

# High-Performance, Coin-Operated Clothes Washer Demonstration and Evaluation

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## ABSTRACT

The California Public Utility Commission's Board of Energy Efficiency identified the multifamily sector as underserved and encouraged California electric utilities to design and implement cost-effective efficiency programs. In response, Southern California Edison (SCE) asked Battelle - Pacific Northwest Division (Battelle) to design and evaluate efficiency programs for Leisure World Laguna Woods (Leisure World), a private, gated, all-electric, retirement community of 18,000 inhabitants with over 99% of the dwelling units being multifamily buildings. One area that Battelle recommended evaluating was coin-operated clothes washers. There are over 300 laundry rooms at Leisure World containing more than 1100 conventional clothes washers owned by the community.

The goal of the program was to verify, through *in situ* demonstration, the performance of selective high-performance, family-size, coin-operated clothes washers. To meet the program goals, Battelle designed and implemented a research agenda that included baseline metering of 12 conventional washers (4 in each of 3 laundry rooms), replacement of the conventional washers, and metering of 12 high-performance washers (4 from each of 3 manufacturers in the 3 laundry rooms). Each washer was end-use metered for hot water, cold water, electricity, and frequency of use. In addition, an analysis was performed of the potential for downsizing standard electric water heaters in these rooms due to reduced hot water demand.

The results of the field verification were positive. If Leisure World converted all 1100 conventional coin-operated clothes washers, the annual savings would be 1 GWh of electricity, 20 million gallons of water, and over \$150,000 in reduced electric and water bills. The annual savings would be greater when coupled with a program to downsize and optimize the water heaters. There would, also, potentially be clothes dryer energy savings due to lower remaining moisture content of the clothes.

## Introduction

In response to increasing electricity demand, escalating cost, and its underserved multifamily sector, SCE commissioned Battelle - Pacific Northwest Division (Battelle) to evaluate the energy and water efficiency of high-performance coin-operated clothes washers installed in a multifamily setting in Southern California (Sullivan et. al. 2000). The site selected was Leisure World Laguna Woods (Leisure World), a prominent all-electric senior citizen community of ~18,000 located in Laguna Woods, CA. This paper gives the results of this evaluation.

The approach included the baseline metering (Phase I) of clothes washers in three laundry buildings located at Leisure World. Each building contains four vertical-axis General Electric (GE) clothes washers. The Phase I effort lasted about six weeks. The Phase II effort followed with the installation of 12 high-performance clothes washers, four from each of three different manufacturers (Maytag, Speed Queen, and Whirlpool). In Phase II, each of the laundry buildings had clothes washers from one manufacture. Table 1 presents the clothes washer characteristics. Note that at the time of the testing, all high-performance washers met the minimum efficiency criteria established by the Consortium for Energy Efficiency; the washers also meet the new ENERGY STAR® criteria for commercial family-sized washers.<sup>1</sup> And, of the new equipment installed, only the Whirlpool is a top-loading vertical axis washer, the other two are front-loading horizontal axis washers.

**Table 1. Participating Manufacturers Clothes Washer Characteristics**

<b>Clothes Washer Manufacturer (Model No.)</b>	<b>Tub Volume (cu ft)</b>	<b>Axis of Rotation of Tub</b>	<b>Clothes Loading Direction</b>	<b>Age of Equipment (years)</b>	<b>Approximate Retail Cost (Dec. 2000)</b>
General Electric/GE (WCCD2050Y) Baseline Clothes Washer	2.7	Vertical (V-axis)	Top	2-14	\$640
Maytag/Maytag Corp. (MAH20PD)	2.85	Horizontal (H-axis)	Front	New	\$1,500 <sup>(a)</sup>
Speed Queen/Alliance Laundry Systems (SWR 261)	2.8	Horizontal (H-axis)	Front	New	\$1,250 <sup>(a)</sup>
Whirlpool/Whirlpool Corp <sup>(b)</sup> (Commercial Resource Saver)	3.0	Vertical (V-axis)	Top	New	\$700-\$900 <sup>(c)</sup>
<p>(a) This washer will qualify for a \$250 water utility rebate beginning in February 2001, per discussions with Joe Berg, Conservation Program Manager, Metropolitan Water District of Orange County.</p> <p>(b) Whirlpool washers in the study are a pre-production commercial version of the residential Resource Saver washer.</p> <p>(c) Whirlpool cost is a best estimate received from sales staff.</p>					

<sup>1</sup> See [www.cee1.org/com/cwsh/cwsh-specs.php3](http://www.cee1.org/com/cwsh/cwsh-specs.php3) and [www.energystar.gov/products/clotheswashers/commercial-cw.shtml](http://www.energystar.gov/products/clotheswashers/commercial-cw.shtml) for certified washers.

## Data Collection

The same parameters were metered in Phase I and Phase II; these were:

- **Clothes Washer Water Temperature:** Water temperature, both hot and cold, was metered using resistance temperature detectors (RTDs) attached to the water supply piping. The RTDs provide the temperature data to the data logger where it is stored in a time-series format. Each washer had one RTD attached to either the hot or the cold water supply piping; thus, multiple (redundant) hot and cold-water temperature measurements were collected.
- **Clothes Washer Water Use:** Water use was metered by water-flow meters installed on the hot and cold supply line to each machine. The water meters are installed in series with the standard washer-hose connections and placed on the floor behind the washers. This is a proven installation technique and, because it does not affect existing piping, it eliminates the need for a plumber's intervention. The meters provide per-cycle (hot and cold) water use data to the data logger, where it is stored in a time-series format.
- **Clothes Washer Electrical Energy Use:** Electrical energy use (washer motor and controls) was metered by a watt transducer. The watt transducer was designed to be plugged into an existing electrical outlet and to have the washer plugged into it. This also is a proven installation technique and, because it does not affect existing electrical circuitry, it eliminates the need for an electrician's intervention. The watt transducer provides per-cycle electricity use data to the data logger, where it is stored in a time-series format.
- **Clothes Washer Utilization:** The total number of cycles per machine was captured by the watt transducer in the form of run-time data. The watt transducer provides the run-time data to the data logger, where it is stored in a time-series format.

The data logger used to record and store the temperature, energy, and water use data is downloaded remotely via the telephone lines on a weekly basis. All data stored in the data loggers were retrieved on a weekly basis. By design, these data loggers communicate, via telephone lines, with a central polling computer located at Battelle. In addition to this polling arrangement being convenient, it also allowed Battelle staff to look at clothes washer use in a real-time format. These data were collected for two six-week periods, one for the baseline phase and one for the high-performance phase.

Also, as a key element in the Phase II activities, Battelle undertook a non-scientific survey of the users of the high-performance clothes washers to ascertain user satisfaction.

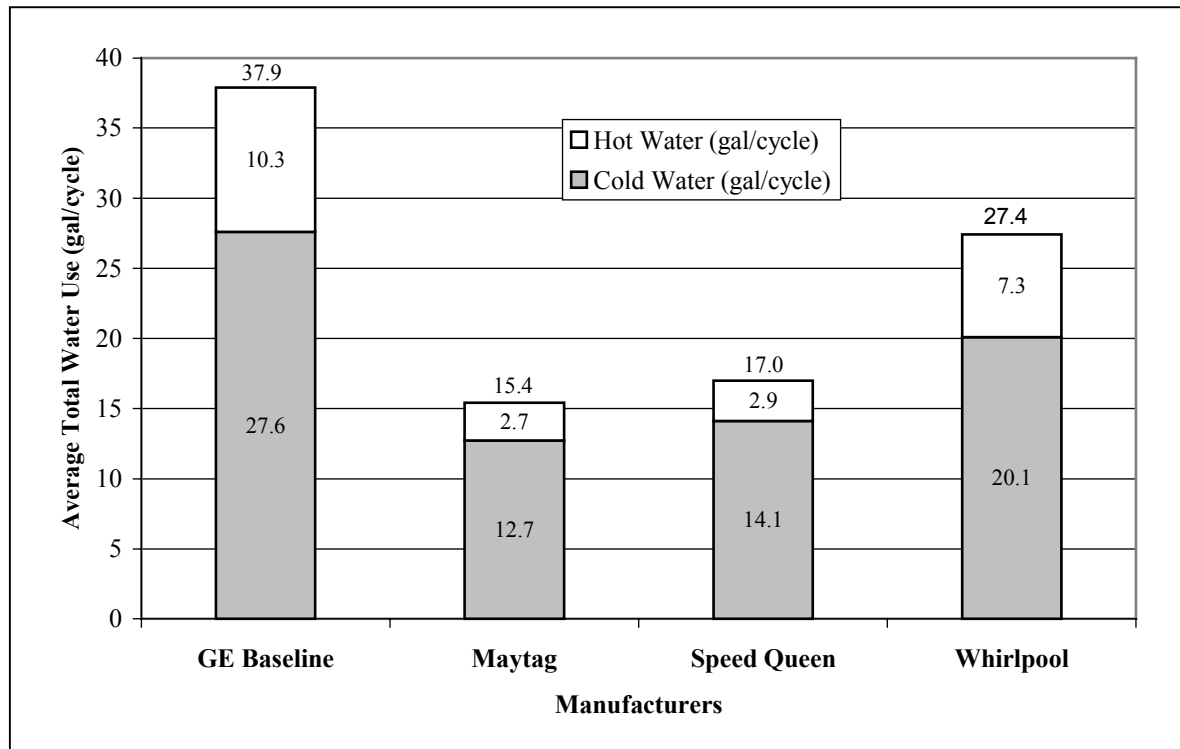
## Metering Results

The efficiency results presented below are from metered data for over 350 clothes washer cycles from each manufacturer's clothes washers. The average number of cycles per day per machine for the study period varied between 1 and 4; the overall average was 2.2 cycles per day per machine.

Figure 1 presents the clothes washer water use in gallons per cycle. All three high-performance washers showed a reduced total water use when compared to the baseline GE

washers. The baseline average water use was 37.9 gallons/cycle, while the Maytag used 15.4 gallons/cycle, the Speed Queen used 17.0 gallons/cycle, and the Whirlpool used 27.4 gallons/cycle. The average water savings compared to the baseline GE washers were Maytag with 22.5 gallons/cycle, Speed Queen with 20.9 gallons/cycle, and Whirlpool with 10.5 gallons/cycle. Table 2 presents these savings and the percentage savings in relation to the GE Baseline.

**Figure 1. Leisure World Average Clothes Washer Water Use (gallons/cycle)**



**Table 2. Summary of Per-Washer Water Savings Compared to GE Baseline**

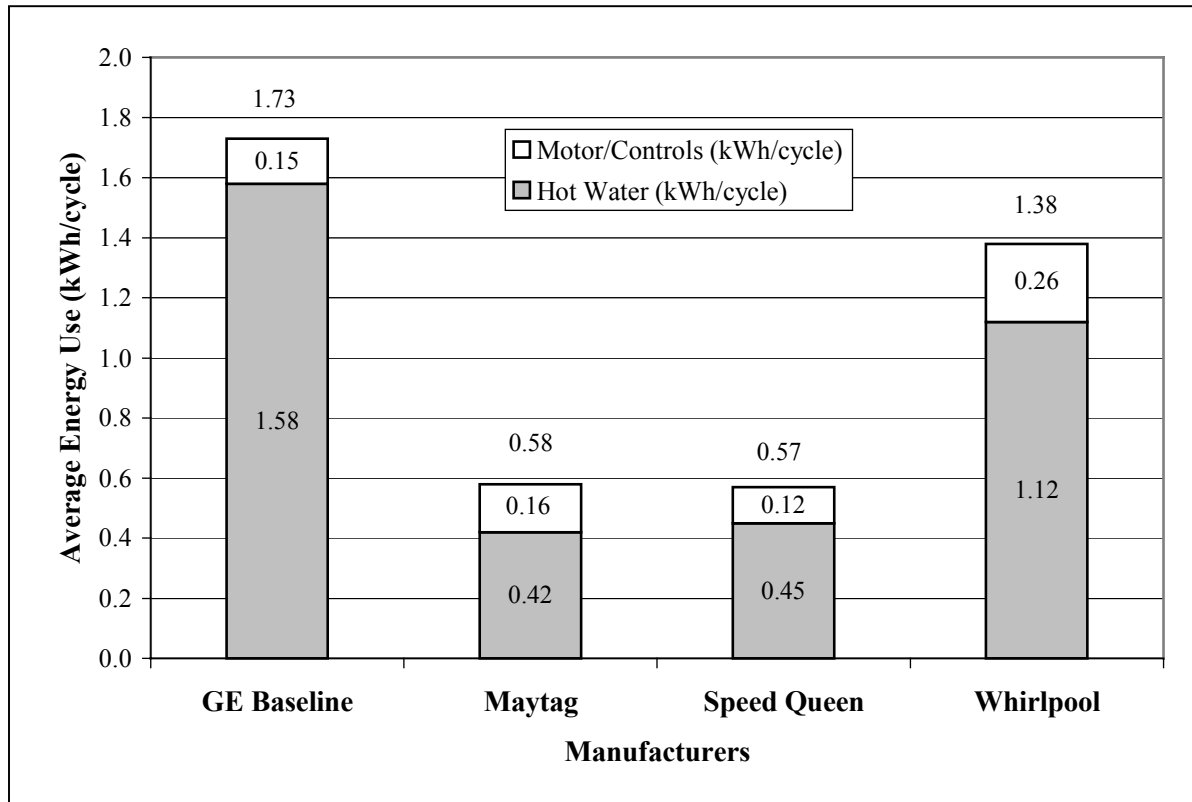
Clothes Washer Manufacturer	Average Water Savings Compared to GE Baseline (gal/cycle)	Percent Water Savings Compared to GE Baseline
Maytag	22.5	59%
Speed Queen	20.9	55%
Whirlpool	10.5	28%

As with the total water consumption, significant hot- and cold-water use reductions were found for the three high-performance washers. Figure 1 also breaks out the total average water use into the hot and cold-water components. The baseline average hot-water use was 10.3 gallons/cycle. The three high-performance washers reduced the average hot-water use to 2.7 gallons/cycle with Maytag, 2.9 gallons/cycle with Speed Queen, and 7.3 gallons/cycle with Whirlpool.

Figure 2 presents the average energy use (hot water and motor/controls energy use) in kilowatt-hours (kWh) per cycle. All three high-performance washers showed a reduced energy use compared to the baseline washer, with Maytag at 0.58 kWh/cycle, Speed Queen

at 0.57 kWh/cycle, and Whirlpool at 1.38 kWh/cycle. Table 3 presents these savings and the percentage savings in relation to the GE Baseline.

**Figure 2. Leisure World Average Clothes Washer Energy Use (kWh/cycle)**



**Table 3. Summary of Per-Washer Average Electricity Savings Compared to GE Baseline**

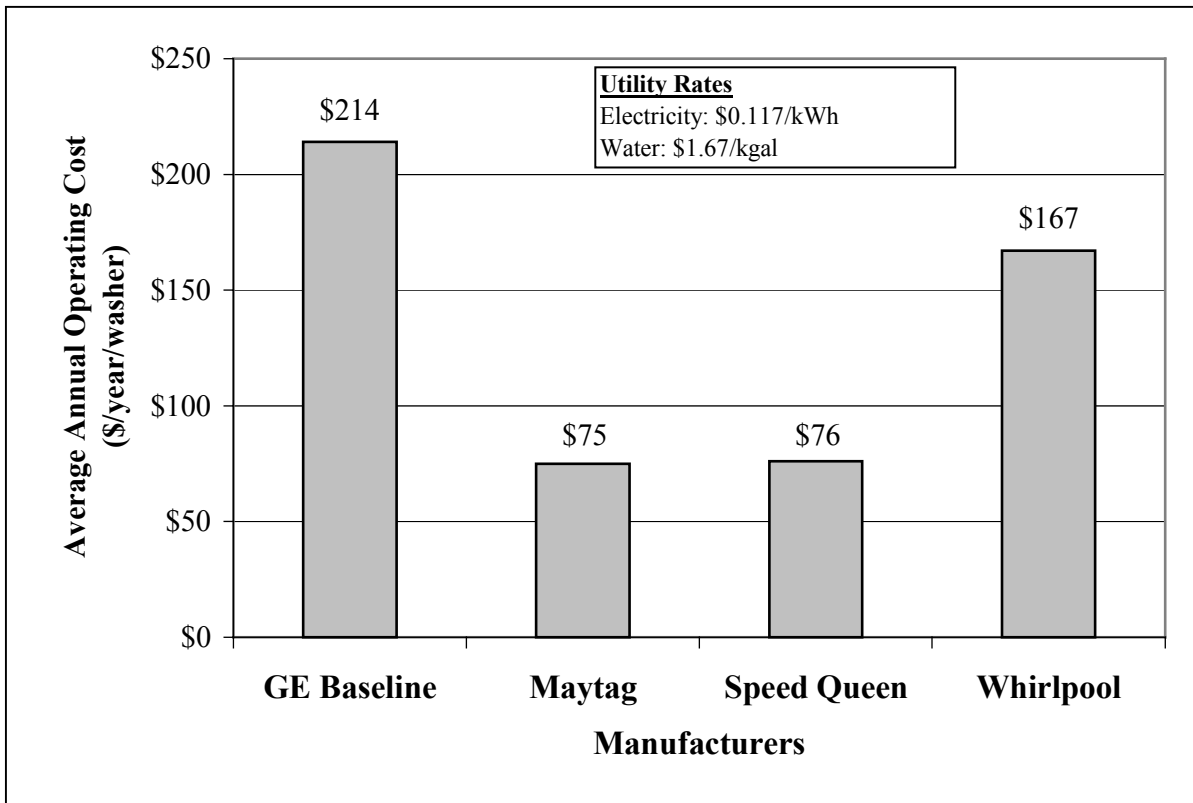
Clothes Washer Manufacturer	Average Electricity Savings Compared to GE Baseline (kWh/cycle)	Percent Electricity Savings Compared to GE Baseline
Maytag	1.15	66%
Speed Queen	1.16	67%
Whirlpool	0.35	20%

Figure 3 presents the average annual cost of operation for the four washer types at Leisure World. The assumptions used in this calculation include the marginal water prices of \$1.67/1,000 gallons (\$1.67/kgal)<sup>2</sup> and the marginal electricity price of \$0.117/kWh.<sup>3</sup> Additionally, this analysis assumes each machine is used an average of 2.2 times per day; this was the average-use metered during the demonstration.

<sup>2</sup> Water service is provided to Leisure World Laguna Woods by the El Toro Water District. Rate information provided by Michael King, Customer Service Supervisor, El Toro Water District.

<sup>3</sup> Electricity service is provided to Leisure World Laguna Woods by Southern California Edison, Inc. Electricity rate is as reported in GS-1 rate tariff.

**Figure 3. Leisure World Average Annual Clothes Washer Utility Cost**



At Leisure World, relative to the baseline GE clothes washer, all three high-performance washers saved significant amounts of energy and water. Table 4 presents these savings. The resulting dollar savings are \$139/year/washer for the Maytag washer, \$138/year/washer for the Speed Queen washer, and \$47/year/washer for the Whirlpool washer. The difference between the Maytag/Speed Queen savings and the Whirlpool savings reflect the greater water and energy efficiency the front-loading washers had over the pre-production version of the top-loading Whirlpool washer.

**Table 4. Summary of Per-Washer Annual Water, Electricity, and Dollar Savings Compared to GE Baseline**

Clothes Washer Manufacturer	Average Water Savings Compared to GE Baseline (gal/year)	Average Electricity Savings Compared to GE Baseline (kWh/year)	Annual Dollar Savings Compared to GE Baseline (\$/year)
Maytag	18,070	923	\$139
Speed Queen	16,780	931	\$138
Whirlpool	8,430	281	\$47

Finally, there are significant dollar savings potential over the life of the clothes washers by replacing existing GE washers with high-performance clothes washers. Table 5 presents discounted and undiscounted savings for each of the high-performance clothes washers compared to the GE baseline washer. These savings assume a 13-year clothes

washer life and the conservative assumption of no change in either the water or the electricity rates paid by Leisure World over the 13-year washer life.

**Table 5. Lifetime Clothes Washer Savings Summary: Per-Machine Discounted (8%) and Undiscounted Savings Compared to GE Baseline**

<b>Clothes Washer Manufacturer</b>	<b>Lifetime Savings Compared to GE Baseline (discounted at 8%)</b>	<b>Lifetime Savings Compared to GE Baseline (undiscounted)</b>
Maytag	\$1,099	\$1,807
Speed Queen	\$1,091	\$1,794
Whirlpool	\$371	\$611

Given the lifetime savings of \$1,099 (the discounted case), this investment opportunity will show a positive cash flow as long as the incremental cost of the new washer (over the baseline washer) does not exceed \$1,099. In the case of the Maytag washer, the incremental cost is \$610, \$1,500 (retail cost) - \$250 (water utility rebate)<sup>4</sup> - \$640 (GE cost) = \$610. Therefore, the net positive savings from investing in the Maytag washer is about \$490 per washer. Again, it should be pointed out that these dollar savings represent a conservative estimate. These calculations did not take credit for expected increases in utility costs, which, when implemented, would serve to improve the cost-effectiveness of the project. While this investment not only offers a positive cash flow today, but it also affords a method of hedging against future utility cost escalations.

### **Total Laundry Room Savings Potential**

The savings ascertained in this study is but one piece of the total potential laundry room savings at Leisure World. Taken as a system, the interactions between the clothes washer, the clothes dryer, and the water heater, represent a significant energy-efficiency opportunity. While this study evaluated the savings potential of only the clothes washers, the authors feel there is significant opportunity to achieve additional savings, by treating the laundry room as a system. The additional savings would result from reduced dryer energy use (clothes removed from an H-axis washer are typically dryer due to the high spin speeds achieved compared to the V-axis washer), and through the proper sizing of hot water heaters now serving a greatly reduced hot water load.

### **User Evaluation of the High-Performance Washers**

High-performance clothes washers are expected to save operating dollars through reduced electricity, water, and sewer bills. However, demonstrating that operating dollars can be saved may not be sufficient for Professional Community Management (PCM) to recommend switching to high-performance machines. The high-performance washers should be acceptable to the people who use the laundry rooms.

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<sup>4</sup> Per discussions with Joe Berg, Conservation Program Manager, Metropolitan Water District of Orange County, the Maytag and Speed Queen washers will qualify for a \$250 high-performance washer rebate. This rebate program began accepting applications on 2/1/01 and offers rebates retroactively to 7/1/00.

Since we could find no studies on senior citizen acceptability of high-performance coin-op clothes washers, we recommended to PCM and SCE that we formally document residents' evaluation of the three different high-performance models being used in the Leisure World demonstration.

Our approach was to survey residents who used the three laundry rooms housing the high-performance washers. The survey was conducted near the end of Phase II metering in order to allow residents to have sufficient experience with the high-performance washers to form a solid opinion.

First, we developed a 23-question survey instrument for interviewing the residents. Second, PCM announced that we would be available in each laundry room over a designated 3-day period to offer any resident free washing in exchange for their opinion regarding the washers in that laundry room. Third, we administered the surveys December 5 through 7. In addition to free washing, we gave each interviewee a free screw-in subcompact (sub-CFL) light bulb. To give every resident the opportunity to express his or her opinion, PCM provided us with the building addresses of residents most likely to use one of the three laundry rooms. We went to 100% of the residences offering a free sub-CFL in exchange for a completed survey.

## Evaluation Results

We received 64 completed survey forms. There were three questions (#3, #13, #18) that were "bottom line" oriented regarding residents' evaluation of the high-performance washers. The results for these three questions are shown in Table 6.

**Table 6. Leisure World Clothes Washer Demonstration Results to Survey Questions #3, #13, and #18**

Clothes Washer Manufacturer	New Washer Same or Better	Somewhat or Very Satisfied	Keep the New Washers
Maytag	81%	73%	63%
Speed Queen	57%	78%	57%
Whirlpool	38%	64%	50%
Total	66%	72%	58%

In completing question #3, "comparing the old equipment and the new equipment," 66% of the residents said the new machines are the same or better than the old machines. The Maytag washer faired the best, with 81% of the residents indicating that this washer is the same or better as the old machines. Overall, 36% of the residents indicated that the new equipment is "much better" than the old equipment with 44% of the residents using the Maytag indicating this washer to be "much better."

In completing question #13, "How satisfied are you with the new washing machines?," 72% of the residents indicated they were at least somewhat satisfied. The Speed Queen faired the best, with 78% of the residents indicating that they were at least somewhat satisfied with this washer. Overall, 44% of the residents indicated that they were "very satisfied" with the new washers. Maytag, Speed Queen, and Whirlpool scored 44%, 43%, and 43%, respectively, by residents on being "very satisfied."

Respondents were given an opportunity to explain their answers to question #3 and #13. "You cannot get clothes clean using so little water" was a common theme for those not



liking the washers. Some people found it difficult to bend over to load the washers. However, after completing the survey, at least two people who expressed this view were asked if they found it difficult bending over to use the dryers, and they responded that it was not difficult to use the dryers. More than one respondent mentioned not being able to do a full load of clothes due to the small drum size. Table 1 shows that the drum for each of the three high-performance models is larger than the drum in the baseline GE models. One person demonstrated that one of the Maytag washers would, at times, “eat quarters.” Finally, the most often mentioned annoyance was associated with the Speed Queen and Maytag washers. Once the wash cycle begins, the washer door cannot be opened. Thus, if the user discovers after the fact, that he/she did not put all of the dirty clothes in the washer, it is not possible to open the door and toss the item into the drum.

Many respondents indicated that the clothes seemed cleaner compared to the GE washers. Some respondents liked the fact that the washers were new and “high tech.” Others mentioned that the high-performance machine was easier to use and that it required less detergent than did the GE washers.

In completing question #18, “given the choice of keeping the new machines or replacing them with the old machines,” 58% of the residents indicated that they would “keep the new machines.” Maytag fared the best, with 63% of the residents indicating that they would “keep the new machines.”

In addition to the results summarized above, there were several other questions that could provide useful information to Leisure World and SCE. These are highlighted below.

- 48% of the respondents believe it takes more time to wash a load of clothes with the new washers (it does take longer) and only 6% believe it takes less time to dry a load washed by the new washers (it does take less).
- 75% believe it is at least as easy to load clothes into the new washers as it is with the old washers.
- 83% believe their clothes get as clean using the new washers and 34% believe their clothes are cleaner.
- 73% encountered no problems using the new washers.
- 56% know that the new washers use less water than the old washers.
- 47% know that the new washers use less energy than the old washers.

In summary, the high-performance washers were positively received, with 72% of those surveyed stating they were “somewhat” or “very” satisfied with the washers. The majority of users of the Maytag and Speed Queen washers would prefer permanent replacement of the existing GE washer with these machines. The users of the Whirlpool washer were evenly divided as to permanent replacement of the existing GE washers.

## **Epilogue**

Since this project was completed in December of 2000, and after reviewing the technical/ economic findings and user acceptance, Leisure World has decided to change its purchasing practices and now purchases only high-performance clothes washers.

## Reference

Sullivan, Gregory P., William J. Currie, Tim C. Hillman, and Graham B. Parker. 2000. *Southern California Edison High-Performance Clothes Washer Demonstration at Leisure World Laguna Woods—Final Report*. Prepared for Southern California Edison Company by Battelle – Pacific Northwest Division, Richland, WA.