(id,7) =       0.6209         4 \$1,800       0.6209         9uF(id,6) =       0.5645         5 \$1,800       0.6209         9uF(id,7) =       0.5132         6 \$0       0.0000         9uF(id,0) =       0.4665         7 \$0       0.0000         9uF(id,0) =       0.3855         9 \$0       0.0000         9uF(id,1) =       0.9545         10 \$0       0.0000         9uF(id,1) =       0.9545         10 \$0       0.0000         9uF(i',1) =       0.9545         10 \$0       0.0000         9uF(i',2) =       0.7722         9uF(i',2) =       0.7722         9uF(i',6) =       0.7802         9uF(i',6) =       0.6280         9uF(i',6) =       0.6280         9uF(i',6) =       0.628			Dk.SL F	WF(id.k)	Disc.Depr		Summarize	the terr	ns			
PWF(id,3) =       0.7513       2       \$1,800       0.8264       \$1,488       Salvage value =       \$91         PWF(id,4) =       0.6830       3       \$1,800       0.7513       \$1,428       Salvage value =       \$91         PWF(id,5) =       0.6209       4       \$1,800       0.7513       \$1,229       Operating Costs =       (\$272)         PWF(id,7) =       0.5645       5       \$1,800       0.6209       \$1,118       Property tax =       (\$20)         PWF(id,7) =       0.5645       7       \$0       0.0000       \$0       Maintenance =       (\$25)         PWF(id,0) =       0.3855       9       0.0000       \$0       Insurance =       \$783         PWF(i',1) =       0.9545       10       \$0       0.0000       \$0       Depreciation deduction =       \$783         PWF(i',2) =       0.912       .       .       .       .       .       .         PWF(i',5) =       0.7564       .       .       \$6,823       .       .       .         PWF(i',6) =       0.7564       .       .       .       .       .       \$783         PWF(i',6) =       0.6579       .       .       .       .       .<												
PWF(id,4) =       0.6330       3 \$1,800       0.7513       \$1,352       Replacements       (\$50)         PWF(id,5) =       0.5645       5 \$1,800       0.6209       \$1,118       Property tax =       (\$20)         PWF(id,6) =       0.5645       5 \$1,800       0.6209       \$1,118       Property tax =       (\$20)         PWF(id,8) =       0.4665       7 \$0       0.0000       \$0       Insurance =       (\$50)         PWF(id,9) =       0.4241       8 \$0       0.0000       \$0       Insurance =       (\$25)         PWF(id,1) =       0.3855       9 \$0       0.0000       \$0       Insurance =       \$783         PWF(i',1) =       0.9545       10       \$0       0.0000       \$0       Insurance =       \$783         PWF(i',2) =       0.9112       TOTAL       \$6,823       \$783       \$783         PWF(i',6) =       0.7564       Now apply the capital recovery factor and tax       \$783         PWF(i',9) =       0.6579       \$783       \$783       \$783         PWF(i',9) =       0.6589       \$783       \$783       \$783         PWF(i',9) =       0.6579       \$799       \$783       \$783         PWF(i',10) =       0.6802       \$					\$1,636				t =			
PWF(id,5) =       0.6209       4 \$1,800       0.6830       \$1,229       Operating Costs =       (\$272)         PWF(id,6) =       0.5645       5 \$1,800       0.6209       \$1,118       Property tax =       (\$20)         PWF(id,7) =       0.5132       6 \$0       0.0000       \$0       Maintenance =       (\$25)         PWF(id,9) =       0.4241       8 \$0       0.0000       \$0       Insurance =       (\$25)         PWF(id,10) =       0.3855       9 \$0       0.0000       \$0       Interest deduction =       \$783         PWF(i',2) =       0.9112					\$1,488							
PWF(id,6) =       0.5645       5 \$1,800       0.6209       \$1,118       Property tax =       (\$20)         PWF(id,7) =       0.5132       6       \$0       0.0000       \$0       Maintenance =       (\$50)         PWF(id,8) =       0.4665       7       \$0       0.0000       \$0       Insurance =       (\$25)         PWF(id,10) =       0.3855       9       \$0       0.0000       \$0       Interest deduction =       \$293         PWF(id,10) =       0.9545       10       \$0       0.0000       \$0       Interest deduction =       \$783         PWF(i',2) =       0.9112        TOTAL       (\$1,544)         PWF(i',5) =       0.7925       Now apply the capital recovery factor and tax       Now apply the capital recovery factor and tax         PWF(i',7) =       0.7221       \$783       \$783         PWF(i',8) =       0.6892       \$783         PWF(i',10) =       0.6280       \$783         Capitol & interest =       \$2,295         Salvage Value =       \$91         Replacement Costs =       \$50         Operating Energy =       \$220         Maintenance =       \$50					\$1,332							
PWF(id,7) =       0.5132       6       \$0       0.0000       \$0       Maintenance =       (\$50)         PWF(id,8) =       0.4665       7       \$0       0.0000       \$0       Insurance =       (\$25)         PWF(id,9) =       0.4241       8       \$0       0.0000       \$0       Insurance =       (\$25)         PWF(id,10) =       0.3855       9       \$0       0.0000       \$0       Depreciation deduction =       \$273         PWF(i',2) =       0.9112       0.9545       10       \$0       0.0000       \$0          PWF(i',2) =       0.912       0.0100       \$0        TOTAL       \$1,544)         PWF(i',5) =       0.7925       0.7925       Now apply the capital recovery factor and tax       Wow apply the capital recovery factor and tax       *783         PWF(i',8) =       0.6892       PWF(i',9) =       0.6280       \$783       \$783         PwF(i',8) =       0.6892       PWF(i',9) =       0.6280       \$783       \$783         Capitol & interest =       \$2,295       \$2       \$2       \$2       \$2       \$2         Property Tax =       \$20       \$2       \$2       \$2       \$2       \$2       \$2 <td></td> <td>5</td> <td></td>		5										
PWF(id,9) =       0.4241       8       \$0       0.0000       \$0       Interest deduction =       \$293         PWF(i',1) =       0.3855       9       \$0       0.0000       \$0       Depreciation deduction =       \$783         PWF(i',2) =       0.9112	PWF(id,7) = 0.5132	6		0.0000	\$0					(\$50)		
PWF(id,10) =       0.3855       9       \$0       0.0000       \$0       Depreciation deduction =       \$783         PWF(i',2) =       0.9112												
PWF(i',1) =       0.9545       10       \$0       0.0000       \$0         PWF(i',2) =       0.8697       TOTAL       TOTAL       (\$1,544)         PWF(i',3) =       0.8302       TOTAL       \$6,823         PWF(i',6) =       0.7564       Now apply the capital recovery factor and tax       Now apply the capital recovery factor and tax         PWF(i',6) =       0.7221       \$783         PWF(i',7) =       0.6579       \$783         PWF(i',10) =       0.66802       \$783         Capitol & interest =       \$2,295         Salvage Value =       \$91         Replacement Costs =       \$50         Operating Energy =       \$222         Maintenance =       \$50												
PWF(i',2) =       0.9112       TOTAL       TOTAL       (\$1,544)         PWF(i',3) =       0.8697       TOTAL       \$6,823       (\$1,544)         PWF(i',4) =       0.8302       Now apply the capital recovery factor and tax       Wow apply the capital recovery factor and tax         PWF(i',6) =       0.7564       \$783         PWF(i',8) =       0.6892       \$783         PWF(i',9) =       0.6579       \$783         PWF(i',10) =       0.6280       \$783         Capitol & interest =       \$2,295         Salvage Value =       \$91         Replacement Costs =       \$50         Maintenance =       \$50							Depreciat	Ton deduc				
PWF(i',3) =       0.8697         PWF(i',4) =       0.8302         PWF(i',5) =       0.7925         PWF(i',6) =       0.7564         PWF(i',7) =       0.7221         PWF(i',8) =       0.6892         PWF(i',9) =       0.6679         PWF(i',10) =       0.6280         Capitol & interest =       \$2,295         Salvage Value =       \$91         Replacement Costs =       \$50         Operating Energy =       \$272         Property Tax =       \$20         Maintenance =       \$50		A 1 A 2 A 2 A 2 A 2 A 2 A 2 A 2 A 2 A 2	40	010000			TOTAL			(\$1,544)		
PWF(i',5) =       0.7925         PWF(i',6) =       0.7564         PWF(i',7) =       0.7221         \$783         PWF(i',8) =       0.6892         PWF(i',9) =       0.6280         Capitol & interest =       \$2,295         Salvage Value =       \$91         Replacement Costs =       \$50         Operating Energy =       \$22         Maintenance =       \$50	PWF(i',3) = 0.8697				\$6,823							
PWF(i',6) =       0.7564         PWF(i',7) =       0.7221         PWF(i',8) =       0.6892         PWF(i',10) =       0.6280         Capitol & interest =       \$2,295         Salvage Value =       \$91         Replacement Costs =       \$50         Operating Energy =       \$272         Property Tax =       \$20         Maintenance =       \$50												
PWF(i',7) =       0.7221       \$783         PWF(i',8) =       0.6892         PWF(i',9) =       0.6579         PWF(i',10) =       0.6280         Capitol & interest =       \$2,295         Salvage Value =       \$91         Replacement Costs =       \$50         Operating Energy =       \$272         Property Tax =       \$50         Maintenance =       \$50			the capit	tal recov	ery factor	and tax.	••					
PWF(i',8) =       0.6892         PWF(i',9) =       0.6579         PWF(i',10) =       0.6280         Capitol & interest =       \$2,295         Salvage Value =       \$91         Replacement Costs =       \$50         Operating Energy =       \$272         Property Tax =       \$20         Maintenance =       \$50												
PWF(i',9) =       0.6579         PWF(i',10) =       0.6280         Capitol & interest =       \$2,295         Salvage Value =       \$91         Replacement Costs =       \$50         Operating Energy =       \$272         Property Tax =       \$20         Maintenance =       \$50												
Capitol & interest = \$2,295 Salvage Value = \$91 Replacement Costs = \$50 Operating Energy = \$272 Property Tax = \$20 Maintenance = \$50												
Salvage Value =\$91Replacement Costs =\$50Operating Energy =\$272Property Tax =\$20Maintenance =\$50												
Replacement Costs =       \$50         Operating Energy =       \$272         Property Tax =       \$20         Maintenance =       \$50												
Operating Energy = \$272 Property Tax = \$20 Maintenance = \$50		1										
Property Tax = \$20 Maintenance = \$50												
	Property Tax = \$20											
Insurance = $22$												
	Insurance = \$25											

TC1.8 HANDBOOK EX #2	Year Payment	Interest Princ	Outstand PWF(id,k)Disc	Disc Ex
VALUES	- Amount	Payment Payment	Princ Inter	Payment
System Cost= \$10,00	0		\$10,000	Ca
Invest.Tax Credit= \$50		0 \$800 \$690		
Life= 1				
Salvage value= \$				
Salvage Year = 1		0 \$621 \$870		
Replacement/disposal \$1,00				
Replace/disposal Yr 1				
	7 \$1,490			
	8 \$1,490		3 \$2,658 0.3269 \$100 \$1,780 0.3269 \$100	
	9 \$1,490			
	10 \$1,490	0 \$110 \$1,380	0 (\$0) 0.2472 \$2	7 \$368 sy
Fuel= \$40		¢/ 007 ¢10 00	\$2,88	1 \$7,479
Maintenance= \$15		\$4,903 \$10,000	J \$2,00	1 \$1,417
Insurance= \$3!		anital necessary foo	han 0 tox note to total dia	sounted int cum
Depreciation = S.L. Inc.Tax= 3		apital recovery fac	tor & tax rate to total dis	counted mt.sum.
	\$161			
	%			
		preciption first	calculate depreciation	
CALCULATIONS	- Carculate the dep		catcutate depreciation	
Effective int.(i')= 0.0952	\$1,000			
Effective int. $(i'')$ = 0.045				
CRF(i',n) = 0.1594		he depreciation and	sum	
CRF(i'',n) = 0.126				
CRF(im,n) = 0.1490		PWF(id,k)Disc.Dep	r Summarize the te	rms
PWF(id,1) = 0.8690		·		
PWF(id,2) = 0.756		0 0.8696 \$870	Capital & Interes	st = (\$1,515)
PWF(id,3) = 0.657		0 0.7561 \$756	5 Salvage value =	\$0
PWF(id,4) = 0.5718			8 Replace/disposal:	= (\$42)
PWF(id,5) = 0.497	4 \$1,000			
PWF(id,6) = 0.432				(\$78)
PWF(id,7) = 0.3759				(\$98)
PWF(id, 8) = 0.3269				(\$23)
PWF(id, 9) = 0.2843				
PWF(id, 10) = 0.247				
PWF(i',1) = 0.9130				
PWF(i',2) = 0.8330		*F 04/	TOTAL	(\$1,641)
PWF(i',3) = 0.7612		\$5,019	1	
PWF(i',4) = 0.6950		nital manayany fact	an and tax	
PWF(i',5) = 0.634!		pital recovery facto	or and tax	
PWF(i', 6) = 0.5794				
PWF(i',7) = 0.5290 PWF(i',8) = 0.4830				
PWF(i',9) = 0.4410 PWF(i',10) = 0.4020				
Capitol & interest = \$1,51				
Salvage Value = \$				
Replacement Costs = \$4				
Operating Energy = \$32				
Property Tax = \$7				
Maintenance = \$99				
Insurance = \$2				

Example that has a disposal cost in year 10.

Calculate the annualized system cost using constant dollars for a \$10,000 system considering the following factors: a 10 ye a disposal cost of \$1,000 at the end of the 10 years, a \$500 investment tax credit for energy efficiency, no replacements, a discount rate id of 15%, a general inflation rate of 5%, a fuel inflation rate je of 10%, a market mortgage im of 8%, an annual operating cost for energy of \$400, a \$150 annual maintenance cost, a \$35 insurance cost, straight line depreciation, an income tax of 35%, a property tax of 2% of assessed value, an assessed system value of equal to 60% of the system value, an a salvage tax rate of 35% (if positive salvage

TC1.8 HANDBOOK EX #3	_	Year		Interest			PWF(id,k)		sc	R
VALUES			Amount	Payment	Payment	Princ		Inter Pa	yment	
System Cost=	\$0		0			\$0				Ca
Invest.Tax Credit=	\$0		1 \$0				0.8696	\$0	\$0	f
Life=	10		2 \$0					\$0	\$0	a
Salvage value=	\$0		3 \$0				0.6575	\$0	\$0	i
Salvage Year =	10		4 \$0				0.5718		\$0	a
Replacement/disposal			5 \$0				0.4972		\$0	L.
Replace/disposal Yr	5		6 \$0				0.4323	\$0	\$0	ir
id=	15%		7 \$0				0.3759		\$0	a
j=	5%		8 \$0	\$0	\$0	\$0	0.3269	\$0	\$0	de
je=	10%		9 \$0	\$0	\$0	\$0	0.2843	\$0	\$0	a
im=	8%	1	0 \$0	\$0	\$0	\$0	0.2472	\$0	\$0	S
Fuel=	\$1,800									
Maintenance=	\$300	TOTAL		\$0	\$0			\$0	\$0	
Insurance=	\$35									
	.L.	Next ap	ply the ca	pital rec	overy fact	or & tax	rate to to	otal discour	nted int	.sum.
Inc.Tax=	35%									
Prop.Tax=	2%	\$	0							
% of system cost=	60%		5.							
Salvage Tax=	35%	Calcula	te the dep	reciation	first c	alculate	depreciati	ion		
CALCULATIONS			and stree mole.							
Effective int.(i')=	0.0952	\$	0							
Effective int.(i'')=			•							
CRF(i',n) =	0.1594	Next d	iscount the	e deprecia	ation and	sum				
CRF(i'',n) =	0.1267	nexe, a	rocourte en	e depreen		o canta a a				
CRF(im,n) =	0.1490	Year	Dk,SL	PWF(id k	)Disc.Depr		Summarize	e the terms.		
PWF(id, 1) =	0.8696	rear	DR, SL	rwi (iu,k	Juisc. Depi		Summar 120	e the termo.		
PWF(id, 2) =	0.7561		1 \$0	0.8696	\$0		Capital 8	& Interest =		\$0
PWF(id,3) =	0.6575		2 \$0		\$0		Salvage V			\$0
PWF(id,4) =	0.5718		<b>3</b> \$0		\$0			disposal=		(\$66)
PWF(id,5) =	0.4972		4 \$0					g Costs =		(\$1,473)
PWF(id,6) =	0.4323		5 \$0		\$0		Property			\$0
	0.3759		6 \$0		\$0		Maintenar			(\$195)
PWF(id,7) =	0.3269		7 \$0				Insurance			(\$23)
PWF(id, 8) =	0.2843		8 \$0					 deduction =		\$0
PWF(id,9) =			9 \$0							\$0
PWF(id, 10) =	0.2472		9 \$0 0 \$0		\$0		Deprecia	tion deducti	011 -	
PWF(i',1) =			0 <del>\$</del> 0	0.2472	<b>\$</b> U		TOTAL			(\$1,756)
PWF(i',2) =	0.8336	TOTA			\$0		TUTAL			(\$1,150)
PWF(i',3) =		TUTA	L		20					
PWF(i',4) =	0.6950	Nou ann	ly the con	ital naca	wany facto	n and tax				
PWF(i',5) =		NOW app	ty the cap	itat reco	very facto	r and tax				
PWF(i', 6) =	0.5794	\$	0							
PWF(i',7) =	0.5290	Ð	U							
PWF(i',8) =	0.4830									
PWF(i',9) =	0.4410									
PWF(i', 10) =	0.4026									
Capitol & interest =	\$0									
Salvage Value =	\$0	l.								
Replacement Costs =	\$66	~								
Operating Energy =	\$1,473									
Property Tax =	\$0									
Maintenance =	\$195									
Insurance =	\$23									

Retrofit example...part one...

Calculate the annualized system cost using constant dollars for an existing system considering the following factors: a 10 a replacement cost of \$1,000 at the end of the 5 years, no investment tax credits, a \$1,000 replacement in year 5, a discount rate id of 15%, a general inflation rate of 5%, a fuel inflation rate je of 10%, a market mortgage im of 8%, an annual operating cost for energy of \$1,800, a \$30 annual maintenance cost, a \$35 insurance cost, straight line depreciation, an income tax of 35%, a property tax of 2% of assessed value, an assessed system value of equal to 60% of the system value, an a salvage tax rate of 35% (if positive salvage

TC1.8 HANDBOOK EX #4 VALUES	¢5.000		Payment Amount	Interest Payment		Princ	PWF(id,k)	Disc Inter	Disc Payment		Retrofit examplepart two.
System Cost=	\$5,000	0	A7/5	¢/00	#7/F	\$5,000	0.9/0/	\$7/0	#//0		Calculate the annualized syst
Invest.Tax Credit=	\$0	1	\$745	\$400			0.8696	\$348	\$648		for an new \$5,000 system cons
Life=	10	2 3	\$745	\$372			0.7561	\$282	\$563		no replacements, no
Salvage value=	\$0	5	\$745	\$343			0.6575	\$225	\$490		investment tax credits,
Salvage Year =	10	4	\$745	\$310			0.5718	\$177			a discount rate id of 15%, a
Replacement/disposal	\$0	5	\$745	\$276		\$2,975	0.4972	\$137			rate of 5%, a fuel inflation
Replace/disposal Yr	5	6	\$745	\$238			0.4323	\$103	\$322		im of 8%, an annual operation
id=	15%	7	\$745	\$197			0.3759	\$74	\$280		annual maintenance cost, a \$3
j=	5%	8	\$745	\$154			0.3269	\$50	\$244		depreciation, an income tax of
je=	10%	9	\$745	\$106			0.2843	\$30			assessed value, an assessed s
im=	8%	10	\$745	\$55	\$690	(\$0)	0.2472	\$14	\$184		system value, an a salvage f
Fuel=	\$1,200							** //0			
Maintenance=	\$150	TOTAL		\$2,451	\$5,000			\$1,440	\$3,740		
Insurance=	\$35										
Depreciation = S.L		Next appl	y the ca	pital rec	overy fact	or & tax r	ate to to	tal disc	ounted int	.sum.	
Inc.Tax=	35%										
Prop.Tax=	2%	\$80									
% of system cost=	60%										
Salvage Tax=	35%	Calculate	the dep	reciation	first c	alculate d	epreciati	on			
CALCULATIONS											
	0.0952	\$500									
Effective int.(i'')=											
CRF(i',n) =	0.1594	Next, dis	count the	e depreci	ation and :	sum					
CRF(i'',n) =	0.1267										
CRF(im,n) =	0.1490	Year	Dk,SL	PWF(1d,k	)Disc.Depr		Summarize	the teri	ms		
PWF(id, 1) =	0.8696		45.00		A/75			-		(4707)	
PWF(id, 2) =	0.7561	1	\$500				Capital &		t =	(\$797)	
PWF(id,3) =	0.6575	2	\$500				Salvage v			\$0	
PWF(id, 4) =	0.5718	3	\$500				Replace/d			\$0	
PWF(id,5) =	0.4972	4	\$500				Operating			(\$982)	
PWF(id, 6) =	0.4323	5	\$500				Property			(\$39)	
PWF(id,7) =	0.3759	6	\$500				Maintenan			(\$98)	
PWF(id, 8) =	0.3269	7	\$500				Insurance			(\$23)	1
PWF(id,9) =	0.2843	8	\$500				Interest			\$80	
PWF(id, 10) =	0.2472	9	\$500				Depreciat	1 on dedu	ction =	\$140	
PWF(i',1) =	0.9130	10	\$500	0.2472							
PWF(i', 2) =	0.8336				*2 500		TOTAL			(\$1,718)	1
PWF(i',3) =	0.7612	TOTAL			\$2,509						
PWF(i', 4) =	0.6950										
PWF(i',5) =	0.6345	Now apply	the cap	ital reco	very facto	r and tax.					
PWF(i', 6) =	0.5794										
PWF(i',7) =	0.5290	\$140									
PWF(i',8) =	0.4830										
PWF(i',9) =	0.4410										
PWF(i', 10) =	0.4026										
Capitol & interest =	\$797										
Salvage Value =	\$0										
Replacement Costs =	\$0										
Operating Energy =	\$982										
Property Tax =	\$39										
Maintenance =	\$98 \$23										
Insurance =	9C3										

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ystem cost using constant dollars onsidering the following: a 10 year l

a general inflation ion rate je of 10%, a market mortgage iting cost for energy of \$1,200, a \$15 \$35 insurance cost, straight line ix of 35%, a property tax of 2% of id system value of equal to 60% of the le tax rate of 35% (if positive salvage

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# INSTALLATION GUIDE:

The floppy disk that accompanies the "Economic Calculations for the ASHRAE Handbook..." contains several Lotus 123 spreadsheet templates that are an electronic version of the last 4 pages of this document. To use this software you will need to have an MSDOS compatible computer with Lotus 123 Version 2x or some other spreadsheet that can convert Lotus 123 Version 2x files such as Excel, or Quatro Pro. The remainder of this document assumes that the reader is familiar with MSDOS and Lotus 123 commands.

To install the 123 templates in your MSDOS computer select the appropriate directory into which you want to copy the templates (let's assume that this is called c:\TEMP. Check to make sure that you do not have any .WK1 Lotus templates (or anything else) named ASHRAE01.WK1 through ASHRAE04.WK1. Place the floppy disk in the A: drive, then type:

CD C:\TEMP	this will put you in C:\TEMP
COPY a:\*.WK1 *.*	this copies everything named *.WK1 into the C:\TEMP directory

Next, you will need to start Lotus 123. Depending upon whether or not you have declared the directory containing the 123.EXE file to be on your path, you may need to change directories to the C:\LOTUS directory. Then start Lotus with:

LOTUS followed by 123

or simply

123

Once Lotus 123 is running the ASHRAE01.WK1 template can then be retrieved with the following command:

/FILE RETRIEVE C:\TEMP\ASHRAE01.WK1

This assumes that ASHRAE01.WK1 is indeed in C:\TEMP.

The template should come alive in column 1, row 1 and display the text 'ASHRAE HANDBOOK EX#1. The other ASHRAE templates have a similar title only contain EX#2, EX#3, and EX#4 respectively.

Cells C3 ... C21 are the only cells that need to be changed by the user. All other cells are displaying the results of calculations and should not require any adjustments. You

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are free to look a the equations by simply moving around the spreadsheet to view the formulas.

The cells E1 ... K15 display the Table 5 contained in the write-up.

The final answer can be found in cells J27 ... M39.

This economic analysis is only valid for 1 to 10 years. For an economic analysis of greater than 10 years, cells E1 ... K15 will need to be expanded. It is suggested that you simply move the cells immediately below this to another location on the spreadsheet, move the totalizing row, copy down the last row of the block until the proper number of years appears, adjust the "year" column, and recalculate.

After any new value has been entered you will need to hit the F9 or RECALCULATE function key. It is advised that after each new value is entered a print is made of the spreadsheet to serve as a handy reference to what has been done.

Unfortunately, this spreadsheet only fits nicely into a landscape mode of printing. To make this adjustment one needs to reset the 123 printer setup command. For example using an HP Laserjet III this would be as follows:

/ PRINT PRINTER OPTIONS SETUP \027&1105.45C\027Cs0p16.67H

Other printers have different set up commands.

If you have any questions about the use of these templates feel free to contact the author.