

ANALYSIS OF 12 JAPANESE REFRIGERATORS IN THE NORTHWEST

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INTRODUCTION

In 1987, Bonneville Power Administration (BPA) started a project to collect and analyze the energy consumption of 12 Japanese-made refrigerators in the Portland-Vancouver metropolitan area. This project's purpose was to collect field data on certain models and compare data collected in other projects and laboratory tests.

Twelve BPA employees placed Japanese refrigerators in their homes for 18 months, and sent in weekly data cards. The information on the card included: site identification number, meter reading for refrigerator energy consumption, door counter number, kitchen air temperature, and any comments the participant felt pertinent to the project. Kitchen air temperatures were only monitored during the last 4 (winter) months of the project. Summertime kitchen air temperatures were not available. Data from the cards were analyzed using a spreadsheet. A preliminary report of the data was issued in March, 1989.

This study determined weekly, monthly and annual average and peak energy consumption of Japanese refrigerators in 'real world' settings. Comparisons relate these figures to tested values from DOE and Japanese manufacturers. Correlations related energy consumption with environmental factors--such as kitchen temperature and number of door openings--to investigate dominant influences on refrigerator energy consumption. Matched pair analysis was also performed.

A BPA report presents those analyses [1]. An earlier report on this project documents the methodology employed for data filtering, compilation and preliminary analysis [2].

RESULTS

The annual energy consumption of the field units generally fell within a range bound on the low end by Japanese manufacturers' results, and on the upper end by DOE lab tests. (See Table 1.) Field energy consumption averaged 25% higher than Japanese results, and 16% lower than DOE results. This agrees with other studies [3,4,5]. Special options on some units, such as ice makers and anti-sweat switches, appeared to produce high variability in field data relative to DOE and Japanese values.

Peak power consumption for nearly all units occurred in July or August. Peak weeks averaged 59% over average weeks. Peak months averaged 25% over average months. Peak 52-week periods averaged 2% over average 52-week periods.

Causes could include decreasing compressor efficiency, occupants initially being self conscious about using a monitored refrigerator, or changing of refrigerator adjustments. Verification requires further monitoring. Regressions between energy consumption and environmental factors show energy consumption of a refrigerator correlates well with outside temperature. Monthly average outdoor temperature regressed with aggregate energy consumption of all 12 refrigerators gave an $r^2=0.86$.

Regression analysis against kitchen temperatures showed extremely low r^2 values. This observation is in contrast to other reports [3,6], and is probably due to poor data collection for this parameter. Collection of kitchen temperatures occurred only during the last four months of the monitoring period. Occupants often used thermostat setpoints. In other cases, large holes in the data exist. Other

Table 1. Energy Consumption Comparison

Site #	Brand	Energy Use (KWH/yr)				% Difference	
		JPN	Field	Std Dev	Doe	JPN	Doe
531	A-1	704	756	3	1049	7	-28
532	A-1	704	678	10	1049	-4	-35
533	B-1	986	1391	26	1365	41	2
534	B-1	986	1425	60	1365	45	4
535	C-1	792	885	9	1077	12	-18
536	C-1	792	729	5	1077	-8	-32
537	C-2	449	549	2	675	22	-19
538	D-1	449	619	10	679	38	-9
539	B-2	1142	2031	11	1799	78	13
540	B-3	292	413	4	537	41	-23
541	C-3	376	414	3	533	10	-22
542	C-4	365	421	8	573	15	-27
Average		670	859	13	982	25	-16

factors, such as number of occupants and door openings showed low correlation.

Analyses of the three matched pairs produced little information. Very high variability in energy usage, combined with a large number of differing variables, made any correlation insignificant. More controlled study of matched pairs must be performed to obtain meaningful data.

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