# Life Cycle Cost Analysis Using Roof Coatings

By William A. Kirn, RRC

## INTRODUCTION

LIFE CYCLE COST ANALYSES HAVE BECOME VALUABLE TOOLS TO THE CONSTRUCTION INDUSTRY as better methods of measuring the value of a product over its service life. They have been used recently by roofing material manufacturers to position more costly but higher valued materials over lower cost analogs.[1,2,3,4] The mechanism for life cycle cost analysis is rather simple: merely compute the long-term cost of several different products and compare. The numbers include the initial cost as well as associated maintenance and routine costs for upkeep. Numbers are also normalized to their net present value (NPV or PV) to eliminate inflationary and investment effects. The Discount Rate or Factor helps to compare different options, where the costs and benefits occurring at different times can be evaluated at a common time. This number is actually the rate of interest reflecting the investor's (building owner's) time value of money. 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.

Roofs are expensive. They are expensive to repair and maintain and they are very expensive to replace. Leaking roofs account for additional untold dollars of damaged internal property, inventory, lost occupancy, business interruption, increased heating and air conditioning costs, and all too often, litigation. Many of these expenses can be avoided if roofs are treated as construction assets requiring the same maintenance as elevators, heaters, air conditioners and other mechanical equipment. All of these other assets require routine maintenance. Minor repairs can be made which will prevent or greatly reduce the possibility of major or catastrophic breakdown of the equipment (roof).

### Life Cycle Cost Analyses Comparing Several Roof Maintenance Scenarios

The technique for conducting a life cycle cost analysis has become formalized through the use of ASTM method E-917, "Standard Practice for Measuring Life-Cycle Costs of Buildings and Building Systems."[5] This mathematical model enables the user to evaluate the life cycle cost of a building (roof) and compare it to alternative designs or practices that satisfy the same functional requirements. Other ASTM methods have been developed to determine the rate of return and pay back for investments and net benefits for investments in buildings.

The objective of this study is to compare three scenarios for roof maintenance and management, ranging from no inspection or maintenance to a very comprehensive roof asset management program. The building used in the analysis is an industrial research laboratory located in Spring House, PA, a suburb of Philadelphia, at the Rohm and Haas Research Center. The roof is a 37,000 ft$^2$ smooth, asphalt-surfaced three-ply organic felt built-up roof, and its size has been rounded off to 100,000 ft$^2$ for computational ease. The roof history is actually scenario #3, while scenarios #1 and #2 represent similarly roofed buildings located nearby where conditions and history were monitored. However, these buildings were not exact replicates to the Scenario #3 building due to differences in occupancy, roof exposure and use. The study period is 20 years. The discount rate is 10% and the escalation rate is 0%. (This is the factor that will influence the increase in certain factors such as energy.)

The three scenarios consider a number of complex factors, including the use of visual and non-destructive moisture surveys, the cost of repairing leaks, interior damage to walls and ceiling tiles, wasted heating and cooling energy caused by wet roof insulation, and saved energy through the use of reflective roof coatings.

### Scenario #1

This scenario assumes no formal roof management or maintenance program. Repairs are made only when the roof leaks. No precautions are made to protect the roof warranty, and the roof will be replaced at the end of 10 years. The initial cost is \$3.00 /ft$^2$ or \$300,000, and the replacement cost is \$5.00/ft$^2$ or \$500,000. We assume total removal of the wet insulation and some deteriorated decking and nailers. No inspections are made of the roof, and leaks are repaired by a roofing contractor at $750 each. We assume no leaks in the first two years (contractor's warranty in effect). From year 3-7 there was one leak and repair per year, two leaks in year 8, three in year 9 and four in year 10.

As the roof develops leaks, wet insulation will reduce the "R" value of the insulation. Typically each year, 25 $ft^2$ more of insulation became wet due to damage to the roof. Wet insulation costs $1.88 /$ft^2$ per year in wasted energy. The detailed economic analysis used to derive this data is attached in the appendix. Interior damage as wet ceiling tile and stained and damaged walls has typically cost $500 to repair. This was incurred in years 5, 8, 11, 15 and 18 during the study.

## Scenario #2

This program is a modest maintenance approach. One visual survey is made of the roof each year. A non-destructive moisture survey is made after year 15, prior to recovering. Damaged areas are repaired rather than just "patched." Again, the initial cost is the same as Scenario #1 at $300,000, but after year 15 the roof is recovered (without tear off) at $3.25/$ft^2$ or $325,000. A formal roof inspection program is implemented for $1,000/year, and a visual survey is conducted once each year for $1,000. The moisture survey at year 15 costs $5,000. Repairs are made each year from 3-15 and 17-20 costing $250 each. The cost is lower here than in Scenario #1 as the leaks are identified earlier, within the year of their development. Interior damage is repaired at years 7 and 16 for $500 each. Once again, wet insulation causes increases in energy costs of $1.88 /$ft^2$/year with a 5' by 5' area noted in years 3, 5, 7, 9, 11, 13, 15, 18 and 20.

## Scenario #3

This is a comprehensive roof maintenance program. A formalized roof asset management and maintenance program is established, costing $1000/year. Visual inspections are made semiannually and after severe storms. Small roof problems and "suspect areas" are easily repaired with sealant and flashing. Nondestructive moisture surveys are made every five years at a cost of $500 each. In year 10, the roof is coated with a white elastomeric roof coating costing $0.75 /$ft^2$ or $75,000 as a capital cost. The white roof reduces the air conditioning load, but increases the heating load, (black roofs are warmer in the winter) yet still saves the building $8,070 the first year. Dirt buildup on the roof reduces the savings to 80% or $6,460/year. This documentation is based on an Oak Ridge National Laboratory Report entitled "Guide to Estimating Differences in Building Heating and Cooling Energy Due to Changes in Solar Reflectance of a Low Slope Roof."[6] The 20% reduction in reflectivity of white roof coatings due to dirt pickup has been observed experimentally in this study and has been demonstrated in studies conducted by Lawrence Berkeley Laboratory.[7] No interior repairs are necessary.

## Results

The summary results are derived from the spreadsheets attached at the end of this article. Present value (PV) numbers are listed and are different than actual costs. The summary statistics are listed in the table below.

**Life Cycle Cost Summary**

| Capital Costs (PV) | Approach #1 | Approach #2 | Approach #3 |
|---|---|---|---|
| Initial Investment | $300,000 | $300,000 | $300,000 |
| Roof Replacement | $175,000 | $70,525 | $0 |
| Roof Coating | $0 | $0 | $28,950 |
| **Maintenance Costs (PV)** | | | |
| Program | $0 | $8,505 | $8,505 |
| Visual Survey | $0 | $8,505 | $17,010 |
| Moisture Survey | $0 | $1,195 | $6,970 |
| Repairing Leaks | $7,142 | $1,638 | $1,693 |
| Interior Damage | $928 | $365 | $0 |
| Wasted Energy | $1,486 | $891 | $0 |
| Saved Energy | $0 | $0 | ($18,393) |
| PV of 20 Year Expenditure | $484,558 | $391,624 | $344,735 |
| Equivalent Annual Value (Cost) UCR i =10% 20 Years (.1175) | $56,936 | $46,016 | $40,506 |
| Depreciated Annual Value (Cost) Straight Line 39 Years 40% Tax Rate PV | $49,563 | $40,609 | $35,646 |
| Cost Savings Over Approach #1 $ /ft2/ year | | $0.09 | $0.14 |

### Conclusions

The data above demonstrate the economic value of a proactive roof maintenance strategy. The last line item, "Cost Savings Over Approach #1," should easily convince the building owner or facility manager of the value of regular professional roof inspections and the use of maintenance coatings as the economically preferred alternative to tear off and reroofing every 10 years.

While the use of a reflective roof coating in this study only increased the savings by $0.05/ft², the reader is reminded that this study was conducted in the Philadelphia, PA area. Actual energy studies, as well as mathematical modeling, have shown significant energy cost saving benefits in the "sun belt" areas of the country. It is not uncommon to return the cost of the coating in less than five years through reduced air conditioning energy use.

Scenario #2 enabled the building owner to sustain his original roof for 15 years before reroofing. However, after the new roof was no longer serviceable, he would be faced with a costly tear off of both roofs. The use of a reflective roof coating in conjunction with a professionally managed roof asset program would possibly allow the roof to be recoated multiple times before replacement of the initial roof membrane.

With proper maintenance and coating, a low-slope roof can last significantly longer than its predicted life. This will reduce the life cycle cost of the roof and reduce demand for dwindling natural raw materials, precious energy resources and shrinking landfill space. Consultants and coatings can truly make "Sustainable Roofing" a reality.



## APPENDIX

### Roof Coating Costs

Assume 3 gallons/square with a selling price of $12.00/gal. or $0.36/ft². Assume $0.25/ft² for roof preparation and $0.13/ft² for coating application.

| | |
|---|---|
| Material | 0.36 |
| Labor | 0.13 |
| Preparation | 0.25 |
| | $0.75/ft² |

### Energy Savings Attributable to White Coating

Location is Philadelphia, PA and building is type Ia (Office) with R=4.0. Fuel costs $0.80/gal for #2 oil and $0.10/KWH for electricity at P.D. rate.

See attached worksheet for calculating energy savings during cooling season and penalty during heating season. Based on LBL/DOE data, after the first year, energy savings are estimated to be only 80% of first year value due to dirt pickup and accompanying decrease in albedo[7]. Similar results were obtained in independent studies conducted by Rohm and Haas Company.

## Energy Calculations For Increased Heating and Cooling Costs Due to Wet Insulation

**Fuel Oil**

$$\frac{\$0.80}{\text{Gal}} \times \frac{\text{Gal}}{140{,}000\ \text{BTU}} \times \frac{100{,}000\ \text{BTU}}{\text{Therm}} = \$0.57/\text{Therm}$$

**Electricity**

$$\frac{\$0.10}{\text{KWH}} \times \frac{1\ \text{KWH}}{3413\ \text{BTU}} \times \frac{100{,}000\ \text{BTU}}{\text{Therm}} = \$2.93/\text{Therm}$$

**Energy Loss (Heating Season)**

Energy loss of $1^0$F 25 ft² leak/yr. =

$$\frac{1\ \text{BTU}}{\text{Hr Ft}^2\ {}^0\text{F}} \times 25\ \text{ft}^2 \times \frac{24\text{hr}}{\text{Day}} \times \frac{\text{Degree Day}}{\text{Year}}$$

= 2,953,800 BTU = 29.54 therm

Assume a 'C' factor of dry insulation of 0.25 (R=4) and when wet 'C' =1 and R=1; thus,

**Energy Loss (Cooling Season)**

Heat gain = U x roof area x ETD x operating

$$\frac{1\ \text{BTU}}{\text{Hr ft}^2\ {}^0\text{F}} \times 25\ \text{ft}^2 \times 60^0\text{F Lt. Const.} \times \frac{820}{\text{Year}}$$

= 1,230,000 BTU = 12.3 therms/year

**Cost of Heating One Wet Area (25 ft²)**

$$\frac{22.1\ \text{Therm}}{\text{Year}} \quad \frac{1}{0.75\ \text{Efficiency}} \times \frac{\$0.57}{\text{Therm}} = \$16.84/\text{yr.}$$

**Cost of Cooling One Wet Area (25 ft²)**

$$\frac{9.23\ \text{Therm}}{\text{Year}} \times \frac{1}{0.90\ \text{Efficiency}} \times \frac{\$2.93}{\text{Therm}}$$

# Life Cycle Cost Analysis #1
# No Maintenance Program

| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dis. Factor (10%) | 1.000 | 0.909 | 0.826 | 0.751 | 0.680 | 0.621 | 0.564 | 0.513 | 0.466 | 0.424 | 0.386 |
| Capital Expense | $300,000 | | | | | | | | | | $0 |
| PV | $300,000 | | | | | | | | | | $0 |
| Mgt. Overhead | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Visual Survey | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Moisture Survey | | | | | | $0 | | | | | $0 |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Leaks | | $0 | $0 | $750 | $750 | $750 | $750 | $750 | $1,500 | $2,250 | $3,000 |
| PV | | $0 | $0 | $563 | $510 | $466 | $423 | $385 | $699 | $954 | $1,158 |
| Interior Damage | | | | | | $500 | | | $500 | | |
| PV | | $0 | $0 | $563 | $510 | $466 | $423 | $385 | $699 | $954 | $1,158 |
| Wet Insul. Sq. Ft. | | 0 | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 |
| Wasted Energy | | | $47 | $94 | $141 | $188 | $235 | $282 | $329 | $376 | $423 |
| PV Energy | | $0 | $39 | $71 | $96 | $117 | $133 | $145 | $153 | $159 | $163 |
| Energy Saved | | | | | | | | | | | $0 |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | | | | | | | | | | |

| Year | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Summary |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dis. Factor (10%) | 0.350 | 0.319 | 0.290 | 0.263 | 0.239 | 0.217 | 0.197 | 0.179 | 0.163 | 0.148 | |
| Capital Expense | $500,000 | | | | | | | | | | |
| PV | $175,000 | | | | | | | | | | $370,525 |
| Mgt. Overhead | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | |
| PV | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Visual Survey | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | |
| PV | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Moisture Survey | | | | | $0 | | | | | $0 | |
| PV | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Leaks | $0 | $0 | $0 | $750 | $750 | $750 | $750 | $750 | $1,500 | $2,250 | |
| PV | $0 | $0 | $0 | $563 | $510 | $466 | $423 | $385 | $699 | $954 | $1,158 |
| Interior Damage | $500 | | | | $500 | | | $500 | | | |
| PV | $175 | $0 | $0 | $0 | $120 | $0 | $0 | $90 | $0 | $0 | $928 |
| Wet Insul. Sq. Ft. | 0 | 25 | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 225 | |
| Wasted Energy | $0 | $47 | $94 | $141 | $188 | $235 | $282 | $329 | $376 | $423 | |
| PV Energy | $0 | $15 | $27 | $37 | $45 | $51 | $56 | $59 | $61 | $63 | $1,489 |
| Energy Saved | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | |
| PV | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | | | | | | | | | | $484,558 |

# Life Cycle Cost Analysis #2
# Modest Maintenance Program

| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dis. Factor (10%) | 1.000 | 0.909 | 0.826 | 0.751 | 0.680 | 0.621 | 0.564 | 0.513 | 0.466 | 0.424 | 0.386 |
| Capital Expense | $300,000 | | | | | | | | | | $0 |
| PV | $300,000 | | | | | | | | | | $0 |
| Mgt. Overhead | | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 |
| PV | | $909 | $826 | $751 | $680 | $621 | $564 | $513 | $466 | $424 | $386 |
| Visual Survey | | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 |
| PV | | $909 | $826 | $751 | $680 | $621 | $564 | $513 | $466 | $424 | $386 |
| Moisture Survey | | | | | | $0 | | | | | $0 |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Leaks | | $0 | $0 | $250 | $250 | $250 | $250 | $250 | $250 | $250 | $250 |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Interior Damage | | | | | | $0 | | $500 | $0 | | |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $257 | $0 | $0 | $0 |
| Wet Insul. Sq. Ft. | | 0 | 0 | 25 | 25 | 50 | 50 | 75 | 75 | 100 | 100 |
| Wasted Energy | | | $0 | $47 | $47 | $94 | $94 | $141 | $141 | $188 | $188 |
| PV Energy | | $0 | $0 | $35 | $32 | $358 | $53 | $72 | $66 | $80 | $73 |
| Energy Saved | | | | | | | | | | | $0 |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | | | | | | | | | | |

| Year | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Summary |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dis. Factor (10%) | 0.350 | 0.319 | 0.290 | 0.263 | 0.239 | 0.217 | 0.197 | 0.179 | 0.163 | 0.148 | |
| Capital Expense | $0 | | | | | $325,000 | | | | | |
| PV | $0 | | | | | $70,525 | | | | | $370,525 |
| Mgt. Overhead | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | |
| PV | $350 | $319 | $290 | $263 | $239 | $217 | $197 | $179 | $163 | $148 | $8,505 |
| Visual Survey | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | |
| PV | $350 | $319 | $290 | $263 | $239 | $217 | $197 | $179 | $163 | $148 | $8,505 |
| Moisture Survey | | | | | $5,000 | | | | | $0 | |
| PV | $0 | $0 | $0 | $0 | $1,195 | $0 | $0 | $0 | $0 | $0 | $1,195 |
| Leaks | $0 | $0 | $250 | $250 | $250 | $0 | $250 | $250 | $250 | $250 | |
| PV | $88 | $80 | $73 | $66 | $60 | $0 | $49 | $45 | $41 | $37 | $1,638 |
| Interior Damage | $0 | | | | $0 | $500 | | | | | |
| PV | $0 | $0 | $0 | $0 | $0 | $109 | $0 | $0 | $0 | $0 | |
| Wet Insul. Sq. Ft. | 125 | 125 | 150 | 150 | 175 | 0 | 0 | 25 | 25 | 50 | |
| Wasted Energy | $235 | $235 | $282 | $282 | $329 | $0 | $0 | $8 | $8 | $14 | $891 |
| PV Energy | $82 | $75 | $82 | $74 | $79 | $0 | $0 | $8 | $8 | $14 | $891 |
| Energy Saved | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | |
| PV | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| | | | | | | | | | | | $391,624 |

# Life Cycle Cost Analysis #3
# Comprehensive Maintenance Program

| Year | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dis. Factor (10%) | 1.000 | 0.909 | 0.826 | 0.751 | 0.680 | 0.621 | 0.564 | 0.513 | 0.466 | 0.424 | 0.386 |
| Capital Expense | $300,000 | | | | | | | | | | $75,000 |
| PV | $300,000 | | | | | | | | | | $28,950 |
| Mgt. Overhead | | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 |
| PV | | $909 | $826 | $751 | $680 | $621 | $564 | $513 | $466 | $424 | $386 |
| Visual Survey | | $2,000 | | | | | | | | | $2,000 |
| PV | | $1,818 | $1,652 | $1,502 | $1,360 | $1,242 | $1,128 | $1,026 | $932 | $848 | $772 |
| Moisture Survey | | | | | | $5,000 | | | | | $5,000 |
| PV | | $0 | $0 | $0 | $0 | $3,105 | $0 | $0 | $0 | $0 | $1,930 |
| Leaks | | | | $250 | $250 | $250 | $250 | $250 | $250 | $250 | $250 |
| PV | | $0 | $0 | $188 | $270 | $155 | $141 | $128 | $117 | $106 | $97 |
| Interior Damage | | | | | | | | | | | |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Wet Insul. Sq. Ft. | | | | | | | | | | | |
| Wasted Energy | | | | | | | | | | | |
| PV Energy | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Energy Saved | | | | | | | | | | | |
| PV | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | ($3,115) |
| | | | | | | | | | | | |

| Year | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Summary |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dis. Factor (10%) | 0.350 | 0.319 | 0.290 | 0.263 | 0.239 | 0.217 | 0.197 | 0.179 | 0.163 | 0.148 | |
| Capital Expense | $0 | | | | | $325,000 | | | | | |
| PV | $0 | | | | | $70,525 | | | | | $370,525 |
| Mgt. Overhead | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | $1,000 | |
| PV | $350 | $319 | $290 | $263 | $239 | $217 | $197 | $179 | $163 | $148 | $8,505 |
| Visual Survey | $2,000 | $2,000 | $2,000 | $2,000 | $2,000 | $2,000 | $2,000 | $2,000 | $2,000 | $2,000 | |
| PV | $700 | $638 | $480 | $526 | $478 | $434 | $394 | $358 | $326 | $296 | $17,010 |
| Moisture Survey | | | | | $5,000 | | | | | $5,000 | |
| PV | $0 | $0 | $0 | $0 | $1,195 | $0 | $0 | $0 | $0 | $740 | $6,970 |
| Leaks | $250 | $250 | $250 | $250 | $250 | $250 | $250 | $250 | $250 | $250 | |
| PV | $88 | $80 | $73 | $66 | $60 | $54 | $49 | $45 | $41 | $37 | $1,693 |
| Interior Damage | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| PV | $0 | $0 | $0 | $0 | $0 | $109 | $0 | $0 | $0 | $0 | |
| Wet Insul. Sq. Ft. | | | | | | | | | | | |
| Wasted Energy | | | | | | | | | | | |
| PV Energy | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Energy Saved | $8,070 | $6,460 | $6,460 | $6,460 | $6,460 | $6,460 | $6,460 | $6,460 | $6,460 | $6,460 | |
| PV | ($2,261) | $2,061) | $1,873) | ($1,699) | ($1,544) | ($1,402) | ($1,273) | ($1,156) | ($1,053) | ($956) | ($18,393) |
| | | | | | | | | | | | $344,735 |

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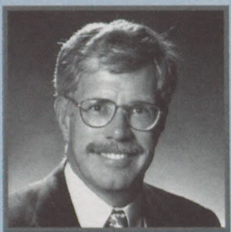
## About The Author



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# Roof Consultants Institute Continuing Education Reading Test (CERT)

*Interface* Journal, the technical publication of the Roof Consultants Institute, offers this opportunity for its members to earn Continuing Educational Units (CEUs) toward registration or renewal of Registered Roof Observer and Registered Roof Consultant certification.

After reading the accompanying article, "Life Cycle Cost Analysis Using Roof Coatings," you may answer the questions below. Check your answers from page 33 and fill out the accompanying report sheet. Retain this sheet with your certification records. DO NOT SEND TO HEADQUARTERS UNTIL YOU ARE SEEKING CERTIFICATION OR RENEWAL OF CERTIFICATION. AT THAT TIME, INCLUDE THIS SHEET WITH OTHER CEU VERIFICATION RECORDS. Successful completion of this self test is worth 0.1 CEU units.

QUESTIONS

1. The factor used to influence the increase in certain costs, such as energy, is the:
   a. Elevated rate.
   b. Escalation rate.
   c. Rate of return.
   d. Discount rate.
2. True/False: Dirt build-up on a white-coated roof has no measurable effect on its reflectivity.
3. True/False: White roof coatings may increase the cost of heating a building.
4. In the Sun Belt, the cost of reflective roof coating usually can be recovered in:
   a. 10 years
   b. 15 years
   c. 5 years
   d. The lifetime of the building.
5. Life cycle cost analysis is:
   a. Best left to palm readers.
   b. Determined by computing long-term costs of products and comparing them.
   c. Best tracked by computer.
   d. A boring subject.
6. True/False: The use of reflective roof coatings is most beneficial in cold-weather areas.
7. True/False: A roof can only be coated once, according to tax laws.