TECH TIP # 44

HEATING, AIRCONDITIONING & REFRIGERATION DISTRIBUTORS INTERNATIONAL

One of a series of dealer contractor technical advisories prepared by HARDI wholesalers as a customer service.

Estimating Annual Operating Costs

There have been formulas to compute energy consumption for many years. One such procedure is published in HARDI's Tech Tip # 9 - *Estimating Energy Usage*. The adoption by the U.S. Department of Energy (DOE) of the Annual Fuel Utilization Efficiency (AFUE) now provides another means to estimate residential energy costs and to compare one furnace or boiler with another. AFUE is different than steady-state efficiency which is a ratio of the heating capacity of a furnace or boiler divided by the heat input.

AFUE is derived from DOE performance testing procedures which include numerous "assumptions" as to operating cycles, over sizing of unit, outdoor temperature, etc. AFUE can be compared to EPA ESTIMATED MPG (miles per gallon) in the auto industry. This is a laboratory-derived miles per gallon based on certain assumptions and computerized simulations.

This is an important point. Just as actual MPG can vary from estimated or published values because of speed, weather, trip length and driver, the actual AFUE experienced in a particular house, in a particular climate and with a particular family can vary from estimated values --- perhaps even substantially.

Nonetheless, the advent of the government-supported AFUE, coupled with the introduction of high efficiency furnaces and boilers has prompted many HVAC dealer-contractors to include a cost savings analysis as part of a sales presentation. One very simple comparison between furnaces or boilers can be computed by comparing AFUE of one unit with another as follows:

$$\frac{AFUE_2 - AFUE_1}{AFUE_2} \times 100 = \text{percent annual energy reduction}$$

(where $AFUE_2$ is higher than $AFUE_1$)

Thus, high efficiency furnace 2 with an AFUE of 88% when compared to standard furnace 1 with an AFUE of 68% would reduce annual energy consumption by:

$$\frac{88 - 68}{88} \times 100 \text{ or } 22.73\%$$

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In residential sales situations where the homeowner desires a dollar and cents analysis, it is possible to use a procedure outlined in the Gas Appliance Manufacturers Association (GAMA) Directory of Certified Furnace and Boiler Efficiency Ratings. The GAMA procedure is based on DOE test procedures, but does not include electrical energy costs to operate blowers and pumps. (Electrical consumption averages about 5% of the cost of the fuel used.)

What follows is a slightly modified GAMA procedure, but one that provides the same end results. The formula is:

$$EAOC = 0.77 \times HLH \times \text{Heat Loss} \times \frac{\text{Fuel Cost}}{\text{Btu content of the fuel} \times AFUE}$$

Where:

0.77 = Adjustment factor taken from DOE procedures

EAOC = Estimated Annual Operating Cost in Dollars

HLH = Heating load hours for location (obtained from map in Figure 1)

Heat Loss = Calculated building heat loss at design conditions

Fuel Cost = Cost of energy as provided by fuel supplier

Btu Content of Fuel = Heat energy in fuel in Btu's per sale unit (Btu/gal or Btu/therm)

AFUE = Annual Fuel Utilization Efficiency - rating based on U.S. Department of Energy tests and published for specific boiler and furnace models.

Please note that the right hand portion of the formula ----

$$\frac{\text{Fuel Cost}}{\text{Btu content of the fuel} \times AFUE}$$

--corresponds to the cost per therm of utilized formula presented in HARDI's Tech Tip # 32 -- Comparing Fuel on the Basis of Cost. (See also Line 5 on the accompanying EAOC worksheet.) Please refer to Tech Tip #32 for additional background. The attached EAOC worksheet, HLH map and published AFUE for specific furnaces and boilers plus local energy costs --- in the units described in the worksheet footnote --- are required to make a dollar and cents estimated cost comparison.

An example comparison is shown on the worksheet. A standard oil furnace with a 70.2 AFUE is matched against a high efficiency gas furnace with a 91 AFUE. The gas furnace also features spark ignition, oil is assumed to cost $1.75 per gallon (DOE national average) and natural gas costs 97.2¢ per therm (again, DOE national average).

The house has a calculated design heat loss of 72,000 Btu/h and is located in an area with 2200 Heating Load Hours. The assumed installed cost for the gas furnace is $3,100.00 and $1800.00 for the standard oil furnace.

By recalculating the example, you should be able to understand the procedure. A second, blank EAOC worksheet is also provided for your convenience.

REMEMBER: Be certain to indicate your analysis provides only an estimate of energy costs and savings. User habits, house characteristics, severity of the winter, fuel pricing, etc. can affect actual experience.

WORKSHEET
ESTIMATED ANNUAL OPERATING COST (EAOC)

		Model 1	Model 2
	Brand	Standard Oil	Best Gas
	Model Number	OU84F-2	GHA061U
	Input Rating	105,000	80,000
	AFUE	70.2	91.0
Line			
1	Heat content of fuel per unit sale *	1.4	1.0
2	AFUE divided by 100	0.702	0.91
3	Line 1 x Line 2	0.9828	0.91
4	Fuel costs in cents per sale unit **	175¢	97.2
5	Cost per therm of utilized heat (Line 4 divided by Line 3)	178.06¢	106.81
6	Heating Load Hours (Figure 1) divided by 100	22	
7	Design Heat Loss divided by 1,000	72	
8	(Line 5 x Line 6 x Line 7) divided by 100	$2,820.47	$1,691.87
9	EAOC - Line 8 x 0.77	$2,171.76	$1,302.74
10	Standing Pilot Cost (Line 4 x 0.7)	N/A	N/A
11	Adjusted EAOC (Line 9 + Line 10)	$2,171.76	$1,302.74
12	Difference between models	$869.02	

Annual (difference between EAOC's on Line 11)

* Btu content of fuel/100,000:

Natural Gas -- 1 therm = 100,000 Btu's
Propane Gas -- 1 gallon = 92,000 Btu's
Heating Oil (No. 2) -- 1 gallon = 140,000 Btu's

** Fuel Cost = Natural Gas -- in cents per therm, Propane Gas -- in cents per gallon, and Heating Oil (No. 2) -- in cents per gallon

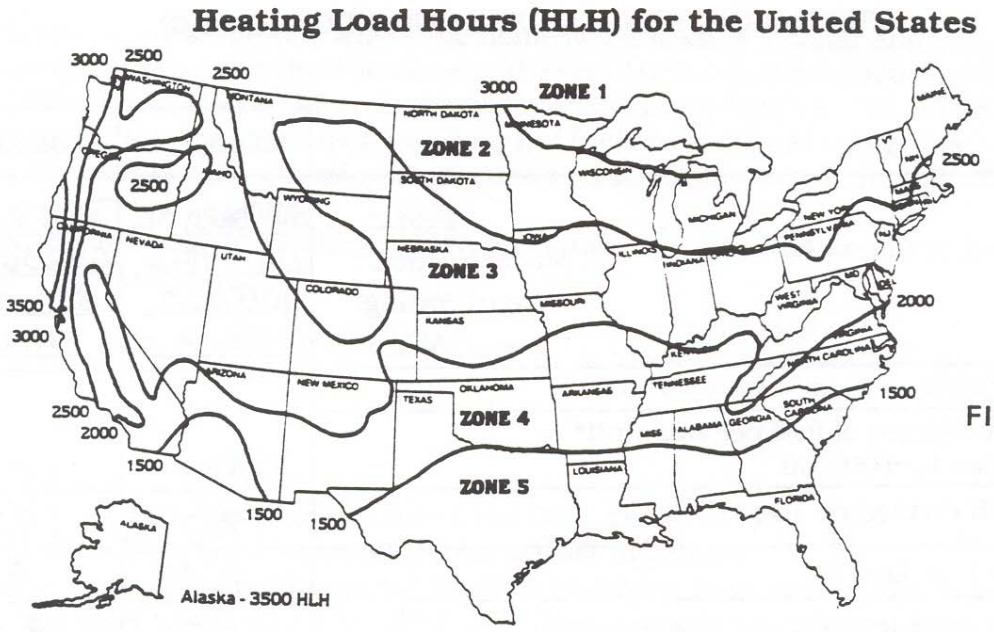

FIGURE 1

This map is reasonably accurate for most parts of the United States but is necessarily highly generalized and consequently not too accurate in mountainous regions, particularly in the Rockies.

Annual Fuel Savings in Percent: $\frac{\text{Annual Savings from Line 12}}{\text{Largest EAOC from Line 9}} \times 100 = \%\ \text{Savings}$

$\frac{\$\ 869.02}{\$2,171.76} \times 100 = 40.01\%$ Savings annually

Payback: Installed price for high efficiency unit $3,100

Installed price for "other" unit $1,800

$\frac{\text{Net added investment}}{\text{Annual Savings (line 12)}} = \text{Years to recover added investment}$

$\frac{\$1,300}{\$869.02} = 1.4959$ years

The above simple amortization assumes there is no increase in fuel costs over the period, there is no tax credit available and neglects any potential interest earnings for the added investment.

WORKSHEET
ESTIMATED ANNUAL OPERATING COST (EAOC)

		Model 1	Model 2
Brand			
Model Number			
Input Rating			
AFUE			
Line			
1	Heat content of fuel per unit sale *		
2	AFUE divided by 100		
3	Line 1 x Line 2		
4	Fuel costs in cents per sale unit **	¢	¢
5	Cost per therm of utilized heat (Line 4 divided by Line 3)	¢	¢
6	Heating Load Hours (Figure 1) divided by 100		
7	Design Heat Loss divided by 1,000		
8	(Line 5 x Line 6 x Line 7) divided by 100		
9	EAOC - Line 8 x 0.77	$	$
10	Standing Pilot Cost (Line 4 x 0.7)	$	$
11	Adjusted EAOC (Line 9 + Line 10)	$	$
12	Difference between models	$	

Annual (difference between EAOC's on Line 11)

* Btu content of fuel/1000:

Natural Gas -- 1 therm = 100,000 Btu's
Propane Gas -- 1 gallon = 92,000 Btu's
Heating Oil (No. 2) -- 1 gallon = 140,000 Btu's

** Fuel Cost = Natural Gas -- in cents per therm, Propane Gas -- in cents per gallon, and Heating Oil (No. 2) -- in cents per gallon

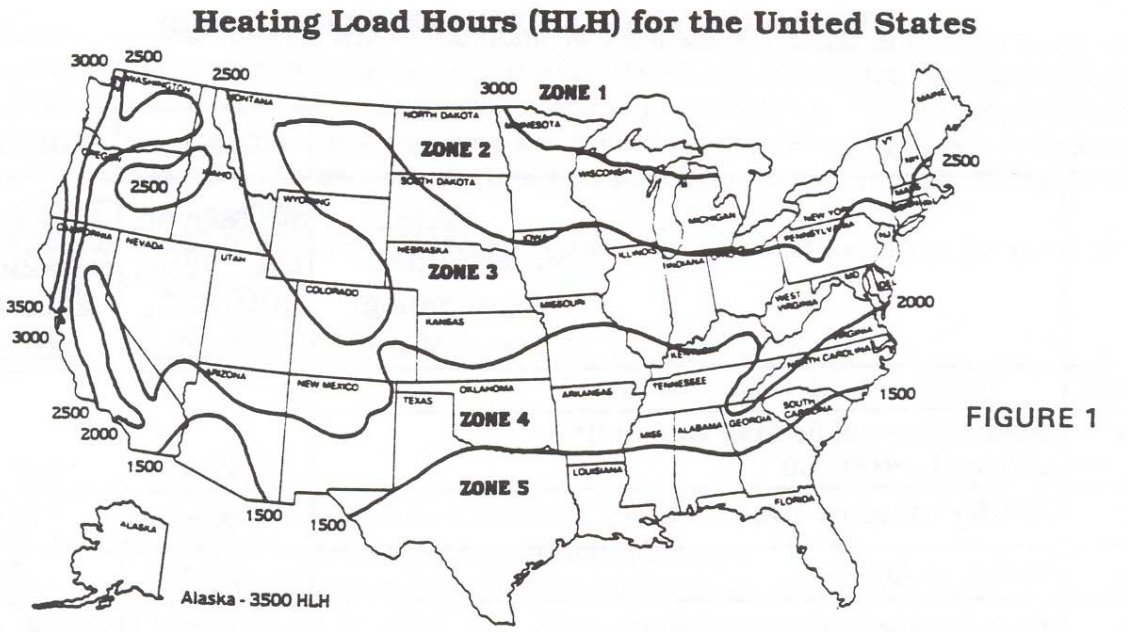

FIGURE 1

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Annual Fuel Savings in Percent: $\frac{\text{Annual Savings from Line 12}}{\text{Largest EAOC from Line 9}} \times 100 = \%\ \text{Savings}$

$\frac{\$}{\$} \times 100 =$ _____ % Savings annually

Payback: Installed price for high efficiency unit $_____

Installed price for "other" unit $_____

$\frac{\text{Net added investment}}{\text{Annual Savings (line 12)}} =$ Years to recover added investment

$\frac{\$}{\$} =$ _____ years

The above simple amortization assumes there is no increase in fuel costs over the period, there is no tax credit available and neglects any potential interest earnings for the added investment.