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An American National Standard

Standard Practice for
Measuring Life-Cycle Costs of Buildings and Building Systems[1]

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INTRODUCTION

Several methods of economic evaluation are available to measure the economic performance of a building or building system over a specified time period. These methods include, but are not limited to, life-cycle cost (LCC) analysis, the benefit-to-cost ratio, internal rate of return, net benefits, payback, multiattribute decision analysis, risk analysis, and related measures (see Practices E 964, E 1057, E 1074, E 1121, E 1765, and E 1946). These methods differ in their measure and, to some extent, in their applicability to particular types of problems. Guide E 1185 directs you to the appropriate method for a particular economic problem. One of these methods, life-cycle cost (LCC) analysis, is the subject of this practice. The LCC method sums, in either present-value or annual-value terms, all relevant costs associated with a building or building system over a specified time period. Alternative (mutually exclusive) designs or systems for a given functional requirement can be compared on the basis of their LCCs to determine which is the least-cost means of satisfying that requirement over a specified study period.

1. Scope

1.1 This practice establishes a procedure for evaluating the life-cycle cost (LCC) of a building or building system and comparing the LCCs of alternative building designs or systems that satisfy the same functional requirements.

1.2 The LCC method measures, in present-value or annual-value terms, the sum of all relevant costs associated with owning and operating a building or building system over a specified time period.

1.3 The basic premise of the LCC method is that to an investor or decision maker all costs arising from an investment decision are potentially important to that decision, including future as well as present costs. Applied to buildings or building systems, the LCC encompasses all relevant costs over a designated study period, including the costs of designing, purchasing/leasing, constructing/installing, operating, maintaining, repairing, replacing, and disposing of a particular building design or system.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

E 631 Terminology in Building Constructions

E 833 Terminology of Building Economics

E 964 Practice for Measuring Benefit-to-Cost and Savings-to-Investment Ratios for Buildings and Building Systems

E 1057 Practice for Measuring Internal Rate of Return and Adjusted Internal Rate of Return for Investments in Buildings and Building Systems

E 1074 Practice for Measuring Net Benefits and Net Savings for Investments in Buildings and Building Systems

E 1121 Practice for Measuring Payback for Investments in Buildings and Building Systems

E 1185 Guide for Selecting Economic Methods for Evaluating Investments in Buildings and Building Systems

E 1369 Guide for Selecting Techniques for Treating Uncertainty and Risk in the Economic Evaluation of Buildings and Building Systems

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E 1765 Practice for Applying the Analytical Hierarchy Process (AHP) to Multiattribute Decision Analysis of Investments Related to Buildings and Building Systems

E 1946 Practice for Measuring Cost Risk of Building and Building Systems

E 2204 Guide for Summarizing the Economic Impacts of Building-Related Projects

2.2 *ASTM Adjuncts:*

Discount Factor Tables, Adjunct to Practice E 917[3]

3. Terminology

3.1 *Definitions*—For definitions of terms used in the practice, refer to Terminologies E 631 and E 833.

4. Summary of Practice

4.1 This practice outlines the recommended procedures for computing the LCCs associated with a building or building system over a specified time period. It identifies and gives examples of objectives, alternatives, and constraints for an LCC analysis; identifies project data and general assumptions needed for the analysis; and presents alternative approaches for computing LCCs. This practice requires that the LCCs of alternative building designs or systems be compared over a common time period to determine which design or system has the lowest LCC. This practice also states that uncertainty, unquantifiable effects, and funding constraints shall be considered in the final analysis. It identifies the recommended contents of an LCC report, describes proper applications of the LCC method, provides examples of its use, and identifies limitations of the method. A comprehensive example of the LCC method applied to a building economics problem is provided in Appendix X1.

5. Significance and Use

5.1 LCC analysis is an economic method for evaluating a project or project alternatives over a designated study period. The method entails computing the LCC for alternative building designs or system specifications having the same purpose and then comparing them to determine which has the lowest LCC over the study period.

5.2 The LCC method is particularly suitable for determining whether the higher initial cost of a building or building system is economically justified by reductions in future costs (for example, operating, maintenance, repair, or replacement costs) when compared with an alternative that has a lower initial cost but higher future costs. If a building design or system specification has both a lower initial cost and lower future costs relative to an alternative, an LCC analysis is not needed to show that the former is the economically preferable choice.

5.3 If an investment project is not essential to the building operation (for example, replacement of existing single-pane windows with new double-pane windows), the project must be compared against the "do nothing" alternative (that is, keeping the single pane windows) in order to determine if it is cost

effective. Typically the "do nothing" alternative entails no initial investment cost but has higher future costs than the proposed project.

6. Procedure

6.1 Follow these steps in calculating the LCC for a building or building system:

6.1.1 Identify objectives, alternatives, and constraints (see Section 7).

6.1.2 Establish basic assumptions for the analysis (see 8.1).

6.1.3 Compile cost data (see 8.2).

6.1.4 Compute the LCC for each alternative (see Section 9).

6.1.5 Compare LCCs of each alternative to determine the one with the minimum LCC (see 10.1).

6.1.6 Make final decision, based on LCC results as well as consideration of risk and uncertainty, unquantifiable effects, and funding constraints (if any) (see 10.2, 10.3, 10.4, and 10.5).

7. Objectives, Alternatives, and Constraints

7.1 Specify the design or system objective that is to be accomplished, identify alternative designs or systems that accomplish that objective, and identify any constraints that limit the available options to be considered.

7.2 An example is the selection of a space heating system for a new house. The system must satisfy the thermal comfort requirements of the occupants throughout the heating season. Available alternatives (for example, various gas furnaces, oil furnaces, heat pumps, and electric baseboard heaters) may have different types of fuel usage with different unit costs, different fuel conversion efficiencies, different initial costs and expected maintenance and repair costs, and different lives. System selection will be constrained to those fuel types available at the building site.

8. Data and Assumptions

8.1 *Basic Assumptions*—Establish the uniform assumptions to be made in the economic analysis of all alternatives. These assumptions usually include, but are not limited to, the consistent use of the present-value or annual-value calculation method, the base time and study period, the general inflation rate, the discount rate, the marginal income tax rate (where relevant), the comprehensiveness of the analysis, and the operational profile of the building or system to be evaluated.

8.1.1 *Present-Value Versus Annual-Value Calculations*—The LCCs of project alternatives must be calculated uniformly in present-value or annual-value terms. In the former, all costs are discounted to the base time; in the latter, all costs are converted to a uniform annual amount equivalent to the present value when discounted to the base time.

8.1.2 *Study Period*—The study period appropriate to the LCC analysis may or may not reflect the life of the building or system to be evaluated. The same study period must be used for each alternative when present-value calculations are used. An annual-value LCC may, under certain restrictive assumptions, be used to compare alternatives with different study periods (see 9.2.3). The following guidelines may be useful for selecting a study period for an LCC analysis:

8.1.2.1 When analyzing a project from an individual investor's standpoint, the study period should reflect the investor's

time horizon. For a homeowner, the study period for a house-related investment might be based on the length of time the homeowner expects to reside in the house. For a commercial property owner, the study period might be based on the anticipated holding period of the building. For an owner/occupant of a commercial building, the study period might correspond to the life of the building or building system being evaluated. For a speculative investor, the study period might be based on a relatively short holding period. For investments by government agencies and large institutions, specific internal policies often direct the choice of study period.

8.1.2.2 When LCC analyses of alternative building systems or design practices are performed for general information rather than for a specific application (for example, government or industry research to determine the cost effectiveness of thermal insulation or high-efficiency heating and cooling equipment in typical installations), the study period will often coincide with the service life of the material or system (but be limited to the typical life of the type of building where it is to be installed). When the service life is very long, a more conservative choice for the study period might be used if the uncertainty associated with the long-term forecasting of costs substantially reduces the credibility of the results.

8.1.2.3 Regardless of the type of investor or purpose of the analysis, use the same study period for all types of costs when calculating the present value of any cost associated with a project. Furthermore, when comparing alternative designs or systems on the basis of their present-value LCCs, use the same study period for each investment alternative.

8.1.2.4 When the study period selected is significantly shorter than the service life of the building or system evaluated, it is important that a realistic assessment of the project's resale (or residual) value at the end of the study period be included in the LCC analysis. Even if the building will not be sold at that time, the resale value will likely have a significant impact on the LCC.

8.1.3 *Inflation*—General price inflation is the reduction in the purchasing power of the dollar from year to year, as measured, for example, by the percent increase in the gross national product (GNP) deflator over a given year. LCC analyses can be calculated in constant-dollar terms (net of general inflation) or in current-dollar terms (including general inflation). If the latter is used, a consistent projection of general price inflation must be used throughout the LCC analysis, including adjustment of the discount rate to incorporate the general inflation rate.

8.1.3.1 When income tax effects are not included in the LCC analysis, as in the case of LCC evaluations of nonprofit buildings and owner-occupied houses (without financing), it is usually easier to express all costs in constant dollars. Price changes for individual cost categories that are higher or lower than the rate of general inflation can be included by using differential rates of price change for those categories.

8.1.3.2 When income tax effects are included in the LCC analysis, it is usually easier to express all costs in current dollars because income taxes are tied to current-dollar cash flows rather than constant-dollar cash flows.

8.1.4 *Discount Rate*—The discount rate selected should reflect the investor's time value of money. That is, the discount rate should reflect the rate of interest that makes the investor indifferent between paying or receiving a dollar now or at some future point in time. The discount rate is used to convert costs occurring at different times to equivalent costs at a common point in time.

8.1.4.1 Select a discount rate equal to the rate of return on the next best available use of funds. Where the discount rate is legislated or mandated for a given institution, that rate takes precedence.

8.1.4.2 A discount rate that includes general price inflation over the study period is referred to as the "nominal" discount rate in this practice. A discount rate expressed in terms net of general price inflation is referred to as the "real" discount rate.

8.1.4.3 A nominal discount rate, i, and its corresponding real discount rate, r, are related as follows:

$$r = \frac{1+i}{1+I} - 1 \text{ or } i = (1+r)(1+I) - 1 \tag{1}$$

where:
I = the rate of general price inflation.

8.1.4.4 Use a real discount rate if estimates of future costs are expressed in constant dollars, that is, if they do not include general inflation.

8.1.4.5 Use a nominal discount rate if estimates of future costs are expressed in current dollars, that is, if they include general inflation.

8.1.4.6 When alternative building or system designs are compared using the LCC method, use the same discount rate in each LCC computation.

8.1.5 *Comprehensiveness*—Different levels of effort can be applied in undertaking an LCC analysis. The appropriate level of comprehensiveness depends upon the degree of complexity of the problem, the intended purpose of the evaluation, the level of monetary and nonmonetary impacts contingent upon the investment decision, the cost of the different levels of comprehensiveness, and the resources available to the investor or decision maker.

8.1.5.1 Some anticipated effects are more difficult to quantify in monetary terms than others. Include effects that are difficult to quantify through the use of multiattribute decision analysis (see Practice E 1765). (See 10.4 for more information on unquantifiable effects.) Overlooking or omitting significant factors from an LCC evaluation diminishes the comprehensiveness and usefulness of the evaluation.

8.1.5.2 Comprehensiveness requires that all suitable alternatives be considered when selecting among alternative designs or systems for a particular purpose.

8.1.6 *Income Taxes*—For building investments that are subject to income tax, include in the analysis adjustments of capital costs, expenses, and resale value to reflect income tax effects (see 9.3).

8.2 *Cost Data*—Compile the cost data required to estimate the LCC of each alternative design or system to be evaluated. This includes the timing of each cost as it is expected to occur during the study period.

8.2.1 The measurement of the LCC of a building design or building system requires data on initial investment costs,

including the costs of planning, design, engineering, site acquisition and preparation, construction, purchase, and installation; financing costs (if specific to the investment decision); annually and non-annually recurring operating and maintenance costs (including, for example, scheduled and unscheduled maintenance, repairs, energy, water, property taxes, and insurance); capital replacement costs; and resale value (or salvage/disposal costs).

8.2.2 Data will also be needed for functional use costs if these costs are significantly affected by the design or system alternatives considered. These are costs related to the performance of the intended functions within the building, such as salaries, overhead, services, and supplies.

8.2.3 The shorter the study period selected for the LCC analysis relative to the expected useful lifetime of the project being considered, the more important the assessment of resale value becomes, even if the building or system will not be sold at the end of the study period. Where relevant, deduct tax liabilities due to anticipated gains in asset value.

8.2.4 Omit from LCC evaluation costs that are not significantly affected by the design decision or system selection.

8.2.5 To select among design or system alternatives solely on the basis of the lowest LCC presumes that each alternative is at least capable of satisfying the project requirements and that the analyses have been conducted using the same operational profile. When there are performance advantages that favor one alternative over another, make an adjustment to incorporate such differences into the LCC measure. For example, adjustments are needed to reflect higher rental income, higher sales, improved comfort, or improved employee productivity for one design relative to the other. Make this adjustment to the LCC by subtracting the value of any improvement in performance from the corresponding costs of that alternative in each year that such differences occur. However, do not use the LCC method if such improvements are large relative to the cost differences among alternatives (see 13.1).

8.2.6 *Timing of Cash Flows*—In addition to compiling all relevant costs, the timing of each cash flow must be determined. The time of occurrence is needed so that costs incurred at different points in time can be discounted to their time-equivalent values before summation.

8.2.6.1 Cash flows may be single events, such as a one-time replacement cost or a resale value. They may be recurring and relatively constant in nature, such as routine maintenance costs, or they may occur at regular intervals but change over time at some projected rate of increase or decrease, such as energy costs.

8.2.6.2 Cash flows may occur in lump-sum amounts, concentrated at a certain time of the year, such as an annual insurance premium. They may be spread out evenly over the year, such as salaries, or they may occur irregularly during the year. Rather than accounting for the specific pattern of each cash flow, a simplifying model of cash flow is usually adopted for an LCC analysis. In the simplified model, all cash flows in a given year are assumed to occur at the same point in time within the year, usually at the end of the year. This simplifying assumption normally provides sufficient accuracy for the LCC

analysis while reducing computational requirements. (The discounting methods outlined in Section 9 are all based on end-of-year cash flows.)

8.2.7 *Current Dollar Analysis*—When all cash flows over the study period are to be denominated in current dollars (that is, when general price inflation is included in projecting all future costs), the following guidelines apply:

8.2.7.1 Future cash flows that are fixed in amount (such as loan payments) should be used without adjustments.

8.2.7.2 Future cash flows that are expected to change at rates significantly different from the general rate of price increase (for example, energy costs) should be estimated on the basis of the specific rate of price change expected, be it faster or slower than the general rate of price inflation.

8.2.7.3 All other future cash flows should be estimated to reflect the rate of general price inflation.

8.2.8 *Constant Dollar Analysis*—When all cash flows over the study period are to be denominated in constant dollars (that is, when general price inflation is excluded in projecting all future costs), the following guidelines apply:

8.2.8.1 Cash flows expected to increase at the same rate as general price inflation require no adjustment. Their values should be stated in base-year dollars.

8.2.8.2 Future costs expected to change faster (slower) than the rate of general price inflation, I, can be estimated in base-year constant dollars by multiplying the base-time value of such costs by the differential rate of price change (see Note 1) for that cost category, as follows:

$$C_t = C_0(1 + e)^t \qquad (2)$$

where:
e = the differential price escalation rate,
C_t = the constant-dollar value of a cost in year t, and
C_0 = the cost at the beginning of the study period (the base time).

8.2.8.3 The differential rate of price change, e, and the actual rate of price change, E, are related as follows:

$$e = \frac{1 + E}{1 + I} - 1 \text{ or } E = (1 + e)(1 + I) - 1 \qquad (3)$$

NOTE 1—In Eq 2 and Eq 3, e and I are assumed to be constant over the study period. If e and I are not the same in each time period i, then:

$$C_t = C_0 (1 + e_1)(1 + e_2)\ldots(1 + e_t)$$

where

$$e_i = \frac{1 + E_i}{1 + I_i} - 1 \text{ or } E_i = (1 + e_i)(1 + I_i) - 1$$

9. Compute LCC[4]

9.1 . To compute the LCC of a building or building system, all relevant cash flows in periods $t = 0$ through $t = N$ are discounted to a common point in time and summed.

9.1.1 Conceptually, the computation of an LCC in present-value terms (PVLCC) can be represented as:

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[4] The NIST Building Life-Cycle Cost (BLCC) Computer Program helps users calculate measures of worth for buildings and building components that are consistent with ASTM standards. The program is downloadable from http://www.eere.energy.gov/femp/information/download.blcc.cfm.

$$PVLCC = \sum_{t=0}^{N} \frac{C_t}{(1 + i)^t} \qquad (4)$$

where:
C_t = the sum of all relevant costs occurring in year t,
N = length of study period, years, and
i = the discount rate.

9.1.2 For example, at the base time ($t = 0$), C_t is typically equal to the initial investment cost; in each subsequent year ($t = 1$ to N), C_t is typically equal to the sum of operating, maintenance, and replacement costs in that year; at the end of the study period ($t = N$), C_t also typically includes a credit for the resale value of the project.

9.2 For ease of computation, the following equivalent approach can be used instead of Eq 4:

9.2.1 Find the present value (PV) of each cost category (for example, initial cost (IC), maintenance and repairs (M), replacements (R), fuel (F), and resale value (S)), using the appropriate discount formula as found in Table 1, or the

TABLE 1 Discount Formulas

Equation Name	Schematic Illustration	Application	Algebraic Form[A,B]
Single compound amount (SCA)	[P] ⟶ [F?]	to find F when P is known	$F = P \cdot [(1 + i)^N]$
Single present value (SPV)	[P?] ⟵ [F]	to find P when F is known	$P = F \cdot \left(\dfrac{1}{(1 + i)^N} \right)$
Uniform sinking fund (USF)	[A?] + [A?] ⋯ + [A?] ⟵ [F]	to find A when F is known	$A = F \cdot \left(\dfrac{i}{(1 + i)^N - 1} \right)$
Uniform capital recovery (UCR)	[P] ⟶ [A?] + [A?] ⋯ + [A?]	to find A when P is known	$A = P \cdot \left(\dfrac{i(1 + i)^N}{(1 + i)^N - 1} \right)$
Uniform compound amount (UCA)	[A] + [A] ⋯ + [A] ⟶ [F?]	to find F when A is known	$F = A \cdot \left(\dfrac{(1 + i)^N - 1}{i} \right)$
Uniform present value (UPV)	[P?] ⟵ [A] + [A] ⋯ + [A]	to find P when A is known	$P = A \cdot \left(\dfrac{(1 + i)^N - 1}{i(1 + i)^N} \right)$
Modified uniform present value (UPV*)[C]	[P?] ⟵ [A₁] + [A₂] ⋯ + [Aₙ]	to find P when known A_0 is escalating at rate e	$P = A_0 \cdot \left(\dfrac{1 + e}{i - e} \right) \cdot \left[1 - \left(\dfrac{1 + e}{1 + i} \right)^N \right]$

where:
P = present sum of money,
F = future sum of money equivalent to P at the end of N periods of time at i interest or discount rate,
A = end-of-period payment (or receipt) in a uniform series of payments (or receipts) over N periods at i interest or discount rate,
A_0 = initial value of a periodic payment (receipt) evaluated at the beginning of the study period,
$A_t = A_0 \cdot (1 + e)^t$, where $t = 1, ... , N$,
N = number of interest or discount periods,
i = interest or discount rate, and
e = price escalation rate per period.

[A] Note that the USF, UCR, UCA, and UPV equations yield undefined answers when $i = 0$. The correct algebraic forms for this special case would be as follows: USF formula, $A = F/N$; UCR formula, $A = P/N$; UCA formulas, $F = A \cdot N$. The UPV* equation also yields an undefined answer when $e = i$. In this case, $P = A_0 \cdot N$.

[B] The terms by which the known values are multiplied in these equations are the formulas for the factors found in Discount Factor Tables. Using acronyms to represent the factor formulas, the discounting equations can also be written as $F = P \cdot SCA$, $P = F \cdot SPV$, $A = F \cdot USF$, $A = P \cdot UCR$, $F = A \cdot UCA$, $P = A \cdot UPV$, and $P = A_0 \cdot UPV^*$.

[C] To find P when A_t changes from year to year at a different rate each year (either due to a change in price or a change in physical quantity, or both), use the following equation:

$$P = \sum_{t=1}^{N} \frac{A_t}{(1 + i)^t}$$

where:
A_t = $A_{t-1} \cdot (1 + e_t)$, and
e_t = the rate of change in A for year t.

equivalent discount factor from the adjunct Discount Factor Tables (see 2.2). Then sum these present value amounts to find PVLCC, as shown in Eq 5.

$$PVLCC = IC + PVM + PVR + PVF - PVS \qquad (5)$$

Note that resale value, when explicitly expressed as a positive cash flow, is subtracted from the other cost categories in calculating the PVLCC. (If the cost of removal results in a negative cash flow, this should be added to the other cost categories.)

9.2.2 Each of the following patterns of cash flows has a specific type of discounting procedure that can be used to expedite the calculation of the present value for each cost category:

9.2.2.1 Amounts expected to occur at a single point in time (for example, capital replacement costs and resale value) can be discounted to present value by multiplying that amount by the single present value factor for the specified time and discount rate.

9.2.2.2 Amounts expected to occur in approximately the same amount from year to year (for example, operating and maintenance (O and M) costs when expressed in constant dollars) can be discounted to present value by multiplying the annual cost by the uniform present value factor for the specified study period and discount rate.

9.2.2.3 Amounts changing over time at some projected rate (for example, energy costs) can be discounted to present value by multiplying the annual cost, as of the base time, by the modified uniform present value factor for the specified study period and discount rate.

9.2.2.4 Initial investment costs (or any other costs occurring at time $t = 0$) need not be discounted to present value since they are already stated in present-value terms.

9.2.3 The LCC, or any present-value amount, may also be expressed in equivalent annual-value terms (AV) by multiplying the present-value amount by an appropriate uniform capital recovery (UCR) factor, as shown in Table 1. The annual-value LCC may be used, under restrictive assumptions, to compare alternative building systems using different study periods. This approach assumes that all costs for each system are exactly replicated with each replacement for a length of time equal to the lowest common multiple of system lives (that is, the shortest time period into which each of the system lives can be divided with no remainder).

9.2.4 Table 2 illustrates the use of the discount formulas and factors to find present values and annual value equivalents for the set of cost data displayed in Fig. 1 (see Note 2). Fig. 2 illustrates graphically the relationship between these data and their equivalent present values.

NOTE 2—For any given set of cost data and assumptions, the present value of an investment and the annual value of the same investment are time-equivalent values.

9.3 *Income Tax Adjustments*—For investor-owned building facilities, income tax adjustments (including tax credits, if any) may be a significant factor in determining the cost effectiveness of alternative building designs or system selection. Therefore, include them in the analysis.

9.3.1 One method of including income tax effects is to adjust all costs that are tax deductible to their after-tax equivalents before discounting, deduct any tax credits from investment costs, establish a depreciation schedule for capital components and compute the corresponding tax savings in each year, and adjust the resale value (if any) for additional tax liabilities or savings related to capital gains, capital losses, and depreciation recapture, as appropriate. Calculate the present value of each cash flow category and the depreciation tax savings and sum these present values to find the after-tax PVLCC. Note that the present value of the depreciation tax savings is treated as a negative cost and therefore has a negative sign in the PVLCC equation.

9.3.2 An alternative method of including income tax effects is to establish a separate category for all income tax adjustments in each year, calculate these annual amounts and discount them to present value, sum them, and adjust the PVLCC accordingly.

TABLE 2 Illustration of Discounting Cash Flows
(Based on a Study Period of 10 Years and a Real Discount Rate of 8 %)

Description of Cash Flow (1)	Discounting to Present Value Equivalents			Discounting to Annual Value Equivalents		
	Discount Formula[A] (2)	Corresponding Discount Factor[B] (3)	Present Value, Dollars[C] (4)	Discount Formula (5)	Corresponding Discount Factor (6)	Annual Value, Dollars[D] (7)
Initial investment cost of $6000	n.a.[E]	1	6000	UCR	0.14903	894
Replacement cost in fifth[F] year of $500, constant $	SPV	0.6806	340	UCR	0.14903	51
Yearly (non-energy) O and M cost over 10 years, constant $[F]	UPV	6.710	671	UCR	0.14903	100
Yearly energy cost over 10 years, valued at $1000 at the beginning of the study period, escalating at a differential rate of 5 % per year[F]	UPV*	8.5923	8593	UCR	0.14903	1281
Resale value of $1200 at end of tenth year, constant $	SPV	0.4632	556	UCR	0.14903	83

[A] From Table 1.
[B] From Discount Factor Tables Adjunct.
[C] Column 4 = amount in column 1 × discount factor in column 3.
[D] Column 7 = amount in column 4 × discount factor in column 6.
[E] No discounting necessary.
[F] Payments to occur at the end of the year.