

APPENDIX E-3. MANUFACTURING COST DISTRIBUTIONS

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APPENDIX E-3. MANUFACTURING COST DISTRIBUTIONS

E-3.1 BACKGROUND

The LCC analysis uses individual design options grouped together in combinations according to the results of the Engineering Analysis. This analytic procedure requires incremental manufacturing costs of individual design options.

The distributions of the manufacturing costs for most design options were provided by the Gas Appliance Manufacturers Association (GAMA) as cumulative curves of total cost.¹ GAMA data only apply to 50-gal electric and 40-gal gas-fired water heaters. These data are used as the basis for the development of the incremental manufacturing costs for the other standard sizes and for the analyzed design options.

The data summarize 10,000 samples randomly drawn from ranges of total manufacturing cost provided by four major water heater manufacturers. Figure E-3.1 shows manufacturing costs for the existing baseline gas-fired water heater and the same water heater with heat traps.

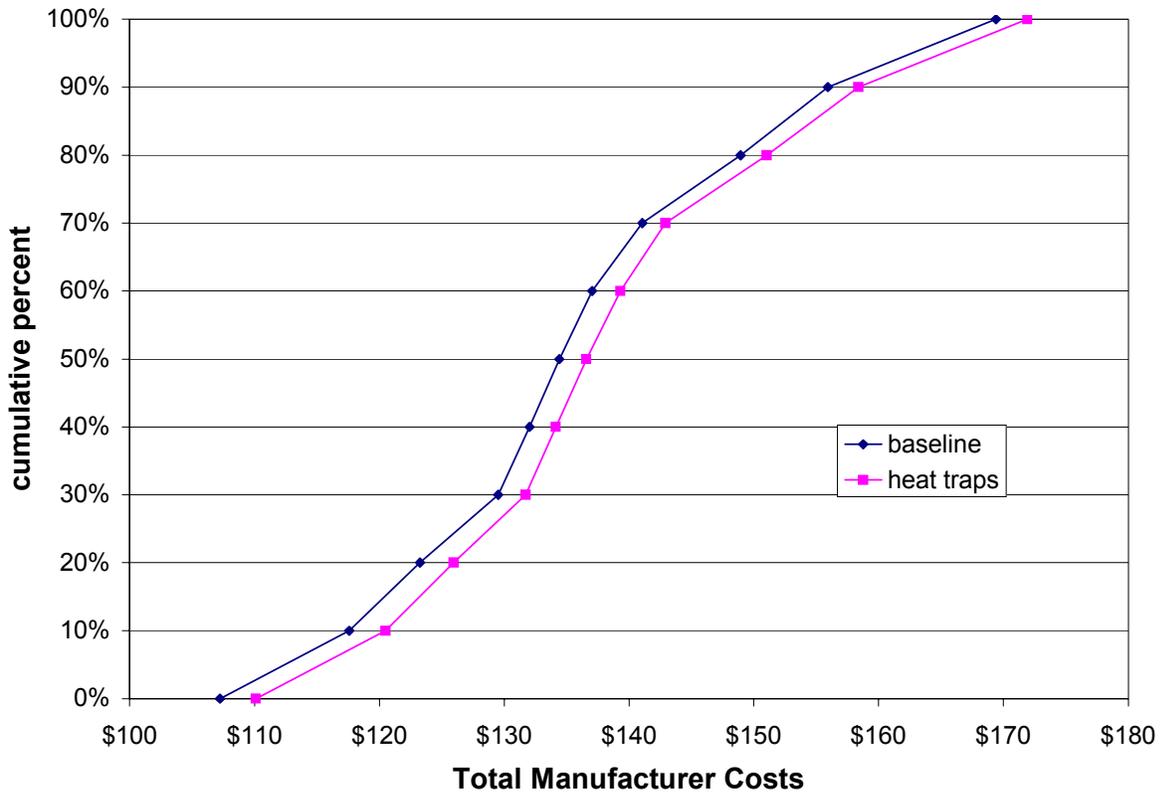


Figure E-3.1 Manufacturer Costs

E-3.2 MANUFACTURING COST DISTRIBUTIONS

The distributions of manufacturing costs for the baseline models are based on data from GAMA with modifications as described below. The incremental cost of increased insulation thickness used in the LCC Analysis is provided by the Engineering Analysis. These costs vary by tank size. The incremental costs of thicker insulation are not applied as distributions. Only single values are used. Incremental manufacturing costs for design options not provided by GAMA are distributions provided by an LBNL consultant.²

E-3.2.1 Existing Baseline

In order to address concerns about manufacturers' costs, DOE adjusted the range of the manufacturer's cost distribution. We did this to bring manufacturers' costs in line with known appliance manufacturing costs, derived from SEC reports and the A.O. Smith 10K reports. This change also ensures consistency within the data. Since the overall retail prices remain constant, this change eliminates the occurrences of unreasonably low markups on the baseline gas and electric water heaters.

The U.S. Census Bureau's 1997 *Current Industrial Report, Major Household Appliances*³ reports the total value of electric and gas-fired water heaters as \$1,253 million for 8.7 million units sold. Thus, the average price per unit would be \$144. Because these data include premium models and manufacturers' markups as well as warranty costs, freight, profits, and commissions, the resulting price will be higher than the baseline model factory cost; thus it represents an upper limit of the factory cost.

The upper limit of the range of manufacturer cost data provided by GAMA (\$164.49 for electric water heaters and \$169.39 for gas-fired water heaters) (see Appendix C-2) is significantly above the factory price calculated from the *Current Industrial Report*. We assumed one of the manufacturers had supplied cost data that was not in agreement with what we were expecting. To correct this, we developed four triangular distributions to the cost data distribution provided by GAMA. The cost data from GAMA was provided in the form of a cumulative probability distribution, reported by deciles. This data was transformed into a frequency distribution. The fitted triangular distributions superimposed on to the frequency distribution chart for the baseline electric water heater are shown in Figure E-3.2. Similar fitting was done for gas-fired water heaters as well. We also applied this correction technique to the manufacturer costs for baseline water heaters with heat traps and increased insulation.

After the parameters for the distribution cost data from the four manufacturers was determined, we adjusted the costs reported by the most expensive manufacturer downward, so that the average cost of that manufacturer matched the average cost of the other three manufacturers. (See Figure E-3.3) This operation changed the average manufacturer cost for the existing baseline model electric water heater from \$124.00 to \$114.45. Similar calculations were done for the existing baseline model gas-fired water heater as well as for heat traps and increased insulation. The results are shown in Table E-3.1.

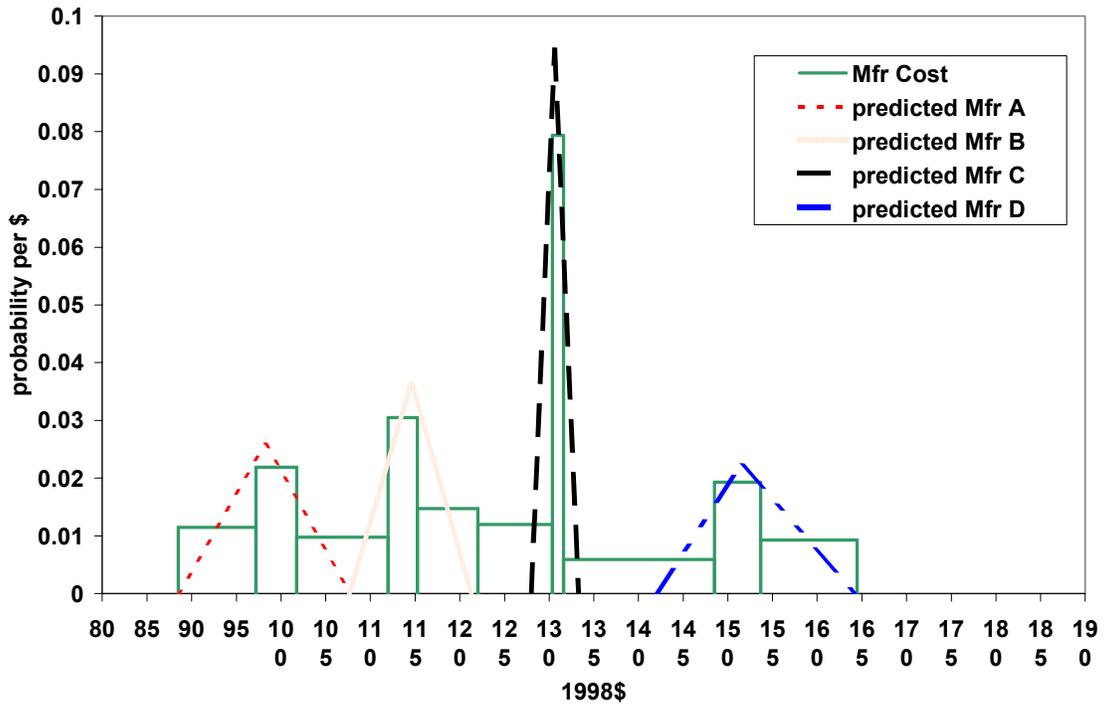


Figure E-3.2 Manufacturer Cost Distribution for Baseline Electric Water Heaters

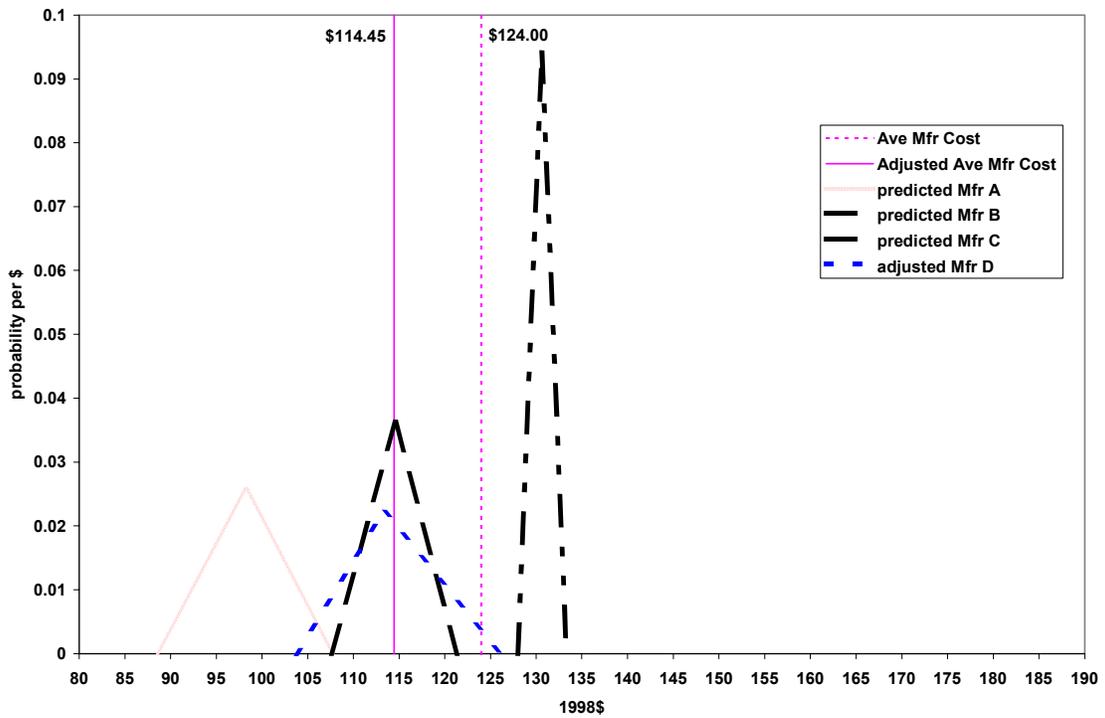


Figure E-3.3 Adjusted Manufacturer Cost Distribution for Baseline Electric Water Heaters

Table E-3.1 Adjusted Manufacturer Cost Distributions

	Unadjusted			Adjusted		
	Minimum	Average	Maximum	Minimum	Average	Maximum
Electric						
Existing Baseline	88.49	124.00	164.49	88.49	114.45	133.31
Heat Traps	91.57	127.07	166.66	91.57	117.95	135.01
Increased Insulation	105.63	143.63	187.41	105.63	136.14	172.41
Gas-Fired						
Existing Baseline	107.25	135.75	169.39	107.25	129.53	147.44
Heat Traps	110.12	138.08	171.93	110.12	131.88	148.20
Increased Insulation	113.87	150.45	184.16	113.87	144.74	167.47

No effect was observed on the lower end of the distribution of manufacturer cost data.

After the data adjustment was made, it was re-formatted into the same form as was used before, a cumulative distribution reported in deciles. Subsequent analyses were carried out in the same manner as previously.

The adjusted manufacturer cost data is used directly for the typical existing water heater size (50-gallon rated volume for electric water heaters and 40-gallon rated volume for gas-fired water heaters). The distributions of the manufacturing costs for smaller sizes are calculated by subtracting the cost of extra foam and extra sheet metal from the cumulative manufacturing cost data for the typical size water heaters. The distributions of the manufacturing costs for the larger sizes are calculated by adding the cost of extra foam and extra sheet metal to the typical size.

E-3.2.2 2003 Baseline

The distribution of the manufacturing cost for the 2003 baseline water heater is calculated by adding the incremental cost of the HFC-245fa foam to the cost ranges already calculated for the existing baseline models of the corresponding size.

E-3.2.3 Heat Traps

The frequency distribution of the incremental manufacturing costs of heat traps is calculated as the cost difference between "GAMA Level 2" and "GAMA Level 1" data as explained later in this appendix. The same incremental cost distribution is used for all sizes of water heaters. Note that the cost data reported for heat traps are different for electric and gas-fired water heaters.

E-3.2.4 Plastic Tank

GAMA provided no data for this design option. The incremental cost distribution was provided by the consultant. The cost range varies -5% to +10%. The same incremental cost distribution is used for the all sizes of water heaters.

E-3.2.5 Insulated Tank Bottom

We used incremental cost distribution provided by consultants. The same incremental cost distribution is used for the all sizes of water heaters.

E-3.2.6 Side Arm Heater

GAMA provided no data for this design option. The incremental cost distribution was provided by the LBNL consultant. The cost range varies -10% to +20%. The same incremental cost distribution is used for all water heater sizes.

E-3.2.7 Electronic Ignition

The frequency distribution of the incremental manufacturing costs is calculated as a cost difference between "GAMA Level 6" and "GAMA Level 1" data as explained below. The same incremental cost distribution is used for the other size water heaters.

E-3.2.8 Improved Flue Baffle

The frequency distribution of the incremental manufacturing costs is calculated as a cost difference between "GAMA Level 5" and "GAMA Level 1" data. The same incremental cost distribution is used for the other size water heaters.

E-3.3 CUMULATIVE DISTRIBUTIONS TO FREQUENCY DISTRIBUTIONS

It was assumed that the cumulative manufacturing cost distributions reported for the existing baseline water heater and the water heater with other additional design options were highly correlated. This assumption allows the difference between these two cumulative curves to be determined.

A plot of the difference between the cumulative cost curves of heat traps and baseline gas-fired water heaters shows each segment separately as in Figure E-3.4. What can be seen in this plot is that some of the segments spread across a much larger range of costs, so that the sample density, in samples per dollar, is much lower. Also, many of the segments overlap in cost.

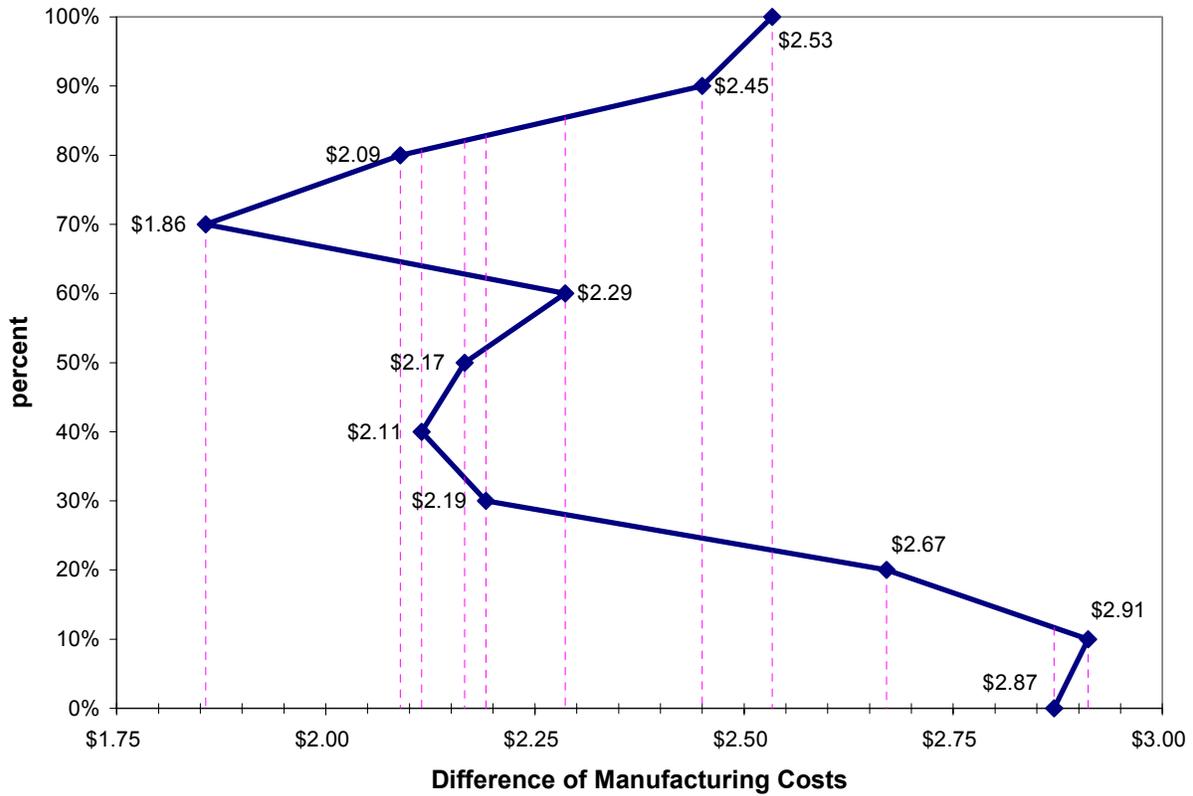


Figure E-3.4 Difference Between Cumulative Cost Curves of Heat Traps and Baseline Gas-Fired Water Heaters

A constant sample density throughout each segment is assumed. With this assumption, it is possible to assign a fraction of the samples in each segment to any cost range the segment spans. The segments are then divided at the points where the cost ranges overlap and the fractions of samples are assigned to the new smaller cost ranges.

The fractions of the original segments are combined where they span identical cost ranges to give the relative frequency of samples within each cost range. This data can be plotted as a histogram of the frequency of samples by incremental cost for that design option. This is done for heat traps on gas-fired water heaters in Figure E-3.5.

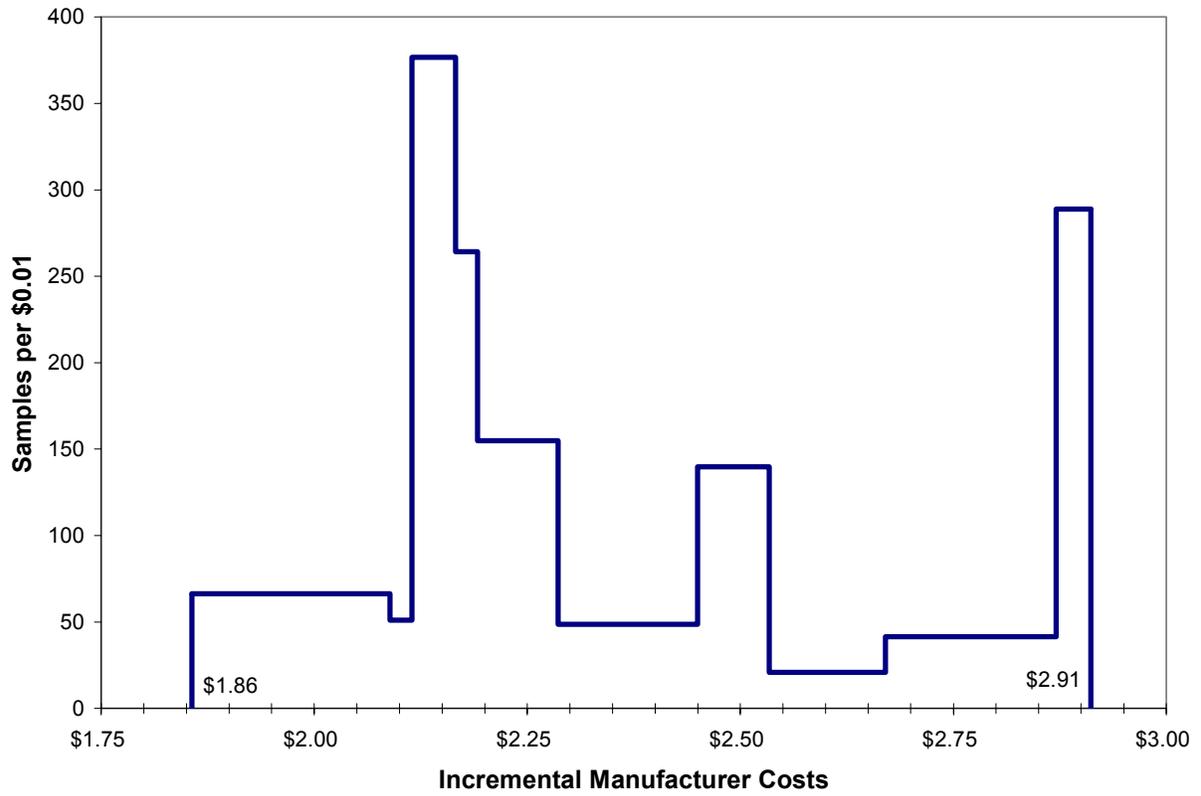


Figure E-3.5 Incremental Manufacturer Costs of Heat Traps on Gas-Fired Water Heaters

REFERENCES

1. Gas Appliance Manufacturers Association, *GAMA Cost Data*, 1998. Received by LBNL on October 20, 1998.
2. Minniear, M., *Residential Water Heaters: Initial Estimates of Manufacturing Costs and Energy Consumption*, November 12, 1997, Minniear Corporation. Panama City, FL. Report No. Task 1 of LBNL Subcontract No. 6466797.
3. U.S. Department of Commerce-Bureau of the Census, *Current Industrial Reports for Major Household Appliances (MA36F)*, 1997. Published 25 August, 1998, revised 23 September, 1998. <<http://www.census.gov/industry/ma36f97.txt>>