(PRELIMINARY)

# LIFE CYCLE PROCUREMENT

# BOOK

--- NOTICE ---

The contents of this book are preliminary. All materials will be subjected to a technical review and a practical application review prior to being recommended for state and local use.

Prepared by the Conservation Division of the Iowa Energy Policy Council and the Iowa Department of General Services. August, 1980

# INTRODUCTION TO LIFE CYCLE COST ANALYSIS

In the past, most government purchasing decisions were based on only one factor--purchase price. This has frequently resulted in the purchase of products that are inexpensive to buy, but costly to operate.

Life cycle costing is a method by which the estimated cost of ownership is considered when making a purchasing decision. The major costs of ownership for most commodities are the purchase price, the cost of energy, and the cost of maintenance. This booklet emphasizes the cost of energy because generally there is no reliable data on the cost of maintenance for different pieces of equipment. The greatest problem in conducting life cycle cost analysis is to locate reliable and accurate data for the various factors of the cost of ownership.

By using life cycle costing, a purchaser will be buying more energy-efficient equipment. It is hoped that all state and local agencies will use life cycle cost techniques. Significant energy and monetary savings can be realized by using life cycle cost techniques.

GENERAL TECHNIQUES OF LIFE CYCLE COSTING

The basic concept in life cycle cost analysis is that the product with the lowest total estimated cost to the user should be purchased, not necessarily the item which costs the least initially. When making a life cycle cost analysis, a purchaser will compute the life cycle cost (total cost) for each item being considered and should then buy the item which has the lowest life cycle cost.

To make a complete life cycle cost analysis there are seven factors that should be considered: initial cost, energy consumption, energy cost, warranties, product performance, maintenance, and resale value. This booklet will discuss only intial cost, energy consumption, energy cost, and produce performance in detail.

Initial cost is whatever the product user has to pay to obtain the item. This should include purchase price, transportation cost, installation cost, and any other direct costs that must be paid prior to the use of the product.

The amount of energy use is sometimes very difficult to determine, even for commodities which are obvious energy consumers. Energy use includes not only the direct use of energy in the forms of gas, oil, coal, electricity, steam, and hot water, but can also include the effects the equipment has on other energy consuming products. For instance, a computer heats up a room requiring air-conditioning to cool the room. Currently, only a few products have their energy use calculated under equal test conditions. If life cycle costing is to be done on other products, manufacturer's data must be used. Whenever a purchaser asks for manufacturer's data, he must carefully specify the conditions under which the data is to be valid.

Almost all data on the energy use is based on estimated energy use over some interval. It will be the purchaser's job to determine the total yearly energy use, based on the expected use of the product.

After a purchaser has determined the amount of energy that a product will use during a year, it is then necessary to determine how much this energy will cost over the product's life. The current cost of energy is almost always easy and straight-forward to determine. However, for products which are expected to last longer than one year, it is necessary to estimate the rate of future price increases for energy and the minimum acceptable return on investment to determine the cost of energy (in current value dollars) in future years. The formula below gives the cost of energy in any future year in current value dollars:

$$CF = CP \times \frac{e^{jn}}{e^{in}}$$

where CF = Future Value

CP = Present Value

j = Fuel Escalation Rate

i = Minimum Return on Investment

n = Number of Years in the Future

By summing the future values of energy for every year a product is expected to last, an escalation factor can be obtained. This escalation factor, when multiplied by the current cost of energy and the energy use per year, gives the cost of energy over a unit's life. The escalation factors are built into each life cycle cost formula in this booklet. The fuel escalation rates vary with the fuel types while the minimum return on investment has been taken to be ten percent a year.

Total Energy Cost = Yearly Energy Use x Current Energy Cost x Escalation Factor

Performance is viewed in two different ways. For some products (such as cars), the only performance criteria is whether the product can perform the task. Then a life cycle analysis is done between the products able to meet the performance criteria. The product with the lowest life cycle cost should be purchased. For some products (such as washers), somewhat over-sized units may not have to operate as many hours per year to accomplish the desired task. In this case, the unit(s) which can process the specified amount of work at the lowest cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR ELECTRIC AIR-CONDITIONERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| EER | Btu/Watt-hr | Vendor |
| Required Cooling Capacity | Btu/hr | Purchaser |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |

1) Energy Use per Hour (EPH)

$$EPH = \frac{\text{Required Cooling Capacity}}{\text{EER}} \qquad EPH = \underline{\qquad\qquad} \text{ Watt}$$

2) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + \frac{EPH \times 800 \text{ hr} \times 12.7 \times \text{Cost of Elec.}}{1000 \text{ watts/kw} \times 100¢/\$} \qquad LCC = \underline{\qquad\qquad} \$$$

NOTES:

12.7 represents an electric escalation rate of 15% per year and a minimum return on investment of 10% per year for an average 10 year use life.

A purchaser must first determine the size of the unit needed. The purchaser should either find out what size unit was previously installed or have the proper size calculated. Units will probably not exactly match the size needed so units within 10 or 15 percent of the specified size should be considered.

The life cycle cost should be found for all the units being considered and the one with the lowest life cycle cost should be purchased.

Purchase price should include any delivery or installation charges.

The current cost of electricity must be the same for all units.

# LIFE CYCLE COST TECHNIQUE FOR GAS AIR-CONDITIONERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| C.O.P. | Btu Cooling / Btu Gas | Vendor |
| Required Cooling Capacity | Btu/hr | Purchaser |
| Current Cost of Natural Gas | $/ccf | Power Bill or Power Company |
| or Current Cost of L.P. Gas | $/gal | Fuel Supplier |

1) Energy Use per Hour (EPH)

$$EPH = \frac{\text{Required Cooling Capacity}}{\text{C.O.P.}}$$ EPH = ________ Btu

2a) Life Cycle Cost (natural gas) (LCCa)

$$LCCa = \text{Purchase Price} + \frac{EPH \times 800\text{ hr} \times 28.9 \times \text{Current Cost of Gas}}{101{,}800\text{ Btu/ccf}}$$ LCCa = ________ $

2b) Life Cycle Cost (L.P.G.) (LCCb)

$$LCCb = \text{Purchase Price} + \frac{EPH \times 800\text{ hr} \times 28.9 \times \text{Current Cost of L.P.}}{95{,}500\text{ Btu/gal}}$$ LCCb= ________ $

NOTES:

28.9 represents a gas escalation rate of 30% per year and a minimum return on investment of 10% per year for an average 10 year use life.

A purchaser must first determine the size of the unit needed. The purchaser should either find out what size unit was previously installed or have the proper size calculated. Units will probably not exactly match the size needed so units within 10 or 15 percent of the specified size should be considered.

The life cycle cost should be found for all the units being considered and the one with the lowest life cycle cost should be purchased.

Purchase price should include any delivery or installation charges.

The current cost of natural or L.P. gas must be the same for all units.

## COOLING LOAD

This form is designed to calculate a more precise estimate of cooling load (size of air conditioner needed) than the "rule of thumb" provides.*

1. Doors and Arches: Add the width of all doors and arches that are frequently opened between cooled and uncooled areas. Consider rooms that are connected by a 5 ft or wider arch as one continuous room

   Total width ________________ft. X Factor (300) = ________________

2. Solar Gain (Radiation) Through Windows: Multiply the total window area for each description given below. For windows with outside awnings or shaded constantly by trees, use the factor for "Outside Shade." Factors given are for single glazing and should be multiplied by 0.8 for double glass.

| Direction | Total Sq. Ft. | No Shade | Inside Shades** | 50% Outside Shade | 100% Outside Shade | Answers |
|---|---|---|---|---|---|---|
| Northeast | | 60 | 25 | 40 | 20 | |
| East | | 80 | 40 | 53 | 25 | |
| Southeast | | 75 | 30 | 48 | 20 | |
| South | | 75 | 35 | 48 | 20 | |
| Southwest | | 110 | 45 | 70 | 30 | |
| West | | 150 | 65 | 98 | 45 | |
| Northwest | | 120 | 50 | 78 | 35 | |
| North | | 0 | 0 | 0 | 0 | ____________ |

Enter Largest Number ______________

3. Heat Gain (Conduction) Through Windows: Multiply total square feet of all windows in areas to be cooled by the appropriate factor.

   Single Glass________________sq. ft. X Factor (14) = ________________

   Double Glass________________sq. ft. X Factor (7) = ________________

Seek professional help in determining the size of cooling equipment needed. Oversized units especially are to be avoided, because they draw more energy than is necessary. They also cannot dehumidify properly and cycle more frequently, thus increasing maintenance and reducing use-life. A rule of thumb for calculating the size you need is to multiply the number of square feet to be cooled by 24 Btu's/hour.

4. Walls: Multiply the total area (length and width) of spaces to be cooled that are exposed to the outside by the appropriate factor (include doors but subtract windows).

| | Sq. Ft. | Insulated | Not Insulated |
|---|---|---|---|
| Outside walls with north exposure | | 20 | 30 |
| Outside walls, other than north exposure | | 30 | 60 |
| Inside walls between cooled and uncooled spaces | | 30 | 60 |

Cumulate Total = ____________

5. Ceilings: Multiply total area (length and width) to be cooled by the factor that best represents your ceiling.

| | Square Feet | Factors |
|---|---|---|
| No insulation with no space above | | 19 |
| 1" or more insulation with no space above | | 8 |
| No insulation with attic space above | | 12 |
| Insulation with attic space above | | 5 |
| Occupied space above (not cooled) | | 3 |
| Occupied space above (air conditioned) | | 0 |

(enter only one)

> Note: If an air conditioner is to be used only for night cooling, the factor in item one should be 200; item 2 should be disregarded; in item 4 the factor for insulated walls should be 20, and all other factors 30; in item 5, the factors should be 5, 3, 7, 4 and 3 respectively.

6. Floor: Multiply total floor area (length and width) within the area to be cooled by the factor provided. Disregard this step if floor is directly on the ground or over a basement.

____________ sq. ft. x (Factor (3) = ____________

7. People: Multiply the average or normal occupancy of the cooled area by the factor given. Use a minimum of 2 persons

____________ People X Factor (600) = ____________

8. Electrical Equipment Heatload: Determine the total wattage for frequently operated electrical equipment.

____________ Total Watts X Factor (3.413) = ____________

9. Total Cooling Load: Add the individual loads calculated in items 1 through 8.

Size of Unit Needed = ____________

LIFE CYCLE COST TECHNIQUE FOR COMMERCIAL ELECTRIC DRIERS (TUMBLERS)

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Clothes Basket Volume | Cubic Feet | Vendor |
| Electricity used/lbs of Water Removed | kwh/lbs | Vendor |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Laundry to be Dried per week | pounds | Estimate* |

1) Basket Capacity (BC)

BC = Clothes Basket Volume x 2.83 lbs/ft$^3$ BC = ______ lbs

2) Loads per Week (LW)

$$LW = \frac{\text{Laundry to be Dried per Week}}{BC}$$ LW = ______

3) Electricity Used per Load (EL)

EL = (Electricity Used/lbs of Water Removed) x BC x .50

EL = ______ kwh

4) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + EL \times LW \times 52 \times \frac{\text{Cost of Electricity}}{100\ ¢/\$} \times 21.8$$

LCC = ______ $

NOTES:

*The weekly laundry to be dried should be the amount of laundry the user expects the new tumbler to dry in a week.

The number 21.8 in the final life cycle cost equation is the electric escalation factor. It represents a 15% per year increase in electric rates and a minimum return on investment of 10% per year, over a 15 year expected life.

We strongly recommend that purchasers require that all vendor-supplied data be verified in writing by the manufacturer's technical representative. This should eliminate any confusion which could result if salespeople were wholly responsible for the data.

The life cycle cost for all units being considered should be calculated. The unit with the lowest life cycle cost should be purchased.

## LIFE CYCLE COST TECHNIQUE FOR COMMERCIAL GAS DRIERS (TUMBLERS)

| | Data | Units | Source |
|---|---|---|---|
| | Purchase Price | Dollars | Vendor |
| | Clothes Basket Volume | Cubic Feet | Vendor |
| | Gas Consumption per Pound of Water Removed | Btu/lbs. | Vendor |
| | Electric Consumption per Hour | kw/hr | Vendor |
| | Current Cost of Natural Gas[1] | $/ccf | Fuel Supplier |
| or | Current Cost of L.P. Gas[1] | $/gal. | Fuel Supplier |
| | Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| | Laundry to be Dried per Week | Pounds | Estimate[2] |

1) Basket Capacity (BC)

$$BC = \text{Clothes Basket Volume} \times 2.83\ \text{lbs/ft}^3$$ BC = ________ lbs

2) Loads per Week (LW)

$$LW = \frac{\text{Laundry to be Dried per Week}}{BC}$$ LW = ________

3) Gas Use per Load (GPL)

$$GPL = (\text{Gas Consumption per Pound of Water Removed}) \times BC \times .50$$

GPL = ________ Btu

4) Electric Use per Load (EPL)

$$EPL = (\text{Electric Consumption per Hour}) \times .67$$ EPL = ________ kwh

5a) Life Cycle Cost using Natural Gas (LCCa)

$$LCCa = \text{Purchase Price} + \frac{GPL \times \text{Current Cost of Natural Gas} \times 86.2}{101{,}800\ \text{Btu/ccf}}$$

$$+\ EPL \times \text{Current}\ \frac{\text{Cost of Electricity}}{100\ ¢/\$} \times 21.8$$ LCCa = ________ $

5b) Life Cycle Cost using L.P. Gas (LCCb)

$$LCCb = \text{Purchase Price} + \frac{GPL \times \text{Current Cost of L.P. Gas} \times 52.4 \times LW \times 52}{95{,}000\ \text{Btu/gal.}}$$

$$+\ EPL \times LW \times 52 \times \frac{\text{Current Cost of Electricity}}{100\ ¢/\$} \times 21.8$$

LCCb = ________ $

NOTES:

[1]Either the current cost of natural or L.P. gas is needed, depending on which type the institution uses.

Gas Driers

[2]The weekly laundry to be dried should be the amount of laundry the user expects the new tumbler to dry in a week.

The numbers 21.8, 86.2, and 52.4 in the final life cycle cost equation are respectively, the electric escalation factor, the natural gas escalation factor, and the L.P. gas escalation factor. They represent an expected 15% per year increase in electric rates, a 30% per year increase in natural gas rates, a 25% per year increase in L.P. gas rates, and a minimum return on investment of 10% per year, over an expected life of 15 years.

We strongly recommend that purchasers require that all vendor supplied data be verified in writing by the manufacturer's technical representative. This should eliminate any confusion which could result if salespeople were wholly responsible for the data.

The life cycle cost for all units being considered should be calculated, the unit with the lowest life cycle cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR COMMERCIAL STEAM DRIERS (TUMBLERS)

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Clothes Basket Volume | Cubic Feet | Vendor |
| Steam Used per Pound of Water Removed | Btu/lbs | Vendor |
| Electric Consumption per Hour | kw/hr | Vendor |
| Current Cost of Steam[1] | \$/Million Btu | Boiler Manager |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Steam Escalation Factor | --- | Estimate[2] |
| Laundry to be Dried per Week | Pounds | Estimate[3] |

1) Basket Capacity (BC)

BC = Clothes Basket Volume x 2.83 lbs/$ft^3$ BC = ______ lb

2) Loads per Week (LW)

$$LW = \frac{\text{Laundry to be Dried per Week}}{BC}$$

LW = ______

3) Steam Used per Load (SPL)

SPL = (Steam Used per Pound of Water Removed) x BC x .50

SPL = ______ Bt

4) Electric Use per Load (EPL)

EPL = (Electric Consumption per Hour) x .667 EPL = ______ kw

5) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + SPL \times LW \times 52 \times \text{Current Cost of Steam} \times \text{Steam Escalation Factor} + EPL \times LW \times 52 \times \frac{\text{Current Cost of Electricity}}{100\ \text{¢/\$}} \times 21.8$$

LCC = ______

NOTES:

[1]The current cost of steam must be expressed in terms of \$/Million Btu. To convert common pricing units to \$/Million Btu use the chart below:

| Common Pricing Unit | | Steam Conversion Factor | |
|---|---|---|---|
| \$/1000 # | x | .847 | = \$/Million Btu |
| ¢/Gal of Condensate | x | 1.017 | = \$/Million Btu |

Steam Driers

If the cost of steam is not known the purchaser should find out what fuels are used to generate steam, find the cost per million Btu for each fuel type (using the table below), and take the weighted average fuel price as the average cost of steam.

| Fuel | Common Pricing Unit(s) | | Conversion Factor | | Boiler Inefficiency Factor | | Cost of Steam ($/Million Btu) |
|---|---|---|---|---|---|---|---|
| Electricity | ¢/kwh | x | 2.930 | x | 1.05 | = | $/Million Btu |
| Coal | $/Ton | x | .0493 | x | 1.25 | = | $/Million Btu |
| #2 Fuel Oil | $/Gal | x | 7.210 | x | 1.25 | = | $/Million Btu |
| #6 Fuel Oil | $/Gal | x | 6.680 | x | 1.25 | = | $/Million Btu |
| L.P.G. | $/Gal | x | 10.471 | x | 1.25 | = | $/Million Btu |
| Natural Gas | ¢/ccf | x | .097 | x | 1.25 | = | $/Million Btu |
| | $/MBtu | x | 1 | x | 1.25 | = | $/Million Btu |

[2]The steam escalation factor should be the same as the escalation factor for the main fuel used to produce steam. Use the table below to find the proper escalation factor.

| Fuel | Escalation Factor |
|---|---|
| Electricity | 21.8 |
| Natural Gas | 86.2 |
| Coal | 15.0 |
| L.P. Gas | 52.4 |
| Fuel Oil | 86.2 |

[3]The weekly laundry to be dried should be the amount of laundry the user expects the new tumbler to dry in a week.

We strongly recommend the purchasers require that all vendor supplied data be verified in writing by the manufacturer's technical representative. This should eliminate any confusion which could result if salespeople were wholly responsible for the data.

The life cycle cost for all units being considered should be calculated. The unit with the lowest life cycle cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR STANDARD[1] DOMESTIC ELECTRIC DRIERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Clothes Basket Volume[2] | $ft^3$ | Vendor |
| Electric Use per Load | kwh/load | Vendor |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Laundry to be Dried per Week[3] | Pounds | Estimate |

1) Basket Capacity (BC)

$$BC = \text{Clothes Basket Volume} \times 2.83\ \text{lbs/ft}^3$$ BC = ______ lb

2) Loads per Week (LW)

$$LW = \frac{\text{Laundry to be Dried per Week}}{BC}$$ LW = ______

3) Electric Use per Week (EW)

$$EW = \frac{\text{Electric Use per Load}}{4.9\ \text{lbs water/load}} \times BC \times .5\ \frac{\text{lbs. water}}{\text{lbs. clothes}} \times LW$$

EW = ______ kw

4) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + \frac{EW \times 52\ \text{weeks} \times \text{Cost of Electricity} \times 12.7}{100\ ¢/\$}$$

LCC = ______

NOTES:

[1]Standard driers are driers with basket volumes greater than 4.4 cubic feet.

[2]The electric use per load and the basket volume shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Clothes Driers, as reported in the Federal Register, Volume 42, No. 178 - Wednesday, September 14, 1977, beginning page 46145.

[3]The weekly laundry to be dried should be the amount of laundry the user expects the new drier to dry in a week. A typical standard drier will dry 16 pounds per load.

The number 12.7 in the final life cycle cost equation is the electric escalation factor. It represents an expected 15% per year increase in electric rates and a minimum return on investment of 10% per year, over an expected life of 10 years.

The life cycle cost should be calculated for all the units being considered and the unit with the lowest life cycle cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR COMPACT[1] DOMESTIC ELECTRIC CLOTHES DRIERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Clothes Basket Volume[2] | $ft^3$ | Vendor |
| Electric Use per Load[2] | kwh/load | Vendor |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Laundry to be Dried per Week[3] | Pounds | Estimate |

1) Basket Capacity (BC)

$$BC = \text{Clothes Basket Volume} \times 2.83\ lbs/ft^3$$

BC = ______ lbs

2) Loads per Week (LW)

$$LW = \frac{\text{Laundry to be Dried per Week}}{BC}$$

LW = ______

3) Electric Use per Week (EW)

$$EW = \frac{\text{Electric Use per Load}}{2.10\ \text{lbs water/load}} \times BC \times .5\ \frac{\text{lbs. water}}{\text{lbs. clothes}} \times LW$$

EW = ______ kwh

4) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + \frac{EW \times 52\ \text{weeks} \times \text{Cost of Electricity} \times 12.7}{100\ ¢/\$}$$

LCC = ______ $

NOTES:

[1]Compact driers are driers with basket volumes less than 4.4 cubic feet.

[2]The electric use per load and the basket volume shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Clothes Driers, as reported in the Federal Register, Volume 42, No. 178 - Wednesday, September 14, 1977, beginning page 46145.

[3]The weekly laundry to be dried should be the amount of laundry the user expects the new drier to dry in a week. A typical compact drier will dry 7 pounds per load.

The number 12.7 in the final life cycle cost equation is the electric escalation factor. It represents an expected 15% per year increase in electric rates and a minimum return on investment of 10% per year, over an expected life of 10 years.

The life cycle cost should be calculated for all the units being considered and the unit with the lowest life cycle cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR STANDARD[1] DOMESTIC GAS CLOTHES DRIERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Clothes Basket Volume[2] | $ft^3$ | Vendor |
| Electric Use per Load[2] | kwh/load | Vendor |
| Gas Use per Load[2] | Btu/load | Vendor |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Current Cost of Natural Gas | \$/ccf | Fuel Supplier |
| or Current Cost of L.P. Gas | \$/Gal. | Fuel Supplier |
| Laundry to be Dried per Week[3] | Pounds | Estimate |

1) Basket Capacity (BC)

$$BC = \text{Clothes Basket Volume} \times 2.83 \text{ lbs/ft}^3$$

BC = ________ lbs

2) Loads per Week (LW)

$$LW = \frac{\text{Laundry to be Dried per Week}}{BC}$$

LW = ________

3) Electric Use per Week (EW)

$$EW = \frac{\text{Electric Use per Load}}{4.9 \text{ lbs water/load}} \times BC \times .5 \frac{\text{lbs. water}}{\text{lbs. clothes}} \times LW$$

EW = ________ kwh

4) Gas Use per Week (GW)

$$GW = \frac{\text{Gas Use per Load}}{4.9 \text{ lbs. water/load}} \times BC \times .5 \frac{\text{lbs. water}}{\text{lbs. clothes}} \times LW$$

LW = ________ Btu

5a) Life Cycle Cost (Natural Gas) (LCCa)

$$LCCa = \text{Purchase Price} + \frac{EW \times 52 \text{ weeks} \times \text{Cost of Electricity} \times 12.7}{100 \text{ ¢/\$}} + \frac{GW \times 52 \text{ weeks} \times \text{Cost of Natural Gas} \times 28.9}{101{,}800 \text{ Btu/ccf}}$$

LCCa = ________ \$

5b) Life Cycle Cost (L.P. Gas) (LCCb)

$$LCCb = \text{Purchase Price} + \frac{EW \times 52 \text{ weeks} \times \text{Cost of L.P.G.} \times 21.5}{95{,}500 \text{ Btu/gal.}}$$

LCCb = ________ \$

Standard Domestic Gas Clothes Driers

NOTES:

[1]Standard driers are driers with basket volumes greater than 4.4 cubic feet.

[2]The basket volume, the electric use per load, and the gas use per load shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Clothes Driers, as reported in the Federal Register, Volume 42, No. 178 - Wednesday, September 14, 1977, beginning page 46145.

[3]The weekly laundry to be dried should be the amount of laundry the user expects the new drier to dry in a week. A typical standard drier will dry 16 pounds of clothes per load.

The numbers 12.7, 28.9 and 21.5 in the final life cycle cost equations are respectively, the electric escalation factor, the natural gas escalation factor, and the L.P. gas escalation factor. They represent an expected 15% per year increase in electric rates, a 30% per year increase in natural gas rates, a 25% per year increase in L.P. gas prices, and a minimum return on investment of 10% per year, over an expected life of 10 years.

The life cycle cost should be calculated for all units being considered and the unit with the lowest life cycle cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR COMPACT[1] DOMESTIC GAS CLOTHES DRIERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Clothes Basket Volume[2] | $ft^3$ | Vendor |
| Electric Use per Load[2] | kwh/load | Vendor |
| Gas Use per Load[2] | Btu/load | Vendor |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Current Cost of Natural Gas | $/ccf | Fuel Supplier |
| or Current Cost of L.P. Gas | $/Gal. | Fuel Supplier |
| Laundry to be Dried per Week[3] | Pounds | Estimate |

1) Basket Capacity (BC)

$$BC = \text{Clothes Basket Volume} \times 2.83\ \text{lbs/ft}^3$$

BC = ______ lbs

2) Load per Week (LW)

$$LW = \frac{\text{Laundry to be Dried per Week}}{BC}$$

LW = ______

3) Electric Use per Week (EW)

$$EW = \frac{\text{Electric Use per Load}}{2.1\ \text{lbs water/load}} \times BC \times .5\ \frac{\text{lbs. water}}{\text{lbs. clothes}} \times LW$$

EW = ______ kwh

4) Gas Use per Week (GW)

$$GW = \frac{\text{Gas Use per Load}}{2.1\ \text{lbs water/load}} \times BC \times .5\ \frac{\text{lbs. water}}{\text{lbs. clothes}}$$

LW = ______ Btu

5a) Life Cycle Cost (Natural Gas) (LCCa)

$$LCCa = \text{Purchase Price} + \frac{EW \times 52\ \text{weeks} \times \text{Cost of Electricity} \times 12.7}{100\ ¢/\$} + \frac{GW \times 52\ \text{weeks} \times \text{Cost of Natural Gas} \times 28.9}{101{,}800\ \text{Btu/ccf}}$$

LCCa = ______ $

5b) Life Cycle Cost (L.P. Gas) (LCCb)

$$LCCb = \text{Purchase Price} + \frac{EW \times 52\ \text{weeks} \times \text{Cost of Electricity} \times 12.7}{100\ ¢/\$} + \frac{GW \times 52\ \text{weeks} \times \text{Cost of L.P. Gas} \times 21.5}{95{,}500\ \text{Btu/gal.}}$$

LCCb = ______ $

Compact Domestic Gas Clothes Driers

NOTES:

[1]Compact driers are driers with basket volumes less than 4.4 cubic feet.

[2]The basket volume, the electric use per load, and the gas use per load shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Clothes Driers, as reported in the Federal Register, Volume 42, No. 178 - Wednesday, September 14, 1977, beginning page 46145.

[3]The weekly laundry to be dried should be the amount of laundry the user expects the new drier to dry in a week. A typical compact drier will dry 7 pounds of clothes per load.

The numbers 12.7, 28.9 and 21.5 in the final life cycle cost equations are respectively, the electric escalation factor, the natural gas escalation factor, and the L.P. gas escalation factor. They represent an expected 15% per year increase in electric rates, a 30% per year increase in natural gas rates, a 25% per year increase in L.P. gas prices, and a minimum return on investment of 10% per year, over an expected life of 10 years.

The life cycle cost should be calculated for all units being considered and the unit with the lowest life cycle cost should be purchased.

## LIFE CYCLE COST TECHNIQUE FOR ELECTRIC HOT WATER HEATERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Recovery Efficiency[1] | Btu Heat / Btu Elec. | Vendor |
| Standby Loss[1] | Btu lost/hr / Btu of system | Vendor |
| Heating Elements Input Rate[1] | kw/hr | Vendor |
| Tank Volume[1] | Gallons | Vendor |
| Weekly Hot Water Use[2] | Gallons | Estimate |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |

1) Weekly Electricity to Heat Water (WE)

$$WE = \frac{\text{Weekly Hot Water Use} \times 742.5 \text{ Btu/gal.}}{\text{Recovery Efficiency}}$$

WE = ______ Btu

2) Hourly Standby Loss (HSL)

$$HSL = \text{Standby Loss} \times 742.5 \text{ Btu/gal.} \times \text{Tank Volume}$$

HSL = ______ Btu/hr

3) Weekly Standby Loss (WSL)

$$WSL = HSL \times \left(168 \text{ Hours} - \frac{WE}{\text{Heating Elements Input Rate}}\right)$$

WSL = ______ Btu/wk

4) Total Electric use per Week (TE)

$$TE = WE + WSL - JK - JS$$

where

JK = Weekly Energy Credit for an Output Heat Trap = 9177 Btu
JS = Weekly Energy Credit for an Input Heat Trap = 6881 Btu

TE = ______ Btu

5) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + \frac{TE \times 52 \text{ weeks} \times \text{Current Cost of Electricity} \times 12.7}{3413 \text{ Btu/kwh} \times 100 \text{ ¢/\$}}$$

LCC = ______ $

Electric Hot Water Heaters

NOTES:

[1]Recovery efficiency, standby loss, heating elements input rate, and tank volume shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Water Heaters, as reported in the Federal Register, Volume 42, No. 192 - Tuesday, October 4, 1977, beginning page 54110.

[2]An average household uses 450 gallons of hot water per week. If the water heater is not for a home or if a more accurate estimation of hot water usage is desired the weekly hot water use for each appliance should be added up. Below are some typical hot water usages.

| Activity | Hot Water Usage |
|---|---|
| One shower | 15 gallons |
| One load in domestic clothes washer | 25 gallons |
| One load in domestic dishwasher | 15 gallons |

The number 12.7 in the final life cycle cost equation is the electric escalation factor. It represents an expected 15% a year increase in electric rates and a minimum return on investment of 10% a year over an expected life of 10 years.

Besides the numerical data ask for vendors should also be asked whether the units they are bidding have output or input heat traps.

The life cycle cost should be found for all units being considered and the unit with the lowest life cycle cost should be purchased.

LIFE CYCLE COST TECHNIQUE FOR GAS HOT WATER HEATERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Recovery Efficiency[1] | $\frac{\text{Btu Heat}}{\text{Btu Gas}}$ | Vendor |
| Standby Loss[1] | $\frac{\text{Btu lost/hr}}{\text{Btu of System}}$ | Vendor |
| Gas Burners Input Rate[1] | Btu/hr | Vendor |
| Electric Power Needed when Burners On[1] | kw/hr | Vendor |
| Electric Power Needed when Burners Not On[1] | kw/hr | Vendor |
| Tank Volume[1] | Gallons | Vendor |
| Weekly Hot Water Use[2] | Gallons | Estimate |
| Current Cost of Natural Gas | \$/ccf | Fuel Supplier |
| or Current Cost of L.P. Gas | \$/gal | Fuel Supplier |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |

1) Weekly Gas Needed to Heat Water (WG)

$$WG = \frac{\text{Weekly Hot Water Use} \times 742.5 \text{ Btu/gal.}}{\text{Recovery Efficiency}}$$

WG = ______ Btu

2) Hourly Standby Loss (HSL)

$$HSL = \text{Standby Loss} \times 742.5 \text{ Btu/gal.} \times \text{Tank Volume}$$

HSL = ______ Btu/hr

3) Weekly Standby Loss (WSL)

$$WSL = HSL \times \left(168 \text{ hours} - \frac{WG}{\text{Gas Burners Input Rate}}\right)$$

WSL = ______ Btu/wk

4) Auxiliary Electrical Use per Week (AE)

$$AE = \text{Electric Power needed when Burners On} \times \frac{WG}{\text{Gas Burners Input Rate}}$$
$$+ \text{Electric Power needed when Burners Not On} \times \left(168 \text{ hours} - \frac{WG}{\text{Gas Burners Input Rate}}\right)$$

AE = ______ kwh

Gas Hot Water Heaters

5) Total Gas Use per Week (TG)

$$TG = WG + WSL - JK - JS$$

where

JK = Weekly Energy Credit for an Output Heat Trap = 9177 Bt
JS = Weekly Energy Credit for an Input Heat Trap = 6881 Btu

TG = ________ B

6a) Life Cycle Cost (Natural Gas) (LCCa)

$$LCCa = \text{Purchase Price} + \frac{TG \times 52 \text{ weeks} \times \text{Cost of Nat. Gas} \times 28.9}{101{,}800 \text{ Btu/ccf}}$$

$$+ \frac{AE \times 52 \text{ weeks} \times \text{Cost of Electricity} \times 12.7}{100\ ¢/\$}$$

LCCa = ________

6b) Life Cycle Cost (L.P. Gas) (LCCb)

$$LCCb = \text{Purchase Price} + \frac{TG \times 52 \text{ weeks} \times \text{Cost of L.P. Gas} \times 21.5}{95{,}500 \text{ Btu/gal.}}$$

$$+ \frac{AE \times 52 \text{ weeks} \times \text{Cost of Electricity} \times 12.7}{100\ ¢/\$}$$

LCCb = ________

NOTES:

[1]Recovery efficiency, standby loss, gas burners input rate, electric power needed when burners are on, electric power when burners are not on, and tank volume shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Water Heaters, as reported in the Federal Register, Volume 42, No. 192 - Tuesday, October 4, 1977, beginning page 54110.

[2]An average household uses 450 gallons of hot water per week. If the water heater is not for a home or if a more accurate estimation of hot water usage is desired the weekly hot water use for each appliance should be added up. Below are some typical hot water usages.

| Activity | Hot Water Usage |
|---|---|
| One shower | 15 gallons |
| One load in domestic clothes washer | 25 gallons |
| One load in domestic dish washer | 15 gallons |

Gas Hot Water Heaters

The numbers 12.7, 28.9, and 21.5 in the final life cycle cost equations are respectively, the electric escalation factor, the natural gas escalation factor, and the L. P. gas escalation factor. They represent an expected 15% per year increase in electric rates, a 30% per year increase in natural gas rates, a 25% per year increase in L. P. gas rates, and a minimum return on investment of 10% per year, over an expected life of 10 years.

Besides the numerical data asked for, vendors should also be asked whether the units they are bidding have output or input heat traps.

The life cycle cost should be found for all units being considered and the unit with the lowest life cycle cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR OIL HOT WATER HEATERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Recovery Efficiency[1] | $\frac{\text{Btu Heat}}{\text{Btu Oil}}$ | Vendor |
| Standby Loss[1] | $\frac{\text{Btu Lost/hr}}{\text{Btu of Steam}}$ | Vendor |
| Oil Burners Input Rate[1] | Btu/hr | Vendor |
| Electric Power Needed when Burners On[1] | kw/hr | Vendor |
| Electric Power Needed when Burners Not On[1] | kw/hr | Vendor |
| Tank Volume[1] | Gallons | Vendor |
| Weekly Hot Water Use[2] | Gallons | Estimate |
| Current Cost of Fuel Oil | $/gal | Fuel Supplier |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Compan} |

1) Weekly Oil needed to Heat Water (WO)

$$WO = \frac{\text{Weekly Hot Water Use} \times 742.5 \text{ Btu/gal.}}{\text{Recovery Efficiency}}$$

WG = ______ Bt

2) Hourly Standby Loss (HSL)

$$HSL = \text{Standby Loss} \times 742.5 \text{ Btu/gal.} \times \text{Tank Volume}$$

HSL = ______ Btu/h

3) Weekly Standby Loss (WSL)

$$WSL = HSL \times \left(168 \text{ hours} - \frac{WO}{\text{Oil Burners Input Rate}}\right)$$

WSL = ______ Btu/w

4) Auxiliary Electrical Use per Week (AE)

$$AE = \text{Electric Power needed when Burners On} \times \left(\frac{WO}{\text{Oil Burners Input Rate}}\right) + \text{Electric Power needed when Burners Not On} \times \left(168 \text{ hours} - \frac{WO}{\text{Oil Burners Input Rat}}\right.$$

AE = ______ kw

Oil Hot Water Heaters

5) Total Oil Use per Week (TO)

$$TO = WO + WSL - JK - JS$$

where

JK = Weekly Energy Credit for an Output Heat Trap = 9177 Btu
JS = Weekly Energy Credit for an Input Heat Trap = 6881 Btu

TO = ________ Btu

6) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + \frac{TO \times 52 \text{ weeks} \times \text{Cost of Fuel Oil} \times 28.9}{138{,}700 \text{ Btu/gal.}}$$

$$+ \frac{AE \times 52 \text{ weeks} \times \text{Cost of Electricity} \times 12.7}{100 \text{ ¢/\$}}$$

LCC = ________ $

NOTES:

[1]Recovery efficiency, standby loss, oil burners input rate, electric power needed when burners are on, electric power needed when burners are not on, and tank volume shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Water Heaters, as reported in the Federal Register, Volume 42, No. 192 - Tuesday, October 4, 1977, beginning page 54110.

[2]An average household uses 450 gallons of hot water per week. If the water heater is not for a home or if a more accurate estimation of hot water usage is desired the weekly hot water use for each appliance should be added up. Below are some typical hot water usages.

| Activity | Hot Water Usages |
|---|---|
| One shower | 15 gallons |
| One load in domestic clothes washer | 25 gallons |
| One load in domestic dish washer | 15 gallons |

The numbers 12.7 and 28.9 in the final life cycle cost equation are respectively the electric escalation rate and the fuel oil escalation rate. They represent an expected 15% a year increase in electric rates, a 30% a year increase in fuel oil rates, and a minimum return on investment of 10%, over an expected life of 10 years.

Besides the numerical data asked for vendors should also be asked whether the units they are bidding have output or input heat traps.

The life cycle cost should be found for all units being considered and the unit with the lowest life cycle cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR DOMESTIC DEHUMIDIFIERS

| Data | Units | Source |
| --- | --- | --- |
| Purchase Price | Dollars | Vendor |
| Energy Factor for Dehumidifiers* | Pints/kwh | Vendor |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Size of Dehumidifier Needed | Pints/day | Purchaser |

1) Electric Use per Year (EPY)

$$EPY = \frac{\text{Size of Dehumidifier Needed x 989 hours/year}}{\text{Energy Factor for Dehumidifiers x 24 hours/day}}$$

EPY = ________ kw

2) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + \frac{\text{EPY x Current Cost of Electricity x 12.7}}{100\ ¢/\$}$$

LCC = ________

NOTES:

*The energy factor for dehumidifiers shall be determined using test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Dehumidifiers, as reported in the Federal Register, Volume 42, No. 201 - Tuesday, October 18, 1977, beginning on page 55608.

The number 12.7 in the final life cycle cost equation is the escalation factor. It represents an expected 15% a year increase in electric rates and a minimum return on investment of 10% a year, over an expected life of 10 years.

A purchaser must first determine the size of the unit needed. The purchaser should either find out what size was previously installed or have the proper size calculated. Units will probably not exactly match the size needed so units within 10 or 15 percent of the specified size should be considered.

The life cycle cost should be found for all the units being considered and the unit with the lowest life cycle cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR DOMESTIC CENTRAL HUMIDIFIERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Humidification Rate of Unit[1] | Gal. per Day | Vendor |
| Full Load Electric Consumption[1] | Watts/hour | Vendor |
| Waste Water Drained Off[1] | lbs/hour | Vendor |
| Air Flow Through Humidifier[1] | CFM | Vendor |
| Current Cost of Furnace Fuel | \$/Million Btu[2] | Fuel Supplier |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Furnace Efficiency | Percent | Estimate[3] |
| Humidification Rate Needed | Gal. per Day | Purchaser |
| Furnace Fuel Escalation Factor | --- | Footnote (4) |

1) Yearly Hours of Operation (HO)

$$HO = 1050 \times \frac{\text{Humidification Rate Needed}}{\text{Humidification Rate of Unit}}$$ If Unit has a Humidistat.

$$HO = 2400 \times \frac{\text{Humidification Rate Needed}}{\text{Humidification Rate of Unit}}$$ If Unit does not have a Humidistat.

HO = ______ hrs

2) Heating Energy Needed per Hour (HE)

$$HE = \frac{\text{Humidification Rate of Unit} \times 8840 \text{ Btu/gal.}}{\text{24 hours per day}}$$

+ Waste Water Drained Off x 80 Btu/lbs

- 3.413 Btu/Whr x (Electric Consumption + .365 x

Air Flow through Dehumidifier)

HE = ______ Btu

3) Furnace Energy Needed per Year (FE)

$$FE = \frac{HE \times HO}{\text{Furnace Efficiency}/100 \times 1{,}000{,}000 \text{ Btu/Mil. Btu}}$$

FE = ______ Mil. Btu

4) Miscellaneous Electricity Used per Year (ME)

$$ME = \frac{HO \times (\text{Electric Consumption} + .365 \times \text{Air Flow Through Dehumidifier})}{1000 \text{ Watt-hr/kwh}}$$

ME = ________ k

5) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + FE \times \text{Current Cost of Furnace Fuel} \times \text{Furnace Fuel Escalation Factor}$$

$$+ ME \times \frac{\text{Current Cost of Electricity}}{100 \text{ ¢/Dollar}} \times 12.7$$

LCC = ________

NOTES:

[1]Humidification rate of the unit, full load electric consumption, waste water drained off, and air flow through the humidifier shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 530 - Energy Conservation Program for Appliances, Test Procedures for Humidifiers as reported in the Federal Register, Volume 42, No. 201 - Tuesday, October 18, 1977, beginning page 55599.

[2]Furnace fuel costs must be expressed in $/Million Btu. To convert fuel costs from standard pricing units to $/Million Btu, use the table below

| Fuel | Common Pricing Unit | | Conversion Factor | | $/Million Btu |
|---|---|---|---|---|---|
| Coal | $/ton | x | .0493 | = | $/Million Btu |
| Electricity | ¢/kwh | x | 2.930 | = | $/Million Btu |
| #2 Fuel Oil | $/Gal. | x | 7.210 | = | $/Million Btu |
| #6 Fuel Oil | $/Gal. | x | 6.680 | = | $/Million Btu |
| L.P.G. | $/Gal. | x | 10.471 | = | $/Million Btu |
| Natural Gas | ¢/ccf | x | .097 | = | $/Million Btu |

[3]If the efficiency of the furnace is known, that figure should be used. If it is not known, the typical efficiences listed below can be used.

| Furnace Type | Efficiency |
|---|---|
| Natural Gas | 65% |
| L.P. Gas | 65% |
| Fuel Oil | 75% |
| Electric Resistance | 100% |
| Electric Heat Pump | 150% |
| Coal | 60% |

[4]Furnace fuel escalation factors are given below. They are based on an expected unit life of ten years, a 10% per year minimum return on investment, a 30% per year increase in natural gas and fuel oil rates, a 25% per year increase in L.P. gas rates, a 15% per year increase in electric rates, and a 10% per year increase in coal rates.

| Fuel | Escalation Factor |
|---|---|
| Coal | 15.0 |
| Natural Gas | 28.9 |
| L.P. Gas | 21.5 |
| Fuel Oil | 28.9 |
| Electricity | 12.7 |

The number 12.7 in the final life cycle cost equation is the electric escalation factor. It represents an expected 15% a year increase in electric rates and a minimum raturn on investment of 10% a year, over an expected life of 10 years.

A purchaser must first determine the size of the unit needed. The purchaser should either find out what size unit was previously installed or have the proper size calculated. Units will probably not exactly match the size needed so units within 10 or 15 percent of the specified size should be considered.

The life cycle cost should be found for all units being considered and the one with the lowest life cycle cost should be purchased.

LIFE CYCLE COST TECHNIQUE FOR DOMESTIC ROOM HUMIDIFIERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Humidification Rate of Unit[1] | Gal. per Day | Vendor |
| Full Load Electric Consumption[1] | Watts/hour | Vendor |
| Current Cost of Furnace Fuel | \$/Million Btu[2] | Fuel Supplier |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Compan |
| Furnace Efficiency | Percent | Estimate[3] |
| Humidification Rate Needed | Gal. per Day | Purchaser |
| Furnace Fuel Escalation Factor | --- | Footnote (4) |

1) Yearly Hours of Operation (HO)

$$HO = 1050 \times \frac{\text{Humidification Rate Needed}}{\text{Humidification Rate of Unit}}$$ If Unit has a Humidistat.

$$HO = 2400 \times \frac{\text{Humidification Rate Needed}}{\text{Humidification Rate of Unit}}$$ If Unit does not have a Humidistat.

HO = ______ h

2) Heating Energy Needed per Hour (HE)

$$HE = \frac{\text{Humidification Rate of Unit} \times .93 \times 8840 \text{ Btu/gal.}}{24 \text{ hours per day}}$$

$$- 3.413 \text{ Btu/whr} \times \text{Electric Consumption}$$

HE = ______ B

3) Furnace Energy Needed per Year (FE)

$$FE = \frac{HE \times HO}{\text{Furnace Efficiency}/100 \times 1{,}000{,}000 \text{ Btu/Mil. Btu}}$$

FE = ______ M B

4) Miscellaneous Electricity Used per Year (ME)

$$ME = \frac{HO \times \text{Electric Consumption}}{1000 \text{ Watt-hr/kwh}}$$

ME = ______ k

Domestic Room Humidifiers

5) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + FE \times \begin{matrix}\text{Current Cost of}\\ \text{Furnace Fuel}\end{matrix} \times \begin{matrix}\text{Furnace Fuel}\\ \text{Escalation Factor}\end{matrix}$$

$$+ ME \times \frac{\text{Current Cost of Electricity}}{100\ \text{¢/Dollar}} \times 12.7$$

LCC = __________ $

NOTES:

[1]Humidification rate of the unit and the full load electric consumption shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Humidifiers as reported in the Federal Register, Volume 42, No. 201 - Tuesday, October 18, 1977, beginning page 55599.

[2]Furnace fuel costs must be expressed in $/Million Btu. To convert fuel costs from standard pricing units to $/Million Btu, use the table below.

| Fuel | Common Pricing Unit | | Conversion Factor | | $/Million Btu |
|---|---|---|---|---|---|
| Coal | $/Ton | x | .0493 | = | $/Million Btu |
| Electricity | ¢/kwh | x | 2.930 | = | $/Million Btu |
| #2 Fuel Oil | $/Gal. | x | 7.210 | = | $/Million Btu |
| #6 Fuel Oil | $/Gal. | x | 6.680 | = | $/Million Btu |
| L.P.G. | $/Gal. | x | 10.471 | = | $/Million Btu |
| Natural Gas | ¢/ccf | x | .097 | = | $/Million Btu |

[3]If the efficiency of the furnace is known, that figure should be used. If it is not known, the typical efficiences listed below can be used.

| Furnace Type | Efficiency |
|---|---|
| Natural Gas | 65% |
| L.P. Gas | 65% |
| Coal | 60% |
| Fuel Oil | 75% |
| Electric Resistance | 100% |
| Electric Heat Pump | 150% |

Domestic Room Humidifiers

[4]Furnace fuel escalation factors are given below. They are based on an expected unit life of ten years, a 10% per year minimum return on investment, a 30% per year increase in natural gas and fuel oil rates, a 25% per year increase in L.P. gas rates, a 15% per year increase in electric rates, and a 10% per year increase in coal rates.

| Fuel | Escalation Factor |
|---|---|
| Coal | 15.0 |
| Natural Gas | 28.9 |
| L.P. Gas | 21.5 |
| Fuel Oil | 28.9 |
| Electricity | 12.7 |

The number 12.7 in the final life cycle cost equation is the electric escalation factor. It represents an expected 15% a year increase in electric rates and a minimum return on investment of 10% a year, over an expected life of 10 years.

A purchaser must first determine the size of the unit needed. The purchaser should either find out what size unit was previously installed or have the proper size calculated. Units will probably not exactly match the size needed so units within 10 or 15 percent of the specified size should be considered.

The life cycle cost should be found for all units being considered and the one with the lowest life cycle cost should be purchased.

# LIFE CYCLE COST TECHNIQUE FOR LIGHT BULBS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Bulb Life | Hours | Vendor or Lamp Catalog |
| Power Comsumption | Watts/hr | Vendor or Lamp Catalog |
| Hours per Year Bulb is on | Hours/year | Estimate |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Cost to Install Bulb | Dollars | Estimate |

1) Cost for New Lamp (CN)

CN = Purchase Price + Cost to Install Bulb — CN = ________ $

2) Bulb Life in Years (BLY)

$$BLY = \frac{\text{Bulb Life in Hours}}{\text{Hours per year Bulb is on}}$$ BLY = ________ yr

3) Electricity Used per Year (E)

$$E = \frac{\text{(Power Consumption) x (Hours per Year Bulb is on}}{\text{1000 w/kwh}}$$ E = ________ kwh

4) Life Cycle Cost for 5 Years (LCC)

$$LCC = CN \times \frac{5}{BLY} + \frac{\text{E x Cost of Electricity x 5.54}}{\text{100¢ per dollar}}$$ LCC = ________ $

NOTES:

The cost to install a new bulb, in many cases, should be taken to be zero, especially when the bulb would be installed by permanent full-time maintenance staff.

5.54 represents an electric escalation rate of 15% per year and a minimum return on investment of 10% per year for a 5-year period.

Before doing a life cycle cost analysis comparing different light bulb types a purchaser should first consider three things: will all the bulbs being considered fit in the existing fixture, will they all provide enough illumination, and do they all have acceptable colors. Vendors and lamp catalogs will provide information on what type of fixture a bulb will fit into. If a bulb will not fit into the existing fixture, it must be dropped from consideration unless the purchaser is willing to change the fixture in order to accommodate the bulb (in which case the cost of changing the fixture must be added to the final life cycle cost). All bulbs to be considered must be able to provide adequate illumination. Unless a lighting study has been done, a purchaser should buy bulbs with lumen outputs within 10 or 15 percent of the currently installed bulb's output. Bulbs, particularly florescent tubes, come in many different colors. Generally the bulb color is not important unless sorting or picking of colors is to be done, in which case only bulbs of the proper colors should be considered.

Light Bulbs

For each bulb being considered, the life cycle cost should be found. The bulb with the lowest life cycle cost should be purchased.

The current cost of electricity, the hours per year the bulb is on, and usually the cost to install the bulb should be the same for all bulbs.

LIFE CYCLE COST TECHNIQUE FOR PASSENGER VEHICLES

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Car Dealer |
| Gas Mileage | Miles/gal | EPA or Sticker |
| Average Fuel Price for the Next 3 Years* | Dollars | Estimate |
| Resale Value | Dollars | N.A.D.A. Official Used Car Guide |

Life Cycle Cost (LCC)

$$LCC = \frac{50{,}000 \text{ miles} \times \text{Gas Cost}}{\text{Gas Mileage}} + \text{Purchase Price} - \text{Resale Value}$$

LCC = ________$

NOTES:

*30% higher than current gas prices is a good estimate.

The resale value should be the current resale value of the same make of car (if the vehicle in question was not being made three years ago, use the figure for a similar vehicle made by the same manufacturer).

N.A.D.A. is the National Automobile Dealers Association.

EPA is the Environmental Protection Agency.

This life cycle cost technique can be used for any vehicle listed in the E.P.A. Gas Mileage Guide (cars, station wagons, vans, and small pick-up trucks).

Vehicle type must be specified (e.g., compact cars, station wagons, 15-seat vans, etc.) and only vehicles meeting a given specification should be considered. The life cycle cost for each vehicle to be considered should be computed and the vehicle with the lowest life cycle cost should be purchased.

The average fuel price for the next three years must be the same for each vehicle unless they burn different fuels (regular gas, unleaded gas, or diesel fuel).

LIFE CYCLE COST TECHNIQUE FOR

REFRIGERATORS, FREEZERS and REFRIGERATOR/FREEZERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Energy Factor* | $ft^3$/kwh/day | Vendor |
| Size Needed | $ft^3$ | Purchaser |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |

1) Electric Use per Day (EPD)

$$EPD = \frac{\text{Size Needed}}{\text{Energy Factor}}$$

EPD = ______ kwh

2) Life Cycle Cost (LCC)

LCC = Purchase Price + EPD x 365 days/year x Cost of Electricity x 12.7 ÷ 100 ¢/$

LCC = ______

NOTES:

*The energy factor shall be determined using test procedures and conditions as outlined and defined by the Department of Energy, Part 430-Energy Conservation Program for Appliances, Test Procedures for Electric Refrigerators, Electric Refrigerator/Freezers, and Freezers, as reported in the Federal Register, Volume 42, No. 178 - Wednesday, September 14, 1977, beginning page 46140.

The number 12.7 in the final life cycle cost equation is the escalation factor. It represents an expected 15% a year increase in electric rates and a minimum return on investment of 10% a year, over an expected life of 10 years.

The purchaser should find the life cycle cost of each unit being considered and buy the one with the lowest life cycle cost.

# LIFE CYCLE COST TECHNIQUE FOR TELEVISION SETS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Operating Power Consumption* | Watts | Vendor |
| Standby Power Consumption* | Watts | Vendor |
| Current Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Weekly Hours of Operation | Hours | Estimate |

1) Yearly hours of Operation (YO)

YO = Weekly Hours of Operation x 52 weeks/year    YO = ______ hrs

2) Electric Use per Year (EPY)

EPY = (Operating Power Consumption) x YO + (Standby Power Consumption) x (8760 - YO)

EPY = ______ watts

3) Life Cycle Cost (LCC)

$$LCC = \text{Purchase Price} + \frac{\text{EPY} \times \text{Current Cost of Electricity} \times 5.54}{1000 \text{ watts/kwh} \times 100\ ¢/\$}$$

LCC = ______ $

NOTES:

*Operating and standby power consumption shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Television Sets, as reported in the Federal Register, Volume 42, No. 178 - Wednesday, September 14, 1977, beginning on page 46151.

The number 5.54 in the final life cycle cost equation is the escalation factor. It represents an expected 15% a year increase in electric rates and a minimum return on investment of 10% a year, over an expected life of 5 years.

The purchaser should find the life cycle cost of each unit being considered and buy the one with the lowest life cycle cost.

LIFE CYCLE COST TECHNIQUE FOR COMMERCIAL WASHER/EXTRACTORS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Cylinder Volume | Cubic Feet | Vendor |
| Water Use per Load[1] | Gallons | Vendor |
| Percent Moisture Retention[2] | Percent | Vendor |
| Electric Use per Load | kwh | Vendor |
| Hot Water Heating Efficiency | Percent | Estimate[3] |
| Cost of Fuel Used to Heat Water | \$/Mil Btu[4] | Fuel Supplier |
| Cost of Fuel Used to Dry Clothes | \$/Mil Btu[4] | Fuel Supplier |
| Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Cost of Water | \$/1000 gal. | Water Company |
| Weekly Laundry to be Washed[5] | Pounds | Purchaser |
| Escalation Factor for Water Heating Fuel | --- | Footnote (6) |
| Escalation Factor for Clothes Drying Fuel | --- | Footnote (6) |

1) Basket Capacity (BC)

BC = Cylinder Volume x 5.6 BC = ________ lbs

2) Loads per Week (LW)

$$LW = \frac{\text{Weekly Laundry to be Washed}}{BC}$$ LW = ________

3) Energy to Heat Water per Load (HE)

$$HE = \frac{.7 \times \text{Water Use per Load} \times 875\ \text{Btu/gal.}^{\circ}F \times 100^{\circ}\ F}{\text{Water Heating Efficiency}/100}$$

HE = ________ Btu

4) Energy to Dry Clothes per Load (DE)

$$DE = BC \times \frac{\text{Moisture Retention}}{100} \times 2500$$ DE = ________ Btu

5) Water Heating Cost over the Machine's Life (WHC)

WHC = HE x LW x 52 weeks/year x Cost of Fuel Used to Heat Water x Escalation Factor for Water Heating Fuel ÷ 1,000,000 Btu/Million Btu

WHC = ________ \$

6) Cost to Dry Clothes over the Machine's Life (DC)

DC = DE x LW x 52 weeks/year x Cost of Fuel Used to Dry Clothes x Escalation Factor for Clothes Drying Fuel ÷ 1,000,000 Btu/Million Btu

DC = ________ \$

Washer/Extractors

7) Electric Cost over the Machine's Life (EC)

$$EC = \text{Electric Use per Load} \times LW \times 52 \text{ weeks/year} \times \text{Cost of Electricity} \times 21.8 \div 100\ ¢/\$$$

EC = ________ $

8) Water Cost over the Machine's Life (WC)

$$WC = \frac{\text{Water Used per Load} \times LW \times 52 \text{ weeks/year} \times \text{Water Cost} \times 14}{1000}$$

WC = ________ $

9) Life Cycle Cost (LCC)

LCC = Purchase Price + WHC + DC + EC + WC     LCC = ________ $

NOTES:

[1] All data should be based on the following cycle for programmable washer/extractors:

2 washes (at manufacturer's recommended level for heavy soil)
3 rinses (at manufacturer's recommended level)
1 intermediate extraction
1 flush (at the same level as the rinses)
1 final extraction

For non-programmable washer/extractors data should be based on the machine's heavy soil cycle.

Vendors should be told to base all their data on this formula. Since wash and rinse levels vary with manufacturer and with the dimensions of the machine, the manufactures should recommend the wash and rinse levels.

[2] Percent moisture retention data should be based on a full load of 100% cotton muslin sheets. Though this is not a typical load, it is a load which can be duplicated with reasonable precision.

[3] If the efficiency of the hot water heating system is known, that figure should be used. If it is not known, the typical efficiencies listed below can be used.

| Hot Water Heater Type | Efficiency |
|---|---|
| Natural Gas | 45% |
| L.P. Gas | 45% |
| Fuel Oil | 45% |
| Electric | 80% |
| Steam | |
| with Gas Fired Boiler | 70% |
| with Oil Fired Boiler | 70% |
| with Coal Fired Boiler | 70% |
| with Electric Boiler | 90% |

Washer/Extractors

[4]Water heating and clothes drying fuel costs must be expressed in $/Million Btus. To convert fuel costs from standard pricing units to $/Million Btus, use the table below.

| Fuel | Common Pricing Unit(s) | | Conversion Factor | | $/Million Btu |
|---|---|---|---|---|---|
| Electricity | ¢/kwh | x | 2.930 | = | $/Million Btu |
| Coal | $/Ton | x | .0493 | = | $/Million Btu |
| Gasoline | $/Gal | x | 8.003 | = | $/Million Btu |
| #2 Fuel Oil | $/Gal | x | 7.210 | = | $/Million Btu |
| #6 Fuel Oil | $/Gal | x | 6.680 | = | $/Million Btu |
| L.P.G. | $/Gal | x | 10.471 | = | $/Million Btu |
| Natural Gas | ¢/ccf | x | .097 | = | $/Million Btu |
| Steam | $/1000# | x | .847 | = | $/Million Btu |
| | ¢/Gal of condensate | x | 1.017 | = | $/Million Btu |

If steam driers or steam hot water heaters are used and the cost of steam is unknown, the steam cost should be taken to be the weighted average cost of the fuels used to produce steam.

[5]Weekly laundry to be washed should be the amount of laundry the user expects the new washer/extractor to wash in a week.

[6]Escalation factors for different fuel types are given below.

| Fuel | Escalation Factor |
|---|---|
| Coal | 15 |
| Fuel Oil | 86.2 |
| Natural Gas | 86.2 |
| L.P. Gas | 52.4 |
| Electricity | 21.8 |

We strongly recommend that purchasers require that all vendor supplied data be verified in writing by a manufacturer's technical representative. This should eliminate any confusion which can result if salespeople are wholly responsible for the data.

The life cycle cost for all units being considered should be calculated. The unit with the lowest life cycle cost should be purchased.

LIFE CYCLE COST TECHNIQUE FOR DOMESTIC CLOTHES WASHERS

| Data | Units | Source |
|---|---|---|
| Purchase Price | Dollars | Vendor |
| Total Weighted Per-cycle Water Heating Energy Use[1] | kwh | Vendor |
| Cylinder Volume[1] | $ft^3$ | Vendor |
| Electric Use per Load[1] | kwh | Vendor |
| Moisture Retention After Spin[2] | Percent | Vendor |
| Hot Water Heating Efficiency | Percent | Estimate[3] |
| Cost of Fuel Used to Heat Water | $/Mil Btu[4] | Fuel Supplier |
| Cost of Fuel Used to Dry Clothes | $/Mil Btu[4] | Fuel Supplier |
| Cost of Electricity | ¢/kwh | Power Bill or Power Company |
| Cost of Water | $/1000 Gal. | Water Company |
| Weekly Laundry to be Washed[5] | Pounds | Purchaser |
| Escalation Factor for Water Heating Fuel | --- | Footnote (6) |
| Escalation Factor for Clothes Drying Fuel | --- | Footnote (6) |

1) Basket Capacity (BC)

$$BC = \text{Cylinder Volume} \times 5.6\ \text{lbs/ft}^3 \qquad BC = \_\_\_\_\_\_\ \text{lbs}$$

2) Loads per Week (LW)

$$LW = \frac{\text{Weekly Laundry to be Washed}}{BC} \qquad LW = \_\_\_\_\_\_$$

3) Energy to Heat Water per Load (HE)

$$HE = \text{Total Weighted Per-cycle Water Heating Energy Use} \times 3413\ \text{Btu/kwh} \div \text{Hot Water Heating Efficiency}/100$$

$$HE = \_\_\_\_\_\_\ \text{Btu}$$

4) Energy to Dry Clothes per Load (DE)

$$DE = BC \times \frac{\text{Moisture Retention}}{100} \times 2500\ \text{Btu/lbs} \qquad DE = \_\_\_\_\_\_\ \text{Btu}$$

5) Water Heating Cost over the Machine's Life (WHC)

$$WHC = HE \times LW \times 52\ \text{weeks} \times \text{Cost of Fuel Used to Heat Water} \times \text{Escalation Factor for Water Heating Fuel} \div 1{,}000{,}000\ \text{Btu/Mil. Btu}$$

$$WHC = \_\_\_\_\_\_\ \$$$

6) Cost to Dry Clothes over the Machine's Life (DC)

DC = DE x LW x 52 weeks x Cost of Fuel Used to Dry Clothes x Escalation Factor for Clothes Drying Fuel ÷ 1,000,000 Btu/Mil. Btu

DC = ________ $

7) Electric Cost over the Machine's Life (EC)

EC = Electric Use per Load x LW x 52 weeks x Cost of Electricity x 12.7 ÷ 100 ¢/$ EC = ________ $

8) Water Cost over the Machine's Life (WC)

$$WC = \frac{\text{Water Used per Load x LW x 52 weeks x Water Cost x 9.56}}{1000}$$

WC = ________ $

9) Life Cycle Cost (LCC)

LCC = Purchase Price + WHC + DC + EC + WC

LCC = ________ $

NOTES:

[1]Total weighted per-cycle water heating energy use, cylinder volume, and electric use per load shall be measured per test procedures and conditions as outlined and defined by the Department of Energy, Part 430 - Energy Conservation Program for Appliances, Test Procedures for Clothes Washers, as reported in the Federal Register, Volume 42, No. 188 - Wednesday, September 28, 1977, beginning page 49802.

[2]Percent moisture retention after the spin shall be based on a full load of 100% cotton muslin sheets. Though this is not a typical load, it is a load which can be duplicated with reasonable precision.

[3]If the efficiency of the hot water heater is known, that figure should be used. If it is not known, the typical efficiencies listed below can be used.

| Hot Water Heater Type | Efficiency |
|---|---|
| Natural Gas | 45% |
| L.P. Gas | 45% |
| Fuel Oil | 45% |
| Electric | 80% |
| Steam | |
| with Gas Fired Boiler | 70% |
| with Oil Fired Boiler | 70% |
| with Coal Fired Boiler | 70% |
| with Electric Boiler | 90% |

[4] Water heating and clothes drying fuel costs must be expressed in \$/Million Btu. To convert fuel costs from standard pricing units to \$/Million Btu, use the table below.

| Fuel | Common Pricing Unit(s) | | Conversion Factor | | \$/Million Btu |
|---|---|---|---|---|---|
| Electricity | ¢/kwh | x | 2.930 | = | \$/Million Btu |
| Coal | \$/Ton | x | .0493 | = | \$/Million Btu |
| Gasoline | \$/Gal | x | 8.003 | = | \$/Million Btu |
| #2 Fuel Oil | \$/Gal | x | 7.210 | = | \$/Million Btu |
| #6 Fuel Oil | \$/Gal | x | 6.680 | = | \$/Million Btu |
| L.P.G. | \$/Gal | x | 10.471 | = | \$/Million Btu |
| Natural Gas | ¢/ccf | x | .097 | = | \$/Million Btu |
| Steam | \$/1000# | x | .847 | = | \$/Million Btu |
| | ¢/Gal. Condensate | x | 1.017 | = | \$/Million Btu |

If steam driers or steam hot water heaters are used and the cost of steam is unknown, the steam cost should be taken to be the weighted average cost of the fuels used to produce steam.

[5] Weekly laundry to be washed should be the amount of laundry the user expects the new washer to wash in a week (a typical load is about 18 pounds).

[6] Escalation factors for different fuel types are given below. These escalation factors are based on an expected 10% per year increase in coal prices, a 30% per year increase in fuel oil prices, a 30% per year increase in natural gas rates, a 25% per year increase in L.P. gas prices, a 15% per year increase in electric rates, and a minimum return on investment of 10% per year, over an expected life of 10 years.

| Fuel | Escalation Factor |
|---|---|
| Coal | 10 |
| Fuel Oil | 28.9 |
| Natural Gas | 28.9 |
| L.P. Gas | 21.5 |
| Electricity | 12.7 |

The number 12.7 in the electric cost equation is the electric escalation factor. It represents an expected 15% per year increase in electric rates and a minimum return on investment of 10%, over an expected life of 10 years.

The number 9.56 in the water cost equation represents an expected 9% per year increase in water rates and a minimum return on investment of 10%, over an expected life of 10 years.

We strongly recommend that purchasers require that the moisture retention after spin data be verified in writing by a manufacturer's technical representative. This should eliminate any confusion which can result if salespeople are wholly responsible for the data.

This formula cannot be used to compare domestic washers to commercial washer/extractors. If a purchaser wishes to compare domestic and commercial units the technique for commercial washer/extractors should be used for all the units, but the domestic washer purchase price should be multiplied by 1.5 to take into account the longer life expectancy of commercial units.

The life cycle cost of all the units being considered should be calculated. The unit with the lowest life cycle cost should be purchased.