Demand Response Potential of Residential Appliances –Clothes Washer (GE)

DR10SCE1.16.02 Report

Prepared by:

Design & Engineering Services
Customer Service Business Unit
Southern California Edison

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EXECUTIVE SUMMARY

In response to major electrical grid failures over the past few decades, coupled with the emergence of widespread renewable generation and increased need for understanding energy consumption, there has been a growing push for an electric "Smart Grid". The Smart Grid is envisioned to employ vast networks of communicating equipment, such as "Smart Appliances", which will enable much improved visibility and control over how and when energy is consumed. Southern California Edison (SCE) is demonstrating its vision of the future system in its Irvine Smart Grid Demonstration (ISGD). This project deploys technology on both the utility and customer side of the meter to quantify and demonstrate the benefits of the Smart Grid. As part of this effort and in general, Smart Appliances equipped with Demand Response (DR) capabilities must be fully understood to realize the advantages of the Smart Grid in the residential market.

Outside of the ISGD project, SCE has begun a series of projects to test various Smart Appliances, including those that are part of ISGD. This project evaluated the DR capabilities of a residential front-load clothes washer manufactured by General Electric Company in laboratory setting. The intention of this laboratory assessment was to provide SCE a better understanding of how the clothes washer will respond to certain DR signals before its installation at customer sites. SCE's Technology Test Centers conducted a series of tests on the clothes washer's actual response to DR signals in the controlled environment test chambers. Previously, SCE's Advanced Technology Organization conducted testing on the communications capabilities of the clothes washer. This project collected data on the washer's ability to receive and interpret DR event signals, including event cancellations, respond to multiple events sent simultaneously, as well as other errant event data.

Overall, project findings revealed that the clothes washer performed in a manner compliant with its original intended strategy, but not necessarily in alignment with industry protocols. Because the clothes washer responded to either "high" or "critical" price signals, the DR potential varied depending on DR event price signal, duration, and time of occurrence. The clothes washer demonstrated its capacity to respond to delay load during high or critical price signals. However, these events must be received prior to the start of the washer to have the most beneficial impact. In addition, the clothes washer demonstrated its capacity to reduce load by nearly 50% during critical price signal events during various stages of operation.

Unfortunately, there are discrepancies between the manufacturer-implemented strategy, the DR capabilities and/or definitions proposed in widely recognized guiding documents, as well as the specific needs of electric utilities. These

discrepancies must be resolved before the true benefits of a smart grid may be effectively realized.

ABBREVIATIONS

ACEEE	American Council for an Energy-Efficient Economy
AHAM	Association of Home Appliance Manufacturers
DOE	U.S. Department of Energy
DR	Demand Response
EMS	Energy Management System
EPA	U.S. Environmental Protection Agency
GE	General Electric
HAN	Home Area Network
KWh	Kilowatt-hour
lbs	Pounds
NI	National Instruments
NIST	National Institute of Standards and Technology
SCE	Southern California Edison
W	Watts
Wh	Watt-hour

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INTRODUCTION

In response to major electrical grid failures over the past few decades, coupled with the emergence of widespread renewable generation and increased need for understanding energy consumption, there has been a growing push for an electric "Smart Grid". The Smart Grid is envisioned to employ vast networks of communicating equipment, such as "Smart Appliances", which will enable much improved visibility and control over how and when energy is consumed. Southern California Edison (SCE) is demonstrating its vision of the future system in its Irvine Smart Grid Demonstration (ISGD). This project deploys technology on both the utility and customer side of the meter to quantify and demonstrate the benefits of the Smart Grid. Utilities have taken the lead on Smart Meters and upstream components of the transmission and distribution system. However, in order to fully take advantage of the Smart Grid, energy consumers need access to equipment and appliances that enable communication of rates and grid conditions, and offer integrated control capabilities to respond to the information received. Private industry has advanced with technologies to address these needs.

Several appliance manufacturers have begun implementing advanced control features into their products that are focused on energy reduction and the ability to react to adverse grid conditions or price signals. However, little is known about how Demand Response (DR) capabilities will be implemented. Additionally, the Association of Home Appliance Manufacturers (AHAM) and efficiency organizations coordinated by the American Council for an Energy-Efficient Economy (ACEEE) have recently come together in a formal agreement with regard to appliances.[1] This agreement, which outlines a number of requirements for Smart Appliances, has been used by the U.S. Environmental Protection Agency's (EPA) Energy Star program as a platform for building new programs. This agreement marks a key milestone in promoting the vision of an operating Smart Grid. To better understand the capabilities of these appliances and to inform the EPA's efforts, SCE has initiated a series of projects to test a number of appliances from various manufacturers in a laboratory environment.

[1] AHAM, et al. 2011. "Joint Petition To ENERGY STAR To Adopt Joint Stakeholder Agreement As It Relates To Smart Appliances". www.energystar.gov/products/specs/system/files/Petition_to_ENERGY_STAR_from_Joint_Stakeholders.pdf

In the residential space, a combination of Smart Meters, Home Area Networks (HANs) with energy supervisory software, and Smart Appliances will be needed to fully realize the benefits of the Smart Grid. A key benefit to the utility is the enablement of DR. The smart infrastructure allows the utility to send a signal to a customer's Smart Meter. From the Smart Meter, the signal can take a number of paths to reach the appliance, but ultimately the appliance receives a signal requesting that action be taken to reduce load. The Smart Appliances have built-in algorithms that allow them to determine whether they can respond to the signal while maintaining a minimal level of service to the consumer.

This report focuses on DR laboratory testing and evaluation of a clothes washer manufactured by General Electric (GE). Functional testing was performed in Design and Engineering Service's (DES) Technology Test Centers, and was complemented by the communication testing performed at the Advanced Technology Organization's HAN lab. This testing will give SCE a better understanding of how this specific appliance will react to certain DR signals. The appliance tested in this project is one of three GE appliances to be installed in customer residences as part of the ISGD project. The appliances will then be field tested to determine real world benefits.

BACKGROUND

In California, clothes washers are present in nearly all homes, with a market saturation of 96% for single-family homes.[2] The average unit energy consumption for these clothes washers is 121 kilowatt-hours (kWh).[2] It is noteworthy that this energy value reflects only the consumption due to the motor load and do not account for the water-heating portion.[2]

CURRENT DEFINITIONS FOR "DEMAND RESPONSE" AND "SMART APPLIANCES"

The California Public Utilities Commission defines DR in the following manner:[3]

> *"Demand Response is a resource that allows end-use electric customers to reduce their electricity usage in a given time period, or shift that usage to another time period, in response to a price signal, a financial incentive, an environmental condition or a reliability signal. Demand response saves ratepayers money by lowering peak time energy usage, which are high-priced. This lowers the price of wholesale energy, and in turn, retail rates. Demand response may also prevent rolling blackouts by offsetting the need for more electricity generation and can mitigate generator market power."*

In 2010, joint petitioners to the U.S. Department of Energy (DOE) including the AHAM and ACEEE proposed a guideline defining Smart Appliances.4 Below is the definition of a Smart Appliance as provided on pages 9 and 10 of the Joint Petition:[4]

> *"A product that uses electricity for its main power source which has the capability to receive, interpret and act on a signal received from a utility, third party energy service provider or home energy management device, and automatically adjust its operation depending on both the signal's*

[2] KEMA, Inc. 2010. *2009 California Residential Appliance Saturation Study*. California Energy Commission. Publication Number: CEC-200-2010-004.

[3] http://www.cpuc.ca.gov/PUC/energy/Demand+Response/

[4] AHAM, et al. 2011.

contents and settings from the consumer. The product will be sold with this capability, which can be built-in or added through an external device that easily connects to the appliance. The costs of such devices shall be included in the product purchase price."

"These signals must include (but are not limited to) appliance delay load, time-based pricing and notifications for load-shedding to meet spinning reserve requirements. Any appliance operation settings or modes shall be easy for an average, non-technical consumer to activate or implement. Additionally, a smart appliance or added device may or may not have the capability to provide alerts and information to consumers via either visual or audible means. The appliance may not be shipped with pre-set time duration limits that are less than those listed below, but may allow consumer-set time duration limits on smart operating modes, and will also allow consumers to override any specific mode (e.g. override a delay to allow immediate operation, limit delays to no more than a certain number of hours, or maintain a set room temperature)."

*"**The term 'delay load capability'** refers to the capability of an appliance to respond to a signal that demands a response intended to meet peak load deferral requirements, but which also could be used to respond to a sudden maintenance issue at another time of day.*

*"**The term 'spinning reserve capability'** means the capability of an appliance to respond to a signal that demands a response intended to temporarily reduce load by a short-term, specified amount, usually 10 minutes."*

DEMAND RESPONSE EVENT TYPES

The Joint Petition breaks DR into two specific types of capabilities: Spinning Reserve and Delay Load.[5] The major differentiation is by the event duration feature that accompanies the DR signal. DR events with duration of 10 minutes or less are categorized as Spinning Reserve, while those lasting 10 minutes to 4 hours are categorized as Delay Load. A particular appliance's ability to reduce load depends on the type of DR signal received as well as its operational status when the signal is received. Currently, only durational DR signals are sent by the utilities. In the future, however, it is envisioned that

[5] Id.

price signals, namely time of use, will be sent, thus allowing the Smart Appliance to optimize performance based on the total cost of operation.

As an overarching requirement, DR-capable appliances must still be able to provide consumers with the expected value of their operation without adversely affecting performance. For example, a DR-capable clothes washer should still be able to clean the clothes and not damage them by enacting a DR event. In the same way, a refrigerator must maintain safe temperatures even though it is responding to a DR event. In most cases, short interruptions of appliance operation does not affect the performance.

REQUIREMENTS FOR DEMAND RESPONSE CAPABLE CLOTHES WASHERS

The Joint Petition defines the minimum requirements for each type of appliance.[5] Table 1 summarizes the minimum requirements for DR-capable clothes washers under both Spinning Reserve and Delay Load event types. As noted in Table 1, there is no response required for DR event durations greater than 4 hours.

TABLE 1. MINIMUM REQUIREMENTS FOR CLOTHES WASHERS AS A FUNCTION OF DEMAND RESPONSE EVENT TYPES

DEMAND RESPONSE EVENT TYPE	DEMAND RESPONSE DURATION	MINIMUM REQUIREMENTS FOR CLOTHES WASHERS
Spinning Reserve	Up to 10 minutes	Upon receipt of a signal requesting the start of a reduced load period for a duration not exceeding 10 minutes, the product must automatically reduce its average wattage during this period by at least 50% relative to average wattage during this period in the operating cycle under DOE test conditions.
Delay Load	10 minutes to 4 hours	Upon receipt of a signal requesting a delay of load for a duration not exceeding either 4 hours or such other period that the consumer may select, the product must automatically delay the start of the operating cycle beyond the delay period.
----	Over 4 hours	No Response

COMMUNICATION OVERVIEW AND TESTING

Communication with Smart Appliances can be achieved through multiple hardware configurations. While all of the methods described below can conceptually provide connectivity to the end unit, SCE and other utilities tend to support the second option. It avoids certain risks, especially those related to customer information, that are present in some alternative configurations.

1. Smart Meter ⟺ Gateway ⟺ Smart Appliance:
   The meter receives a signal and communicates to the gateway via Zigbee® or other similar protocols. The gateway translates the signal to communicate with multiple appliances and devices via a variety of communication protocols. Figure 1 depicts this configuration.
2. Smart Meter ⟺ Smart Appliance:
   The meter receives a signal and communicates directly with the appliance using one of many protocols, such as Zigbee. This architecture eliminates the Energy Management System (EMS) shown in Figure 1. Most Smart Meters are limited in the number of devices they can pair with in this manner.
3. Utility ⟺ Smart Appliance:
   The utility communicates directly with the appliance using communication outside of the Smart Meter infrastructure (i.e., AC cycling program using pager technology or direct appliance

communication via the cloud). This method does not make use of either the Advanced Meter or on-site EMS (if any), as shown in Figure 1.

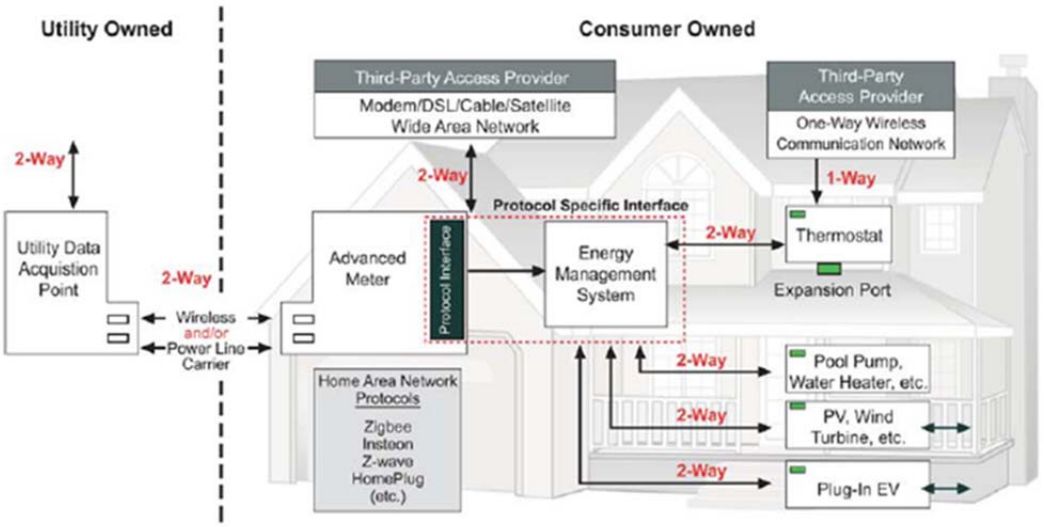

FIGURE 1. TYPICAL RESIDENTIAL NETWORK COMMUNICATION ARCHITECTURE

DEMAND RESPONSE EVENT TYPES FOR THE TESTED CLOTHES WASHER

The DR strategies for this clothes washer were developed prior to the introduction of the AHAM definitions. As a result, different terminology and signal classifications must be sent in order for the clothes washer to take action. The two DR event types that the GE clothes washer was able to identify were "high" and "critical" price signals. Under the "high" price signal, the washer delays the start. Under the "critical" price signal, the washer reduces both the wash and heater duty cycle by half. Both "high" and "critical" price signals contained DR event duration.

ASSESSMENT OBJECTIVES

The goal of this assessment is to observe the clothes washer's response to DR signals and quantify the demand reduction that can be expected during different stages of operation. Specifically, the main objectives of this project are to observe and quantify performance when:

1. Operating under various cycle selections – for establishing baseline
2. Critical DR signal is received during fill, wash, rinse, and spin periods
3. Critical DR signal is received for various water temperature settings
4. Critical DR signal is received for various clothing soil levels
5. Critical DR signal is received for various spin speeds
6. Critical and High DR signals are received prior to the start of wash period

PRODUCT EVALUATION

The GE clothes washer tested was a DR-capable front-load type clothes washer, model PFWS4600L0 (Figure 2). The product was equipped with a liquid crystal display user interface, Zigbee communication via an add-on module (model DRMU1), and an integrated smart control system.

The DR algorithms programmed into the clothes washer aimed at performing the following tasks:

- For "critical" price signal events, reduce duty cycle wash and duty cycle heater at 50%
- For "high" price signal events, delay the start

The scope of testing would both validate the functionality of these algorithms and quantify the DR potential during various stages of operation. Although not an explicit goal, the project also sought to understand how these responses compared to those developed by AHAM. Testing took place in a laboratory environment in SCE's Technology Test Centers, which enabled repeated testing of the appliance using identical loads in controlled environment conditions and with consistent DR signal characteristics. This setting minimized the influence of uncontrolled variables. Furthermore, existing data acquisition equipment could be utilized with minimal infrastructure investment.

FIGURE 2. FRONT VIEW OF THE CLOTHES WASHER UNDER TEST

TECHNICAL APPROACH

Following a series of discussions between GE and SCE, a comprehensive document was compiled on the control algorithms implemented in the clothes washer. Accordingly, a test plan was developed to monitor the washer's performance under various baseline operating conditions, as well as in response to various DR events. The DR test scenarios focused on validating the intended operation algorithms (presented in the "Product Evaluation" section) and therefore do not represent a full demonstration of ALL potential DR event situations.

TEST PLAN

The test plan was roughly modeled after the DOE test method, Appendix J1 of 10 CFR 430 Subpart B.[6] Since the primary goal was to determine DR potential, rather than quantifying energy performance, compliance was limited to instrumentation and general appliance installation and testing practices.

The washer was installed in the controlled environment room at SCE's Technology Test Center. Hot and cold water lines were supplied and a standpipe configuration was established in a neighboring floor drain. A set of baseline tests were designed to capture data on normal wash cycle as a function of clothing fill and soil levels, wash water temperatures, as well as spin speeds (Table 2). These settings can be programmed from the clothes washer's control panel, shown in Figure 3.

[6] The DOE Uniform Test Method for Measuring the Energy Consumption of Automatic and Semi-Automatic Clothes Washers.
http://cfr.regstoday.com/10cfr430.aspx#10_CFR_430pSUBPART_B_APPENDIX_J1

TABLE 2. BASELINE TEST SCENARIOS

TEST NAME	DESCRIPTION	CLOTHING FILL LEVEL	CYCLE SELECTOR	WASH WATER TEMPERATURE	SOIL LEVEL	SPIN SPEED
A	Baseline A	Full	Colors/Normal	Tap Cold	Normal	Medium
B	Baseline B	Full	Colors/Normal	Warm	Normal	Medium
C	Baseline C	Full	Colors/Normal	Hot	Normal	Medium
D	Baseline D	2/3	Colors/Normal	Tap Cold	Normal	Medium
E	Baseline E	1/3	Colors/Normal	Tap Cold	Normal	Medium
F	Baseline F	Full	Colors/Normal	Tap Cold	Extra Light	Medium
G	Baseline G	Full	Colors/Normal	Tap Cold	Extra Heavy	Medium
H	Baseline H	Full	Colors/Normal	Tap Cold	Normal	Low
I	Baseline I	Full	Colors/Normal	Tap Cold	Normal	Extra High
J	Baseline J	Full	Colors/Normal	Cold	Normal	Extra High*
K	Baseline K	Full	Whites/Heavy Duty**	Sanitize [supply only cold water]	Normal	Medium
L	Baseline L	Full	Colors/Normal	Hot [steam assist]	Normal	Medium

*On eWash mode, the spin speed defaults on Extra High.

**Sanitize mode can be activated by dialing cycle selector to Whites/Heavy Duty.

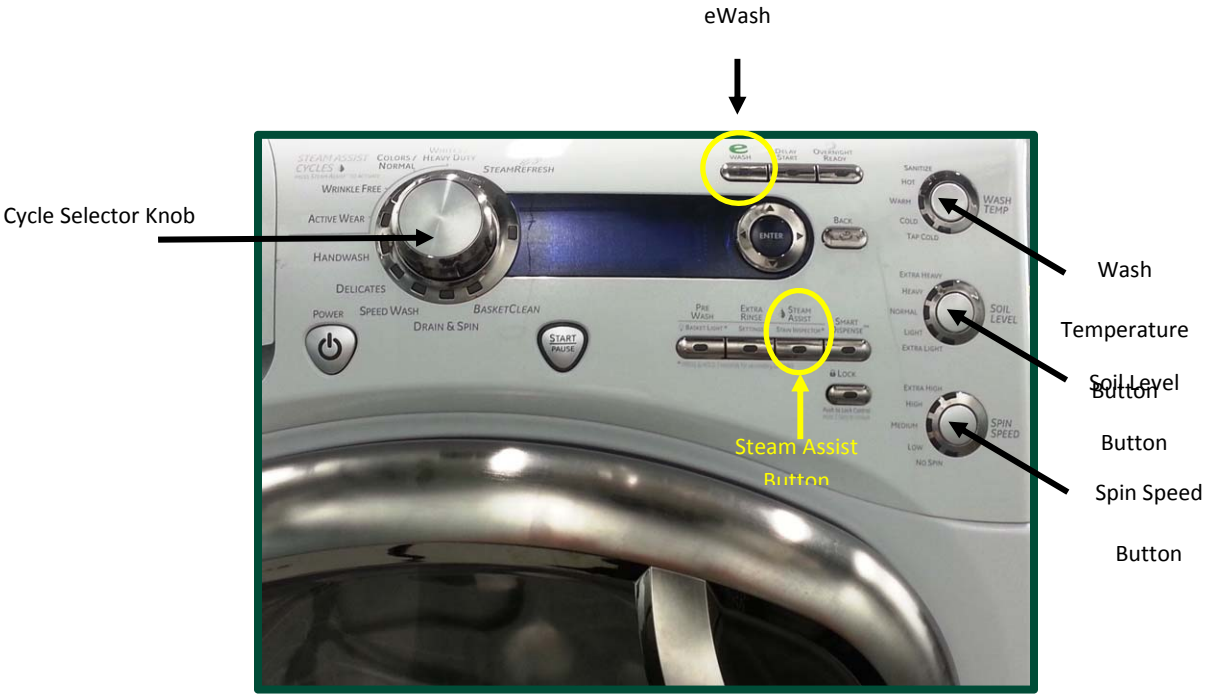

FIGURE 3. CONTROL PANEL OF THE CLOTHES WASHER

Uniform white cotton cloths (Figure 4) were used in place of clothing. A full load was determined to be 10.6 pounds (lbs) by filling the washer's washtub volume entirely with dry unpacked cloth. Accordingly, the 2/3 and 1/3 loads were 7.1 lbs and 3.5 lbs, respectively. The cloth was dried between tests. The material was not dirtied because cleaning performance was not part of the study and because doing so would have introduced additional variables that would have made consistency more difficult.

FIGURE 4. UNIFORM TEST CLOTH

The test plan called for typical hot and cold water temperatures found in residential applications. Historically, 140 degrees Fahrenheit (°F) was a typical setting for residential water heaters[7] and continues to be so in colder climates.[8] However, the California Energy Commission recommends a water heater set-point of 120°F[9] for energy efficiency purposes, which has become standard practice for California residents. Accordingly, the temperature of the supplied hot water was maintained at 120 ± 5°F. However, the temperature of the supplied cold water relied on the incoming city water line, which turned out to be 71 ± 5°F. As part of the test plan, both cold and hot water pressures were maintained at 35.0 ± 2.5 pounds per square inch gage (psig). Additionally, the controlled environment test chamber was maintained at 75 ± 5°F.

A second set of tests was designed to capture the washer's reaction to "high" and "critical" price signal events. The DR events were initiated during

[7] http://www.ehow.com/list_7497272_temperatures-hot-water-heaters.html

[8] http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/waterheater_lifecycle_1098.pdf, (Figure 4).

[9] http://www.consumerenergycenter.org/home/appliances/waterheaters.html

different stages of the wash cycle and with various wash mode settings selected. Figure 5 illustrates a laboratory version of SCE's Smart Meter that was used to generate the DR event signals and communicated wirelessly to the washer via Zigbee interface (Itron OpenWay Development Kit with Zigbee Test Certs, hardware 3.0). Software (Itron DevKit Application Server version 2.0 Build 46 software) allowed the test technician to control all of the signal characteristics and event durations. Table 3 summarizes all DR test scenarios including the DR signal type and duration with the corresponding baseline runs.

To increase confidence in the consistency of washer's performance, all baseline (Table 2) and DR test scenarios (Table 3), with the exception of I2 and J2, were repeated three times. Tests I2 and J2 were added to the test plan later.

FIGURE 5. LABORATORY VERSION OF SMART METER

TABLE 3. DEMAND RESPONSE TEST SCENARIOS WITH CORRESPONDING BASELINE SCENARIOS

DEMAND RESPONSE TEST NAME	BASELINE TEST NAME	DEMAND RESPONSE EVENT SIGNAL-DURATION IN MINUTES	DEMAND RESPONSE EVENT TIMING	CLOTHING FILL LEVEL [CYCLE SELECTOR]	WASH WATER TEMP.	SOIL LEVEL [SPIN SPEED]
A1	A	High-8	initiate event at 1 minute, start wash	Full [Colors/ Normal]	Tap Cold	Normal [Medium]
A2		Critical-8	initiate event at 1 minute, start wash			
A3		Critical-60	start wash load initiate event during fill			
A4		Critical-60	start wash load initiate event during wash			
A5		Critical-60	start wash load initiate event during rinse			
A6		Critical-60	start wash load initiate event during spin			
A7		Critical-8	start wash load initiate event during wash			
A8		Critical-60	start wash load initiate event during spin start 2nd wash 5 minute after 1st wash completed			
C1	C	Critical-60	start wash load initiate event during fill	Full [Colors/ Normal]	Hot	Normal [Medium]
G1	G	Critical-60			Tap Cold	Extra Heavy [Medium]
I1	I	Critical-60			Tap Cold	Normal [Extra High]
I2		Critical-120				
J1	J	Critical-60			Cold	Normal [Extra High]
J2		Critical-120				

Demand Response Test Name	Baseline Test Name	Demand Response Event Signal-Duration in Minutes	Demand Response Event Timing	Clothing Fill Level [Cycle Selector]	Wash Water Temp.	Soil Level [Spin Speed]
K1	K	Critical-60		Full [Whites/ Heavy Duty]	Sanitize	Normal [Medium]

Instrumentation Plan

The backbone of the data acquisition system for the test room and washer consisted of LabVIEW software and National Instruments (NI) hardware as well as a Yokogawa power analyzer. The system currently configured has capacity for 270 sensor inputs.

For this project, instrumentation was designed to follow the requirements of the DOE test method, with additional sensors added to enable more focused analysis of the DR-related performance of the washer. Data were collected every 5 seconds on 22 channels. The sampled 5-second power data were read instantaneously rather than being averaged over a 5-second period. Table 4 lists all of the sensor types, monitoring points, and pertinent accuracy information. All sensors were calibrated to National Institute of Standards and Technology (NIST) traceable requirements prior to installation. Accuracies listed are from sensor manufacturer data and do not necessarily include accuracy of the data acquisition system or calibration.

TABLE 4. LIST OF INSTRUMENTATION

MEASUREMENT	MAKE/MODEL	ACCURACY— NIST TRACEABLE	CALIBRATION DATE (LOCATION)	CORRESPONDING KEY MONITORING POINTS
Dry-bulb	Masy Systems, Ultra-premium probe (type-T thermocouples)	± 0.18°C [at 0°C] (± 0.32°F)	Aug. 2011 (In-house)	• Test room temp.
Temperature	Wilcon Industries, Resistance temp. detector (RTD), platinum 100Ω	± 0.10% of reading	Aug. 2011 (In-house)	• Cold water temp. • Hot water temp.
Water flow rate	Great Plains Industries, GM 1RSP-2	± 0.35% of reading	Jun. 2011 (Manufacturer)	• Cold water flow • Hot water flow
Water pressure	Setra, C207 (0-100 psi)	± 0.13% of full scale	Oct. 2011 (In-house)	• Cold water pressure • Hot water pressure
Power*	Yokogawa, WT1800	± (0.1% of reading + 0.05% of measurement range)	Jun. 2011 (Manufacturer)	• Total power • Motor power • Pump power • Heater power
Scale**	Sartorius, CISL1N-U	± 0.1 gram (± 0.0035 ounces)	Sep. 2011 (In-house)	• Clothing weight

*Data captured internally, not through NI system. Data files were time synced after the fact.

**One-time readings not connected to data acquisition system.

Figure 6 shows the water supply connections and measurement equipment. The drainage valve in the hot water line was opened prior to testing to ensure that water temperature was maintained within the proper range.

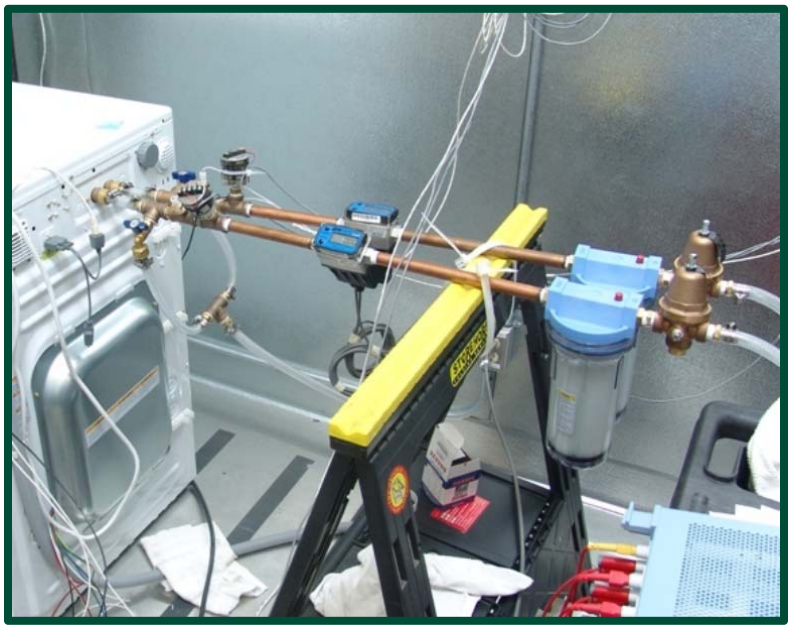

FIGURE 6. INLET WATER SUPPLY LINES AND CORRESPONDING INSTRUMENTATIONS

DATA ANALYSIS

The recorded 5-second raw data were used for graphical presentations and analysis of the key parameters. The analysis involved calculating the arithmetic averages for the instantaneous power demand and temperature measurements. The power demand was used to calculate the energy usage by components and total. Equation 1 shows the format for calculating energy usage, both at the component level and for the total usage.

EQUATION 1. ENERGY USAGE

$$E = \left[\sum_{s=1}^{N} P_s \right] \times \left[\frac{1 \text{ hour}}{(60 \text{ minutes}) \times k} \right]$$

where,

E = energy usage, Wh

P_s = recorded instantaneous power demand for each 5-second sample, W

N = total number of 5-second samples

k = number of 5-second samples per minute, 12

RESULTS

Results are broken into two sections. The first presents the component-level and total power profiles for each of the 12 baseline test scenarios during a complete wash cycle. A complete wash cycle refers to the period when the power and start buttons were pushed until the washer stopped operating. The second compares all 15 DR scenarios to their corresponding baseline scenarios in terms of total power and energy, as well as water consumption for a complete wash cycle. The estimated DR potential is included in this discussion. Test data presented here represent one iteration of each test scenario. Additional iterations can be found in Appendices A and B. All baseline test data are in Appendix A. All DR test data are in Appendix B. Appendix C provides detailed comparative tables.

BASELINE TESTS

Figure 7 through Figure 18 depict the 5-second power demand profile in Watts (W) for the whole washer (or total) and for individual components (motor, water pump, and heater) for every baseline test run. In the figures, the colored bars on the top of the power profiles identify each stage of the wash cycle and provide a general relation between power profiles and stages of the wash cycle. As depicted, the sequential stages of a wash cycle are: fill, agitate (or wash), first drain and spin, first rinse, second drain and spin, second rinse, final drain and spin, and the final tumble stage. In the figures, the elapsed time of "0:00:00" denotes the time when the washer's power button was pushed. The end of the wash cycle is shown and the total operating duration of the washer is noted as well.

Figure 7 shows the power profile of the motor, water pump, and total for the baseline Test A. For this run, the duration of the complete wash cycle was 1 hour, 3 minutes, and 30 seconds. Similarities in the motor and total power demand profile indicated that the motor was the major contributor to the total power of the washer. Clearly, the power demand of the washer was at its highest during the drain and spin stages of the operation. These observations are true for all baseline test runs except for situations where the heaters were operating, specifically Tests K (Figure 17) and L (Figure 18).

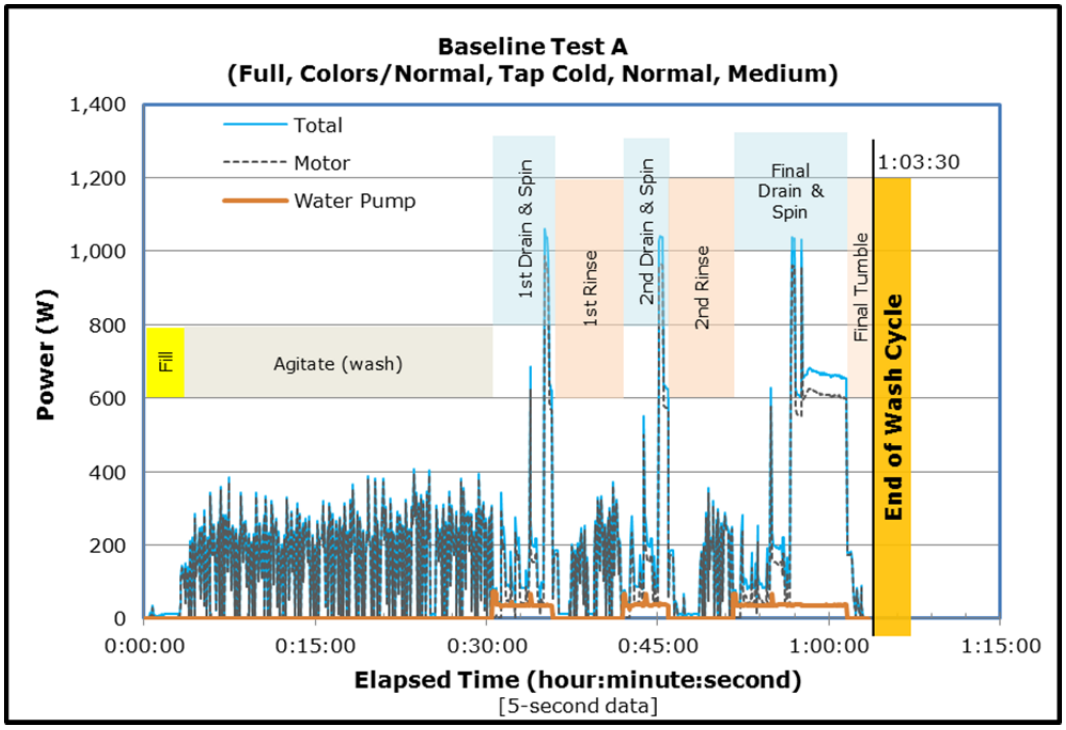

FIGURE 7. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST A

Figure 8 shows the power profile for the baseline Test B, where the water temperature selector was set to Warm. For this test run, the operating duration of the washer was 1 hour, 1 minute, and 50 seconds.

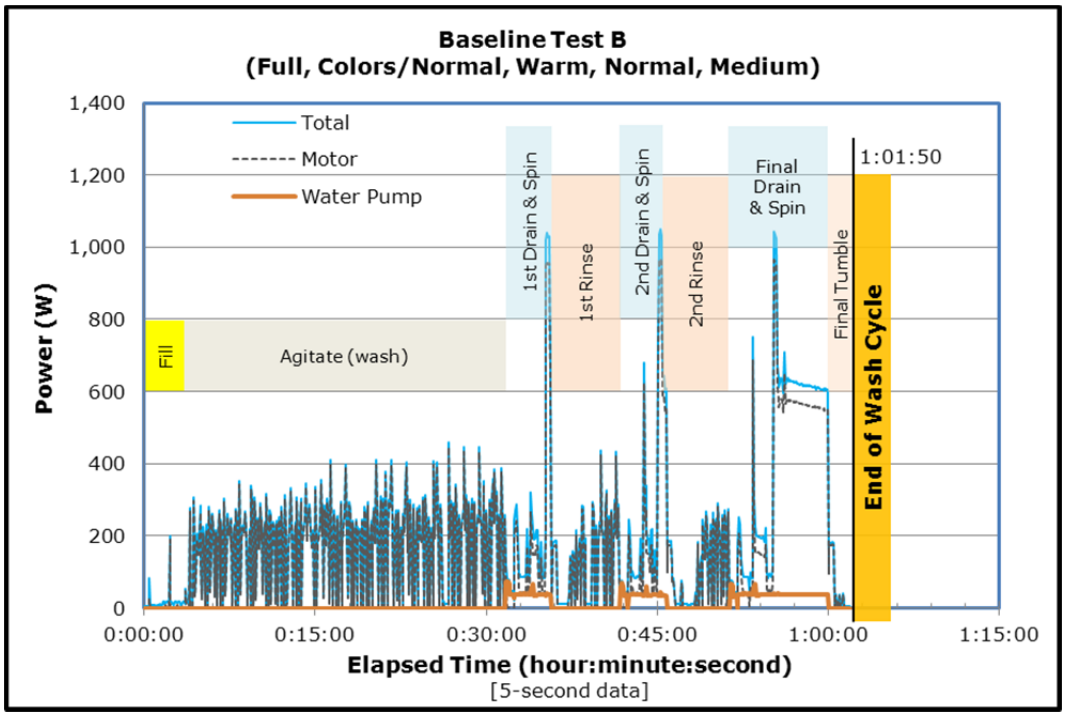

FIGURE 8. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST B

Figure 9 shows the power profile for the baseline Test C with hot wash water temperature setting. The operating duration of the washer under Test C condition was 1 hour, 3 minutes, and 5 seconds.

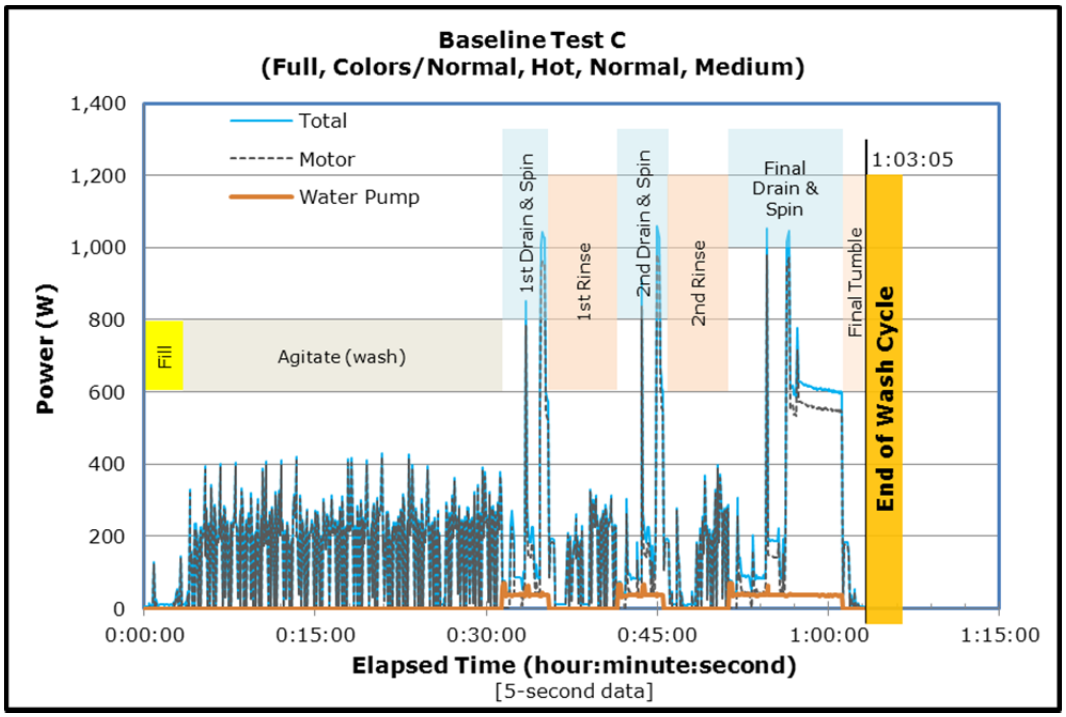

FIGURE 9. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST C

Comparison of baseline Tests B (Figure 8) and C (Figure 9) against baseline Test A (Figure 7) revealed similarities in performance of the washer. Resemblances in the power profiles indicated that changing the water supply temperature from cold to warm or hot had minimal impact on the overall performance of the washer, including demand. In spite of this generality, slightly higher peaks were noticed in the agitate and rinse stages of the wash cycle for Tests B and C. Whereas the motor power—and accordingly the total power during the final drain and spin stage for Tests B and C— were lower than that for Test A.

Figure 10 shows the power profile for the baseline Test D where the amount of clothing in the wash bin was reduced by one-third. For this test run, the operating duration of the washer was 1 hour, 2 minutes, and 10 seconds.

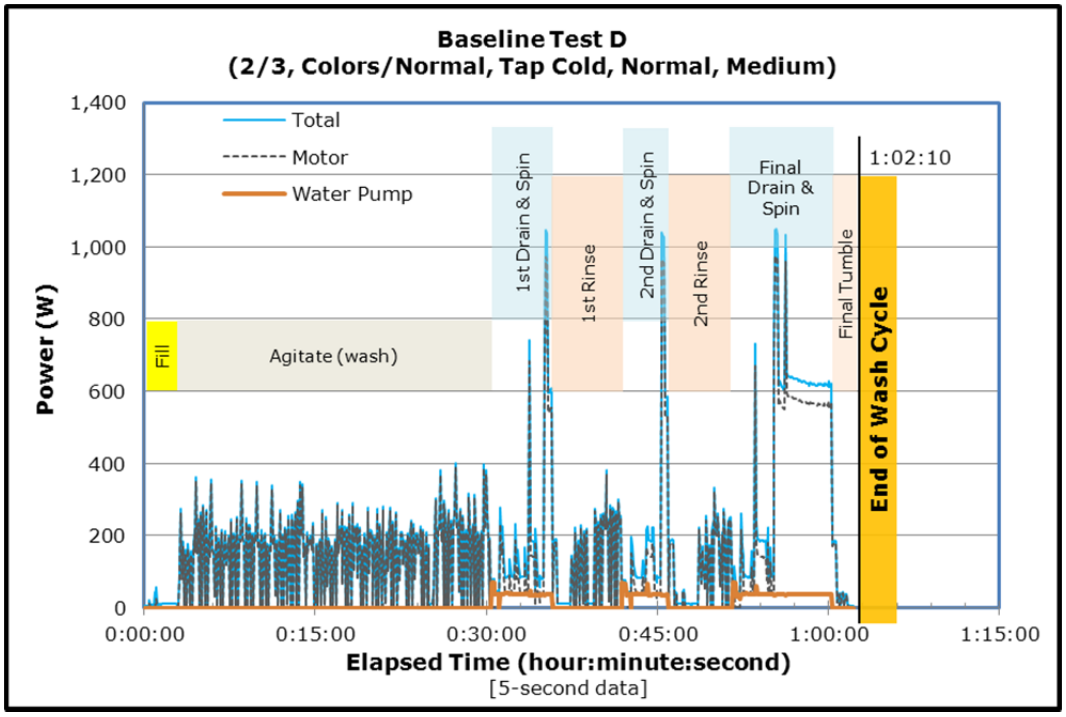

FIGURE 10. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST D

Figure 11 shows the power profile for baseline Test E, where the amount of clothing in the wash bin was reduced by an additional one-third. The operating duration of the washer for Test E was 1 hour and 55 seconds.

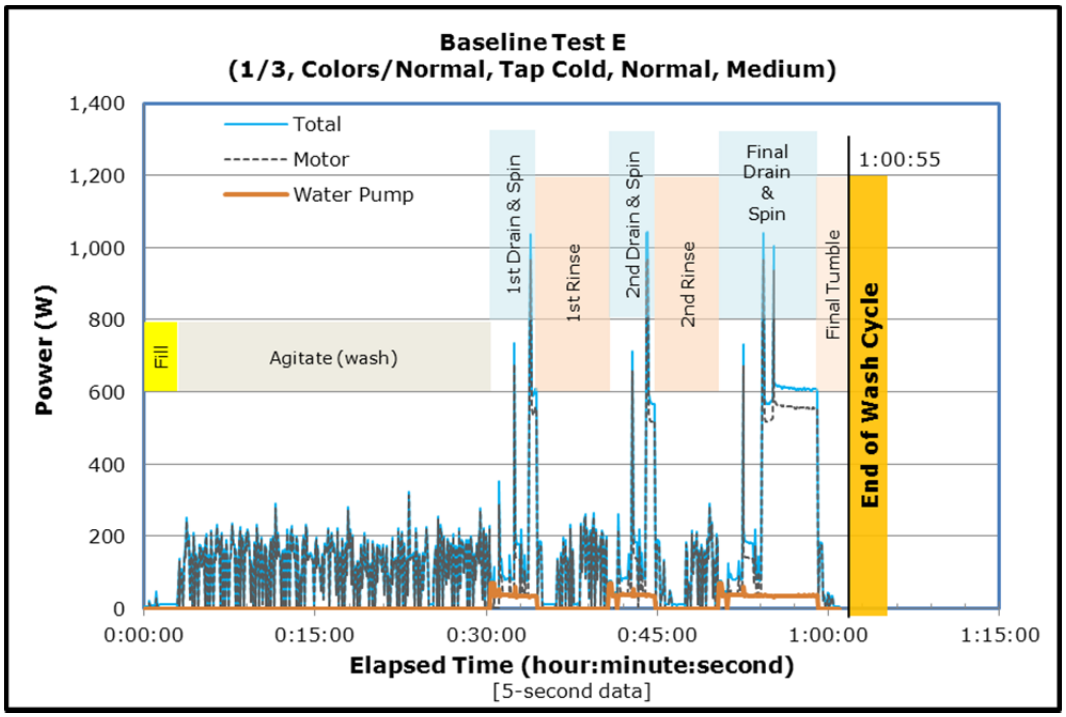

FIGURE 11. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST E

Comparing baseline Test D (Figure 10) with baseline Test A (Figure 7) illustrates that reducing the clothing amount resulted in a slight decrease in motor power, primarily during the agitate stage of the cycle. However, comparison of baseline Test E (Figure 11) with baseline Test A (Figure 7) revealed a noticeable decrease in motor power during the agitate and both rinse stages of the cycle. This result was expected given that the washer had a reduced mass of clothing to move.

Figure 12 illustrates the power profile for the baseline Test F where the soil level was set to Extra Light. For this test run, the washer's operating duration was 50 minutes, and 50 seconds, about 13 minutes shorter than Test A (Figure 7) with 1 hour, 3 minutes, and 30 seconds.

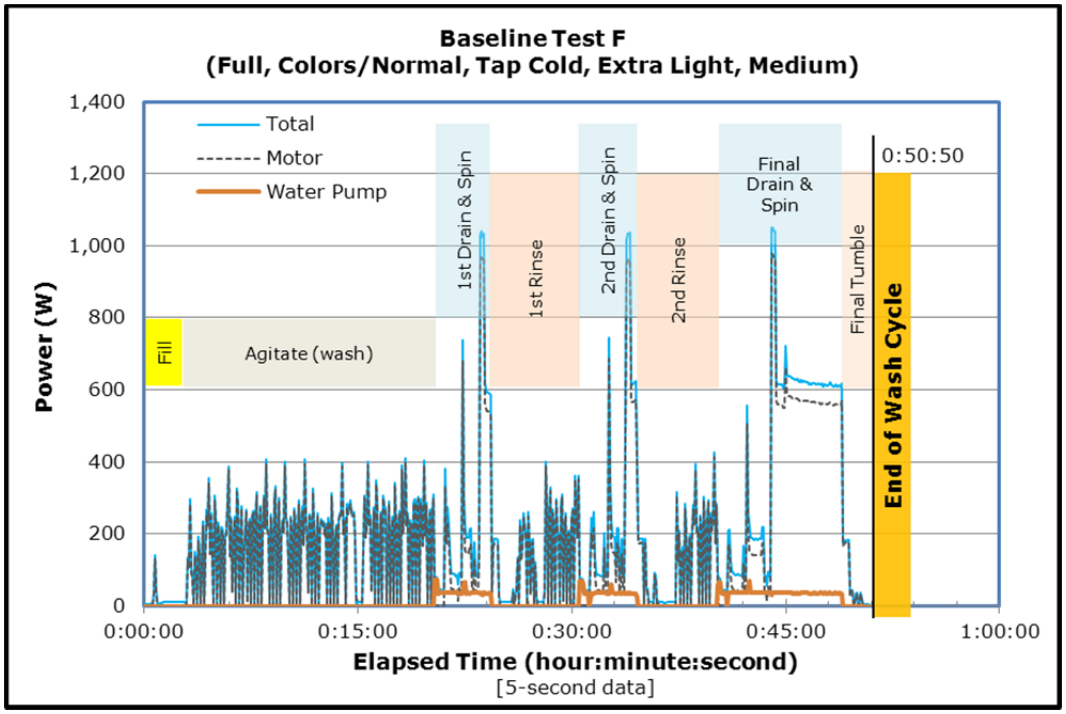

FIGURE 12. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST F

Figure 13 shows the power profile for the baseline Test G where the soil level was set to Extra Heavy. The operating duration of the washer for this test was 1 hour, 15 minutes, and 45 seconds, about 12 minutes longer than Test A.

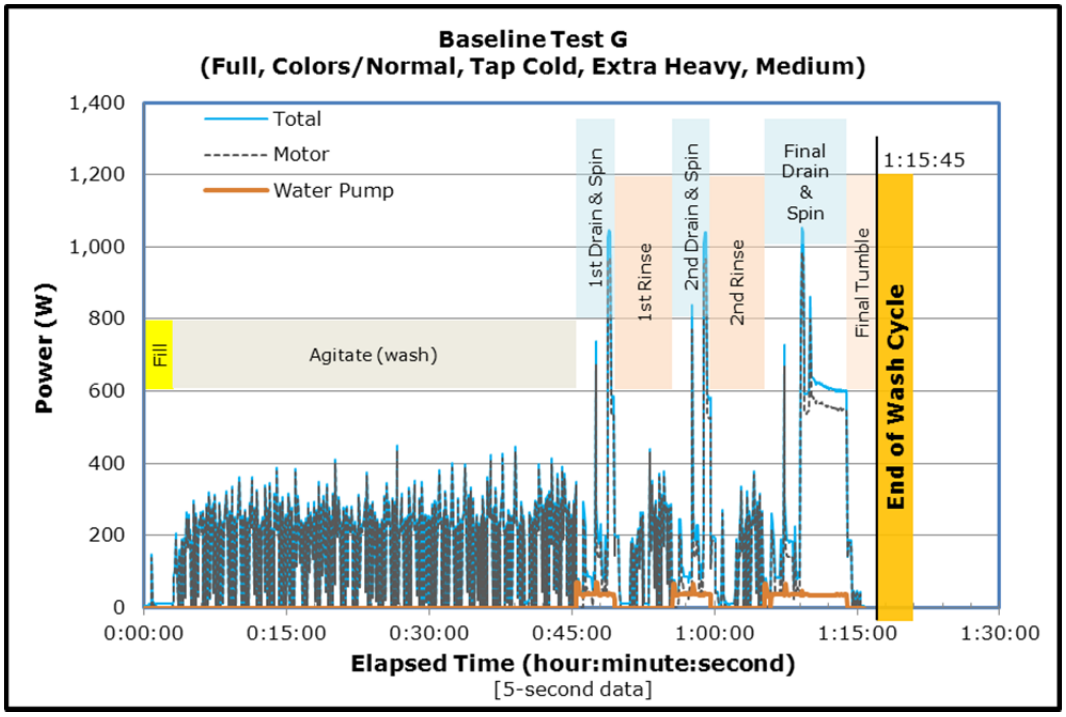

FIGURE 13. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST G

Figure 14 shows the power profile for the baseline Test H with the spin speed set to "low". For this run, the operating duration of the washer was 1 hour and 1 minute, which was very similar to Test A.

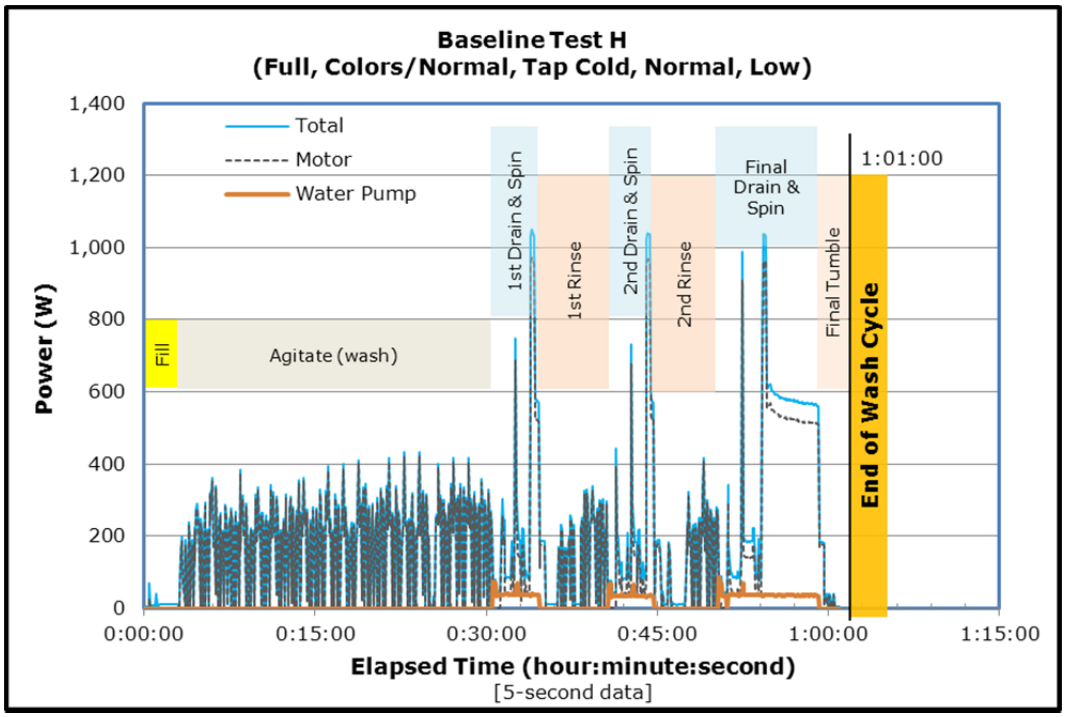

FIGURE 14. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST H

Figure 15 shows the power profile for the baseline Test I with spin speed set to Extra High. The operating duration of the washer for this test run was 1 hour, 2 minutes, and 5 seconds. Overall, higher peaks were observed in Test I in comparison to Test A. The distinguishing characteristic of the final drain and spin stage of Test I was the last two peaks prior to the final tumble. In fact, the total power at the last peak topped at 1,200W.

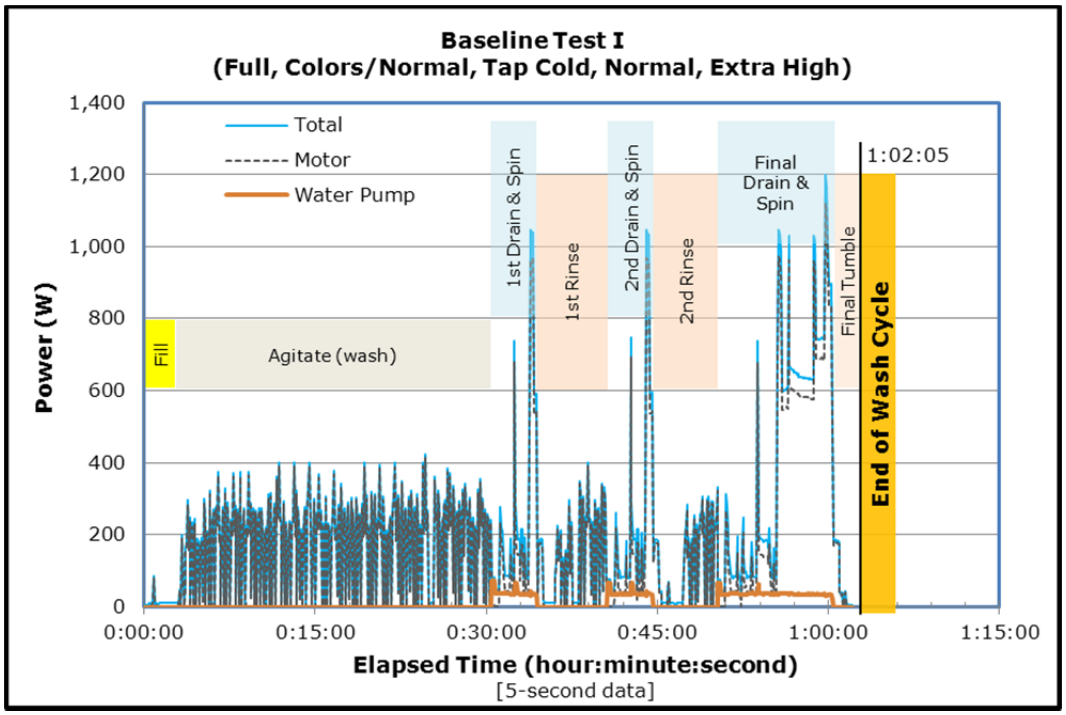

FIGURE 15. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST I

Figure 16 shows the power profile for the baseline Test J. In this test, the washer was set on eWash mode, which according to the manufacturer should produce the same quality wash at the lowest possible energy usage. Like Test I (Figure 15), the distinguishing characteristic of Test J was the final drain and spin stage of the cycle with multiple peaks, or spin cycles. Further, the duration of the final drain and spin stage was longer for Test J relative to Test A, which could be the result of the washer's attempt to squeeze out more water. Therefore, the operating duration of the washer was extended to 1 hour, 11 minutes, and 45 seconds. In general, again, higher peaks were observed in Test J as opposed to Test A.

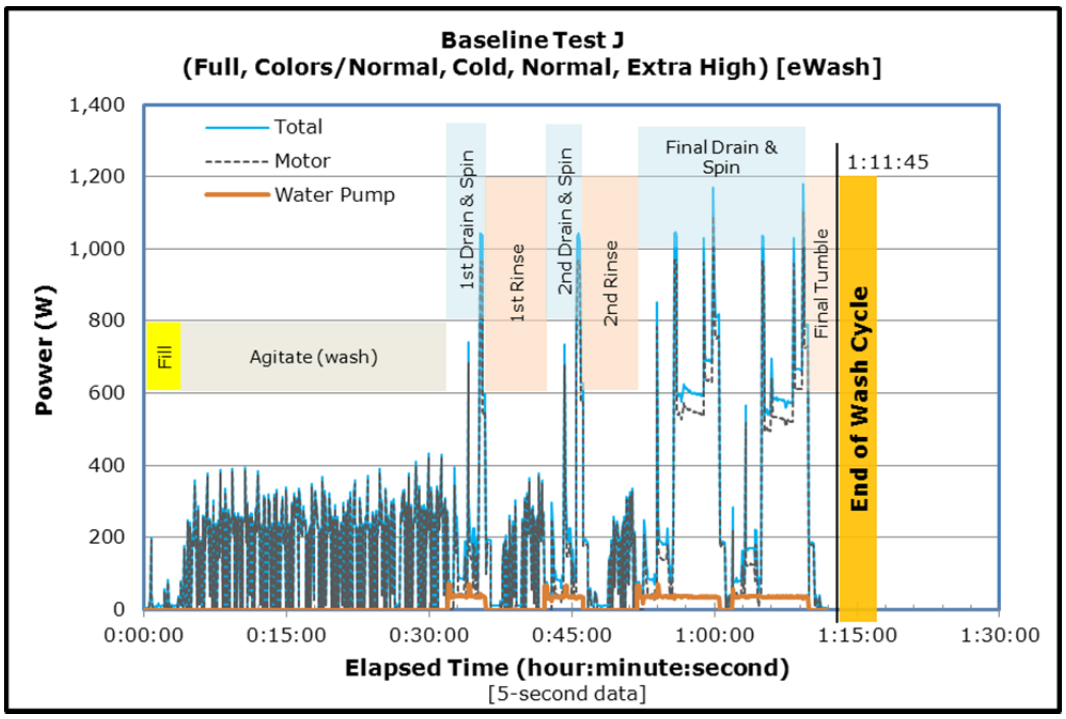

FIGURE 16. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST J

Figure 17 illustrates the power profiles for the baseline Test K. In this test scenario, the washer was set on Sanitize mode while supplying only cold water to the washer. As a result, the internal heater was activated to bring the water to temperature prior to the start of the agitate (wash) stage. In this test, there were two agitate periods, one with the heater and one without the heater. This process increased the operating duration of the washer by more than an hour. Unlike previous test runs, the highest power demand was evident in the agitate with heat stage, where it exceeded 1,300W. This was the result of the heater coming on during this wash cycle. It is notable that the heater comes on and stays on for about 30 minutes, turns off for about one minute, then comes on and stays on for roughly another 44 minutes before turning off completely.

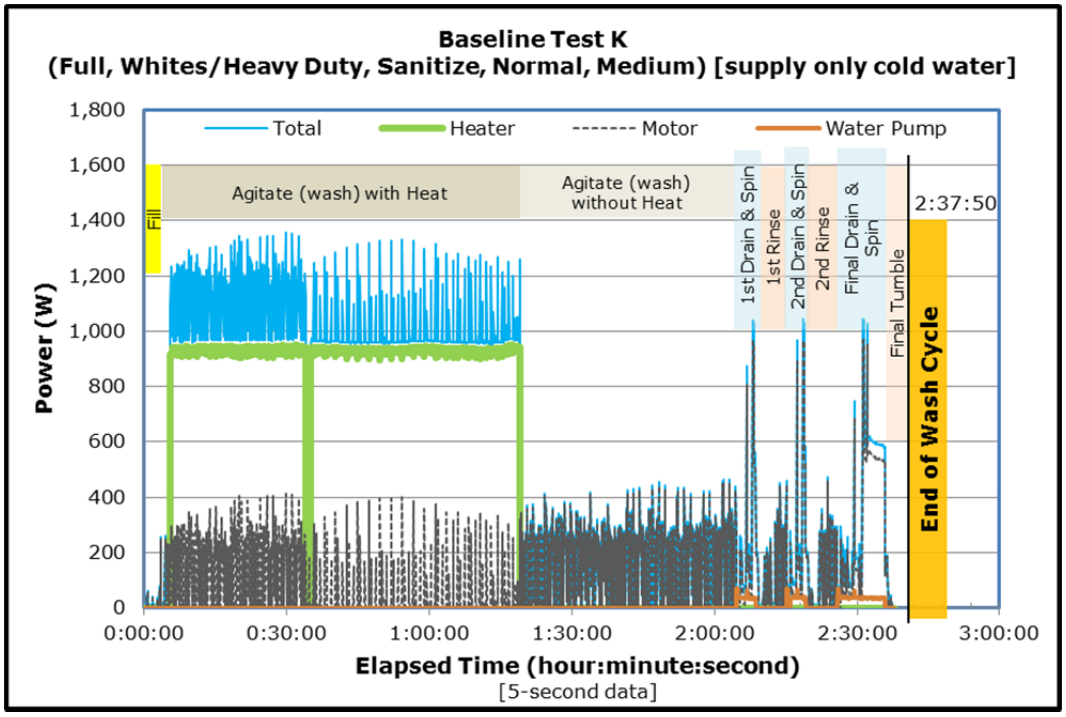

FIGURE 17. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST K

Figure 18 presents the power profiles for the baseline Test L where the Steam Assist was activated. The agitate stage in this test was longer than in Test A. Consequently, it extended the washer's operating duration. In the agitate stage of the cycle, the steam assist heater was activated causing the total power demand to surpass the 1,300W mark.

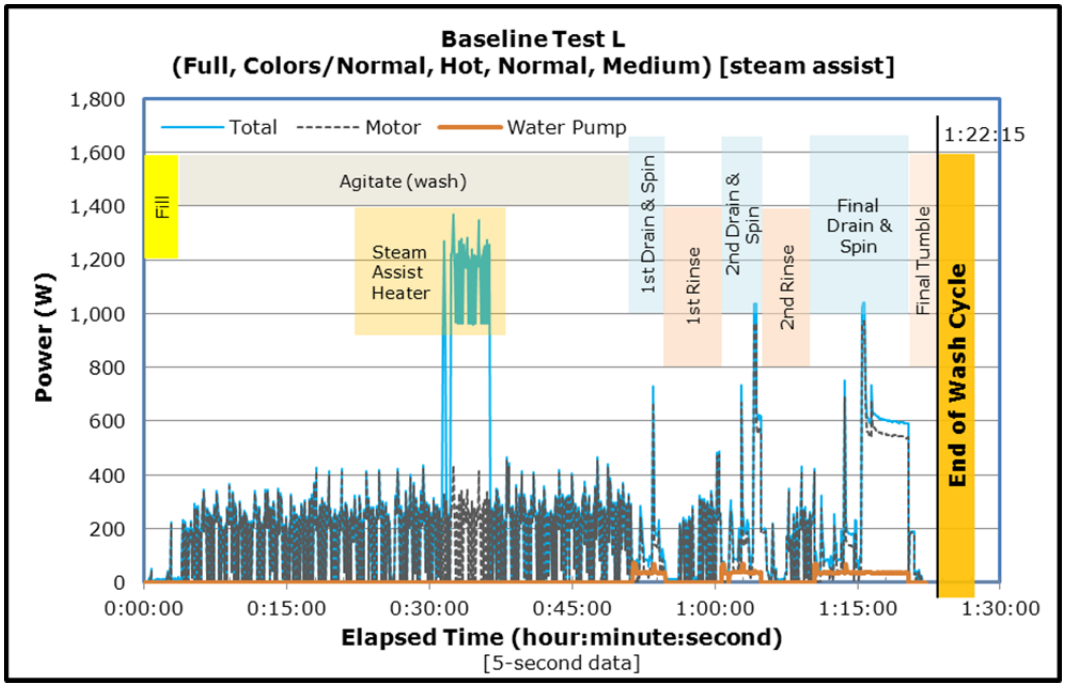

FIGURE 18. POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST L

Figure 19 summarizes the maximum and average total power, total energy, as well as water usage for all baseline test runs. While energy and water consumption of the washer was not a primary focus of the assessment, it can be useful in understanding how various factors affect the washer's overall performance and ultimately the customer's usage. The highest maximum and average total power demand were noted for test runs with the heater operating, specifically Tests K and L. Accordingly, high energy usage values were obtained for baseline Tests K and L. The lowest power and energy values were for Test E, where the majority of the clothing material was removed from the washtub.

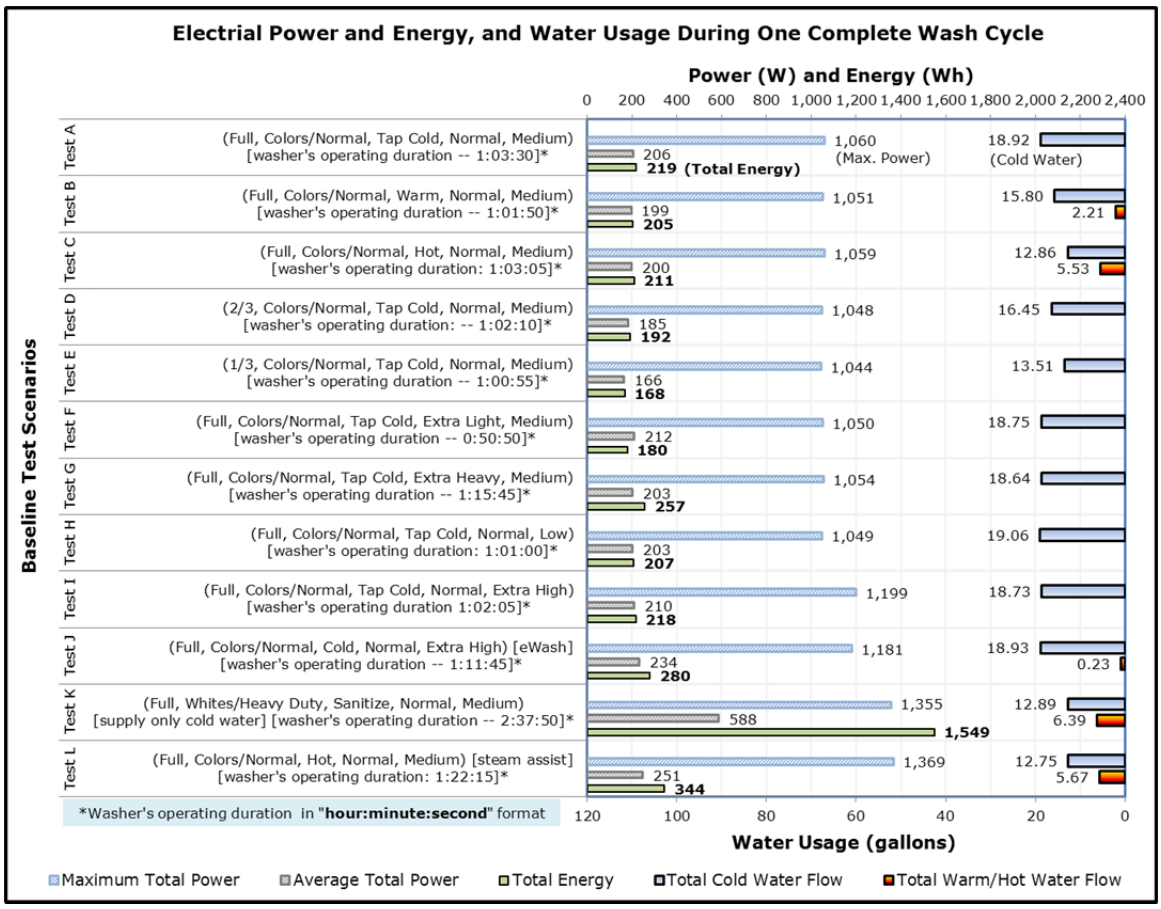

FIGURE 19. SUMMARY OF POWER, ENERGY, AND WATER USAGE FOR ALL BASELINE TEST SCENARIOS DURING ONE COMPLETE WASH CYCLE

COMPARISON OF DEMAND RESPONSE AND BASELINE TESTS

To examine the clothes washer's response to DR events, DR test runs are compared to their corresponding baseline runs. Explicitly, the power profile of the DR test runs are overlaid with the profile from the baseline test runs. The comparison serves to substantiate the functionality of DR algorithms encoded into the washer and to quantify DR potential, as well as the overall impact of DR events on the washer's performance. Note that although energy is not part of the DR potential, it is included in discussions due to its importance. Again, in the figures presented here, the elapsed time of "0:00:00" indicates the time when the washer's power button was pushed. The expected responses, which were discussed in the "Product Evaluation" section, are listed below:

- For "critical" price signal events, reduce duty cycle wash and duty cycle heater at 50%
- For "high" price signal events, delay the start

HIGH PRICE 8-MINUTE EVENT BEFORE STARTING THE WASHER (A1)

In DR Test A1, a high price signal with an 8-minute duration was sent prior to the start of a wash load. Figure 20 compares the total power profile obtained for both baseline Test A and DR Test A1. The DR period is illustrated and the DR potential is noted. The DR period is marked from the time when the DR signal is sent (elapsed time of 0:00:30) until the time when the washer starts its normal operation (elapsed time of 0:10:40). One minute after sending the DR signal (elapsed time of 0:01:30), the washer's start button was pushed. The DR period turned out to be 10 minutes and 10 seconds, even though the signal itself was only 8 minutes. Subsequent re-testing showed various DR periods ranging between 10 minutes and 10 seconds to 11 minutes and 15 seconds.

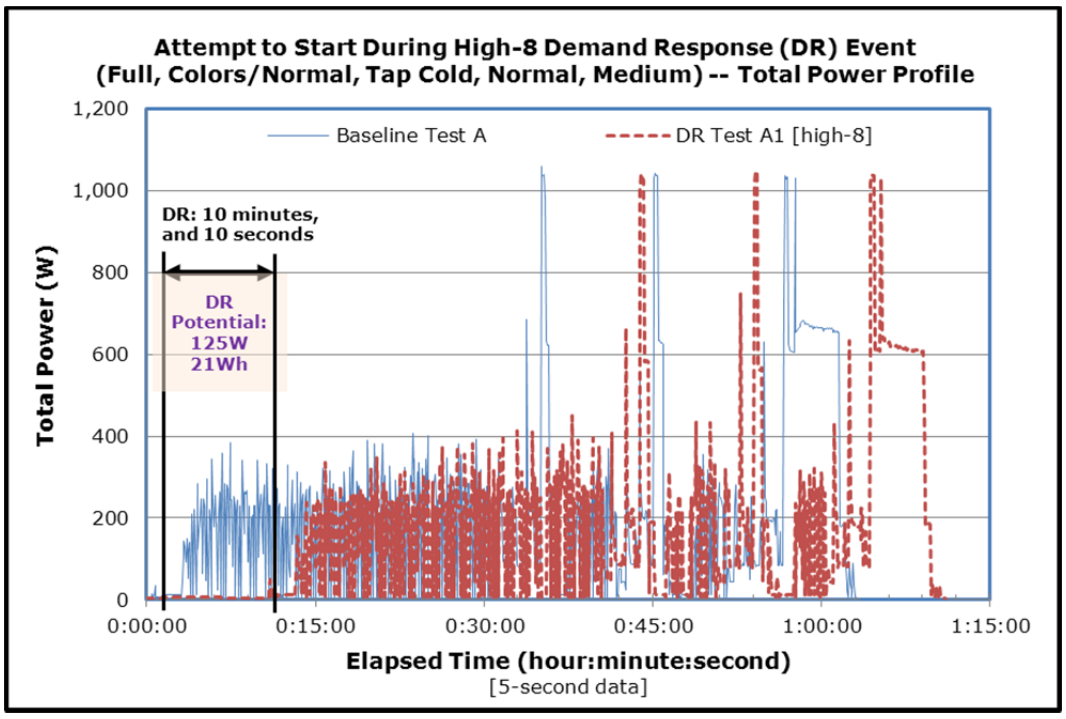

FIGURE 20. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A1

It is evident in Figure 20 that relative to baseline Test A, the wash cycle stages of the DR Test A1 shifted to the right. For the DR test run, the flat power profile during the DR period indicated that the washer was in the idle mode and that there was a delay in the start of the washer. Additional observations include slightly lower power peaks and demand during first and final drain and spin stages of the DR test. Comparing average total power and total energy for baseline and DR run during the DR period established the savings potential from participating in a DR event. Accordingly, during the DR period of 10 minutes and 10 seconds, there was a reduction in

average total power of 125W and a reduction in total energy of 21Wh. Table 5 lists the average total power and total energy usage values for baseline and DR tests during the period when the DR event took place.

TABLE 5. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST A AND DEMAND RESPONSE TEST A1

DATA CATEGORY	BASELINE TEST A [P]	DEMAND RESPONSE TEST A1 [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]
Maximum Total Power (W)	383	6	----
Average Total Power (W)	130	5	125
Total Energy (Wh)	22	1	21

Table 6 summarizes the overall impact of the DR event on the power and energy usage. For the DR Test A1, two operating durations are given, one including the DR period and one excluding the DR period. In relation to the baseline run, the operating duration of the washer with inclusion of the DR period was prolonged by 7 minutes and 35 seconds. This indicates that delaying the start of the washer may or may not result in extending the run time by an equal amount. To have a valid comparison between the baseline and DR run, the power and energy for the DR test excluded the DR period. The average power and total energy were slightly lower in the DR test, which was due to a shorter wash cycle period (1 hour and 55 seconds) in comparison with the baseline. As expected, water usage remained unchanged.

TABLE 6. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A1

DATA CATEGORY	BASELINE TEST A	DEMAND RESPONSE TEST A1
Washer's Operating Duration (hour:minute:second)	1:03:30	1:11:05 (including DR period) 1:00:55 (excluding DR period)
Maximum Total Power (W)	1,060	1,049*
Average Total Power (W)	206	203*
Total Energy (Wh)	219	207*
Total Cold Water Flow (gallons)	18.92	18.50

*Power and energy values exclude the DR period.

CRITICAL PRICE 8-MINUTE EVENT BEFORE STARTING THE WASHER (A2)

In DR Test A2, a critical price signal with an 8-minute duration was sent before starting the washer. By definition, a critical price signal should reduce the duty cycle wash and duty cycle heater by half. However, because the DR event was initiated before the washer started its operation, duty cycle

reductions were not expected. Instead, an 8-minute delay in the start of the washer was anticipated. Similar to DR Test A1, this DR event should delay the operation of the washer.

Figure 21 compares the total power profile of the baseline Test A and DR Test A2 and depicts the DR period and DR potential. The DR period started when the DR signal was sent (elapsed time of 0:00:30) and concluded when the washer started its normal operation (elapsed time of 0:09:00). The washer's start button was pushed one minute after the start of the DR event (elapsed time of 0:01:30). For DR Test A2, the DR period turned out to be 8 minutes and 30 seconds, which was very close to the anticipated 8-minute duration.

Clearly, there was a shift in the stages of the wash cycle for the DR test run compared to the baseline test (Figure 21). For DR Test A2, the noted shift in the wash cycle, combined with a flat power profile during DR period—indicative of washer being in idle mode—confirmed the delay in the start of washer. In the DR test run, slightly higher demand peaks were noted, though the washer operated at lower wattage levels during the drain and spin stages of the wash cycle.

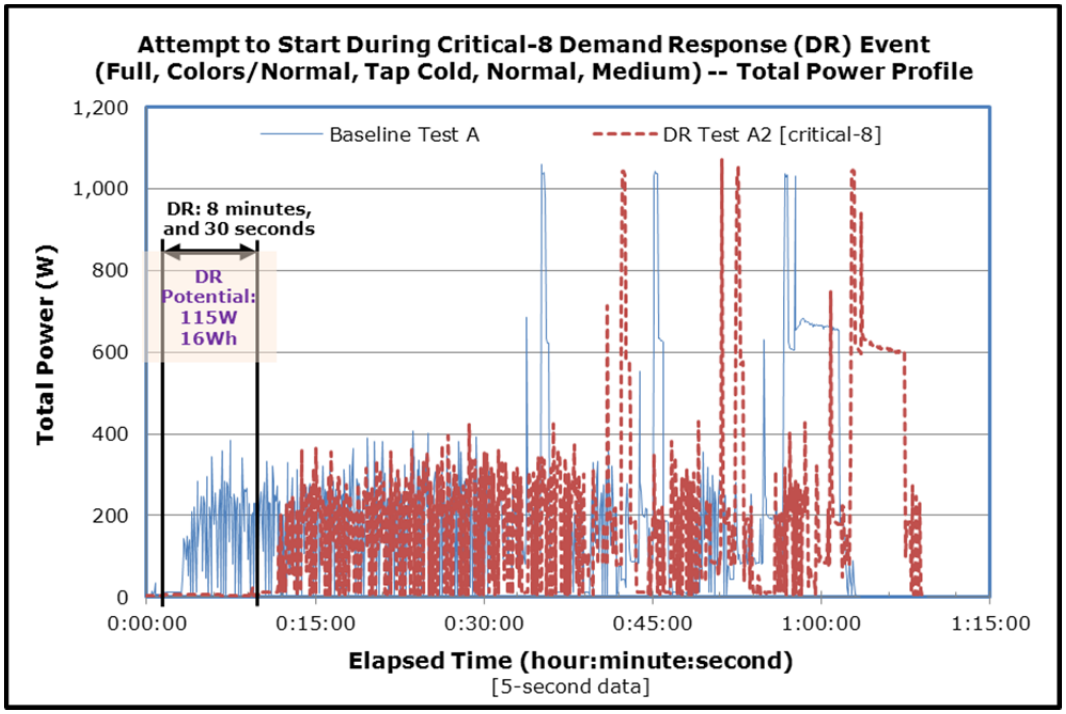

FIGURE 21. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A2

During the DR period, a 115W reduction in average power and a 16Wh reduction in total energy was observed. Table 7 lists the power demand and energy values for baseline Test A and DR Test A2 during the period when the DR event happened.

TABLE 7. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST A AND DEMAND RESPONSE TEST A2

DATA CATEGORY	BASELINE TEST A [P]	DEMAND RESPONSE TEST A2 [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]
Maximum Total Power (W)	383	6	----
Average Total Power (W)	120	5	115
Total Energy (Wh)	17	1	16

Table 8 outlines the overall impact of the DR event on power and total energy usage. For DR Test A2, the operating duration with and without the DR period are provided. Relative to the baseline run, the operating duration of the washer with the DR period was extended by about 6 minutes. Again, this indicates that delaying the start of the washer may or may not result in lengthening the operating time by an equal amount. To facilitate a comparison between the baseline and DR test run, the power and energy for the DR test excluded the DR period. While the average wattage was about the same, the total energy was slightly lower for the DR run due to a shorter wash cycle period (1 hour and 50 seconds) relative to the baseline. Water consumption remained the same.

TABLE 8. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A2

DATA CATEGORY	BASELINE TEST A	DEMAND RESPONSE TEST A2
Washer's Operating Duration (hour:minute:second)	1:03:30	1:09:20 (including DR period) 1:00:50 (excluding DR period)
Maximum Total Power (W)	1,060	1,069*
Average Total Power (W)	206	205*
Total Energy (Wh)	219	208*
Total Cold Water Flow (gallons)	18.92	18.69

*Power and energy values exclude the DR period.

CRITICAL PRICE 60-MINUTE EVENT DURING FILL (A3)

In DR Test A3, a critical price signal with a 60-minute duration was sent during the fill stage of the wash cycle. Figure 22 compares the total power profile of baseline Test A and DR Test A3. A shift in the wash stages is evident. Lengthening the duration of operation was due to the reduced wash duty cycle. Essentially, because the duty cycle was reduced, the washer operated longer to maintain a satisfactory wash quality. During the DR period of 60 minutes, a 108W reduction in average total power and accordingly a 108Wh reduction in total energy were seen.

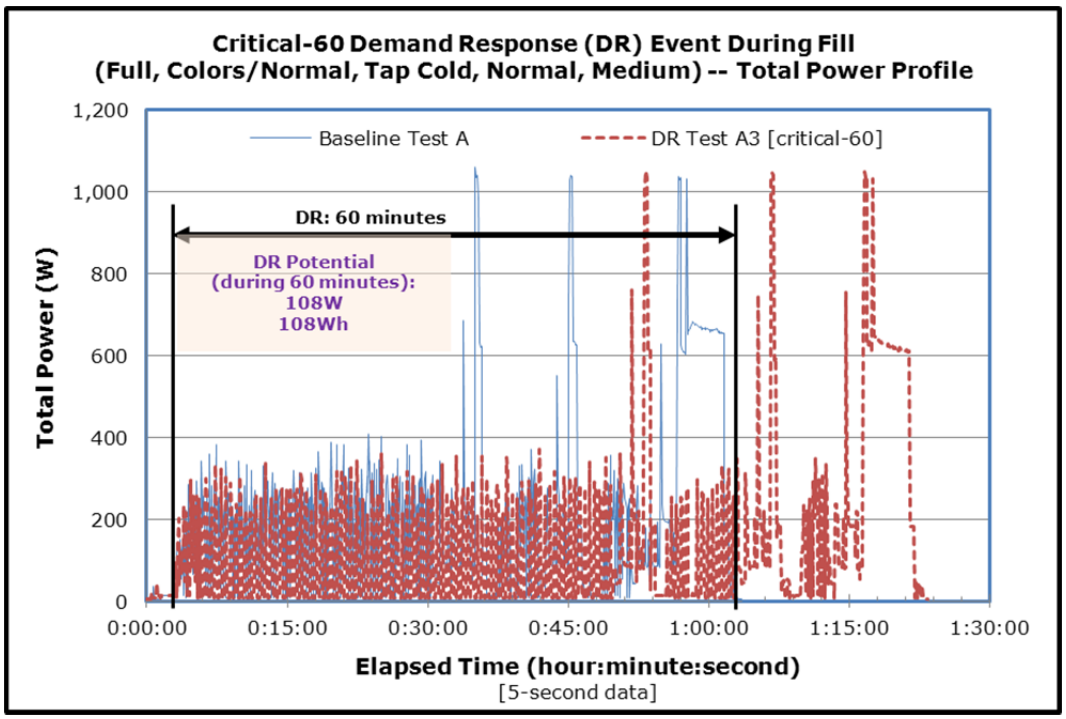

FIGURE 22. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A3

Table 9 summarizes the power and energy values for baseline Test A and DR Test A3 during the period when the DR event took place. During the 60-minute event, the average total power was reduced from 218W to 110W, a 50% reduction.

TABLE 9. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST A AND DEMAND RESPONSE TEST A3

DATA CATEGORY	BASELINE TEST A [P]	DEMAND RESPONSE TEST A3 [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,060	1,051	----	----
Average Total Power (W)	218	110	108	50%
Total Energy (Wh)	218	110	108	50%

Figure 23 compares the variations in duty cycle between baseline Test A and DR Test A3 during the same selected time interval, which falls in the agitate stage of the wash cycle. Though there were no substantial differences in peak power demand, the power profile for the DR test run was less cyclical.

That is, for the DR test, the flat-bottomed off-cycles indicate a reduction in duty cycle because the power remained around zero watts for a longer period compared to the corresponding baseline off-cycles. Accordingly, the average total power during a 20-minute DR interval was 100W for the DR Test A3 and 187W for the baseline Test A.

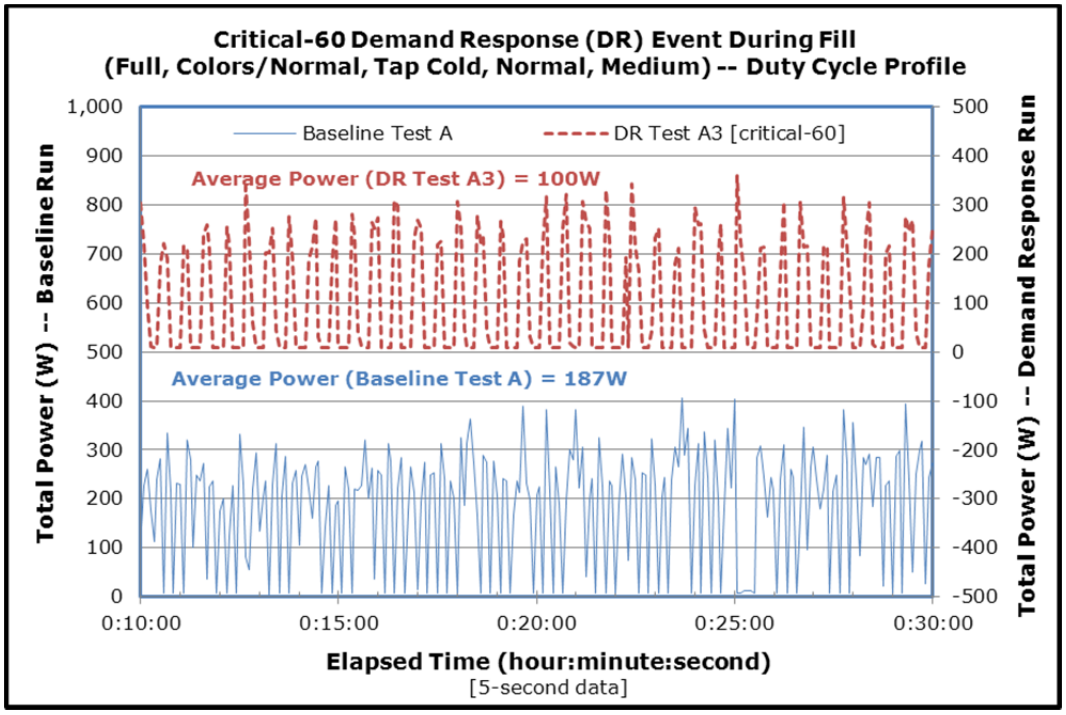

FIGURE 23. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 20-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST A AND DEMAND RESPONSE TEST A3

Table 10 outlines the washer's operating duration in addition to demand and energy usage during a complete wash cycle for baseline Test A and DR Test A3. The washer operated about 20 minutes longer than the baseline, however, its energy usage was lower due to lower average power demand. As expected, there was no difference in water usage between the tests.

TABLE 10. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A3

DATA CATEGORY	BASELINE TEST A	DEMAND RESPONSE TEST A3
Washer's Operating Duration (hour:minute:second)	1:03:30	1:23:20
Maximum Total Power (W)	1,060	1,051
Average Total Power (W)	206	147
Total Energy (Wh)	219	205
Total Cold Water Flow (gallons)	18.92	19.04

CRITICAL PRICE 60-MINUTE EVENT DURING WASH (A4)

In DR Test A4, a critical price signal with 60-minute duration was sent during the agitate (wash) stage of the cycle. The intent was to examine the reductions in duty cycling during the wash cycle. Figure 24 compares the total power profile for baseline Test A and DR Test A4. The stages of the wash cycle in the DR test run shifted to the right. The DR event lasted for 60 minutes. The washer stopped its operation roughly one minute after the conclusion of the DR event.

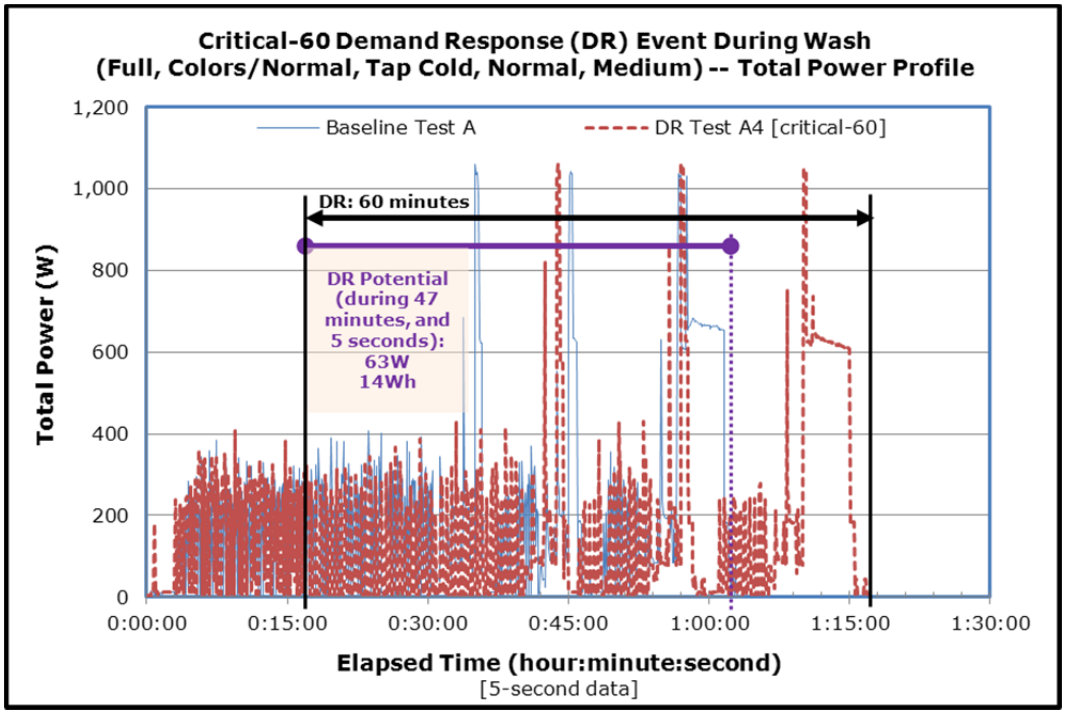

FIGURE 24. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A4

Because the baseline test ended 47 minutes and 5 seconds after the initiation time of the DR event, this interval was used to establish baseline power and

energy values for comparison. For the DR run, the power and energy data were obtained over a 60-minute DR period. The results are summarized in Table 11. The comparison revealed a DR potential of 63W (229W versus 116W) or a 27% reduction in average power. In addition, total energy was reduced by 14Wh (180Wh versus 166Wh) or 8%.

TABLE 11. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST A AND DEMAND RESPONSE TEST A4

DATA CATEGORY	BASELINE TEST A* [P]	DEMAND RESPONSE TEST A4** [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,060	1,061	----	----
Average Total Power (W)	229	166	63	27%
Total Energy (Wh)	180	166	14	8%

*Power and energy values for baseline obtained over a 47-minute and 5-second period.

**Power and energy values for DR run obtained over a 60-minute period.

Figure 25 demonstrates the variations in duty cycle between baseline Test A and DR Test A4 during same time interval. The selected time interval for comparison falls in the agitate stage. Even though the power peaked around 400W for both test runs, the peaks in the DR run were noticeably more spread out. For the DR test, the flat-bottomed off-cycles verify an overall reduction in duty cycle because the power remained around zero watts for a longer period compared to the corresponding baseline off-cycles. Specifically, the average total power during a 15-minute DR interval was 103W for the DR Test A4 and 184W for the baseline Test A.

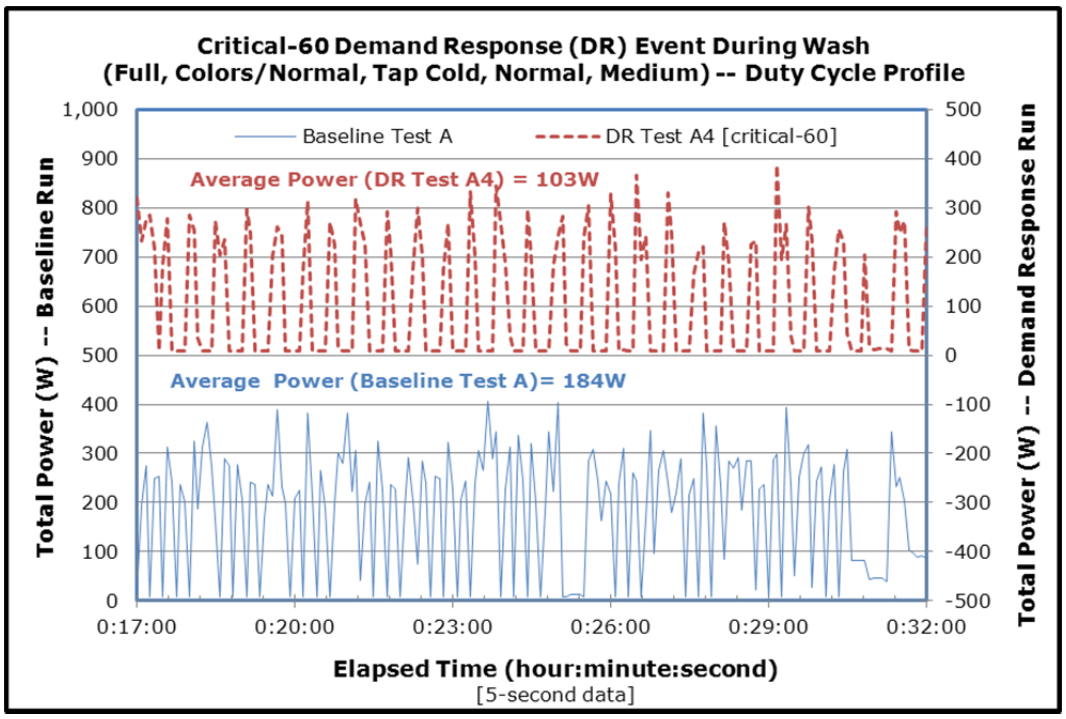

FIGURE 25. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 15-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST A AND DEMAND RESPONSE TEST A4

Overall, the washer's operating duration was longer by about 14 minutes for DR Test A4 (Table 12). Although the maximum total power remained unchanged, the average power and total energy usage were lower in the DR test run. As expected, the water usage was the same under both test runs.

TABLE 12. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A4

DATA CATEGORY	BASELINE TEST A	DEMAND RESPONSE TEST A4
Washer's Operating Duration (hour:minute:second)	1:03:30	1:17:40
Maximum Total Power (W)	1,060	1,061
Average Total Power (W)	206	160
Total Energy (Wh)	219	208
Total Cold Water Flow (gallons)	18.92	18.97

CRITICAL PRICE 60-MINUTE EVENT DURING FIRST RINSE (A5)

Figure 26 compares the total power profiles for baseline Test A and DR Test A5. For DR Test A5, a critical price signal with 60-minute duration was sent during the first rinse stage of the wash cycle. The power profile of the DR

test to some extent coincided with the power profile of the baseline test. In the DR test, the washer stopped its operation 26 minutes after the DR event was initiated. In the baseline run, the washer stopped its operation 24 minutes and 10 seconds after the time the DR event was initiated in DR Test A5. As a result, these intervals were used to evaluate and establish DR potential. Table 13 summarizes the results. The reduction in average power, or the DR potential, was 51W, a 19% reduction. The total energy was also reduced by 14Wh or 13%.

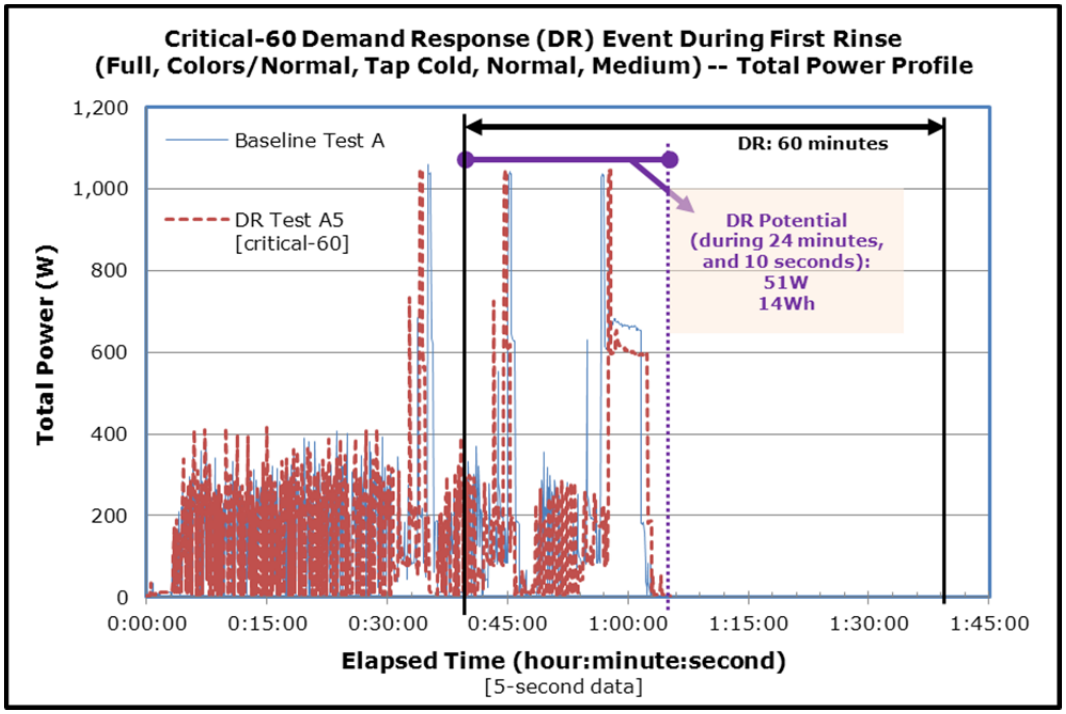

FIGURE 26. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A5

TABLE 13. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST A AND DEMAND RESPONSE TEST A5

DATA CATEGORY	BASELINE TEST A* [P]	DEMAND RESPONSE TEST A5** [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,041	1,048	----	----
Average Total Power (W)	270	219	51	19%
Total Energy (Wh)	109	95	14	13%

*Power and energy values for baseline obtained over a 24-minute and 10-second period.

**Power and energy values for DR run obtained over a 26-minute period.

The variations in duty cycle between baseline and DR test are evident in Figure 27. For the DR test, the flat-bottomed off-cycles verify an overall reduction in duty cycle because the power remained around zero watts for a longer period compared to the corresponding baseline off-cycles. Subsequently, the average power during a 3-minute DR interval was 95W for the DR Test A5 and 167W for the baseline Test A.

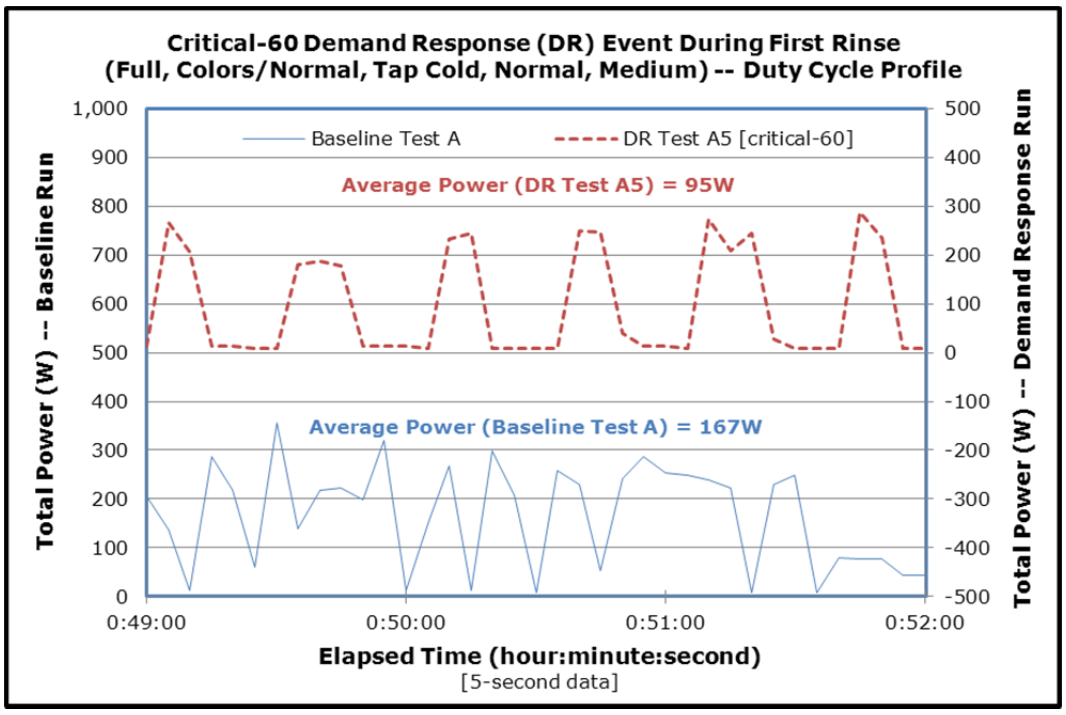

FIGURE 27. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 3-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST A AND DEMAND RESPONSE TEST A5

Table 14 shows that the washer's operating duration was somewhat similar between the baseline and DR test runs. In spite of the similarity in duration, the total energy was slightly lower in the DR test run compared to the baseline due to a reduction in the power drawn.

TABLE 14. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A5

DATA CATEGORY	BASELINE TEST A	DEMAND RESPONSE TEST A5
Washer's Operating Duration (hour:minute:second)	1:03:30	1:05:20
Maximum Total Power (W)	1,060	1,048
Average Total Power (W)	206	188
Total Energy (Wh)	219	205
Total Cold Water Flow (gallons)	18.92	18.07

CRITICAL PRICE 60-MINUTE EVENT DURING FINAL SPIN (A6)

Figure 28 compares the total power profiles for both baseline Test A and DR Test A6. In DR Test A6, a critical price signal with a 60-minute duration was initiated during the final spin stage of the wash cycle. As shown in Figure 28, the DR event was initiated after the peak occurred during the final spin stage.

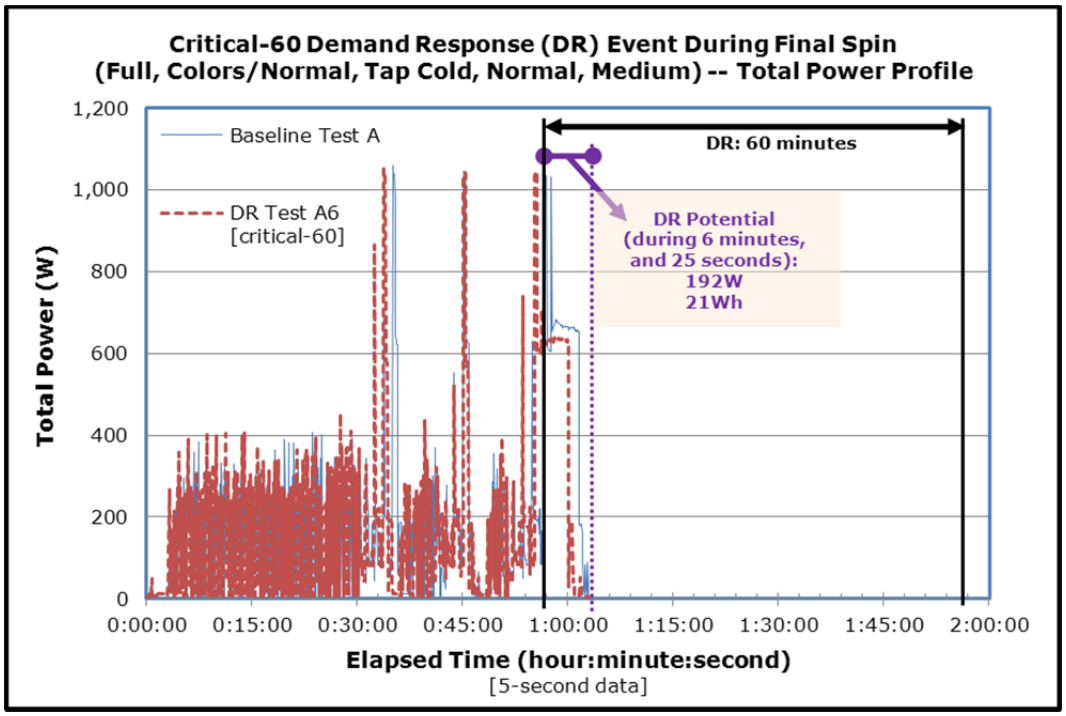

FIGURE 28. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A6

Compared to the baseline run, the first and final drain and spin stages of the wash cycle in the DR test happened slightly sooner. In contrast, the second drain and spin stages of wash cycle coincided perfectly. In general, these test runs were very similar. With respect to the operating duration, the DR test run ended 25 seconds earlier than the baseline run. The duration from the initiation of the DR event until the end of the wash cycle was 6 minutes and 5 seconds. Accordingly, this interval was used for the baseline and DR runs to estimate the DR potential. This resulted in a DR potential of 192W or a 35% reduction in average power (Table 15). The total energy was also reduced by 21Wh or by 35%.

TABLE 15. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST A AND DEMAND RESPONSE TEST A6

DATA CATEGORY	BASELINE TEST A* [P]	DEMAND RESPONSE TEST A6* [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,037	639	----	----
Average Total Power (W)	548	356	192	35%
Total Energy (Wh)	59	38	21	35%

*Power and energy values obtained for a 6-minute and 25-second period.

Table 16 compares the key parameters obtained during an entire wash cycle for both the baseline and DR test runs. There was no significant impact on the performance. This was due to initiating the DR event at the tail end of the wash cycle, which resulted in very similar test runs.

TABLE 16. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A6

DATA CATEGORY	BASELINE TEST A	DEMAND RESPONSE TEST A6
Washer's Operating Duration (hour:minute:second)	1:03:30	1:03:05
Maximum Total Power (W)	1,060	1,049
Average Total Power (W)	206	200
Total Energy (Wh)	219	210
Total Cold Water Flow (gallons)	18.92	18.80

CRITICAL PRICE 8-MINUTE EVENT DURING WASH (A7)

In DR Test A7, a critical price signal with an 8-minute duration was sent during the agitate (wash) stage. Figure 29 compares the total power profile of baseline Test A and DR Test A7. The washer's response period turned out to be 9 minutes (from elapsed time of 0:09:25 to 0:18:25) even though the signal was for 8 minutes. This variation may be attributed to a delay in sending, receiving, and interpreting the signal.

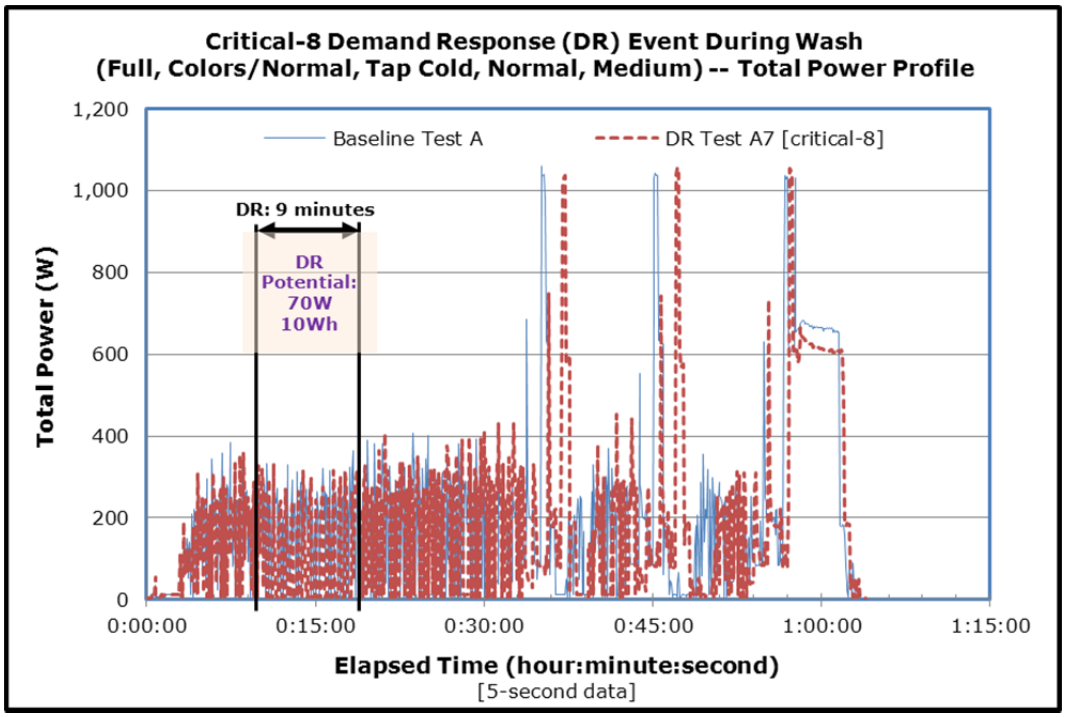

FIGURE 29. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A7

Figure 29 shows a shift in the agitate and successive stages of the overall wash cycle until the final drain and spin stage. The final drain and spin stage of the baseline and DR run coincided. A DR period of 9 minutes did not result in prolonging the overall wash cycle. In addition, there were no significant differences in the peak power between the two test runs. The reduction in average power, or the DR potential, was 70W, a 39% reduction and the total energy was reduced by 10Wh, or 39%. Table 17 outlines the power and total energy values for baseline and DR test during the 9-minute DR period.

TABLE 17. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST A AND DEMAND RESPONSE TEST A7

DATA CATEGORY	BASELINE TEST A [P]	DEMAND RESPONSE TEST A7 [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	364	334	----	----
Average Total Power (W)	181	111	70	39%
Total Energy (Wh)	27	17	10	39%

Figure 30 compares the variations in duty cycles between the baseline and DR tests. For the DR test, the flat-bottomed off-cycles indicate an overall reduction in duty cycling because the power remained around zero watts for a longer period compared to the corresponding baseline off-cycles. In fact, the average power during an 8-minute DR interval was 107W for the DR Test A7 and 176W for the baseline Test A.

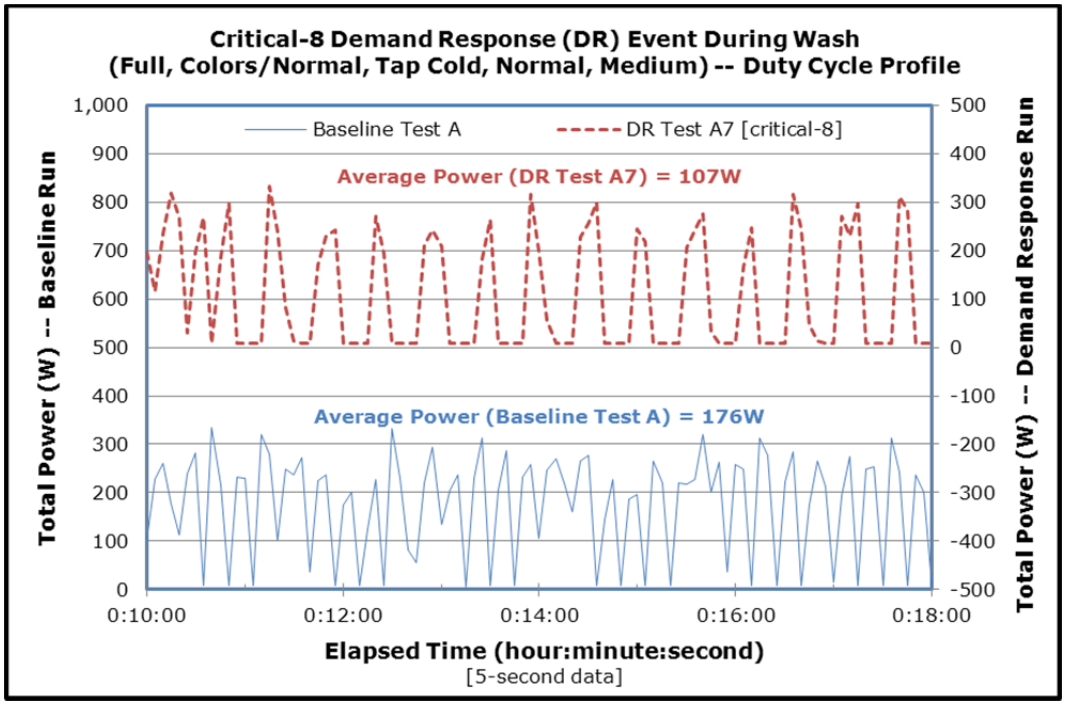

FIGURE 30. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR AN 8-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST A AND DEMAND RESPONSE TEST A7

Table 18 shows the overall impact of the DR event on the washer's performance. The operating duration, maximum total power, and the total water usage during both tests were about the same. The average total power

was slightly lower for the DR test due to a reduction in power during the DR period. Consequently, the total energy was slightly lower for the DR test.

TABLE 18. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A7

DATA CATEGORY	BASELINE TEST A	DEMAND RESPONSE TEST A7
Washer's Operating Duration (hour:minute:second)	1:03:30	1:03:55
Maximum Total Power (W)	1,060	1,055
Average Total Power (W)	206	194
Total Energy (Wh)	219	207
Total Cold Water Flow (gallons)	18.92	18.62

CRITICAL PRICE 60-MINUTE EVENT DURING FINAL SPIN [RESTART AFTER COMPLETION OF FIRST WASH] (A8)

In DR Test A8, a critical price signal with a 60-minute duration was sent during the final spin stage, which was followed by an attempt to start a new wash load 5 minutes after the first one finished. Figure 31 compares the total power profile of the baseline Test A and DR Test A8. The DR period started when the signal was sent in the final spin stage (elapsed time of 0:51:40). The washer stopped its operation 9 minutes and 35 seconds (elapsed time of 1:01:15) after the initiation of the DR event, when it came to the end of the normal wash cycle. The washer did not start the second wash cycle until the DR event had cleared (elapsed time of 1:51:40). As a result, the DR potential was estimated over a 9-minute and 35-second period, and turned out to be 36W or 9% reduction in average power (Table 19). Similarly, a 6Wh or 9% reduction in total energy was obtained.

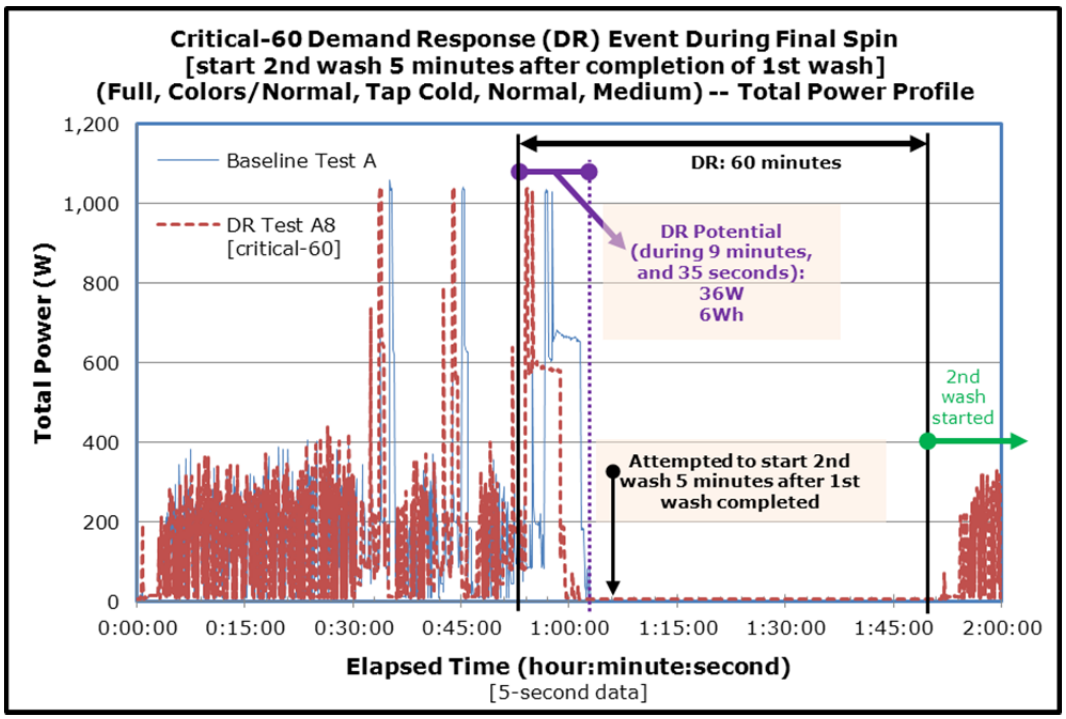

FIGURE 31. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A8

Figure 31 shows the variations in the duration of wash cycle stages between the baseline and DR runs. Specifically, it shows that the drain and spin stages for the DR test occurred earlier compared to the baseline. Lower power peaks and demand during the spin are also noticeable for the DR test.

TABLE 19. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST A AND DEMAND RESPONSE TEST A8

DATA CATEGORY	BASELINE TEST A* [P]	DEMAND RESPONSE TEST A8* [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,037	1,039	----	----
Average Total Power (W)	407	371	36	9%
Total Energy (Wh)	65	59	6	9%

*Power and energy values obtained for a 9-minute and 35-second period.

Table 20 shows the overall impact of the DR event on performance. It shows that the washer's operating duration for the DR test was about 2 minutes shorter than for the baseline. In general, lower power and energy values were obtained for the DR run with minimal impact on the water consumption.

TABLE 20. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A8

DATA CATEGORY	BASELINE TEST A	DEMAND RESPONSE TEST A8*
Washer's Operating Duration (hour:minute:second)	1:03:30	1:01:45
Maximum Total Power (W)	1,060	1,043
Average Total Power (W)	206	201
Total Energy (Wh)	219	207
Total Cold Water Flow (gallons)	18.92	18.72

*Presented data is for the first wash cycle only.

CRITICAL PRICE 60-MINUTE EVENT DURING FILL (C1)

In DR Test C1, a critical price signal with a 60-minute duration was sent during the fill stage. Figure 32 compares the total power profile of baseline Test C and DR Test C1. The DR duration was 60 minutes, from the elapsed time of 0:02:25 to 1:02:25. At the conclusion of the DR event, the washer continued its normal operation and stopped about 23 minutes later (elapsed time of 1:25:00).

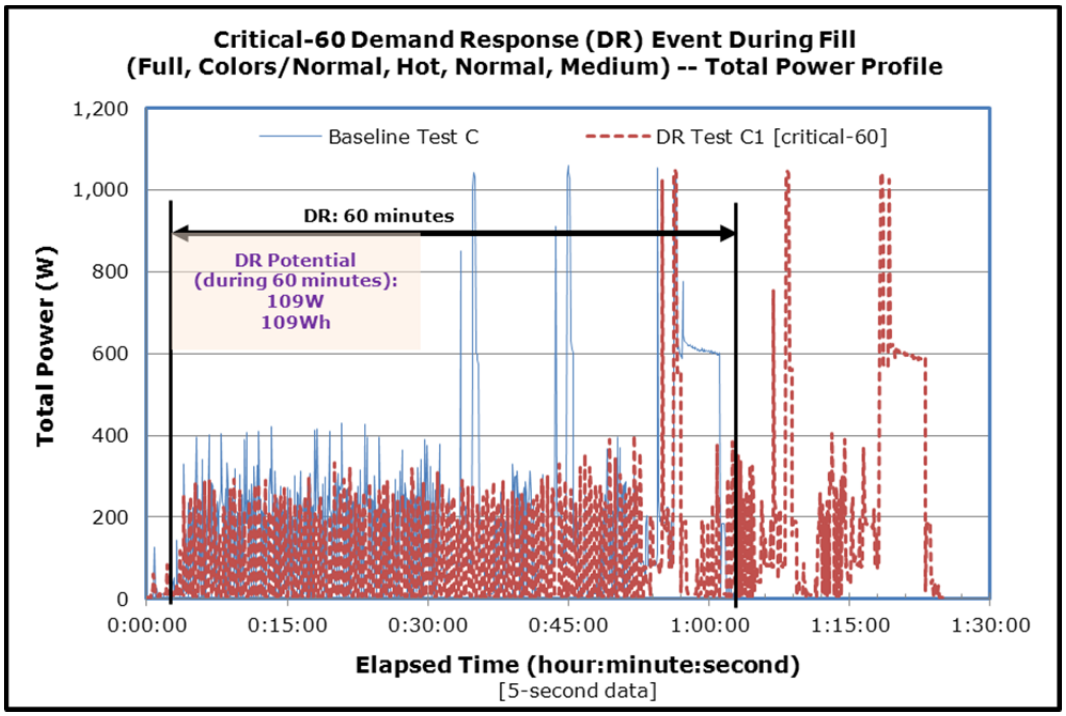

FIGURE 32. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST C AND DEMAND RESPONSE TEST C1

A shift in wash stages caused by a prolonged agitate cycle is evident in Figure 32. The increased duration of the washer's operation was triggered by

a reduction in the duty cycling during the wash cycle, which caused the washer to operate longer to maintain wash quality. Figure 32 shows that although the peaks were about the same, the washer operated at lower average wattage levels in DR Test C1. During a DR period of 60 minutes, a DR potential of 109W or 52% reduction in average total power was observed. Total energy was reduced by 109Wh or by 52%. Table 21 summarizes the power and energy values for both test runs, as well as the savings from the DR.

TABLE 21. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST C AND DEMAND RESPONSE TEST C1

DATA CATEGORY	BASELINE TEST C [P]	DEMAND RESPONSE TEST C1 [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,059	1,049	----	----
Average Total Power (W)	210	101	109	52%
Total Energy (Wh)	210	101	109	52%

Figure 33 demonstrates the variations in duty cycling between baseline Test C and DR Test C1 during the same 20-minute time interval in the agitate stage. For the DR test, the flat-bottomed off-cycles verify an overall reduction in duty cycle because the power remained around zero watts for a longer time compared to the corresponding baseline off-cycles. During the 20-minute DR interval, the average total power for the DR Test C1 was 92W compared to 183W for the baseline Test C.

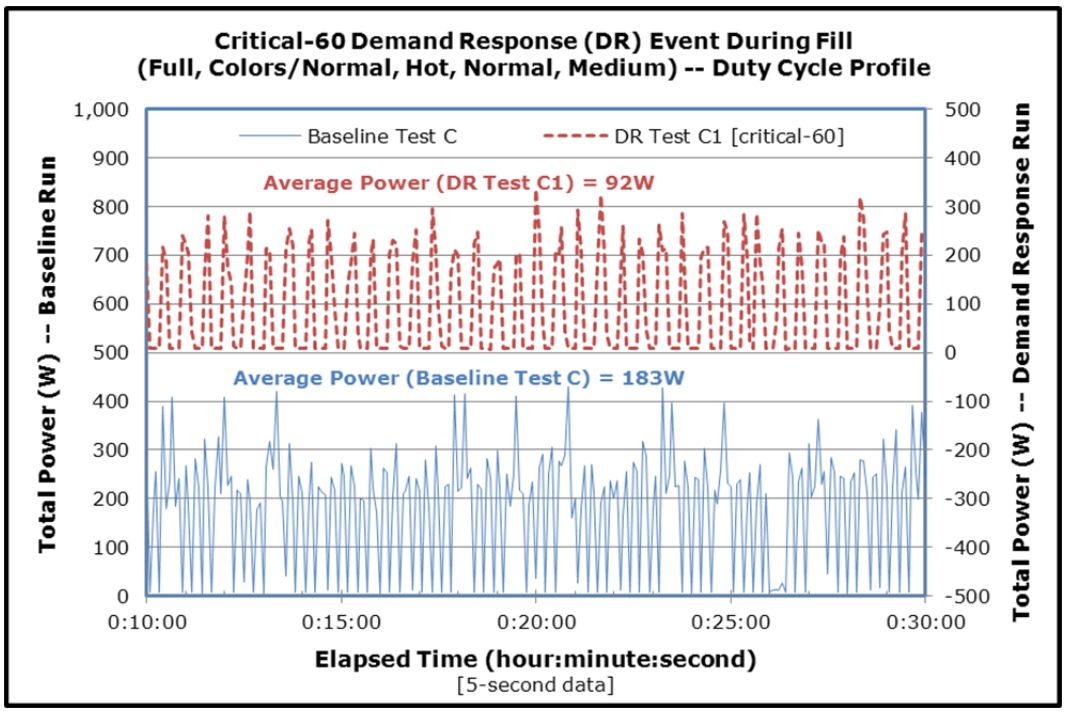

FIGURE 33. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 20-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST C AND DEMAND RESPONSE TEST C1

Overall, during DR Test C1, the clothes washer operated 22 minutes longer while drawing less power and using less energy (Table 22). As expected, there was no impact on water consumption between the tests.

TABLE 22. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST C AND DEMAND RESPONSE TEST C1

DATA CATEGORY	BASELINE TEST C	DEMAND RESPONSE TEST C1
Washer's Operating Duration (hour:minute:second)	1:03:05	1:25:00
Maximum Total Power (W)	1,059	1,049
Average Total Power (W)	200	140
Total Energy (Wh)	211	198
Total Cold Water Flow (gallons)	12.86	12.88
Total Hot Water Flow (gallons)	5.53	5.47

CRITICAL PRICE 60-MINUTE EVENT DURING FILL (G1)

In DR Test G1, a critical price signal with a 60-minute duration was sent during the fill stage. Figure 34 compares the total power profile of baseline Test G and DR Test G1. The DR duration was 60 minutes from the elapsed time of 0:02:20 to 1:02:20. At the conclusion of the DR event, the washer resumed its normal operation and stopped about 40 minutes later (elapsed time of 1:42:30).

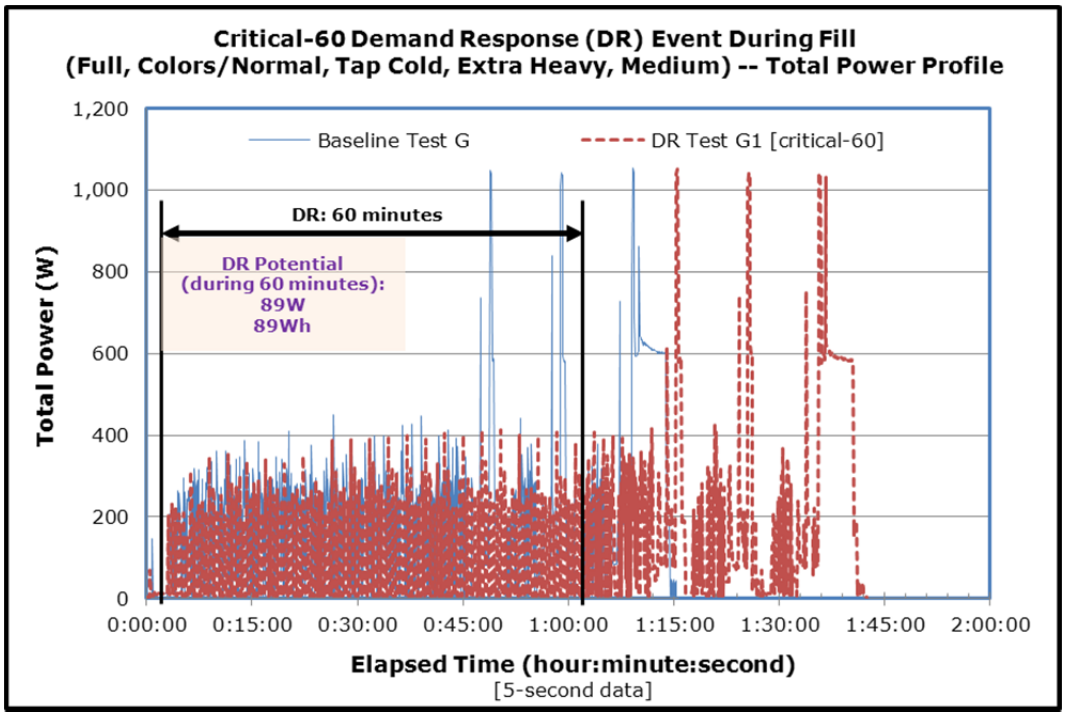

FIGURE 34. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST G AND DEMAND RESPONSE TEST G1

A shift in wash stages caused by the prolonged wash cycle is evident in Figure 34. Because of the reduced duty cycle, the clothes washer operated longer to maintain a satisfactory wash quality. Although the power peaks were about the same, the washer operated at lower wattage levels in DR Test G1. During the 60-minute DR period, a DR potential of 89W or a 48% reduction in average power was obtained. The total energy was reduced by 89Wh or by 48%. Table 23 summarizes the power and energy values for both test runs, as well as the obtained savings from the DR.

TABLE 23. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST G AND DEMAND RESPONSE TEST G1

DATA CATEGORY	BASELINE TEST G [P]	DEMAND RESPONSE TEST G1 [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,047	414	----	----
Average Total Power (W)	185	96	89	48%
Total Energy (Wh)	185	96	89	48%

Figure 35 illustrates duty cycle variations between baseline Test G and DR Test G1 during the same time interval of 20 minutes in the agitate stage of the wash cycle. For the DR test, the flat-bottomed off-cycles indicate an overall reduction in duty cycling because the power remained around zero watts for a longer period compared to the corresponding baseline off-cycles. During a 20-minute DR interval, the average total power for the DR Test G1 was 96W compared to 190W for the baseline Test G.

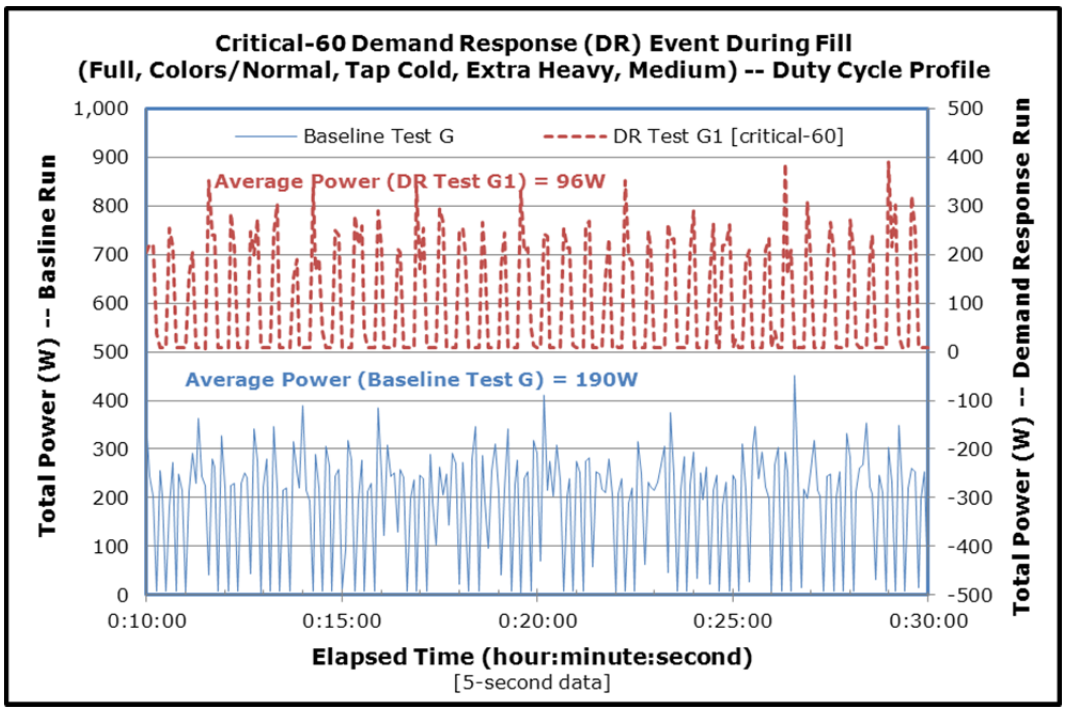

FIGURE 35. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 20-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST G AND DEMAND RESPONSE TEST G1

In general, during DR Test G1, the washer operated about 27 minutes longer and required less power and energy (Table 22). As expected, there was no impact on the water consumption.

TABLE 24. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST G AND DEMAND RESPONSE TEST G1

DATA CATEGORY	BASELINE TEST G	DEMAND RESPONSE TEST G1
Washer's Operating Duration (hour:minute:second)	1:15:45	1:42:30
Maximum Total Power (W)	1,054	1,051
Average Total Power (W)	203	145
Total Energy (Wh)	257	247
Total Cold Water Flow (gallons)	18.64	18.66

CRITICAL PRICE 60-MINUTE EVENT DURING FILL (I1)

In DR Test I1, a critical price signal with a 60-minute duration was sent during the fill stage. Figure 36 compares the total power profile of baseline Test I and DR Test I1. The DR period was 60 minutes from the elapsed time of 0:02:25 to 1:02:25. Once the DR event ended, the washer continued its

normal operation and ended the wash cycle about 23 minutes later (elapsed time of 1:25:35).

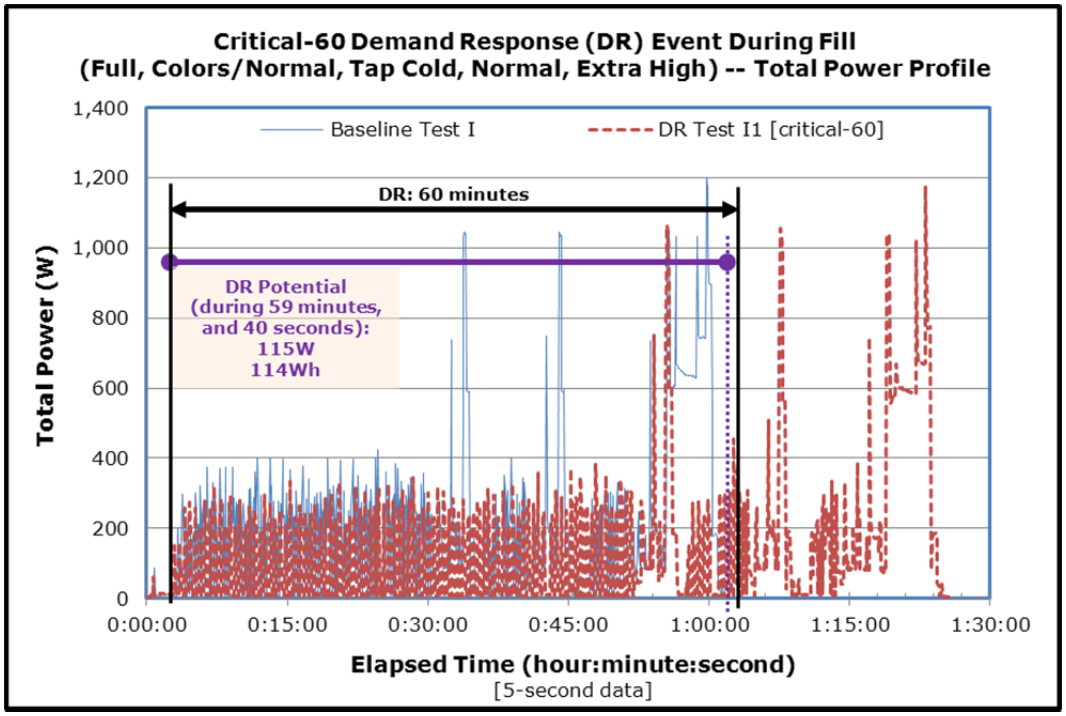

FIGURE 36. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST I AND DEMAND RESPONSE TEST I1

The shift in wash stages of the cycle is evident in Figure 36. Due to a reduction in duty cycle, the washer operated longer to achieve acceptable wash quality. For the baseline test, slightly higher power peaks and wattages were seen.

Compared to the conclusion of the DR event (elapsed time of 1:02:25), the baseline wash cycle ended 20 seconds earlier (elapsed time of 1:02:05). Therefore, to estimate the DR potential, the power and energy for the baseline run were attained over a 59-minute and 40-second interval instead of a 60-minute interval. This revealed a DR potential of 115W or a 52% reduction in average power. Likewise, the total energy was reduced by 114Wh or by 52%. Table 25 summarizes the power and energy values for both test runs, as well as the obtained savings from responding to the DR signal.

TABLE 25. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST I AND DEMAND RESPONSE TEST I1

DATA CATEGORY	BASELINE TEST I* [P]	DEMAND RESPONSE TEST I1** [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,199	1,065	----	----
Average Total Power (W)	219	104	115	52%
Total Energy (Wh)	218	104	114	52%

*Power and energy values for baseline obtained over a 59-minute and 40-second period.

**Power and energy values for DR run obtained over a 60-minute period.

Figure 37 demonstrates the duty cycle variations between baseline Test I and DR Test I1. The selected 20-minute interval falls in the agitate stage of the wash cycle. For the DR test, the flat-bottomed off-cycles indicate an overall reduction in duty cycling due to power remaining around zero watts for a longer period compared to the corresponding baseline off-cycles. Over a 20-minute DR interval, the average total power for the DR Test I1 was 94W compared to 189W for the baseline Test I.

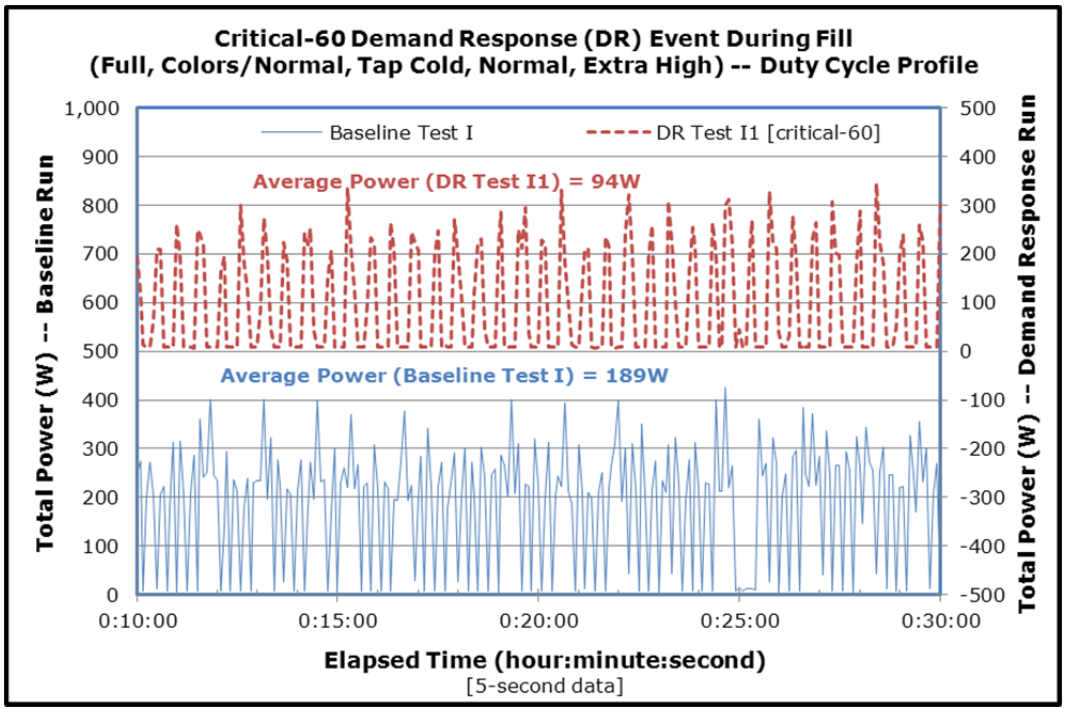

FIGURE 37. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 20-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST I AND DEMAND RESPONSE TEST I1

In DR Test I1, the washer operated about 23 minutes longer and required less power and energy (Table 26). The water usage was not impacted because of the DR event.

TABLE 26. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST I AND DEMAND RESPONSE TEST I1

DATA CATEGORY	BASELINE TEST I	DEMAND RESPONSE TEST I1
Washer's Operating Duration (hour:minute:second)	1:02:05	1:25:35
Maximum Total Power (W)	1,199	1,177
Average Total Power (W)	210	144
Total Energy (Wh)	218	205
Total Cold Water Flow (gallons)	18.73	18.93

CRITICAL PRICE 120-MINUTE EVENT DURING FILL (I2)

In DR Test I2, a critical price signal with 120-minute duration was sent during the fill stage of the wash cycle. This test was designed so that the DR event would extend beyond the length of the entire wash cycle. Figure 38 compares the total power profile of baseline Test I and DR Test I2. The DR period was 120 minutes, from the elapsed time of 0:02:30 to 2:02:30.

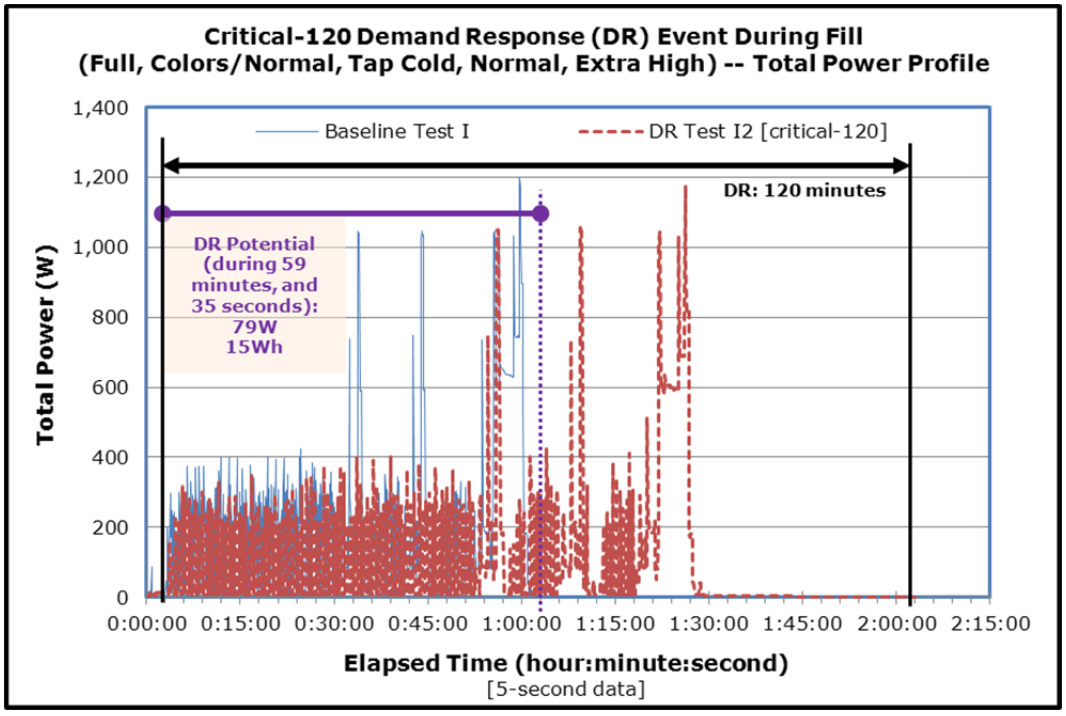

FIGURE 38. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST I AND DEMAND RESPONSE TEST I2

It is evident in Figure 38 that relative to the baseline test, the wash cycle stages in the DR test were shifted to the right. As a result, the overall wash cycle length was extended by about 27 minutes (elapsed time of 1:02:05 versus 1:29:45), which was completed within the DR period. In fact, the agitate stage of the wash cycle in the DR test run was longer by roughly 22 minutes. The duration of the first and second rinse stages of the DR test run were also longer by about 3 minutes each. However, there were no significant variations in the duration of the spin stages of the cycle.

To estimate the savings potential from the DR event, the power and energy for the baseline and DR tests were attained from the time when the DR event was sent until the overall wash cycle ended. For the baseline run, this period turned out to be 59 minutes and 35 seconds. For the DR test run, this period was 1 hour, 27 minutes, and 15 seconds. This resulted in a DR potential of 79W or a 36% reduction in average power. The total energy was reduced by 15Wh or by 7%. Table 27 summarizes the power and energy values for both test runs, as well as the obtained savings potential from the DR event.

TABLE 27. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST I AND DEMAND RESPONSE TEST I2

DATA CATEGORY	BASELINE TEST I* [P]	DEMAND RESPONSE TEST I2** [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,199	1,175	----	----
Average Total Power (W)	219	140	79	36%
Total Energy (Wh)	218	203	15	7%

*Power and energy values for baseline obtained over a 59-minute and 35-second period.

**Power and energy values for DR run obtained over a 1-hour, 27-minute and 15-second period.

Figure 39 illustrates the duty cycle variations between baseline Test I and DR Test I2 over a 25-minute interval. The flat-bottomed off-cycles for DR Test I2 indicate an overall reduction in duty cycling since power remained around zero watts for a longer period compared to the corresponding baseline off-cycles. Over a 25-minute DR interval, the average total power for the DR Test I2 was 93W and 188W for the baseline Test I.

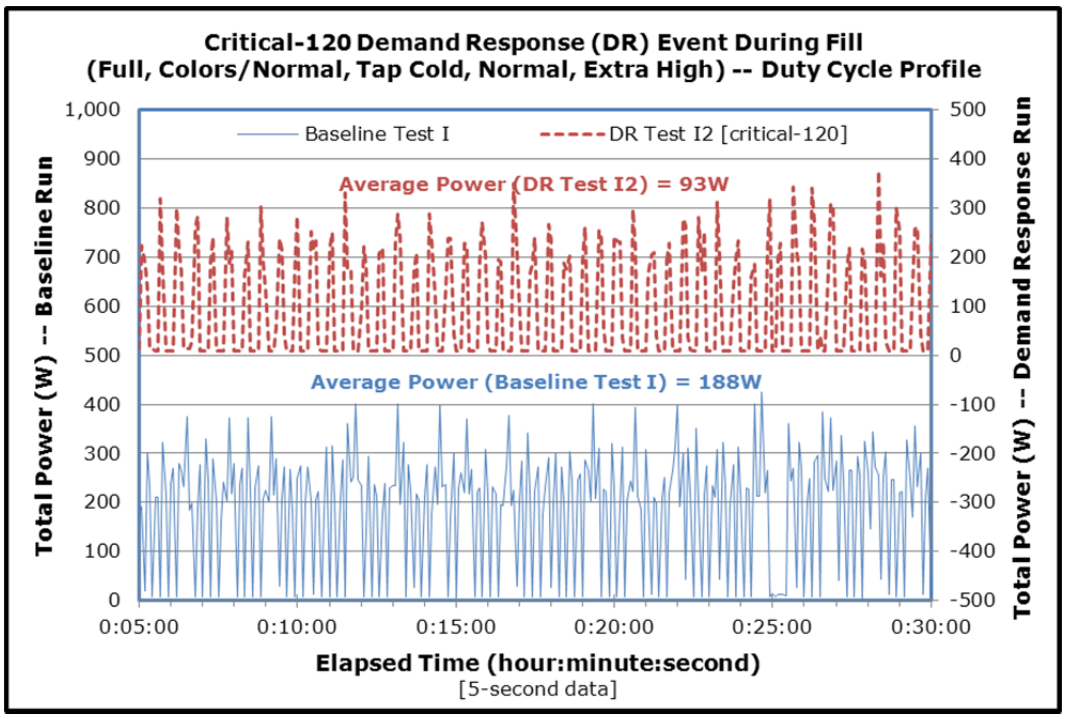

FIGURE 39. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 25-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST I AND DEMAND RESPONSE TEST I2

Overall, in DR Test I2, the washer operated about 27 minutes longer and required less power and energy (Table 28). As anticipated, the water usage did not vary.

TABLE 28. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST I AND DEMAND RESPONSE TEST I2

DATA CATEGORY	BASELINE TEST I	DEMAND RESPONSE TEST I2
Washer's Operating Duration (hour:minute:second)	1:02:05	1:29:45
Maximum Total Power (W)	1,199	1,175
Average Total Power (W)	210	136
Total Energy (Wh)	218	203
Total Cold Water Flow (gallons)	18.73	18.43

CRITICAL PRICE 60-MINUTE EVENT DURING FILL (J1)

In DR Test J1, a critical price signal with a 60-minute duration was sent during the fill stage of the wash cycle. Figure 40 compares the total power profile of baseline Test J and DR Test J1. The DR period was 60 minutes, from the elapsed time of 0:02:25 to 1:02:25. Once the DR event ended, the

washer continued its normal operation and completed the wash cycle roughly 32 minutes later (elapsed time of 1:34:30).

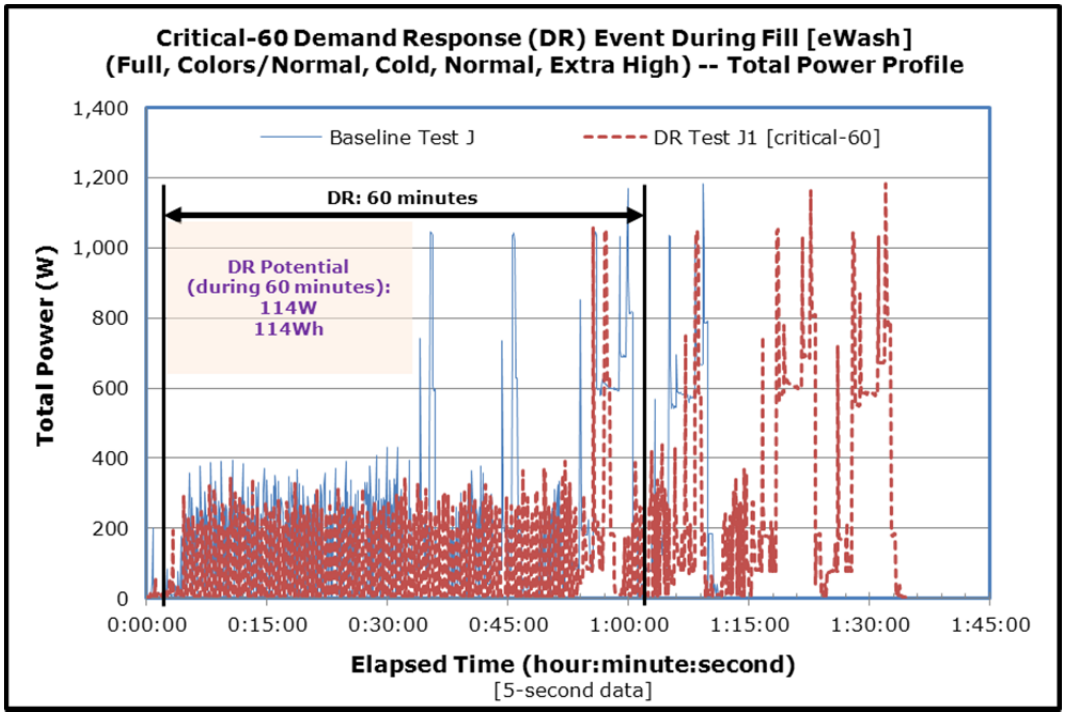

FIGURE 40. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST J AND DEMAND RESPONSE TEST J1

Figure 40 shows the shift in the wash stages of the cycle. The washer operated longer to maintain the wash quality because of the reduced duty cycling. While the demand peaks were about the same, the washer operated at lower wattage levels in DR Test J1. During the 60-minute DR event, a 114W or 53% reduction in average total power and a 114Wh or 53% reduction in total energy were seen. Table 29 summarizes the power and energy values for both test runs, and the obtained savings potential from the DR event.

TABLE 29. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST J AND DEMAND RESPONSE TEST J1

DATA CATEGORY	BASELINE TEST J [P]	DEMAND RESPONSE TEST J1 [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,168	1,058	----	----
Average Total Power (W)	217	103	114	53%
Total Energy (Wh)	217	103	114	53%

Figure 41 presents the duty cycle variations between baseline Test J and DR Test J1. The selected 20-minute interval falls in the agitate stage of the wash cycle. For the DR test, the flat-bottomed off-cycles verify an overall reduction in duty cycling because the power remained around zero watts for a longer period relative to the corresponding baseline off-cycles. Over a 20-minute DR interval, the average total power for the DR Test J1 was 94W and 193W for the baseline Test J.

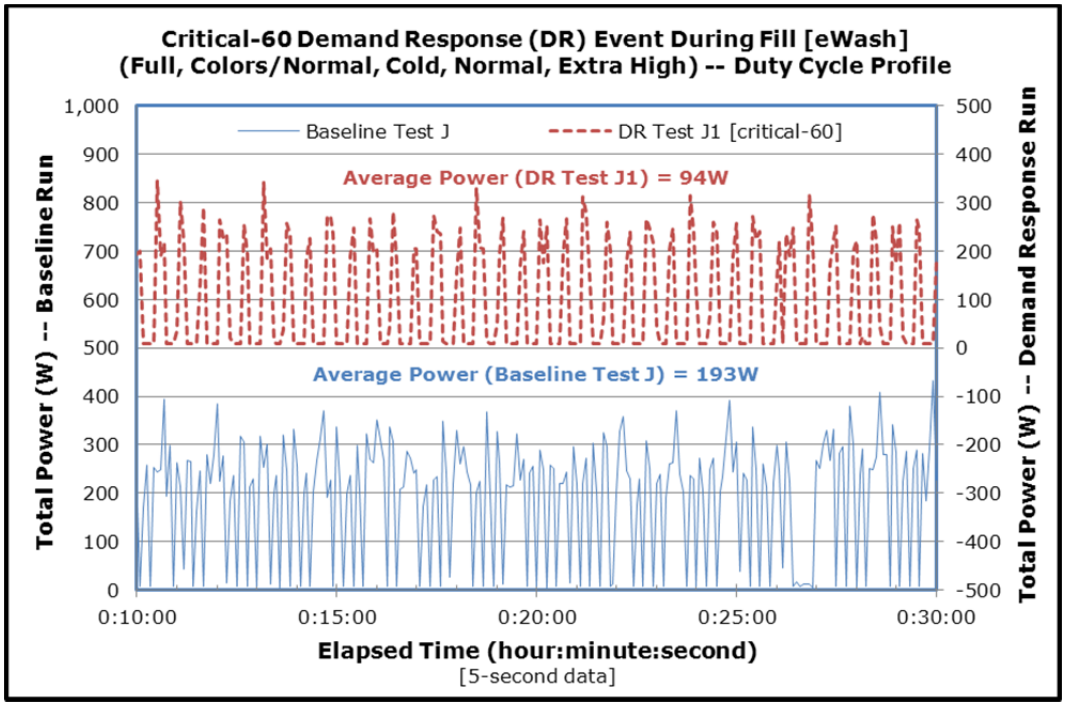

FIGURE 41. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 20-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST J AND DEMAND RESPONSE TEST J1

Overall, in DR Test J1, the washer operated about 23 minutes longer and required less power and energy (Table 30). In addition, the cold and hot water consumption remained relatively unchanged.

TABLE 30. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST J AND DEMAND RESPONSE TEST J1

DATA CATEGORY	BASELINE TEST J	DEMAND RESPONSE TEST J1
Washer's Operating Duration (hour:minute:second)	1:11:45	1:34:30
Maximum Total Power (W)	1,181	1,183
Average Total Power (W)	234	173
Total Energy (Wh)	280	273
Total Cold Water Flow (gallons)	18.93	18.57
Total Hot Water Flow (gallons)	0.23	0.27

CRITICAL PRICE 120-MINUTE EVENT DURING FILL (J2)

In DR Test J2, a critical price signal with 120-minute duration was sent during the fill stage of the wash cycle, again to demonstrate a signal that would extend beyond the operating period of the clothes washer. Figure 42 compares the total power profile of baseline Test J and DR Test J2. The DR period was 120 minutes, from the elapsed time of 0:02:30 to 2:02:30.

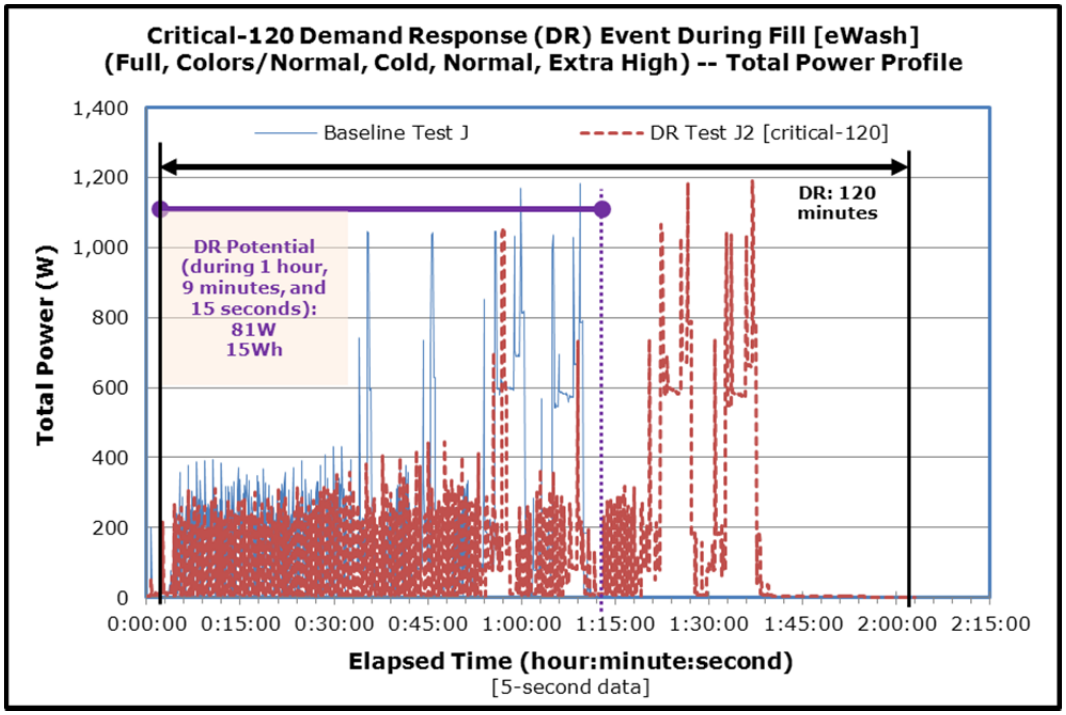

FIGURE 42. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST J AND DEMAND RESPONSE TEST J2

It is evident in Figure 42 that relative to the baseline test, the wash cycle stages in the DR test have shifted to the right. Accordingly, the overall wash cycle length was extended by about 29 minutes (elapsed time of 1:11:05

versus 1:40:35), which was completed within the DR period. In fact, the agitate stage in the DR test run was longer by roughly 22 minutes. The duration of the first and second rinse stages of the DR test run were also longer by about 3 minutes each. However, there were no significant variations in the duration of the spin stages of the cycle.

To evaluate the savings potential from the DR event, the power and energy for both the baseline and DR test run were attained from the time when the DR event was sent until the overall wash cycle ended. For the baseline run, this period was 1 hour, 9 minutes, and 15 seconds. For the DR test run, this period turned out to be 1 hour, 38 minutes, and 5 seconds. This resulted in a DR potential of 81W or a 33% reduction in average power. The total energy was reduced by 15Wh or 5%. Table 31 summarizes the power and energy values for both test runs, as well as the obtained savings potential from the DR event.

TABLE 31. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST J AND DEMAND RESPONSE TEST J2

DATA CATEGORY	BASELINE TEST J* [P]	DEMAND RESPONSE TEST J2** [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,181	1,193	----	----
Average Total Power (W)	242	161	81	33%
Total Energy (Wh)	279	264	15	5%

*Power and energy values for baseline obtained over a 1-hour, 9-minute, and 15-second period.

**Power and energy values for DR run obtained over a 1-hour, 38-minute, and 5-second period.

Figure 43 illustrates the duty cycle variations between baseline Test J and DR Test J2 over a 20-minute interval. The flat-bottomed off-cycles for DR Test J2 indicate an overall reduction in duty cycling because power remained around zero watts for a longer period compared to the corresponding baseline off-cycles. Over a 25-minute DR interval, the average total power for the DR Test J2 was 94W compared to 192W for the baseline Test J.

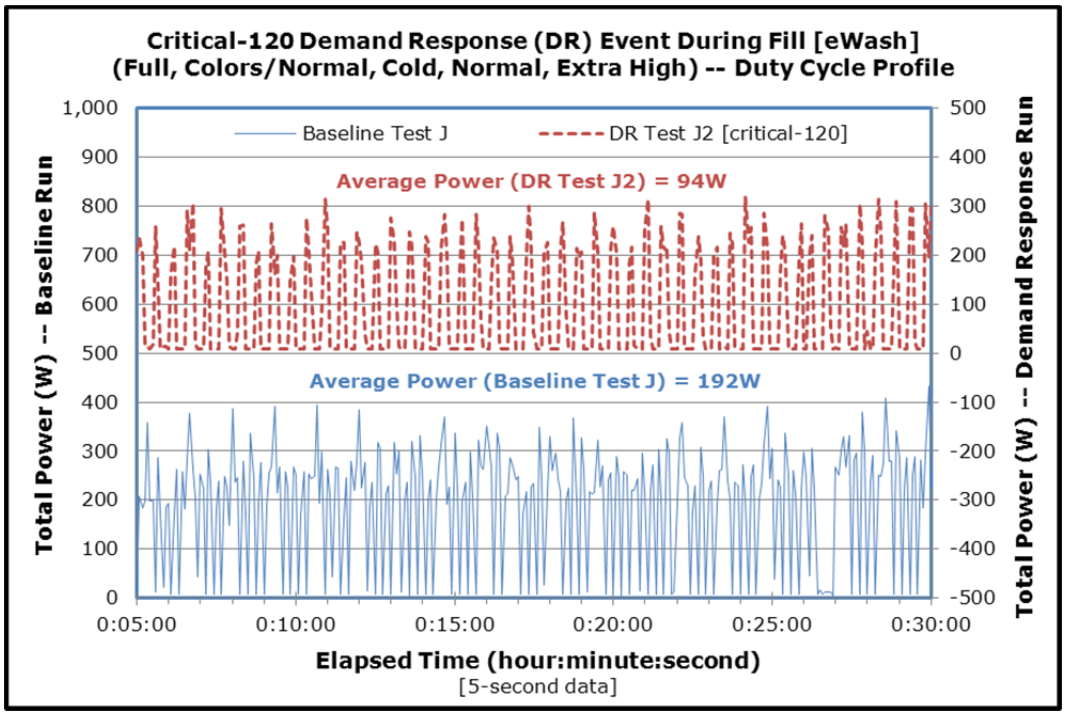

FIGURE 43. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 25-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST J AND DEMAND RESPONSE TEST J2

Overall, in DR Test J2, the washer operated about 29 minutes longer and required less power and energy (Table 32). There were no significant variations in water consumption.

TABLE 32. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST J AND DEMAND RESPONSE TEST J2

DATA CATEGORY	BASELINE TEST J	DEMAND RESPONSE TEST J2
Washer's Operating Duration (hour:minute:second)	1:11:45	1:40:35
Maximum Total Power (W)	1,181	1,193
Average Total Power (W)	234	158
Total Energy (Wh)	280	264
Total Cold Water Flow (gallons)	18.93	17.85
Total Hot Water Flow (gallons)	0.23	0.31

CRITICAL PRICE 60-MINUTE EVENT DURING FILL (K1)

In DR Test K1, a critical price signal with a 60-minute duration was sent during the fill stage of the wash cycle. Figure 44 compares the total power profile of baseline Test K and DR Test K1, which includes the heaters in both

tests. The DR period was 60 minutes, from the elapsed time of 0:02:20 to 1:02:20. At the end of the DR event, the washer resumed its normal operation and ended the wash cycle about 2 hours later (elapsed time of 3:06:00).

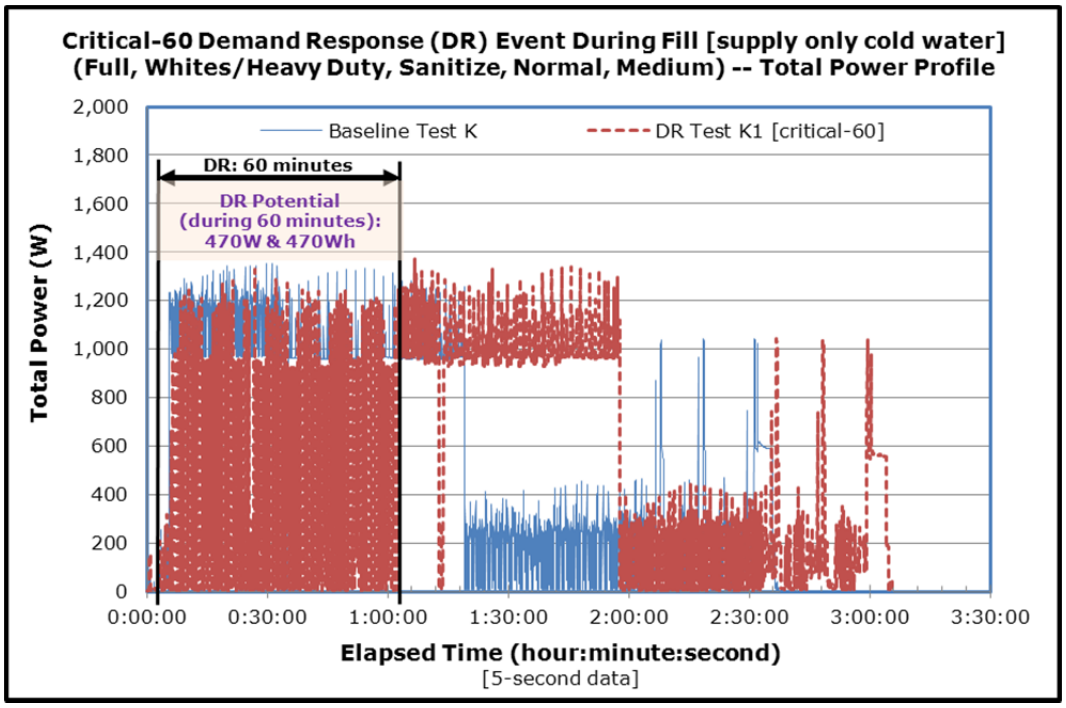

FIGURE 44. COMPARISON OF TOTAL POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST K AND DEMAND RESPONSE TEST K1

The shift in the wash cycle stages, or a prolonged overall wash cycle, in the DR Test K1 is evident in Figure 44. As a result, the agitate stage in the DR Test K1 coincided with the drain and spin stages of the baseline Test K. In addition, for the DR Test K1, the collective effect of duty cycling of the motor and heater on the total power during the DR event is apparent in Figure 44.

Figure 45 illustrates the duty cycling of the heater during the DR event and distinguishes the operation of the heater in the baseline Test K and DR Test K1. The duty cycling pattern of the heater over a 60-minute DR event is shown by vertical (orange color) lines. The average heater power during this period was 905W for the baseline test compared to 439W for the DR test. This translated to a 466W or 51% reduction in heater power during the DR period. The duty cycling, however, prolonged the agitate with heat stage of the wash cycle in the DR test by 38 minutes and 35 seconds. The ultimate effect was an increase in total heater energy in the DR test. Specifically, the total heater energy during a complete wash cycle was 1,127Wh for the baseline test compared to 1,263Wh for the DR test. Another key observation in Figure 45 is the similarity in the operation of the heater in both the

baseline and DR tests. The heater comes on and stays on for a certain period, turns off for one minute, then comes on and stays on, before turning off for good.

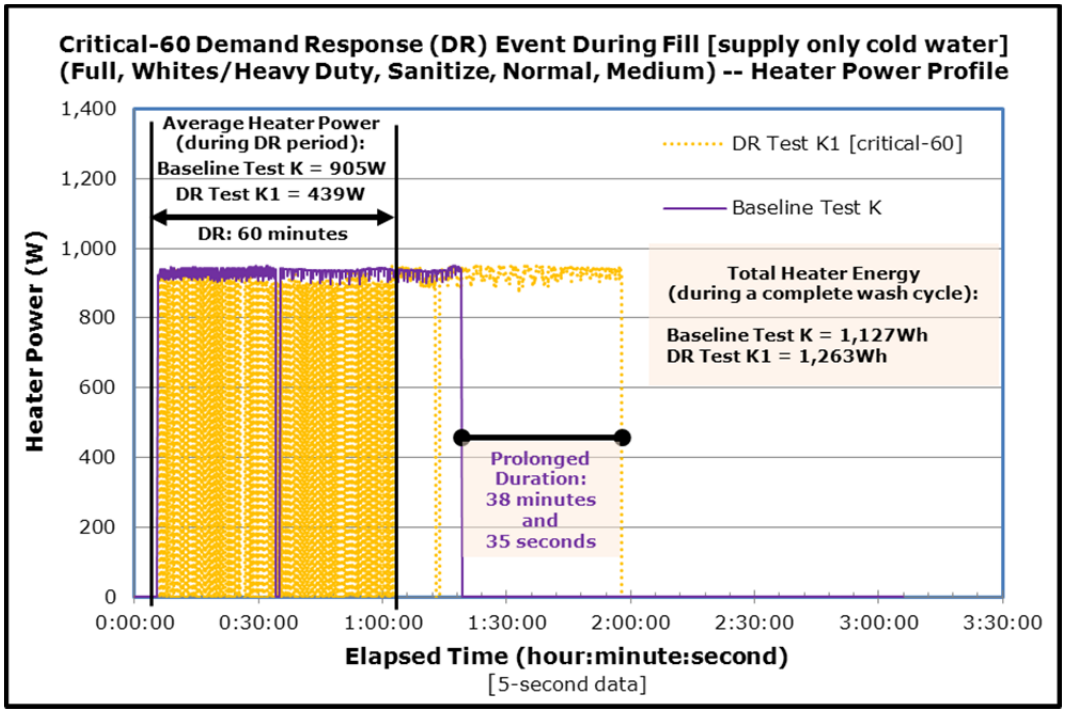

FIGURE 45. COMPARISON OF HEATER POWER PROFILE FOR A COMPLETE WASH CYCLE – BASELINE TEST K AND DEMAND RESPONSE TEST K1

During the 60-minute DR event, a 470W or 47%, reduction in average total power and a 470Wh or 47% reduction in total energy was obtained. Table 33 summarizes the power and energy values for both test runs, as well as the obtained savings potential from the DR event.

TABLE 33. COMPARISON OF DEMAND RESPONSE PERIOD – BASELINE TEST K AND DEMAND RESPONSE TEST K1

DATA CATEGORY	BASELINE TEST K [P]	DEMAND RESPONSE TEST K1 [Q]	SAVINGS POTENTIAL FROM DEMAND RESPONSE [P – Q]	PERCENTAGE OF SAVINGS POTENTIAL FROM DEMAND RESPONSE (%) [P – Q] ÷ P
Maximum Total Power (W)	1,355	1,328	----	----
Average Total Power (W)	993	523	470	47%
Total Energy (Wh)	993	523	470	47%

Figure 46 and Figure 47 depict the total power profile and duty cycle for the baseline Test K and DR Test K1 over a 50-minute and 10-minute DR interval,

respectively. The flat-bottomed off-cycles for the DR Test K1, which are more obvious in Figure 47, confirm the reduction in duty cycle because the power stays around zero watts for a longer period compared to the corresponding baseline off-cycles. As noted in the figures, the average total power for the DR Test K1 was between 550W and 570W, whereas for the baseline Test K it was between 1,000W and 1,130W.

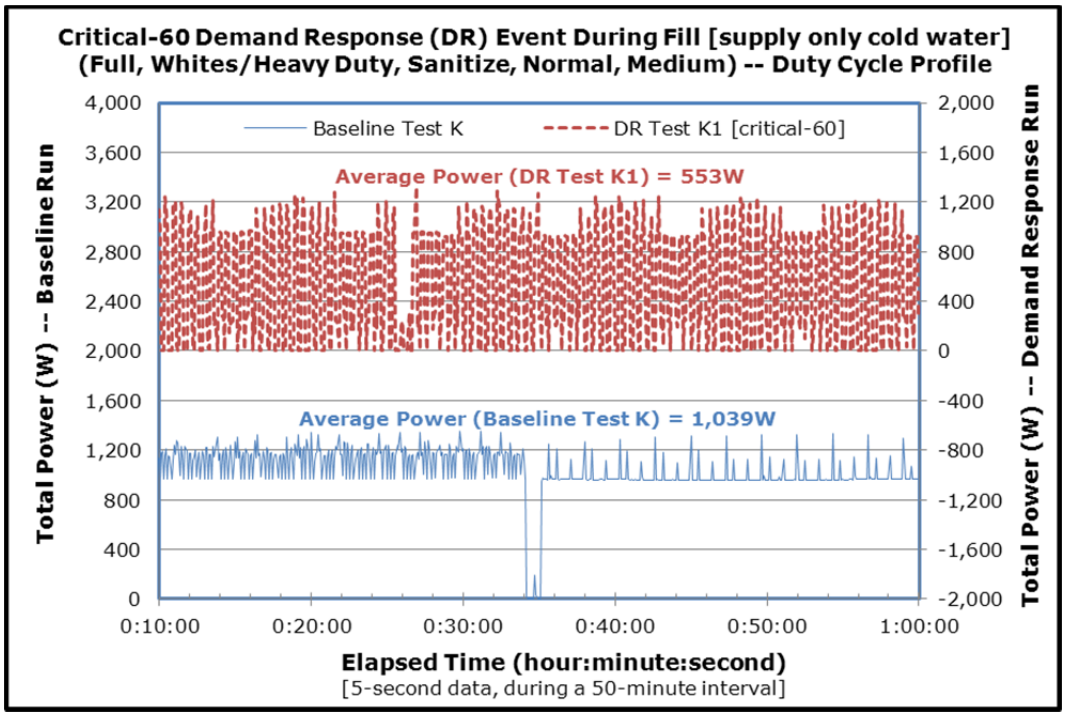

FIGURE 46. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 50-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST K AND DEMAND RESPONSE TEST K1

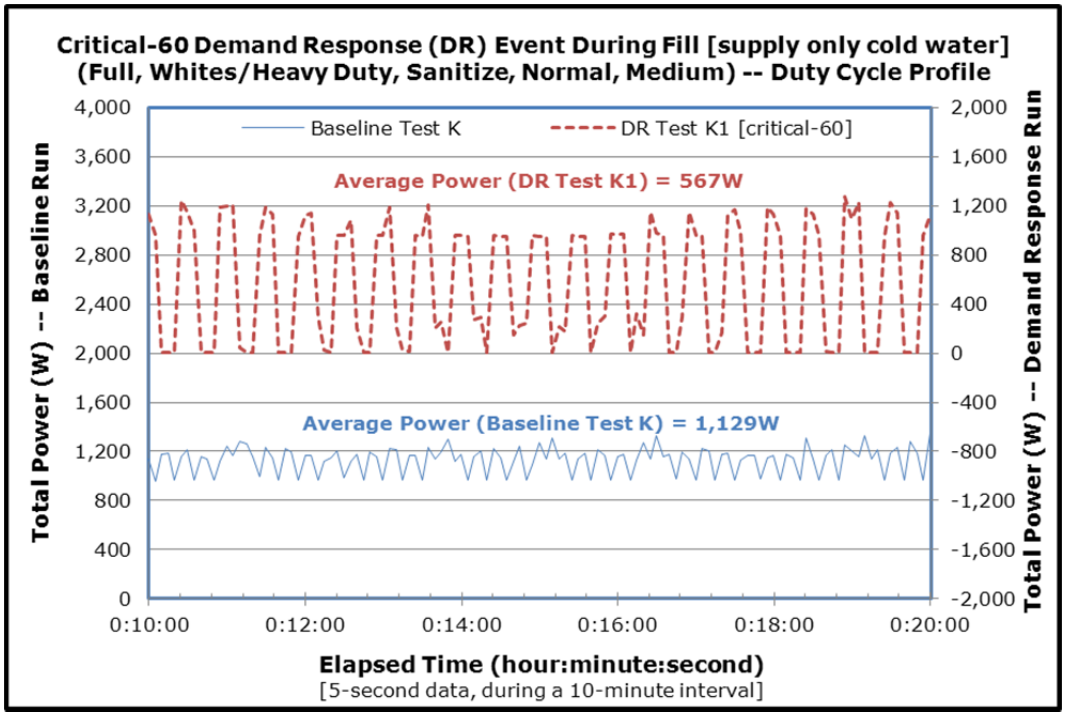

FIGURE 47. COMPARISON OF TOTAL POWER DUTY CYCLE PROFILE FOR A 10-MINUTE DEMAND RESPONSE INTERVAL – BASELINE TEST K AND DEMAND RESPONSE TEST K1

Table 34 summarizes the overall impact of the DR event on the performance of the washer. In general, the washer operated about 28 minutes longer. Even though the average total power was lower in the DR Test K1, the total energy usage was higher. This was attributed to the higher total heater energy usage in the DR test, as noted previously. There was no impact on the water consumption.

TABLE 34. COMPARISON OF A COMPLETE WASH CYCLE – BASELINE TEST K AND DEMAND RESPONSE TEST K1

DATA CATEGORY	BASELINE TEST K	DEMAND RESPONSE TEST K1
Washer's Operating Duration (hour:minute:second)	2:37:50	3:06:00
Maximum Total Power (W)	1,355	1,371
Average Total Power (W)	588	542
Total Energy (Wh)	1,549	1,682
Total Cold Water Flow (gallons)	12.89	12.38
Total Hot Water Flow (gallons)	6.39	6.26

SUMMARY

Table 35 summarizes the savings potential from all the DR test runs. Specifically, the power and energy usage values obtained for the baseline and DR runs during the period when the DR event took place are compared. Clearly, the savings potential varied as a function of when the DR event was initiated and the selected wash mode setting. The lowest and highest reductions in the average total power during the DR event were 9% and 53%, respectively. Similar reductions were seen for the total energy. The maximum total power in Table 35 emphasizes that the DR events may or may not yield any reduction in peak demand. This is not surprising given that the washer responds to DR events by reducing the duty cycle. Hence, the reductions in maximum total power listed in Table 35 are largely due to shifting the stages of the wash cycle.

TABLE 35. SUMMARY COMPARISON OF POWER AND ENERGY USAGE DURING DEMAND RESPONSE PERIOD FOR ALL DEMAND RESPONSE AND THEIR CORRESPONDING BASELINE TESTS

TEST	DR EVENT SIGNAL	MAXIMUM TOTAL POWER (W)	AVERAGE TOTAL POWER (W)	TOTAL ENERGY (WH)	MAXIMUM TOTAL POWER PERCENTAGE DIFFERENCE FROM BASELINE (%)	AVERAGE TOTAL POWER PERCENTAGE DIFFERENCE FROM BASELINE (%)	TOTAL ENERGY PERCENTAGE DIFFERENCE FROM BASELINE (%)
A	---	383	130	22	No comparison was made since this demand response event delayed the start		
A1	High-8	6	5	1			
A	---	383	120	17	No comparison was made since this demand response event delayed the start		
A2	Critical-8	6	5	1			
A	---	1,060	218	218	----	----	----
A3	Critical-60	1,051	110	110	1%	50%	50%
A	---	1,060	229	180	----	----	----
A4	Critical-60	1,061	166	166	0%	27%	8%
A	---	1,041	270	109	----	----	----
A5	Critical-60	1,048	219	95	-1%	19%	13%
A	---	1,037	548	59	----	----	----
A6	Critical-8	639	356	38	38%	35%	35%
A	---	364	181	27	----	----	----
A7	Critical-8	334	111	17	8%	39%	39%
A	---	1,037	407	65	----	----	----
A8	Critical-60	1,039	371	59	0%	9%	9%
C	---	1,059	210	210	----	----	----
C1	Critical-60	1,049	101	101	1%	52%	52%
G	---	1,047	185	185	----	----	----
G1	Critical-60	414	96	96	60%	48%	48%
I	---	1,199	219	218	----	----	----
I1	Critical-60	1,065	104	104	11%	52%	52%
I		1,199	219	218	----	----	----
I2	Critical-120	1,175	140	203	2%	36%	7%
J	---	1,168	217	217	----	----	----
J1	Critical-60	1,058	103	103	9%	53%	53%
J		1,181	242	279	----	----	----
J2	Critical-120	1,193	161	264	-1%	33%	5%
K	---	1,355	993	993	----	----	----
K1	Critical-60	1,328	523	523	2%	47%	47%

Table 36 summarizes the overall impact of the DR event on the performance of the washer. While there were no significant changes in the maximum total power, the average total power and the total energy (except for DR Test K1) were lower for the DR test runs.

TABLE 36. SUMMARY COMPARISON OF POWER AND ENERGY USAGE OVER A COMPLETE WASH CYCLE FOR ALL DEMAND RESPONSE AND THEIR CORRESPONDING BASELINE TESTS

TEST	DR EVENT SIGNAL	MAXIMUM TOTAL POWER (W)	AVERAGE TOTAL POWER (W)	TOTAL ENERGY (WH)	COMPARED BASELINE TEST	MAXIMUM TOTAL POWER PERCENTAGE DIFFERENCE FROM BASELINE (%)	AVERAGE TOTAL POWER PERCENTAGE DIFFERENCE FROM BASELINE (%)	TOTAL ENERGY PERCENTAGE DIFFERENCE FROM BASELINE (%)
A	---	1,060	206	219	----	----	----	----
A1	High-8	1,049	203	207	A	1%	1%	6%
A2	Critical-8	1,069	205	208		-1%	1%	5%
A3	Critical-60	1,051	147	205		1%	29%	6%
A4	Critical-60	1,061	160	208		0%	22%	5%
A5	Critical-60	1,048	188	205		1%	9%	6%
A6	Critical-60	1,049	200	210		1%	3%	4%
A7	Critical-8	1,055	194	207		0%	6%	5%
A8	Critical-60	1,043	201	207		2%	3%	6%
C	---	1,059	200	211	----	----	----	----
C1	Critical-60	1,049	140	198	C	1%	30%	6%
G	---	1,054	203	257	----	----	----	----
G1	Critical-60	1,051	145	247	G	0%	29%	4%
I	---	1,199	210	218	----	----	----	----
I1	Critical-60	1,177	144	205	I	2%	32%	6%
I2	Critical-120	1,175	136	203		2%	35%	7%
J	---	1,181	234	280	----	----	----	----
J1	Critical-60	1,183	173	273	J	0%	26%	2%
J2	Critical-120	1,193	158	264		-1%	33%	6%
K	---	1,355	588	1,549	----	----	----	----

Test	DR Event Signal	Maximum Total Power (W)	Average Total Power (W)	Total Energy (Wh)	Compared Baseline Test	Maximum Total Power Percentage Difference from Baseline (%)	Average Total Power Percentage Difference from Baseline (%)	Total Energy Percentage Difference from Baseline (%)
K1	Critical -60	1,371	542	1,682	K	-1%	8%	-9%

CONCLUSIONS

Generally, the clothes washer consistently performed in a manner compliant with its originally intended strategy and has the potential to avoid its peak demand of roughly 600W. Overall, the DR benefits for this clothes washer that could be realized by an electric utility are dependent upon the price signal, duration, and time of occurrence of a DR event relative to the dishwasher stage of operation. A few areas of key importance:

Event Definitions

The clothes washer under test responded to either "high" or "critical" price signals instead of AHAM's recommended DR event types. AHAM defines the response based on the duration of the event, while GE bases it upon the "criticality" of the event. Again, this is a result of timing, because GE developed their algorithms prior to the development of the AHAM definitions.

"High" Event

The clothes washer responds to "high" price signals by delaying the start of a new wash cycle during the event. It does not affect a cycle already in progress.

"Critical" Event

In response to a "critical" event, the dishwasher performs the "high" response but also has the capacity to reduce average wattage via a reduction in motor and heater duty cycles. It has the capability to reduce wattage by up to 53%. The magnitude of reduction depends on the wash modes selected by the user and the point in the wash cycle when the signal is received by the appliance.

RECOMMENDATIONS

Overall, the clothes washer performed as intended by the manufacturer. However, there appear to be discrepancies between the implemented clothes washer DR strategy and the proposed definitions and requirements in the AHAM/ACEEE Joint Petition. There also seem to be disparities between utility needs during DR events and the proposed AHAM/ACEEE definitions of Spinning Reserve and Delay Load.

Historically, DR events are typically initiated out of need on the utility's end to shed load to avoid more catastrophic events, like black outs, from occurring. For the utility to properly plan its DR resources and account for them in the larger scheme of maintaining grid reliability, the demand reduction must be reliable, repeatable, and easily dispatched. Further, the duration of the required DR event is sometimes unknown at the time the signal must be sent. The DR scheme adopted by GE may not provide optimal benefit to the utility for two reasons:

1. For a High event, no immediate reduction in power is guaranteed. The only response is to postpone the start of a new wash cycle. Wash cycles already in progress will continue unchanged.
2. For a Critical event, there is a reduction in load attributable to the duty cycle alteration of the motor and heater. The remaining components operate at normal power conditions.

These responses do not fully comply with the AHAM guidelines and would likely provide less beneficial demand reduction to the utility. Further simulation and better understanding of the DR programs used to activate these systems are required to fully evaluate the grid-level impacts of various schemes. It is unclear how this problem may be further impacted by other types of DR-capable appliances. Subsequent testing and future increased interaction with AHAM and standards-setting agencies will attempt to address these issues.

APPENDIX A – DATA FOR ALL BASELINE TESTS

This section offers graphical and tabulated data for all baseline test runs. Because each group of baseline test conditions was repeated 3 times, 36 test runs resulted. To exemplify the classification of test runs, the baseline Tests A-1, A-2, and A-3 refer to the first, second, and third/final test within baseline A, respectively. The graphical data (Figure 50 through Figure 85) show component-level and total power profiles. The tabulated data (Table 37 through Table 48) include the washer's operating duration, power and energy values, controlled environment room average temperature, as well as the supplied water temperature, pressure, and flow.

One general observation about Figure 50 through Figure 85 is the variations in the peak power for each of the three test runs within the same category of test condition. More specifically, in some of the test runs, the peak powers are absent from the profile. This was attributed to the 5-second sampling rate of power data, rather than the performance of the washer. Because the instantaneous power was recorded every 5 seconds, power peaks that may have occurred within the 5-second interval may not have been captured. This point was explored by conducting additional tests and collecting 1-second and 5-second data during a complete wash cycle for tests B (Figure 48) and C (Figure 49). Figure 48 and Figure 49 establish the differences in the power profiles with 1-second and 5-second sampling rate. In spite of the observed differences, the variants in the average and maximum total power obtained with 1-second and 5-second sampling rates were negligible, less than 1%. This confirmed the soundness of the power data gathered with a 5-second sampling rate.

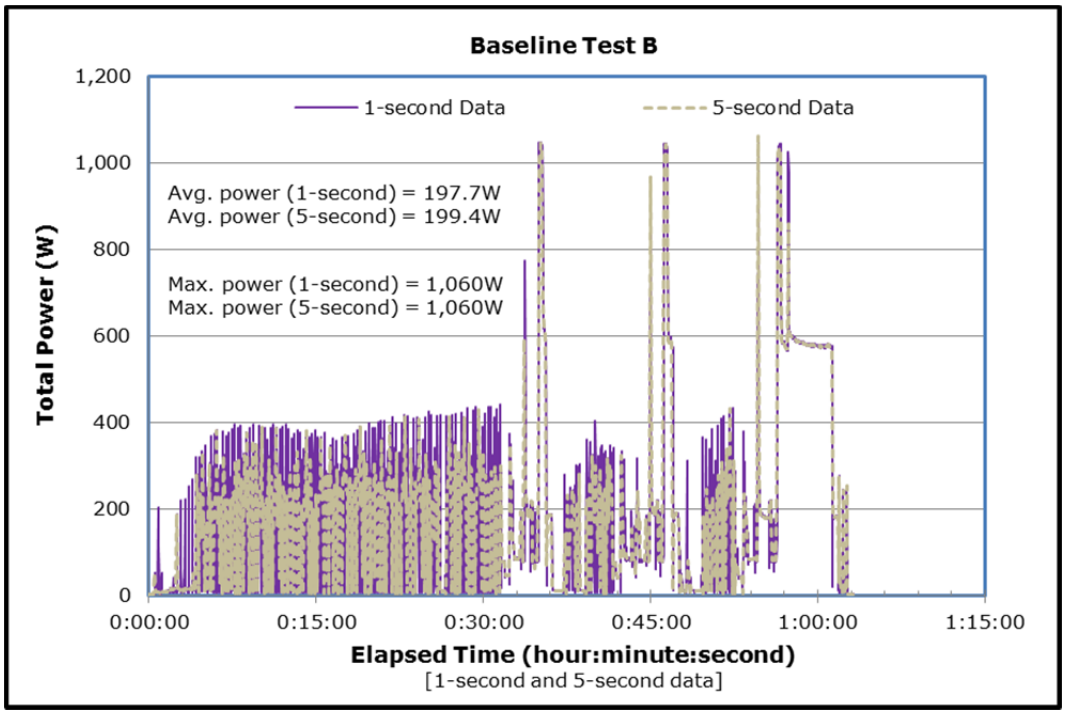

FIGURE 48. COMPARISON OF TOTAL POWER PROFILE WITH 1-SECOND AND 5-SECOND SAMPLING RATE – BASELINE TEST B

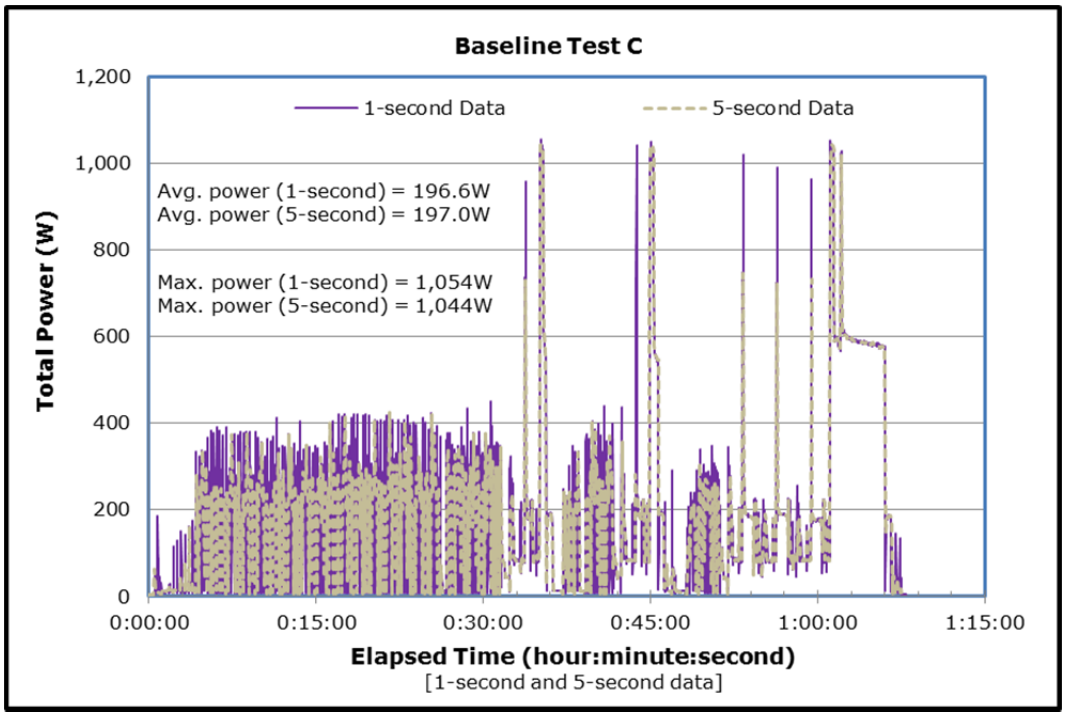

FIGURE 49. COMPARISON OF TOTAL POWER PROFILE WITH 1-SECOND AND 5-SECOND SAMPLING RATE – BASELINE TEST C

Out of three performed test runs, within every group of the baseline scenario, a representative run was selected and discussed in the "Results" section of this report. The selection entailed a side-by-side review of obtained power demand profiles for all three runs and selection of a characteristic run within the group. The selected test runs were A-3, B-3, C-3, D-3, E-3, F-1, G-2, H-1, I-2, J-1, K-3, and finally L-2.

BASELINE A

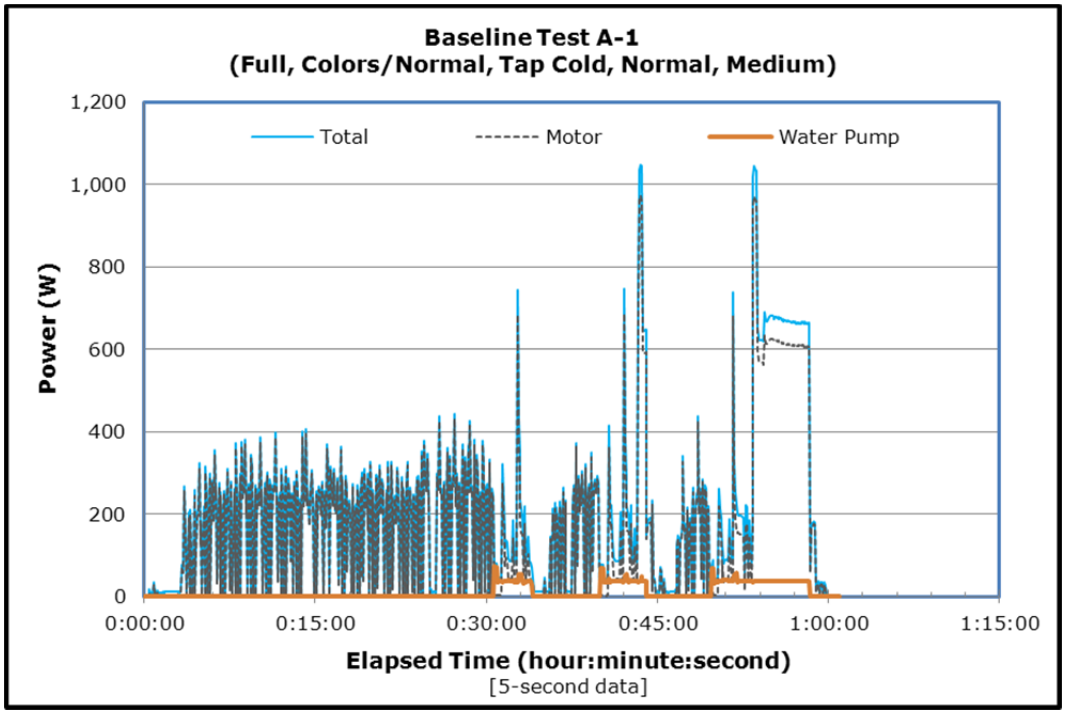

FIGURE 50. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST A [A-1]

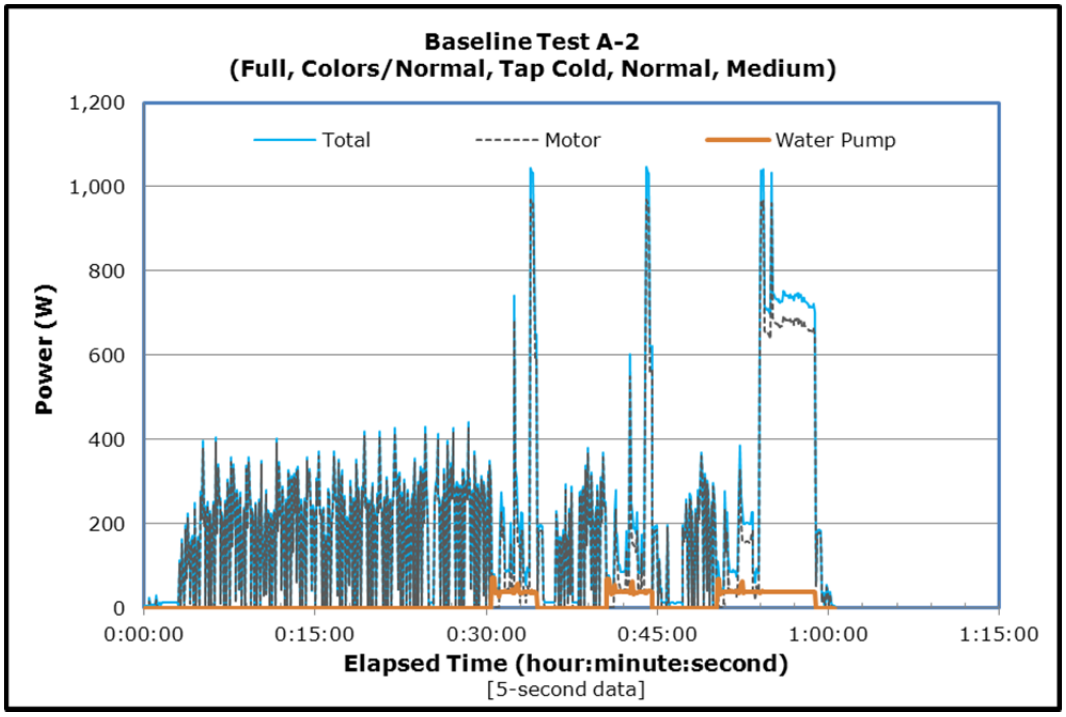

FIGURE 51. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST A [A-2]

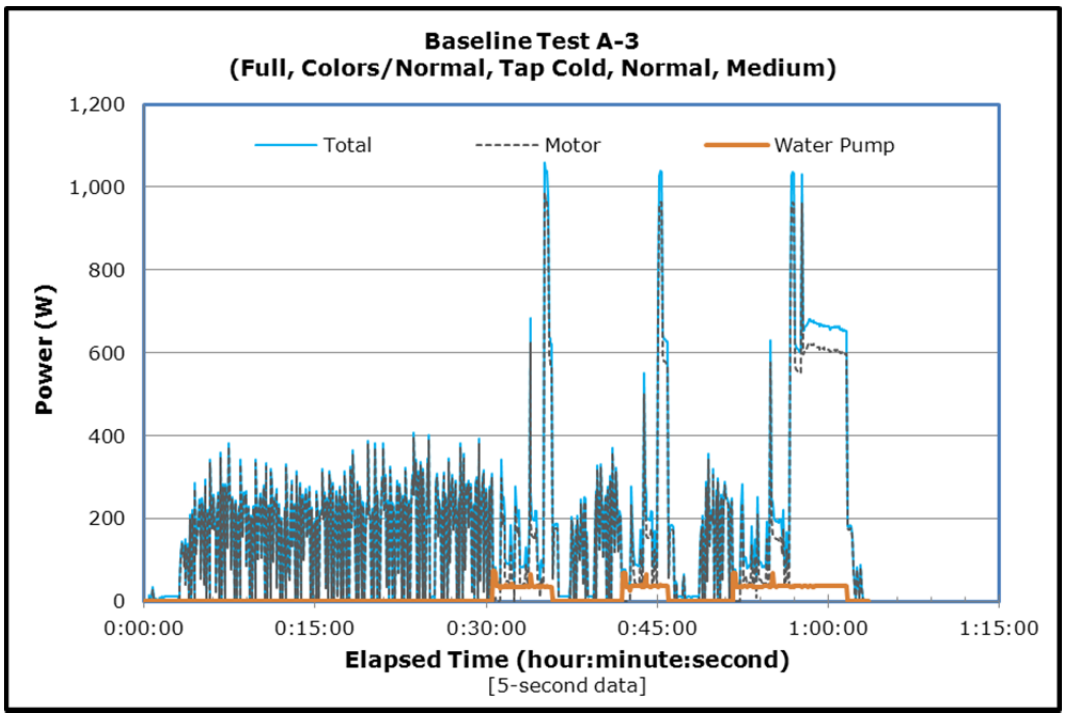

FIGURE 52. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST A [A-3]

TABLE 37. SUMMARY DATA FOR ALL BASELINE A TESTS

DATA CATEGORY	BASELINE TEST A-1	BASELINE TEST A-2	BASELINE TEST A-3
Washer's Operating Duration (hour:minute:second)	1:00:55	1:00:30	1:03:30
Power			
Average Water Pump Power (W)	11	11	12
Maximum Water Pump Power (W)	74	71	74
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	183	198	186
Maximum Motor Power (W)	973	970	988
Average Total Power (W)	202	218	206
Maximum Total Power (W)	1,047	1,048	1,060
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	11	11	12
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	186	200	197
Total Energy (Wh)	206	220	219
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	76	76	76
Water Properties			
Average Cold Water Temperature (ºF)	74	74	72
Average Cold Water Pressure (psig)	35	35	35
Total Cold Water Flow (gallons)	18.61	18.93	18.92
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

BASELINE B

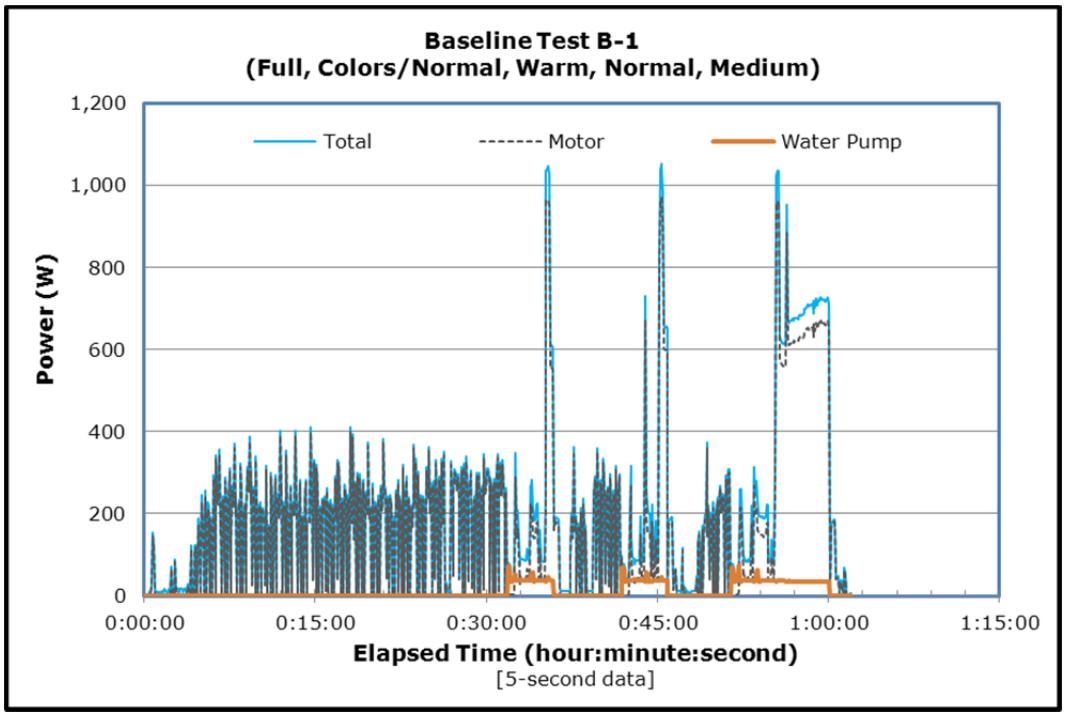

FIGURE 53. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST B [B-1]

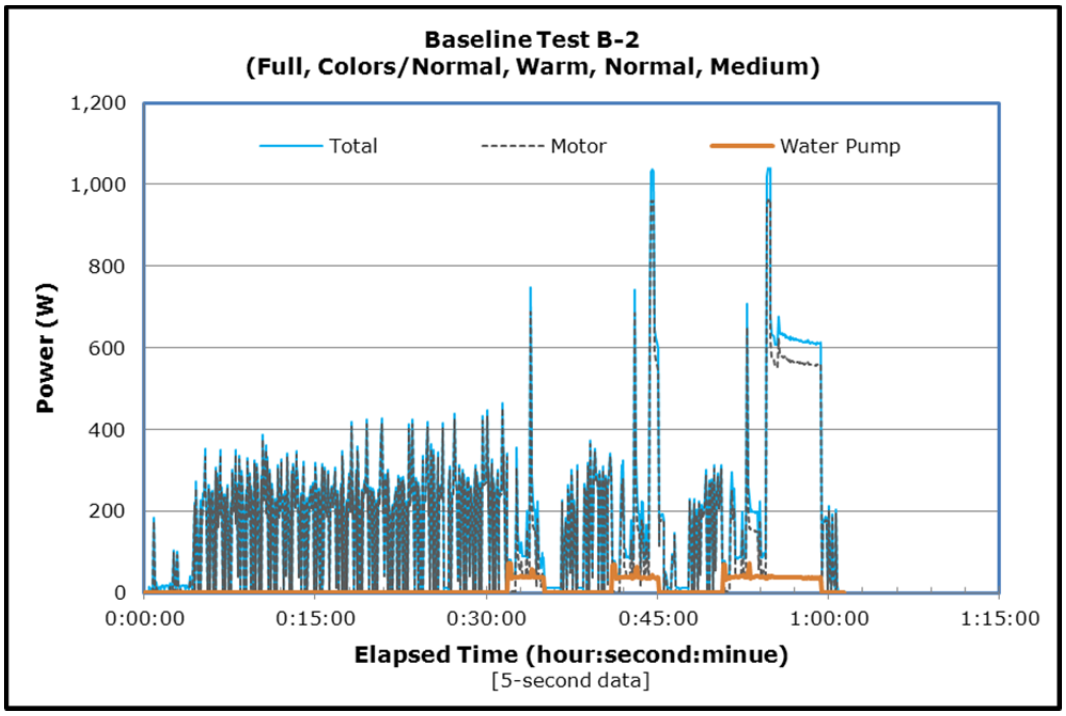

FIGURE 54. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST B [B-2]

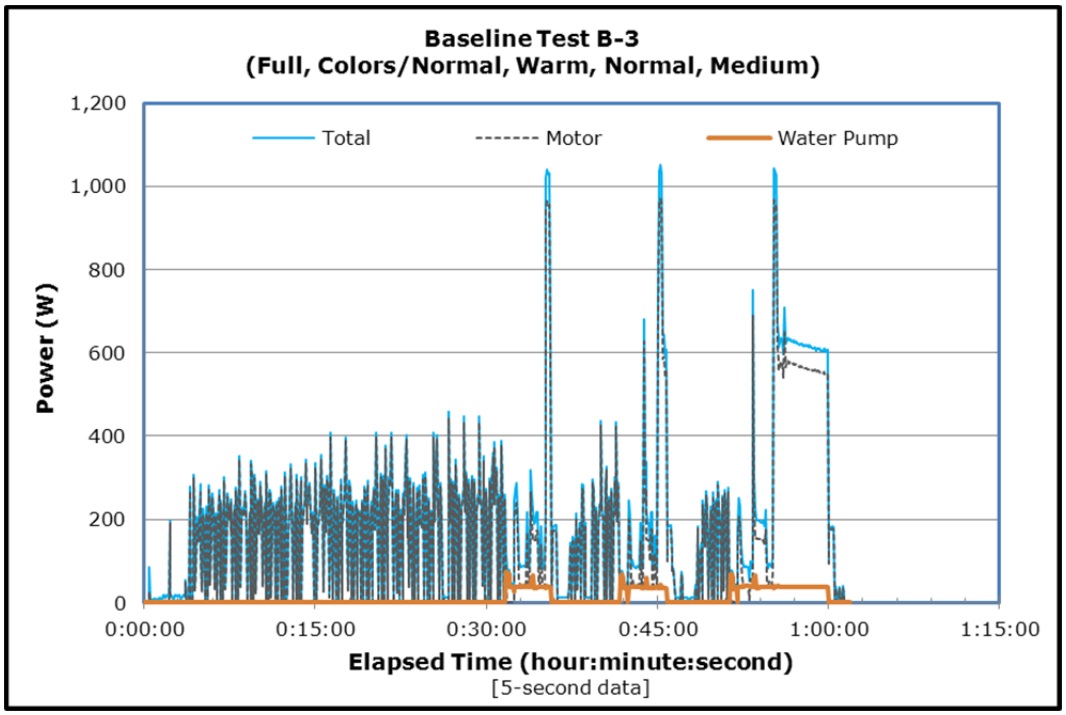

FIGURE 55. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST B [B-3]

TABLE 38. SUMMARY DATA FOR ALL BASELINE B TESTS

DATA CATEGORY	BASELINE TEST B-1	BASELINE TEST B-2	BASELINE TEST B-3
Washer's Operating Duration (hour:minute:second)	1:02:00	1:01:22	1:01:50
Power			
Average Water Pump Power (W)	11	10	11
Maximum Water Pump Power (W)	75	73	73
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	185	180	179
Maximum Motor Power (W)	970	964	969
Average Total Power (W)	204	199	199
Maximum Total Power (W)	1,053	1,039	1,051
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	11	11	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	191	185	185
Total Energy (Wh)	212	204	205
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	76	75	75
Water Properties			
Average Cold Water Temperature (ºF)	73	75	73
Average Cold Water Pressure (psig)	35	35	35
Total Cold Water Flow (gallons)	15.99	15.74	15.80
Average Warm/Hot Water Temperature (ºF)	113	108	113
Average Warm/Hot Water Pressure (psig)	27	27	27
Total Warm/Hot Water Flow (gallons)	2.44	2.28	2.21

BASELINE C

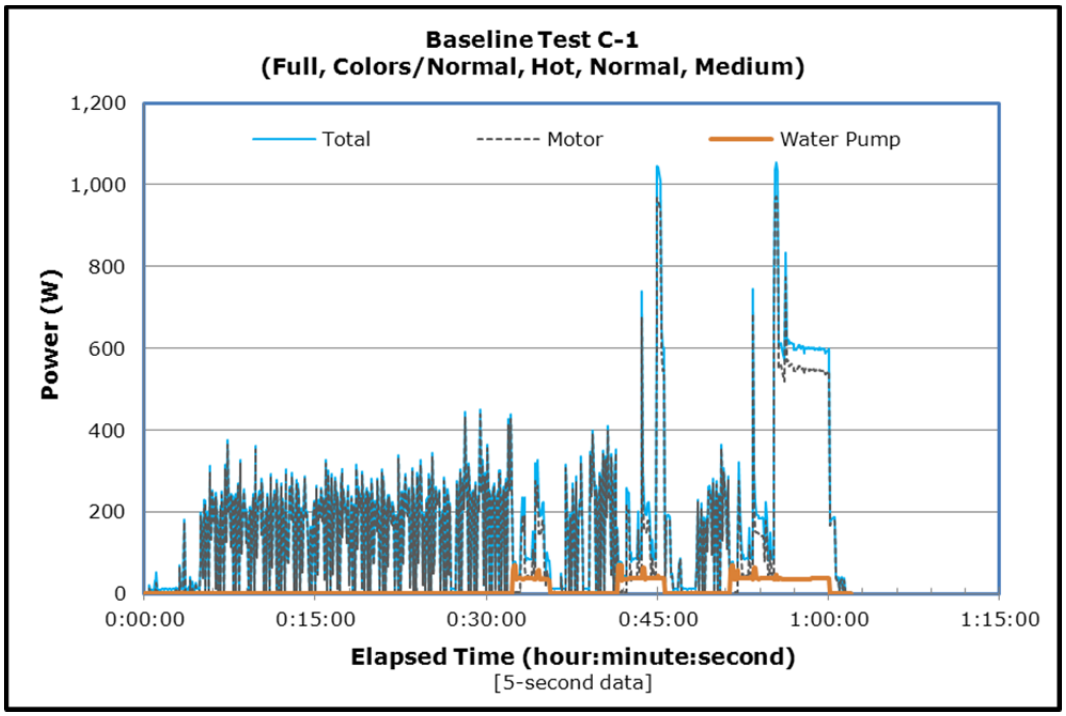

FIGURE 56. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST C [C-1]

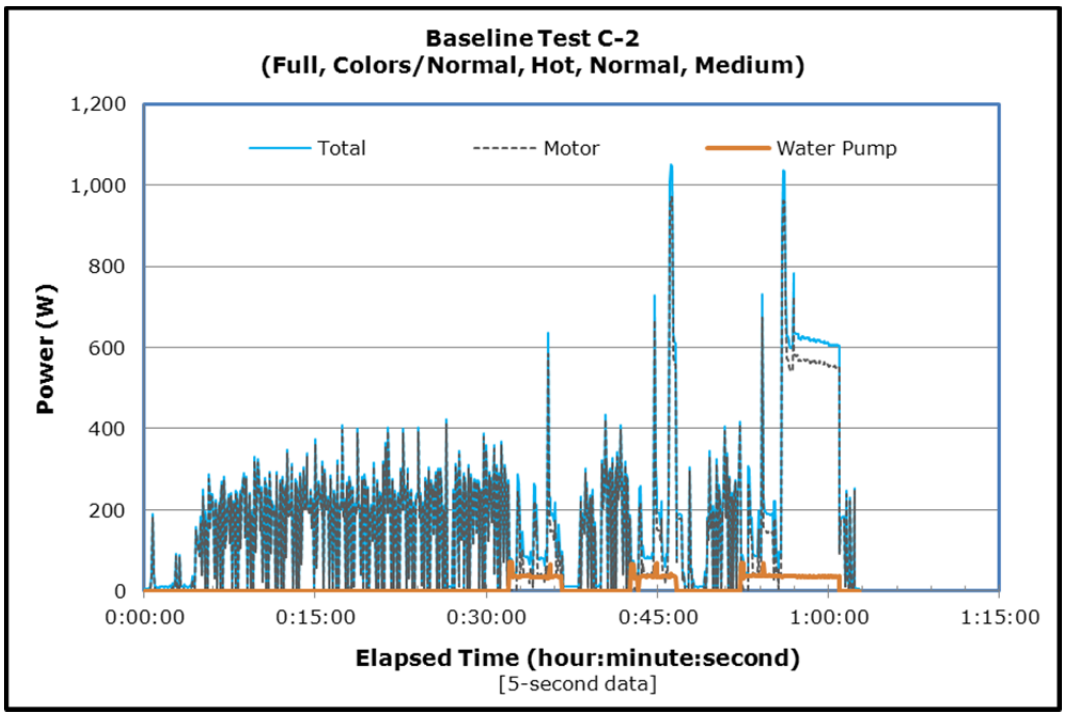

FIGURE 57. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST C [C-2]

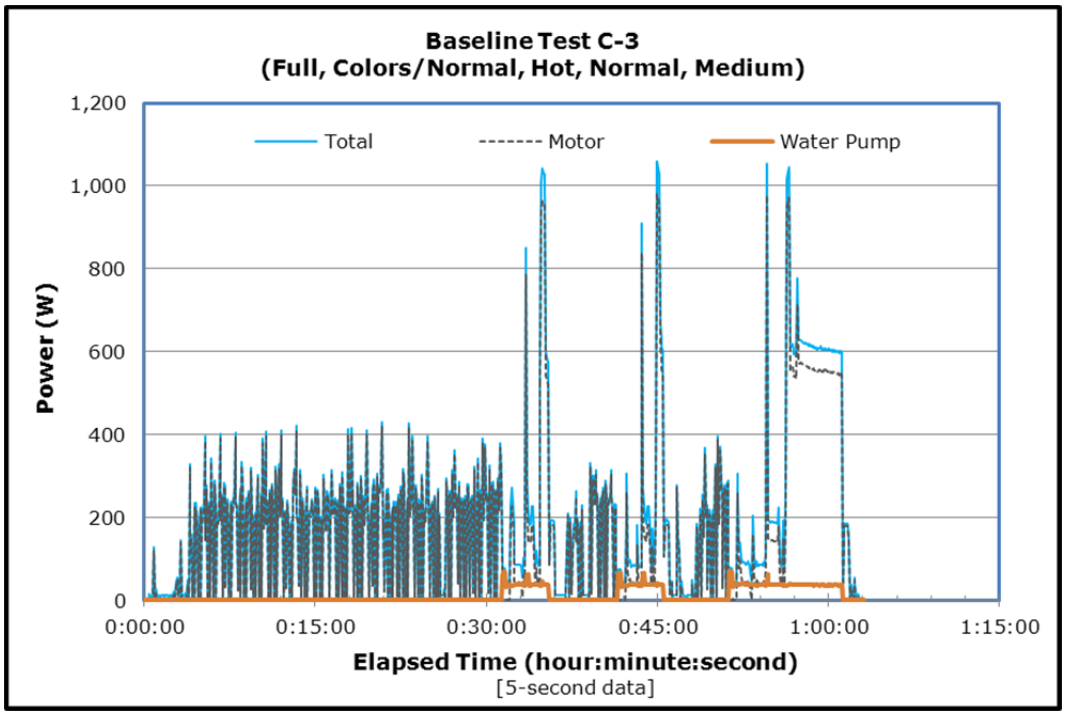

FIGURE 58. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST C [C-3]

TABLE 39. SUMMARY DATA FOR ALL BASELINE C TESTS

DATA CATEGORY	BASELINE TEST C-1	BASELINE TEST C-2	BASELINE TEST C-3
Washer's Operating Duration (hour:minute:second)	1:02:00	1:02:45	1:03:05
Power			
Average Water Pump Power (W)	10	11	11
Maximum Water Pump Power (W)	70	71	70
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	169	174	180
Maximum Motor Power (W)	970	970	980
Average Total Power (W)	188	193	200
Maximum Total Power (W)	1,053	1,049	1,059
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	11	11	12
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	175	183	190
Total Energy (Wh)	194	203	211
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	73	75	76
Water Properties			
Average Cold Water Temperature (ºF)	72	75	75
Average Cold Water Pressure (psig)	35	35	34
Total Cold Water Flow (gallons)	13.03	12.57	12.86
Average Warm/Hot Water Temperature (ºF)	114	114	114
Average Warm/Hot Water Pressure (psig)	27	33	34
Total Warm/Hot Water Flow (gallons)	5.33	5.60	5.53

BASELINE D

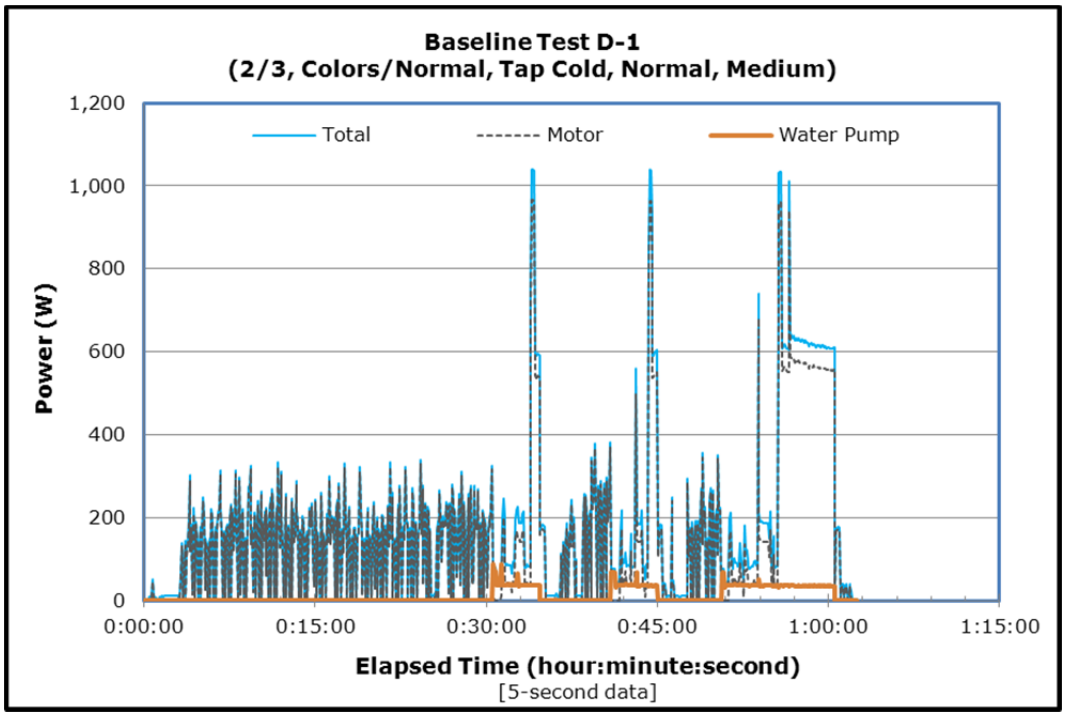

FIGURE 59. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST D [D-1]

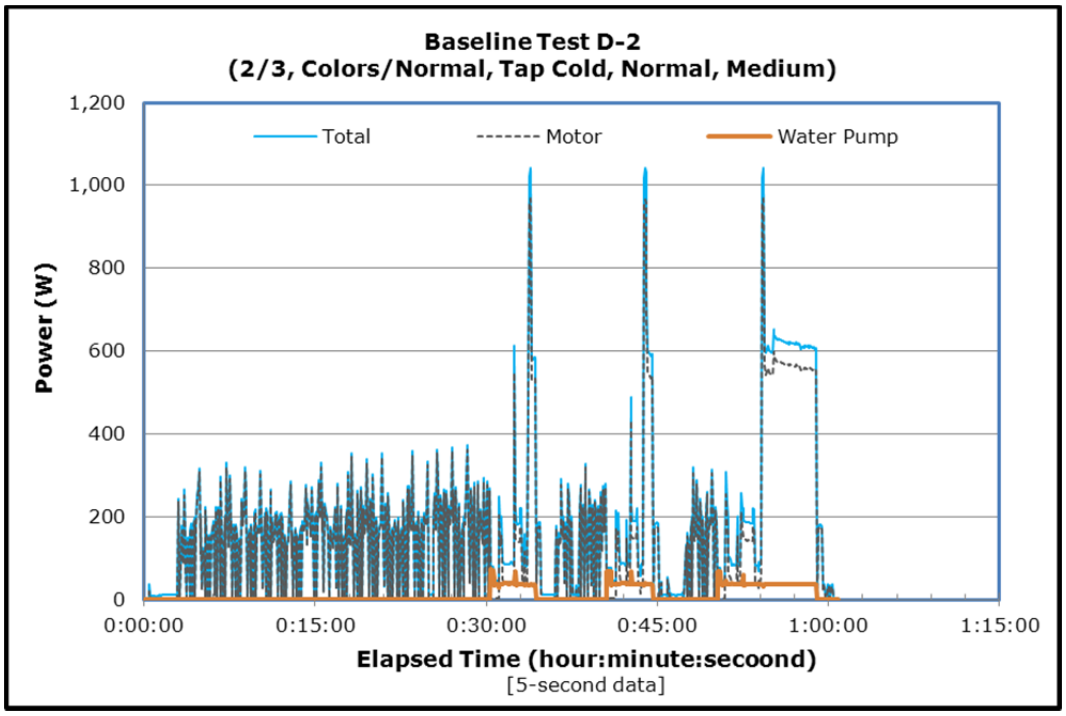

FIGURE 60. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST D [D-2]

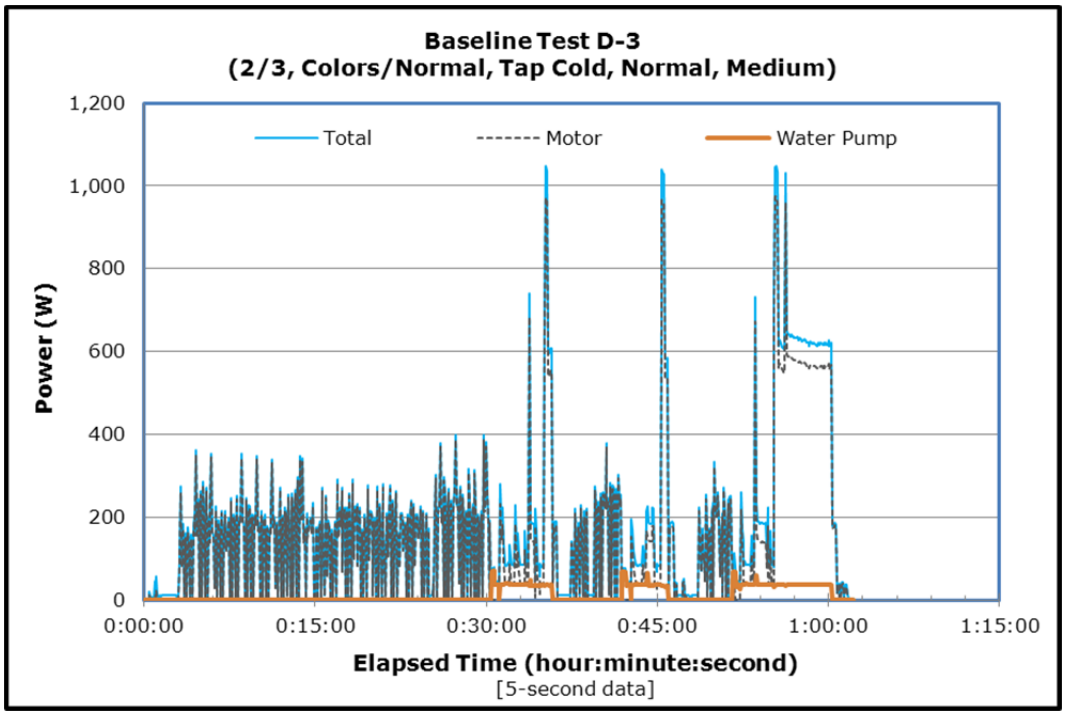

FIGURE 61. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST D [D-3]

TABLE 40. SUMMARY DATA FOR ALL BASELINE D TESTS

DATA CATEGORY	BASELINE TEST D-1	BASELINE TEST D-2	BASELINE TEST D-3
Washer's Operating Duration (hour:minute:second)	1:02:30	1:00:50	1:02:10
Power			
Average Water Pump Power (W)	12	11	11
Maximum Water Pump Power (W)	89	73	70
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	161	162	165
Maximum Motor Power (W)	966	969	976
Average Total Power (W)	181	181	185
Maximum Total Power (W)	1,041	1,042	1,048
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	12	11	12
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	168	164	171
Total Energy (Wh)	189	184	192
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	75	74	74
Water Properties			
Average Cold Water Temperature (ºF)	75	73	74
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	15.77	15.65	16.45
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

BASELINE E

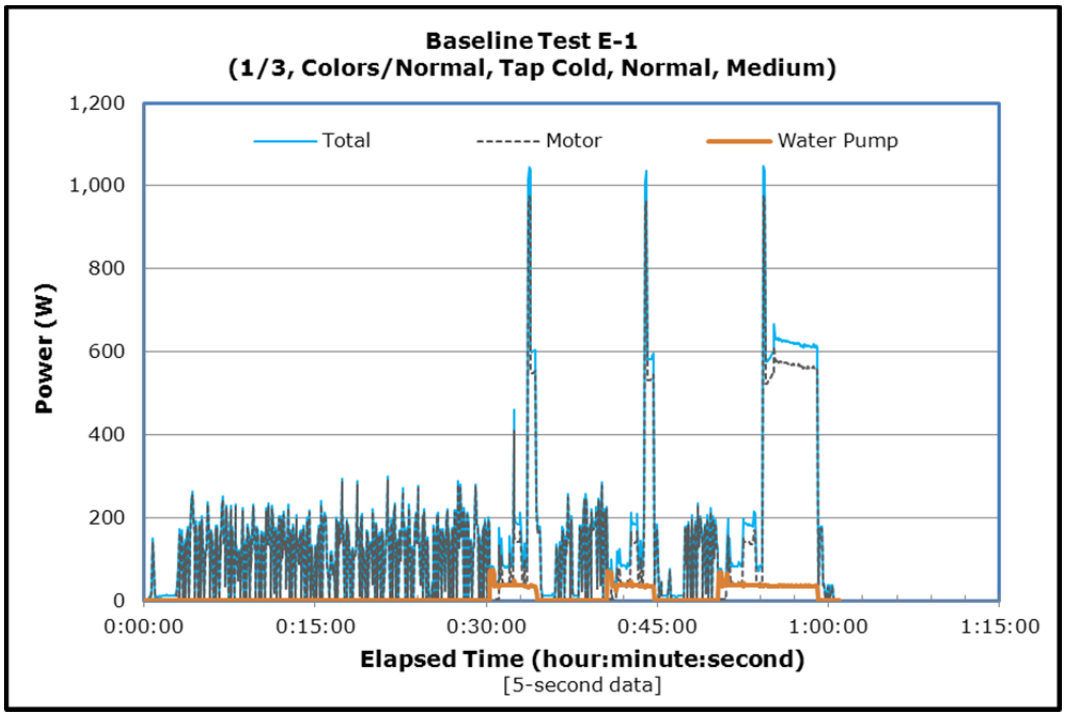

FIGURE 62. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST E [E-1]

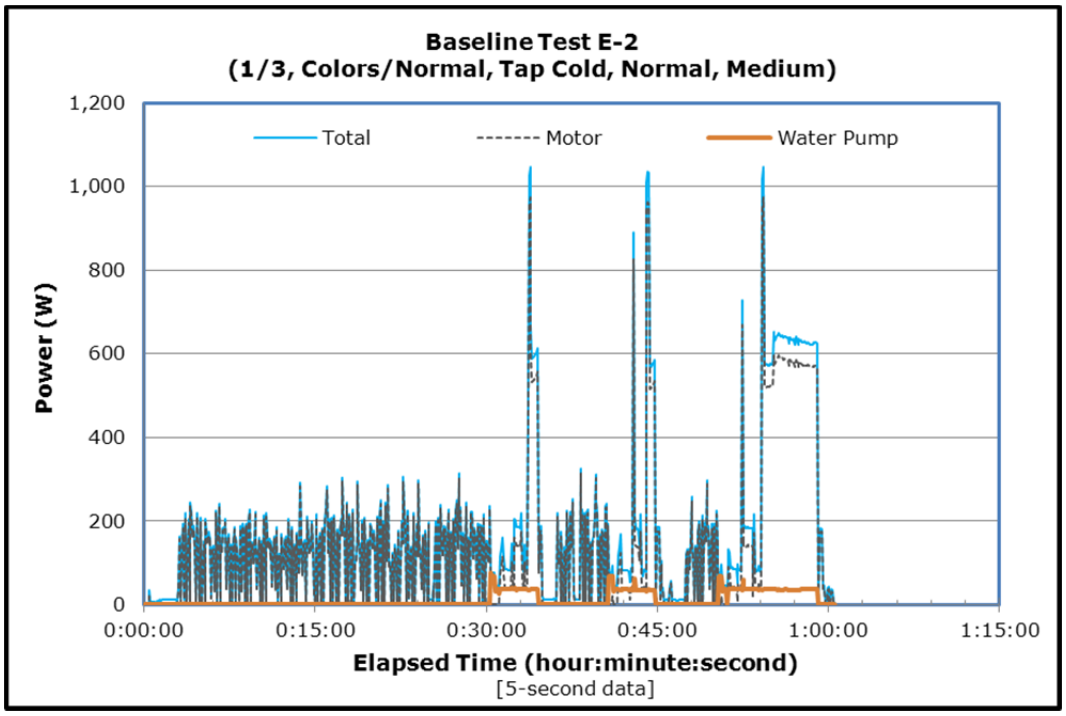

FIGURE 63. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST E [E-2]

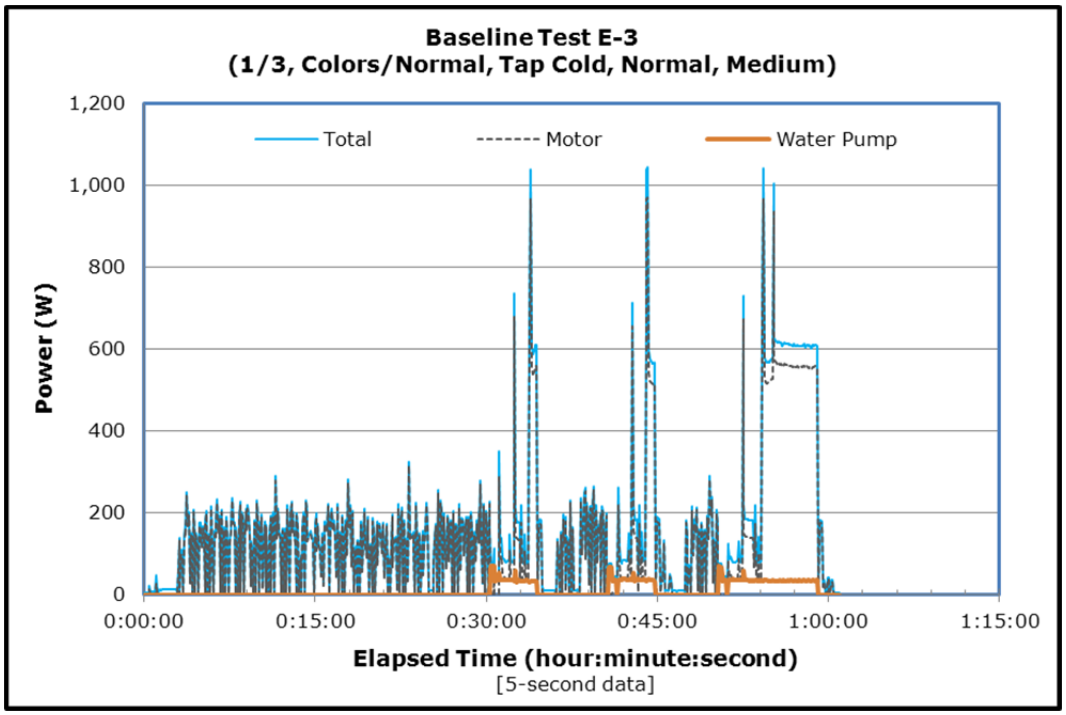

FIGURE 64. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST E [E-3]

TABLE 41. SUMMARY DATA FOR ALL BASELINE E TESTS

DATA CATEGORY	BASELINE TEST E-1	BASELINE TEST E -2	BASELINE TEST E -3
Washer's Operating Duration (hour:minute:second)	1:00:55	1:00:35	1:00:55
Power			
Average Water Pump Power (W)	11	11	10
Maximum Water Pump Power (W)	73	78	70
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	146	151	147
Maximum Motor Power (W)	975	973	970
Average Total Power (W)	165	170	166
Maximum Total Power (W)	1,048	1,047	1,044
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	11	11	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	149	153	150
Total Energy (Wh)	167	172	168
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	73	73	74
Water Properties			
Average Cold Water Temperature (ºF)	72	71	71
Average Cold Water Pressure (psig)	35	35	34
Total Cold Water Flow (gallons)	13.31	13.29	13.51
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

BASELINE F

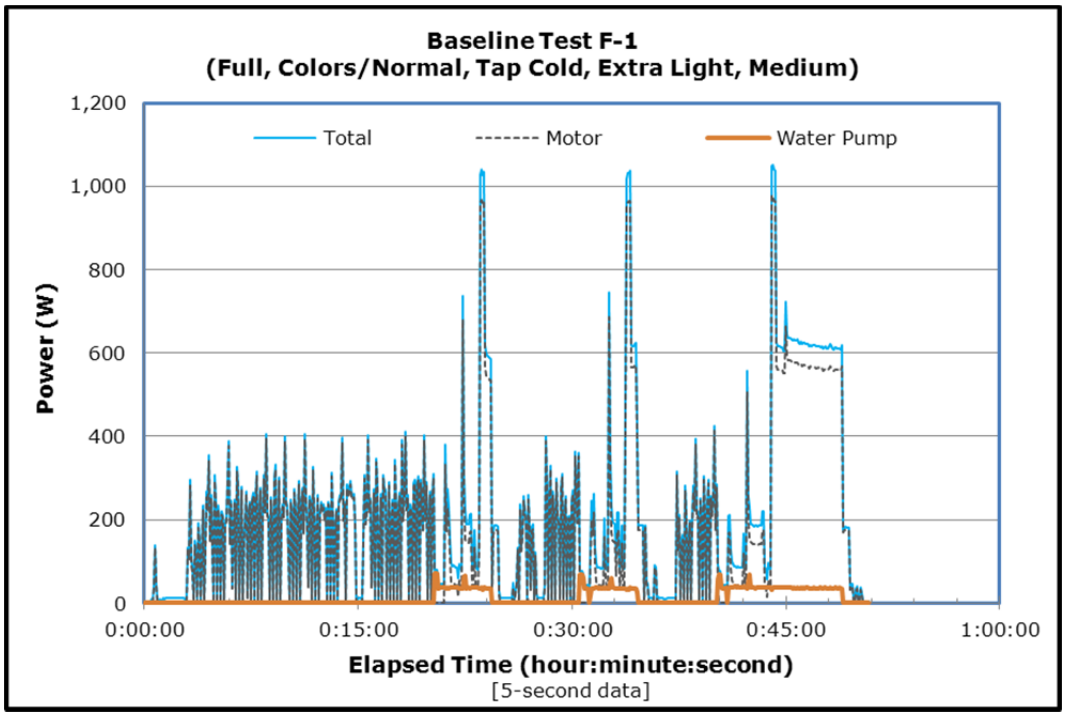

FIGURE 65. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST F [F-1]

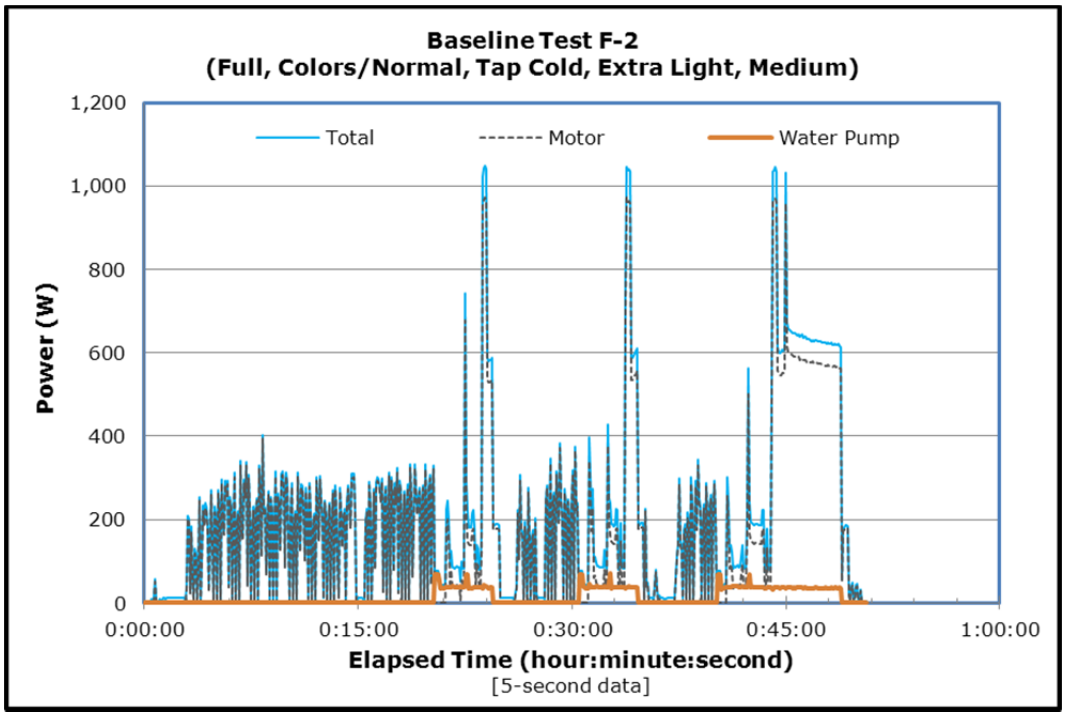

FIGURE 66. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST F [F-2]

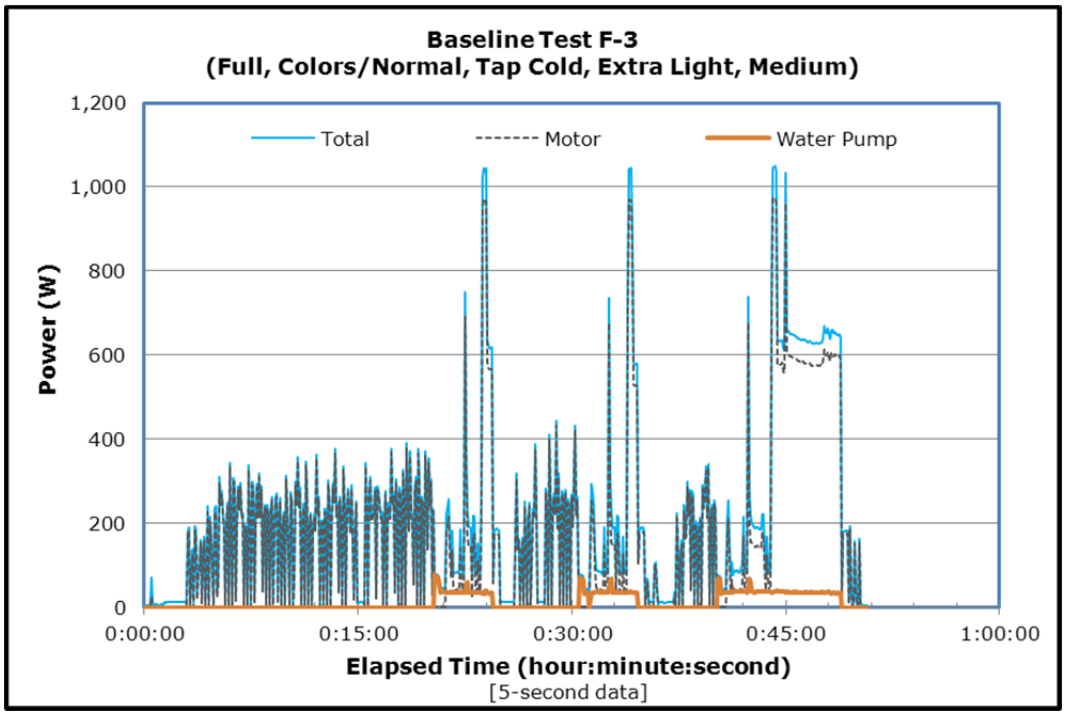

FIGURE 67. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST F [F-3]

TABLE 42. SUMMARY DATA FOR ALL BASELINE F TESTS

DATA CATEGORY	BASELINE TEST F-1	BASELINE TEST F-2	BASELINE TEST F-3
Washer's Operating Duration (hour:minute:second)	0:50:50	0:50:40	0:50:45
Power			
Average Water Pump Power (W)	13	13	13
Maximum Water Pump Power (W)	73	70	79
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	190	187	191
Maximum Motor Power (W)	979	973	974
Average Total Power (W)	212	210	213
Maximum Total Power (W)	1,050	1,050	1,049
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	11	11	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	161	159	162
Total Energy (Wh)	180	177	181
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	75	74	75
Water Properties			
Average Cold Water Temperature (ºF)	71	72	72
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	18.75	18.67	19.07
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

BASELINE G

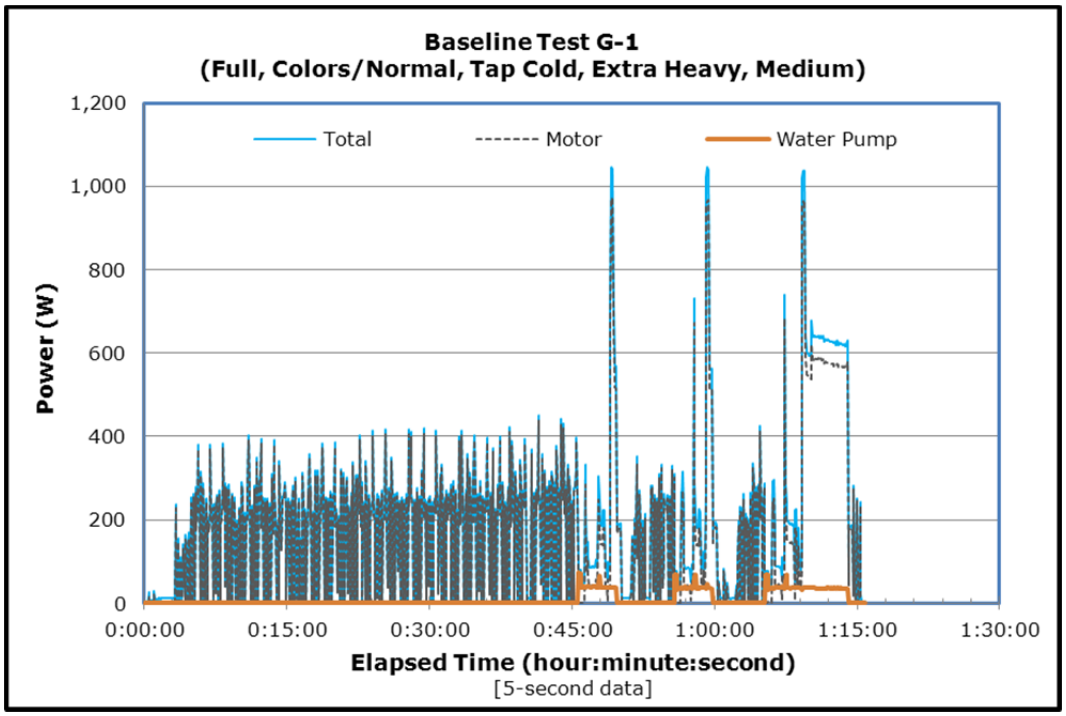

FIGURE 68. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST G [G-1]

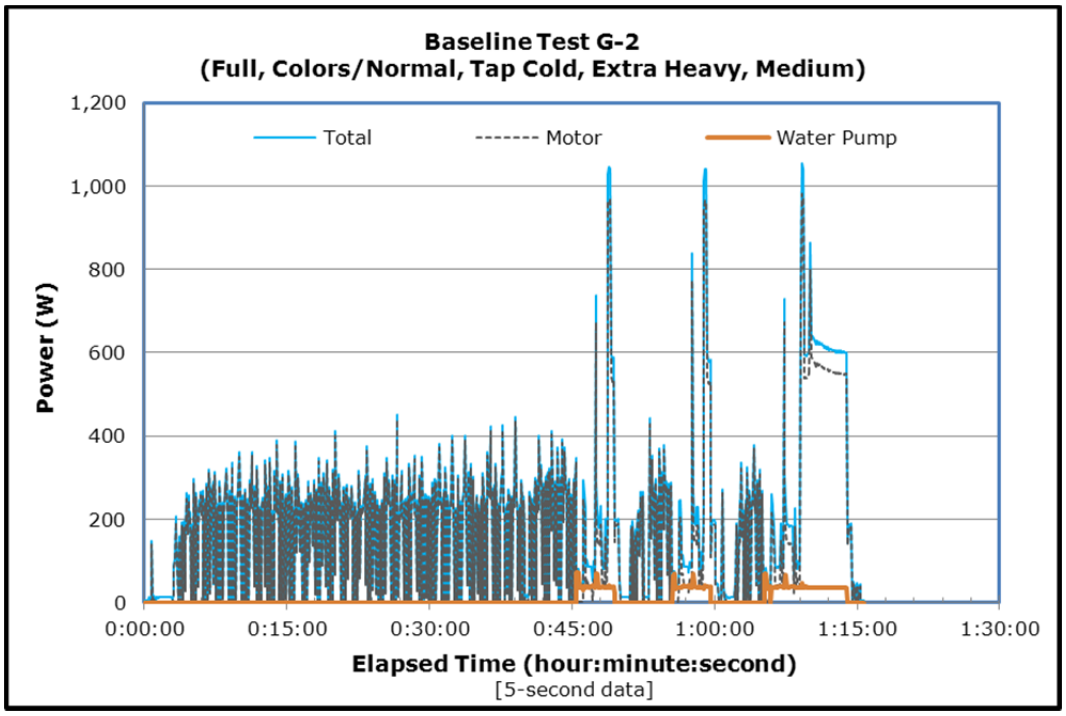

FIGURE 69. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST G [G-2]

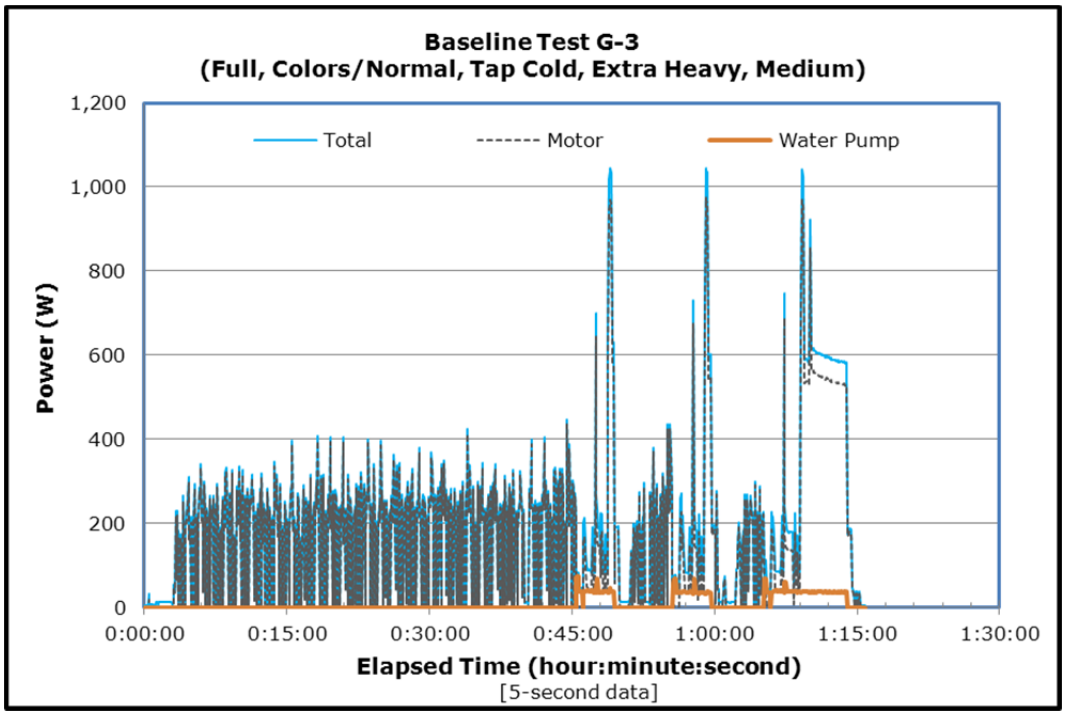

FIGURE 70. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST G [G-3]

TABLE 43. SUMMARY DATA FOR ALL BASELINE G TESTS

DATA CATEGORY	BASELINE TEST G-1	BASELINE TEST G-2	BASELINE TEST G-3
Washer's Operating Duration (hour:minute:second)	1:15:55	1:15:45	1:15:50
Power			
Average Water Pump Power (W)	9	9	9
Maximum Water Pump Power (W)	73	71	73
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	183	187	180
Maximum Motor Power (W)	972	980	974
Average Total Power (W)	200	203	197
Maximum Total Power (W)	1,047	1,054	1,046
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	11	11	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	232	236	227
Total Energy (Wh)	254	257	249
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	75	75	78
Water Properties			
Average Cold Water Temperature (ºF)	73	71	76
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	18.42	18.64	18.26
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

BASELINE H

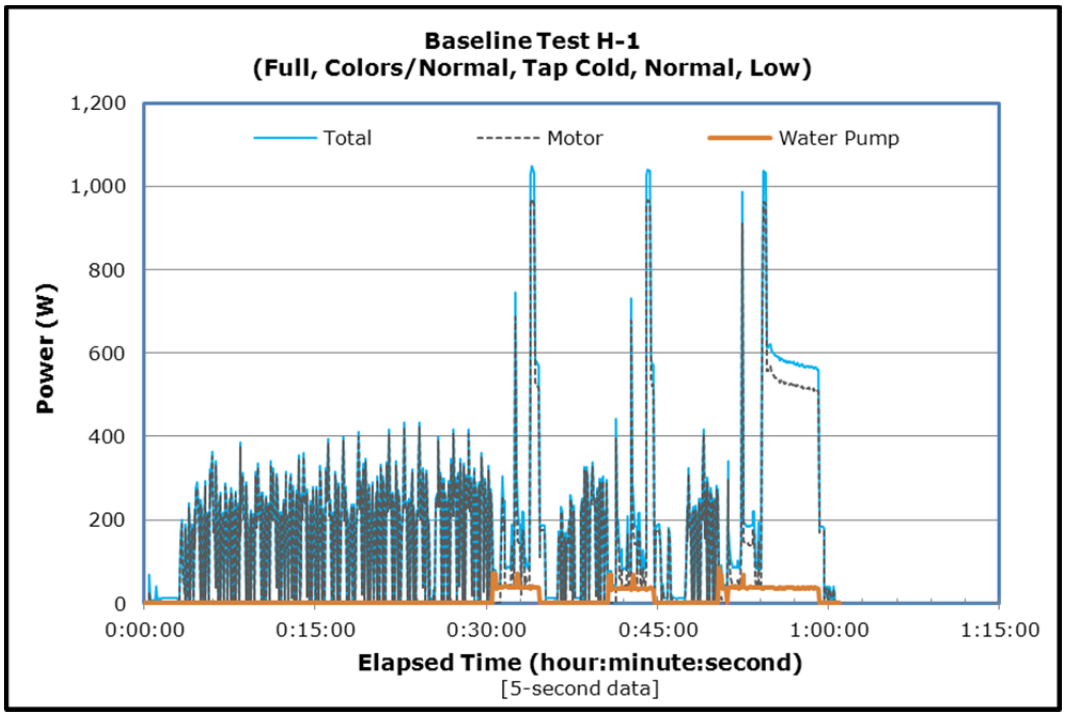

FIGURE 71. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST H [H-1]

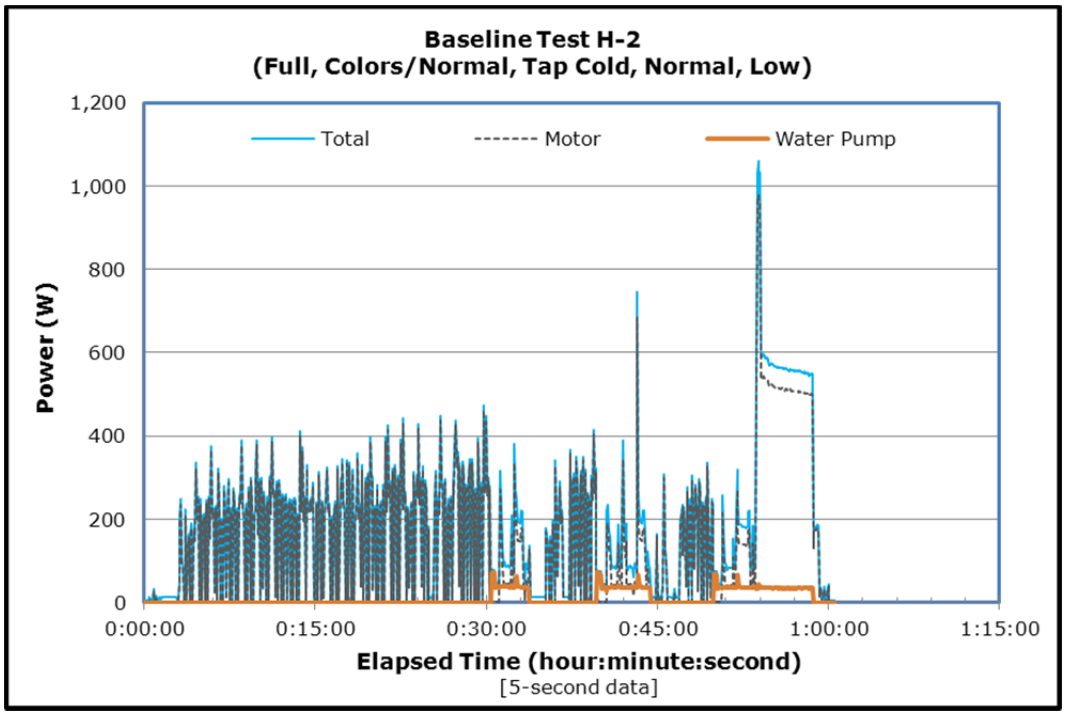

FIGURE 72. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST H [H-2]

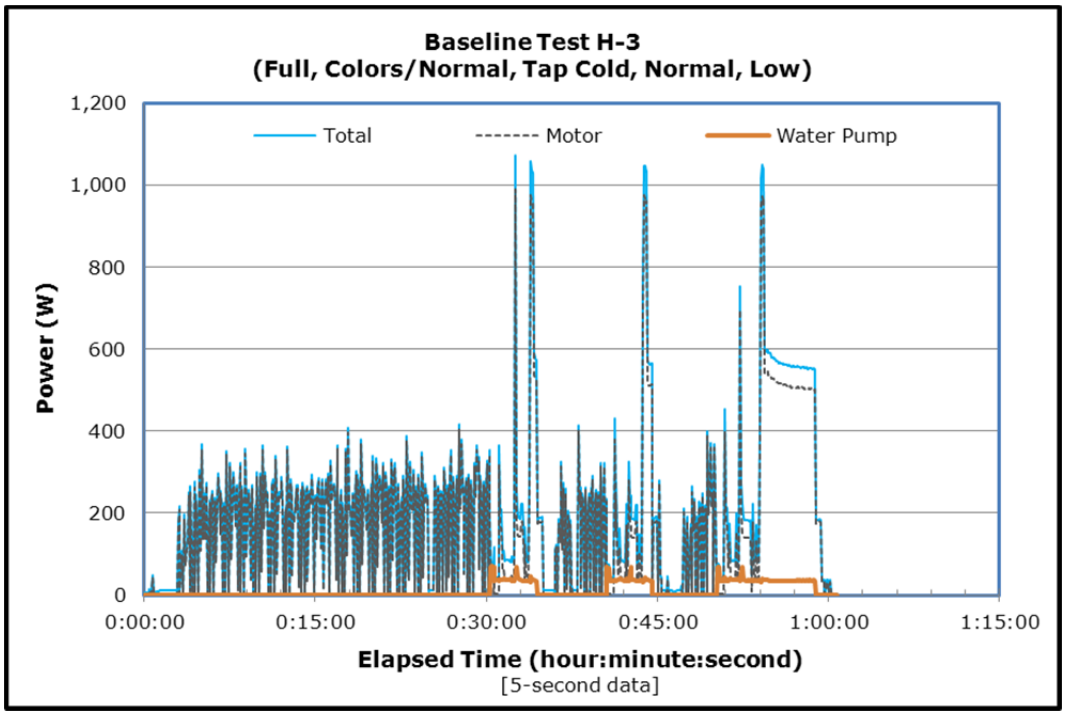

FIGURE 73. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST H [H-3]

TABLE 44. SUMMARY DATA FOR ALL BASELINE H TESTS

DATA CATEGORY	BASELINE TEST H-1	BASELINE TEST H-2	BASELINE TEST H-3
Washer's Operating Duration (hour:minute:second)	1:01:00	1:00:30	1:00:45
Power			
Average Water Pump Power (W)	11	10	11
Maximum Water Pump Power (W)	86	74	71
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	184	167	182
Maximum Motor Power (W)	971	979	990
Average Total Power (W)	203	186	202
Maximum Total Power (W)	1,049	1,061	1,072
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	11	11	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	187	169	185
Total Energy (Wh)	207	188	205
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	75	74	74
Water Properties			
Average Cold Water Temperature (ºF)	72	73	73
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	19.06	18.00	18.81
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

BASELINE I

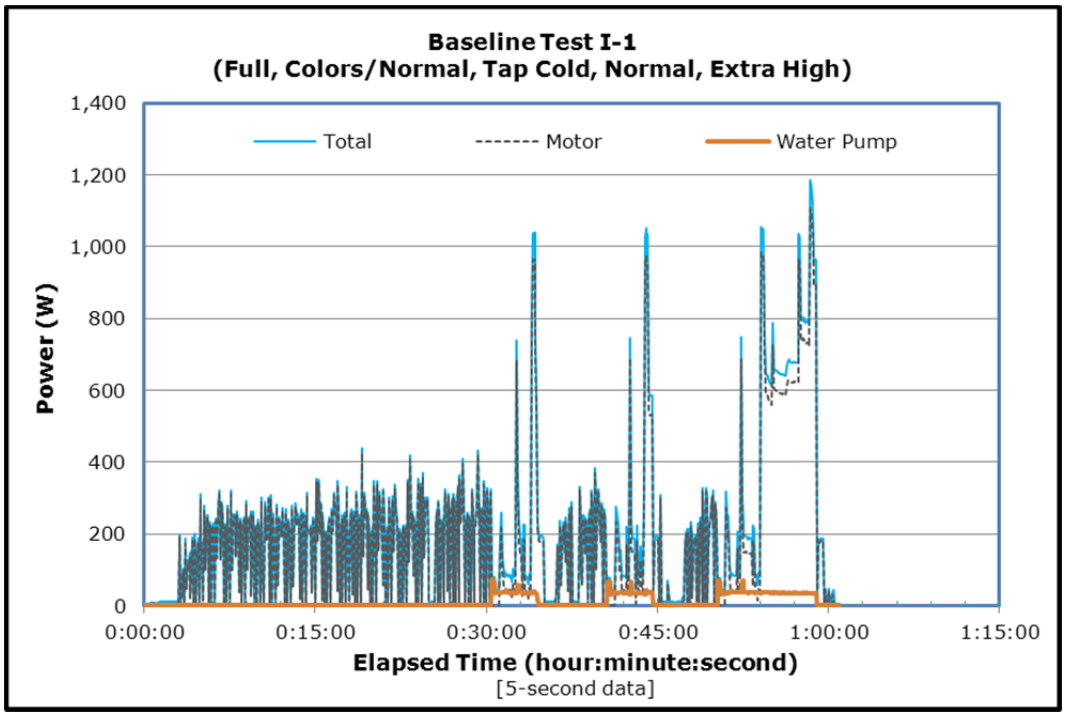

FIGURE 74. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST I [I-1]

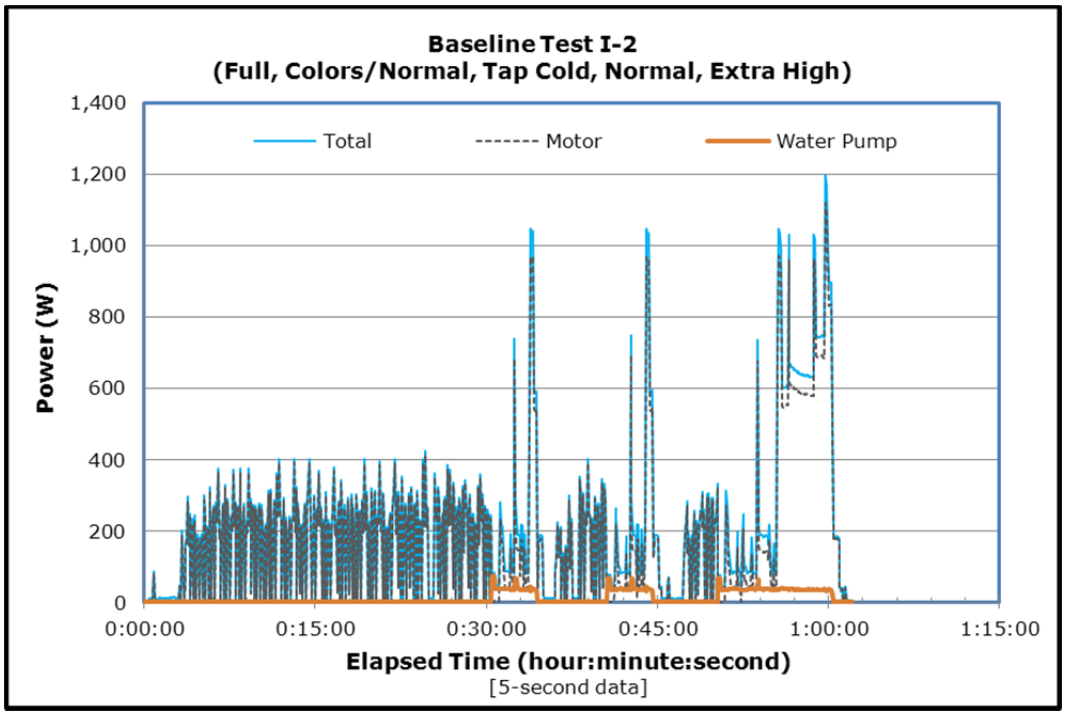

FIGURE 75. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST I [I-2]

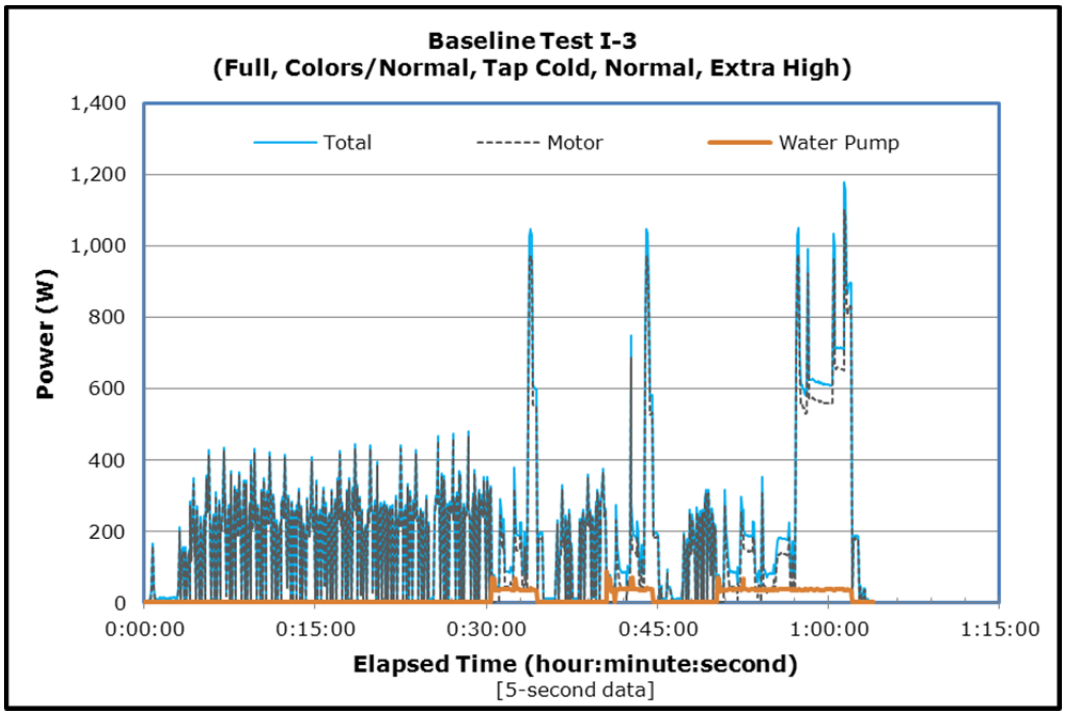

FIGURE 76. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST I [I-3]

TABLE 45. SUMMARY DATA FOR ALL BASELINE I TESTS

DATA CATEGORY	BASELINE TEST I-1	BASELINE TEST I-2	BASELINE TEST I-3
Washer's Operating Duration (hour:minute:second)	1:00:56	1:02:05	1:03:55
Power			
Average Water Pump Power (W)	11	11	12
Maximum Water Pump Power (W)	72	73	86
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	192	190	191
Maximum Motor Power (W)	1,107	1,120	1,098
Average Total Power (W)	212	210	212
Maximum Total Power (W)	1,186	1,199	1,178
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	11	11	13
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	196	197	204
Total Energy (Wh)	216	218	226
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	75	73	74
Water Properties			
Average Cold Water Temperature (ºF)	74	71	73
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	18.71	18.73	18.76
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

BASELINE J

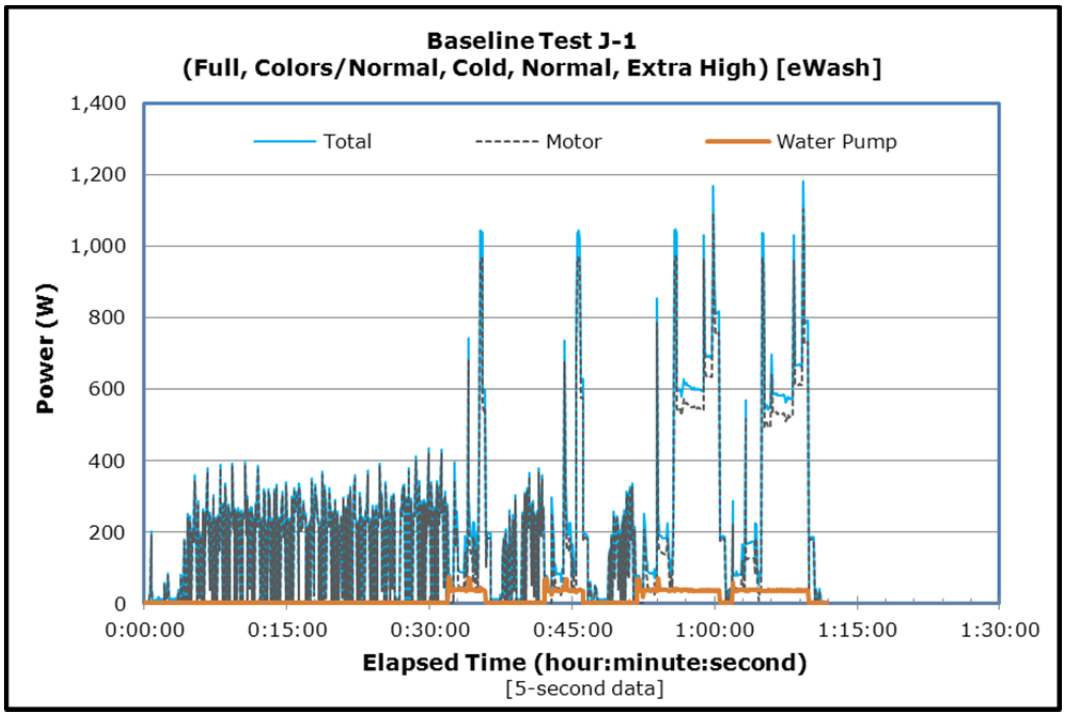

FIGURE 77. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST J [J-1]

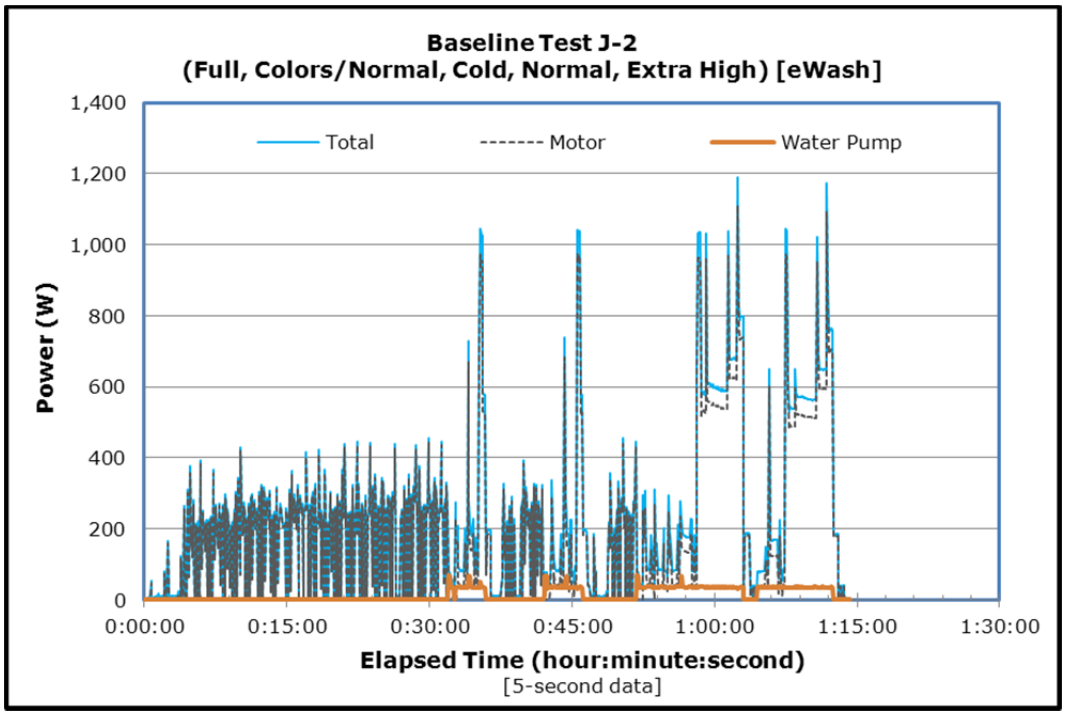

FIGURE 78. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST J [J-2]

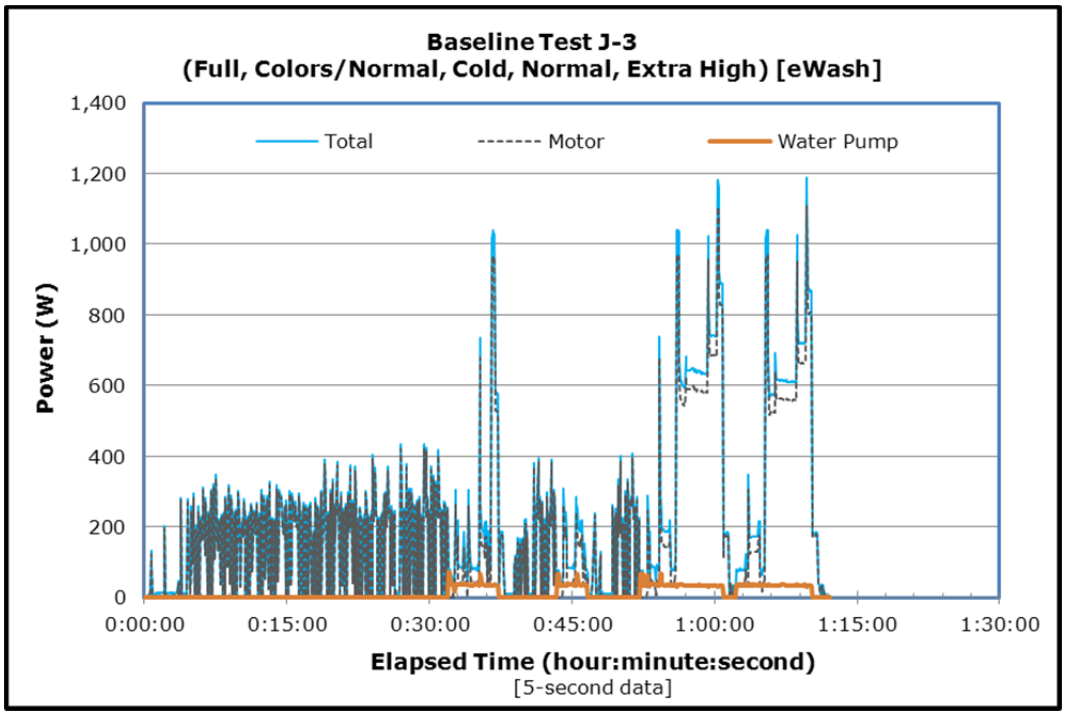

FIGURE 79. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST J [J-3]

TABLE 46. SUMMARY DATA FOR ALL BASELINE J TESTS

DATA CATEGORY	BASELINE TEST J-1	BASELINE TEST J-2	BASELINE TEST J-3
Washer's Operating Duration (hour:minute:second)	1:11:45	1:14:15	1:12:10
Power			
Average Water Pump Power (W)	13	14	13
Maximum Water Pump Power (W)	72	70	72
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	211	209	203
Maximum Motor Power (W)	1,103	1,111	1,108
Average Total Power (W)	234	231	225
Maximum Total Power (W)	1,181	1,190	1,187
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	16	17	15
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	253	258	244
Total Energy (Wh)	280	287	271
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	74	74	74
Water Properties			
Average Cold Water Temperature (ºF)	73	74	74
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	18.93	18.51	17.80
Average Warm/Hot Water Temperature (ºF)	75	75	75
Average Warm/Hot Water Pressure (psig)	35	35	35
Total Warm/Hot Water Flow (gallons)	0.23	0.24	0.24

BASELINE K

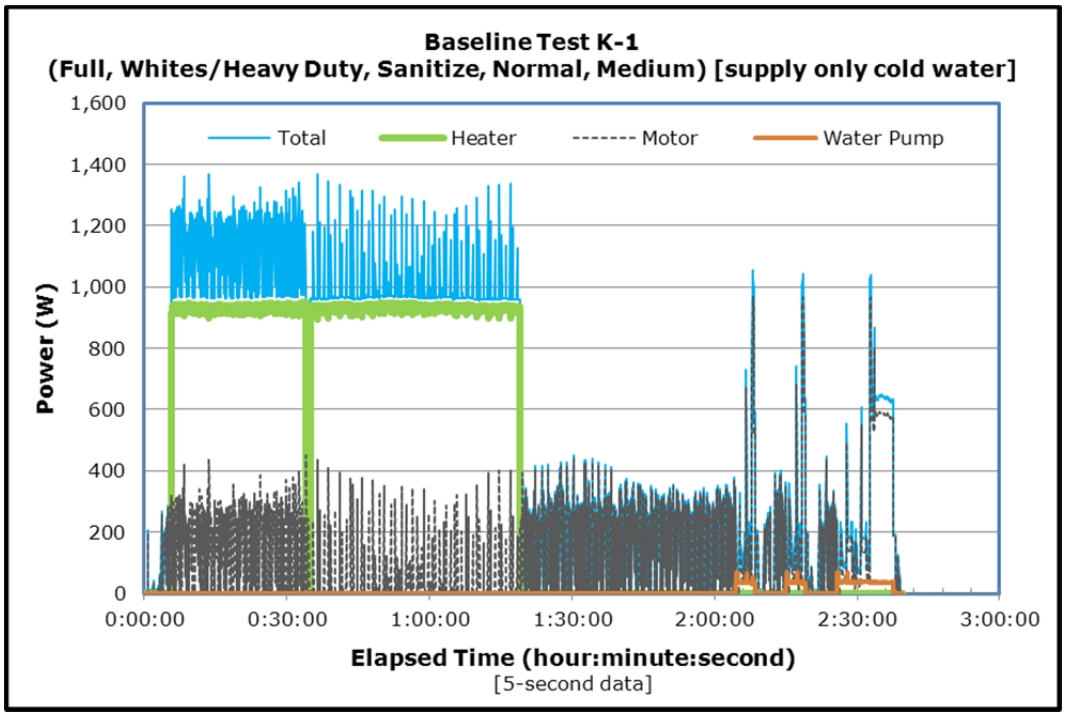

FIGURE 80. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST K [K-1]

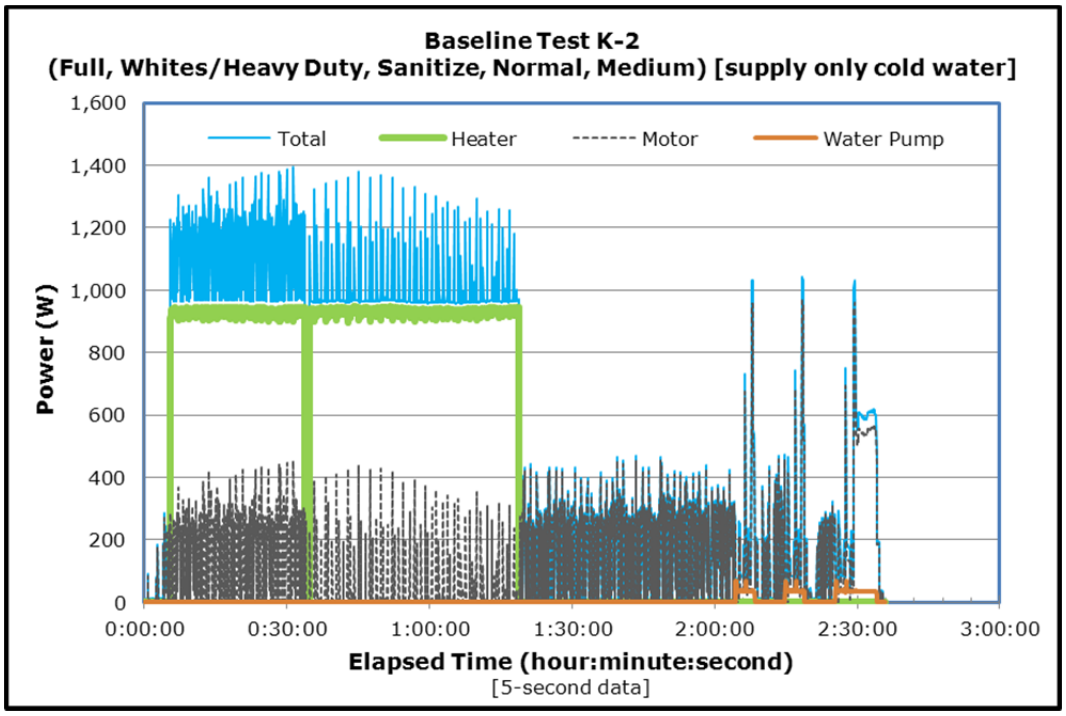

FIGURE 81. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST K [K-2]

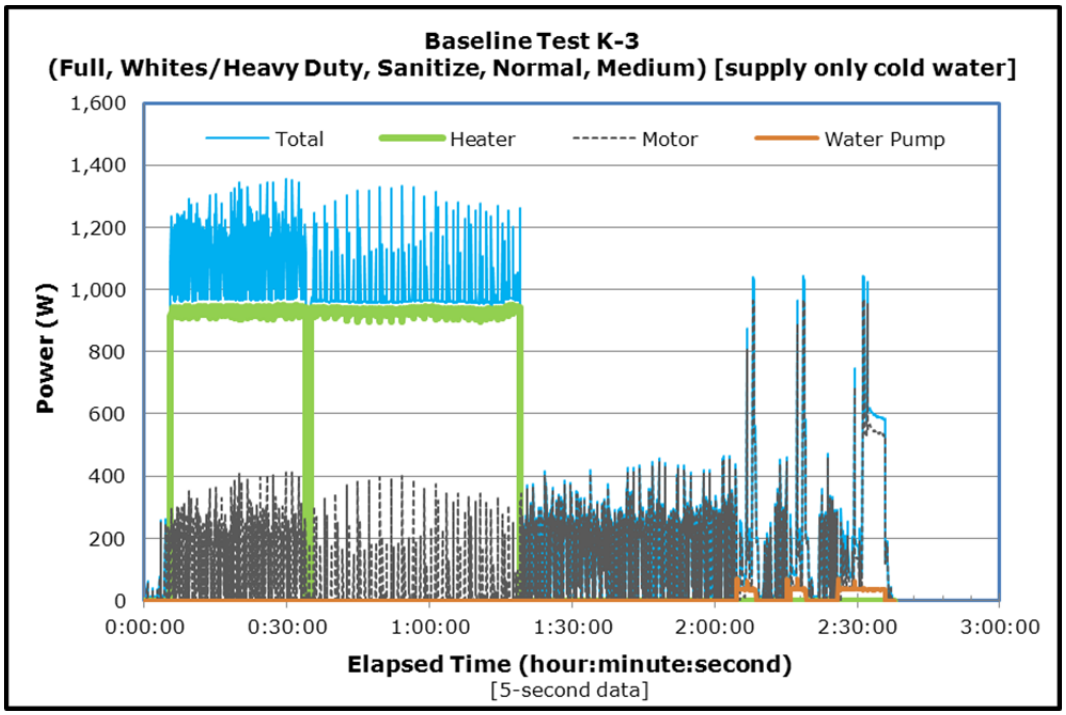

FIGURE 82. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST K [K-3]

TABLE 47. SUMMARY DATA FOR ALL BASELINE K TESTS

DATA CATEGORY	BASELINE TEST K-1	BASELINE TEST K-2	BASELINE TEST K-3
Washer's Operating Duration (hour:minute:second)	2:39:30	2:36:00	2:37:50
Power			
Average Water Pump Power (W)	5	4	4
Maximum Water Pump Power (W)	70	70	69
Average Heater Power (W)	423	432	428
Maximum Heater Power (W)	949	949	951
Average Motor Power (W)	146	146	141
Maximum Motor Power (W)	966	968	968
Average Total Power (W)	589	598	588
Maximum Total Power (W)	1,369	1,393	1,355
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	13	11	11
Heater Energy (Wh)	1,124	1,124	1,127
Motor Energy (Wh)	387	381	370
Total Energy (Wh)	1,565	1,556	1,549
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	74	75	74
Water Properties			
Average Cold Water Temperature (ºF)	74	75	73
Average Cold Water Pressure (psig)	35	35	35
Total Cold Water Flow (gallons)	12.58	12.47	12.89
Average Warm/Hot Water Temperature (ºF)	73	73	75
Average Warm/Hot Water Pressure (psig)	36	37	36
Total Warm/Hot Water Flow (gallons)	6.54	6.54	6.39

BASELINE L

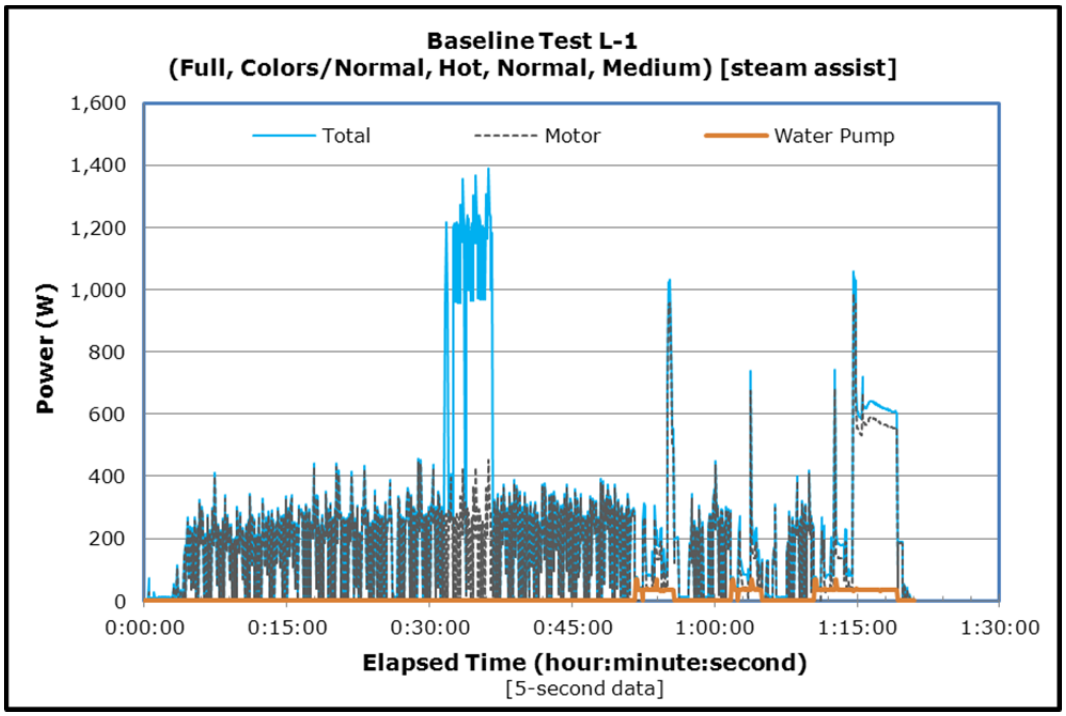

FIGURE 83. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST BASELINE TEST L [L-1]

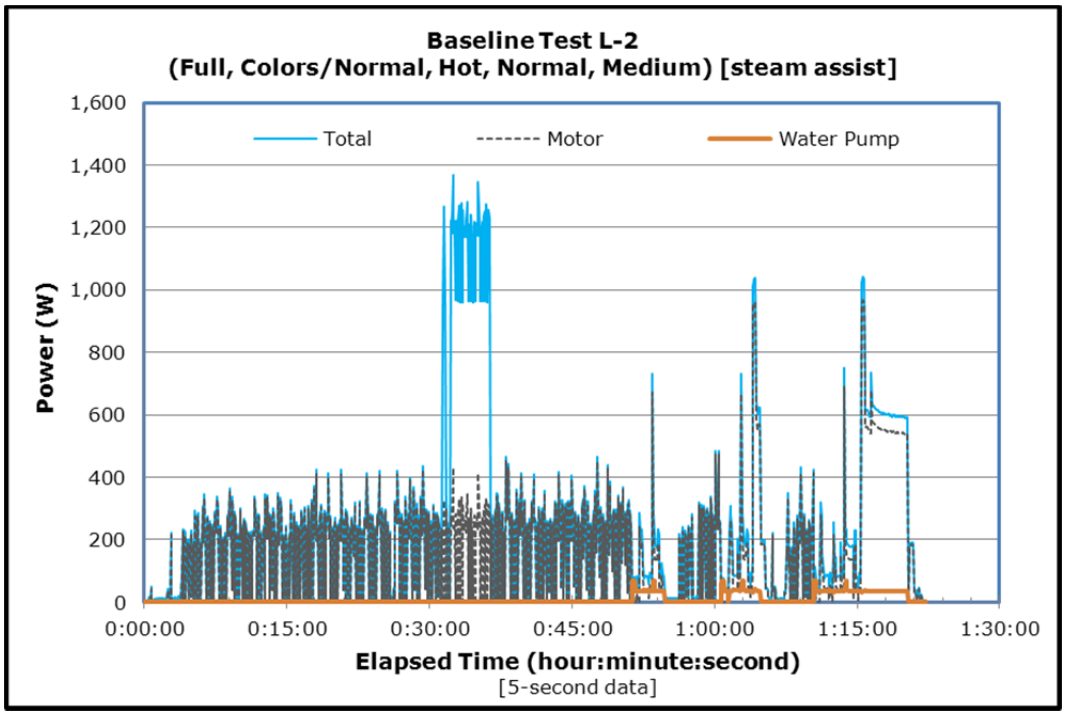

FIGURE 84. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND BASELINE TEST L [L-2]

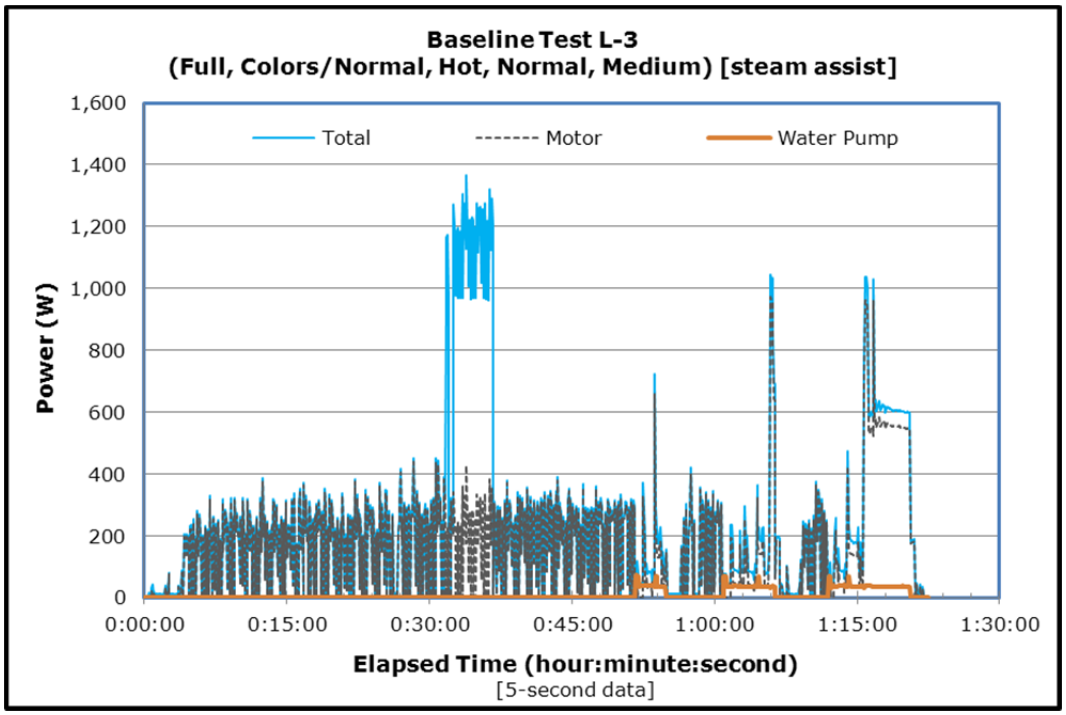

FIGURE 85. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL BASELINE TEST L [L-3]

TABLE 48. SUMMARY DATA FOR ALL BASELINE L TESTS

DATA CATEGORY	BASELINE TEST L-1	BASELINE TEST L-2	BASELINE TEST L-3
Washer's Operating Duration (hour:minute:second)	1:21:05	1:22:15	1:22:30
Power			
Average Water Pump Power (W)	7	8	8
Maximum Water Pump Power (W)	69	71	72
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	186	183	178
Maximum Motor Power (W)	988	969	972
Average Total Power (W)	252	251	246
Maximum Total Power (W)	1,389	1,369	1,365
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	10	11	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	252	251	246
Total Energy (Wh)	340	344	339
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	76	76	75
Water Properties			
Average Cold Water Temperature (ºF)	74	75	74
Average Cold Water Pressure (psig)	35	35	35
Total Cold Water Flow (gallons)	11.80	12.75	12.58
Average Warm/Hot Water Temperature (ºF)	114	117	117
Average Warm/Hot Water Pressure (psig)	34	34	34
Total Warm/Hot Water Flow (gallons)	6.11	5.67	6.10

APPENDIX B – DATA FOR ALL DEMAND RESPONSE TESTS

This section provides graphical and tabulated data for all DR test runs. Because each group of DR test conditions was repeated 3 times, except for I2 and J2, 41 runs resulted. The naming convention for the DR tests corresponds to the baseline outlined in Appendix A. DR test runs A1-1, A1-2, and A1-3 refer to the first, second, and third/final tests within DR A1, respectively. The graphical data (Figure 86 through Figure 126) show component-level and total power profiles. The tabulated data (Table 49 through Table 63) include the washer's operating duration, power and energy values, controlled environment room average temperature, as well as the supplied water temperature, pressure, and flow.

In Figure 86 through Figure 126, the variations in peak power for each of the three test runs with the same category of test condition are evident. As discussed in detail for the baseline runs in Appendix A, the noted variations in the peak power were due to data sampling rate rather the performance of the washer. From the three performed test runs within each DR scenario group, a representative run was selected and discussed in the "Results" section of this report. The selection entailed a side-by-side review of obtained power demand profiles for all three runs and choosing a characteristic run within the group. The selected test runs are A1-2, A2-1, A3-2, A4-2, A5-2, A6-2, A7-1, A8-1, C1-2, G1-1, I1-2, J1-1, and finally K1-1.

DEMAND RESPONSE A1

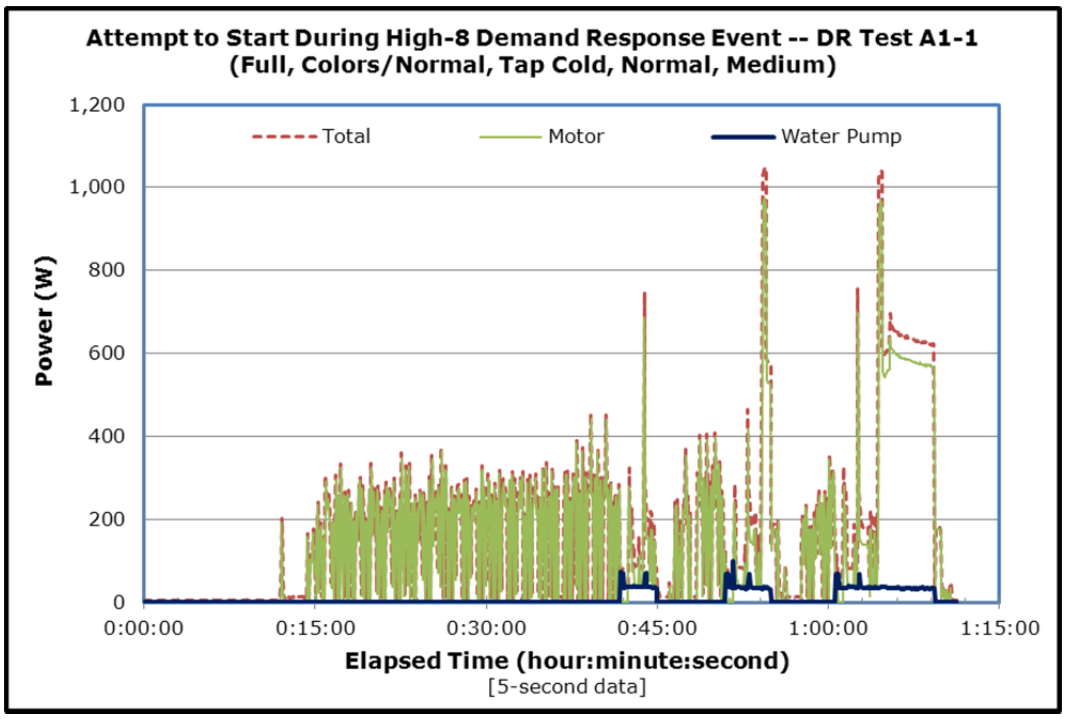

FIGURE 86. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST A1 [A1-1]

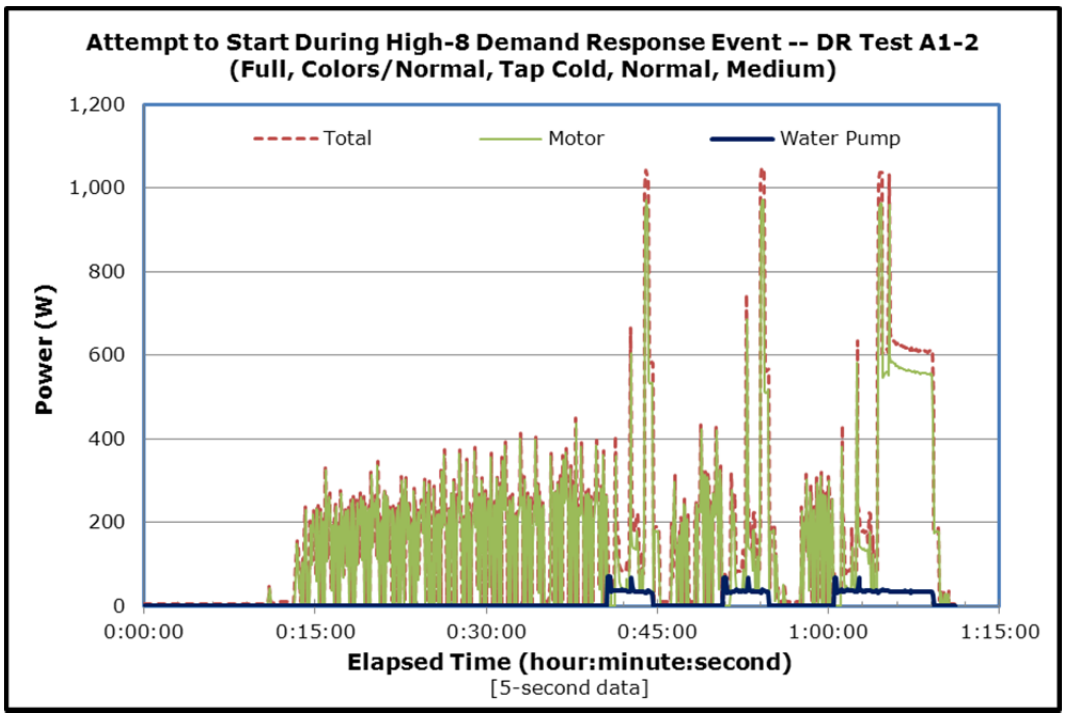

FIGURE 87. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST A1 [A1-2]

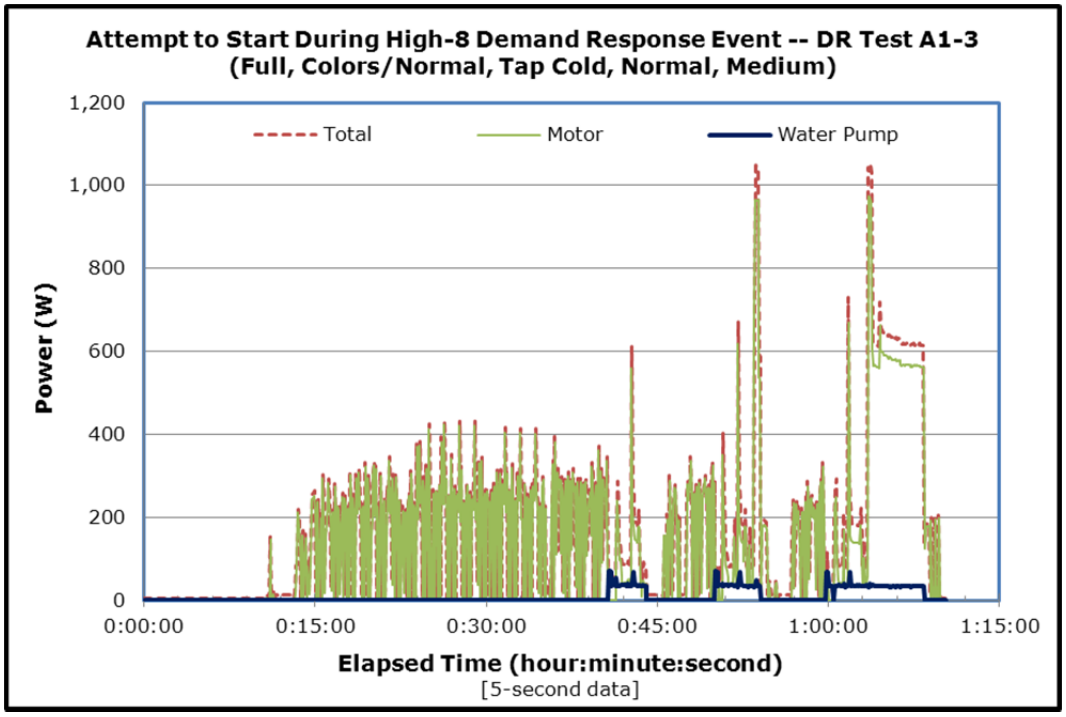

FIGURE 88. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST A1 [A1-3]

TABLE 49. SUMMARY DATA FOR ALL DEMAND RESPONSE A1 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST A1-1	DEMAND RESPONSE TEST A1-2	DEMAND RESPONSE TEST A1-3
Washer's Operating Duration (hour:minute:second)	1:11:15	1:11:05	1:10:15
Power			
Average Water Pump Power (W)	10	10	10
Maximum Water Pump Power (W)	99	71	71
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	179	184	180
Maximum Motor Power (W)	973	971	975
Average Total Power (W)	198	203	198
Maximum Total Power (W)	1,049	1,049	1,050
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	10	11	10
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	180	187	180
Total Energy (Wh)	199	207	199
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	76	75	78
Water Properties			
Average Cold Water Temperature (ºF)	75	74	77
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	18.78	18.50	18.26
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE A2

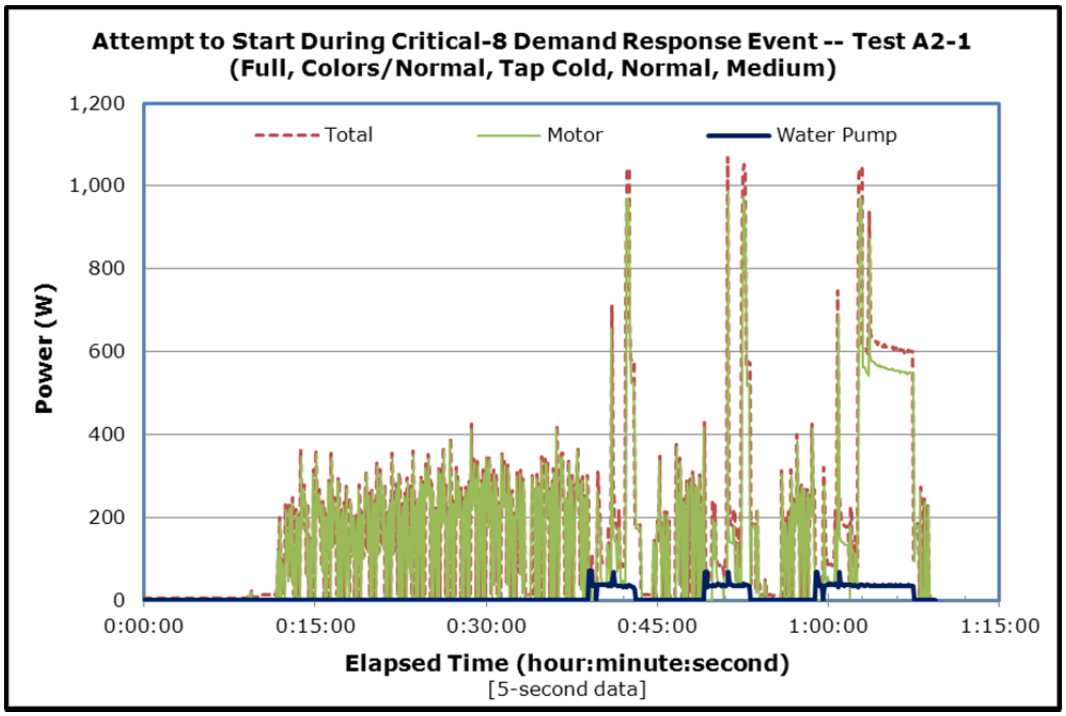

FIGURE 89. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST A2 [A2-1]

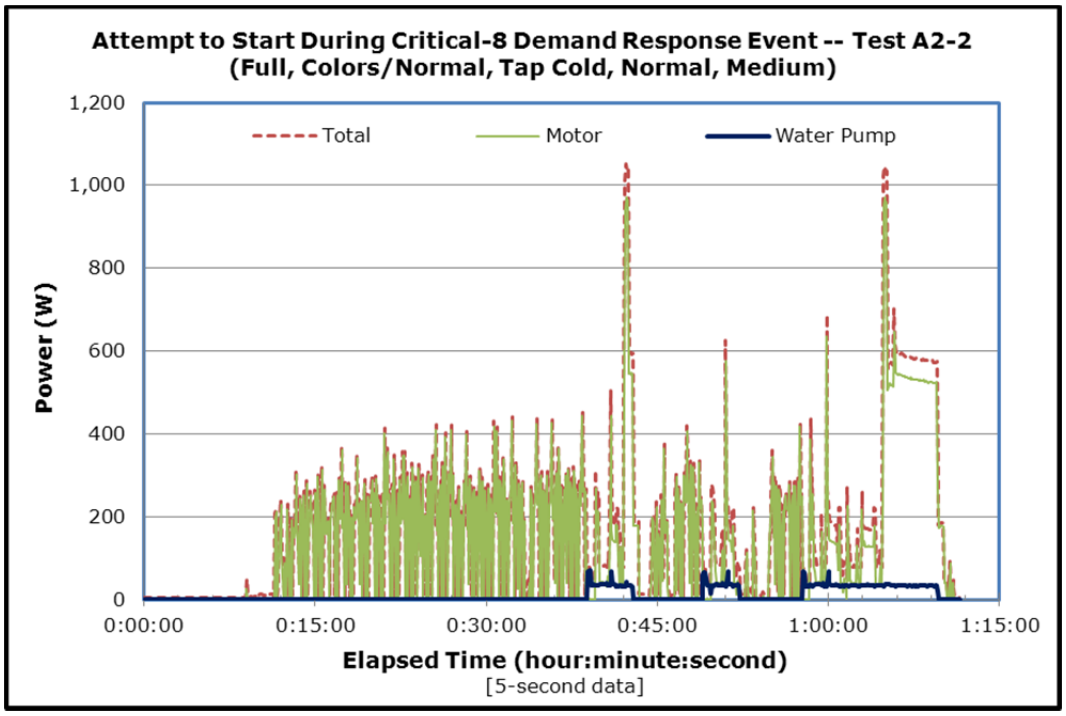

FIGURE 90. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST A2 [A2-2]

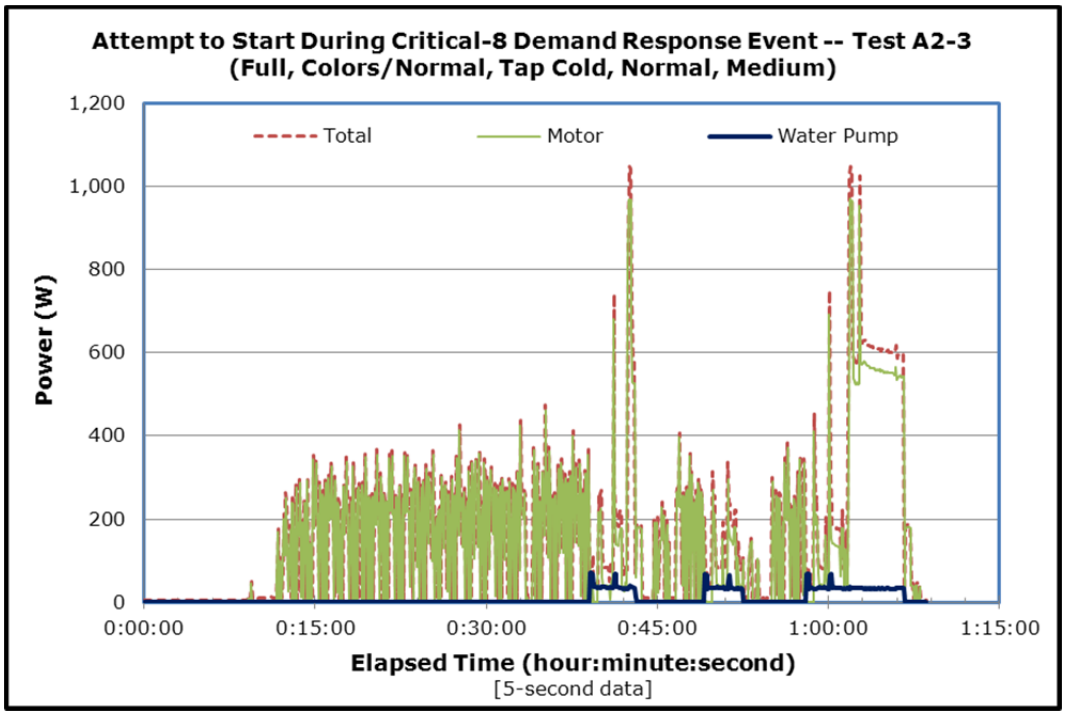

FIGURE 91. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST A2 [A2-3]

TABLE 50. SUMMARY DATA FOR ALL DEMAND RESPONSE A2 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST A2-1	DEMAND RESPONSE TEST A2-2	DEMAND RESPONSE TEST A2-3
Washer's Operating Duration (hour:minute:second)	1:09:20	1:11:30	1:08:35
Power			
Average Water Pump Power (W)	10	11	10
Maximum Water Pump Power (W)	71	70	71
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	186	174	181
Maximum Motor Power (W)	989	972	969
Average Total Power (W)	205	194	200
Maximum Total Power (W)	1,069	1,053	1,046
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	10	12	10
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	188	183	181
Total Energy (Wh)	208	204	200
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	79	80	80
Water Properties			
Average Cold Water Temperature (ºF)	76	74	75
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	18.69	17.70	18.01
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE A3

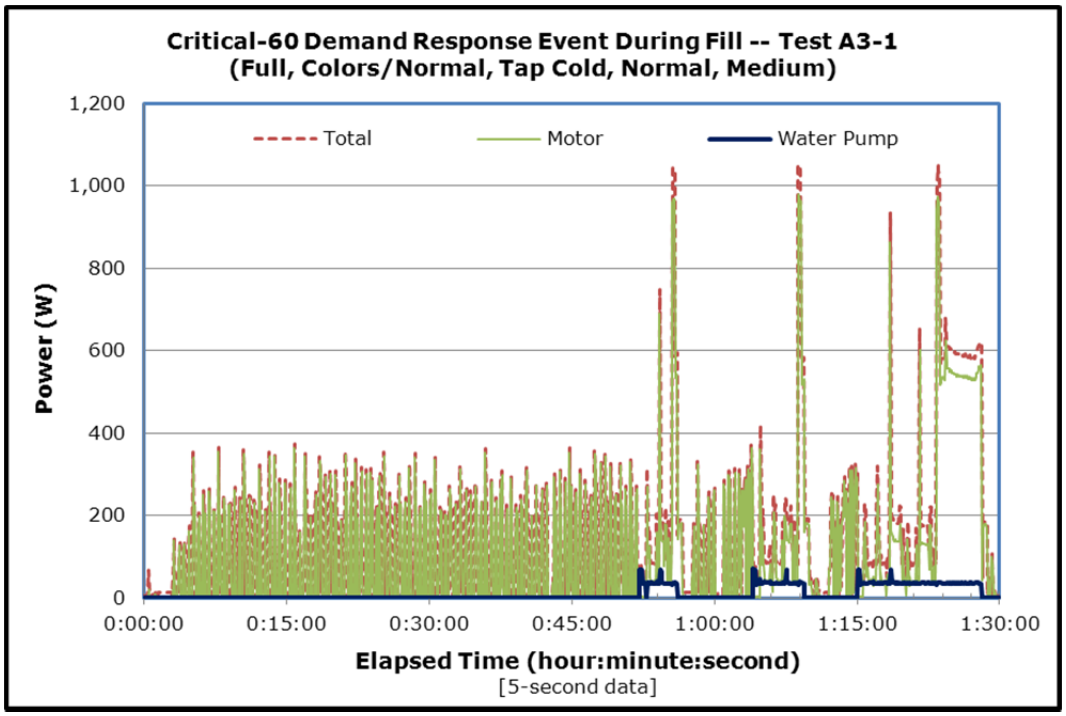

FIGURE 92. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST A3 [A3-1]

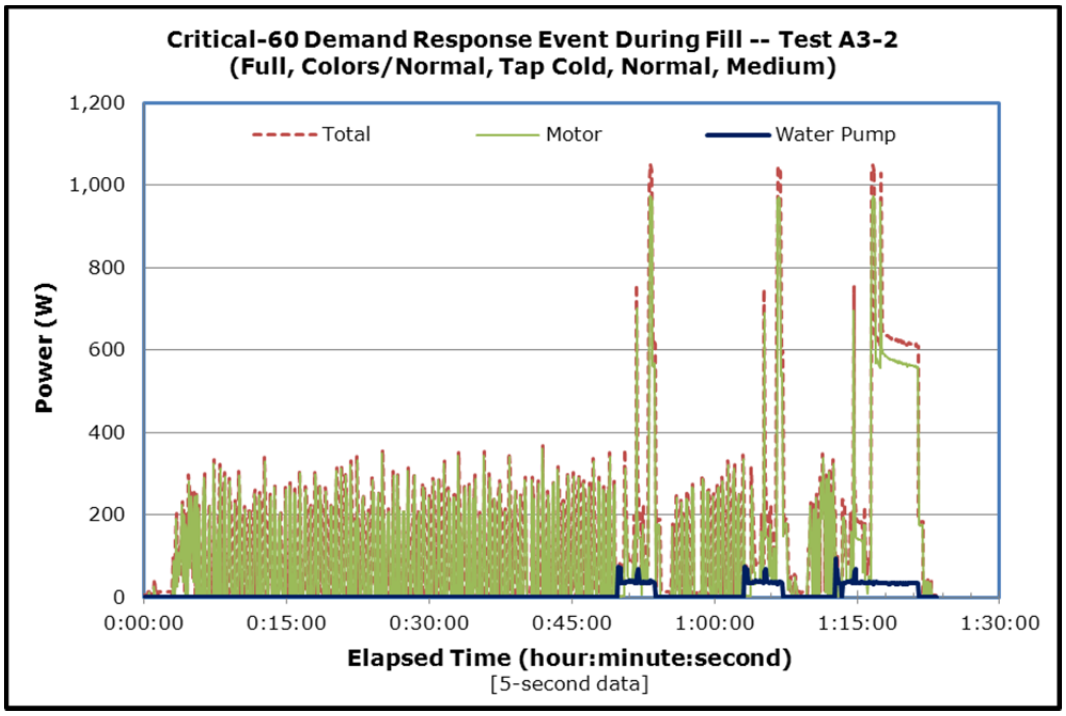

FIGURE 93. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST A3 [A3-2]

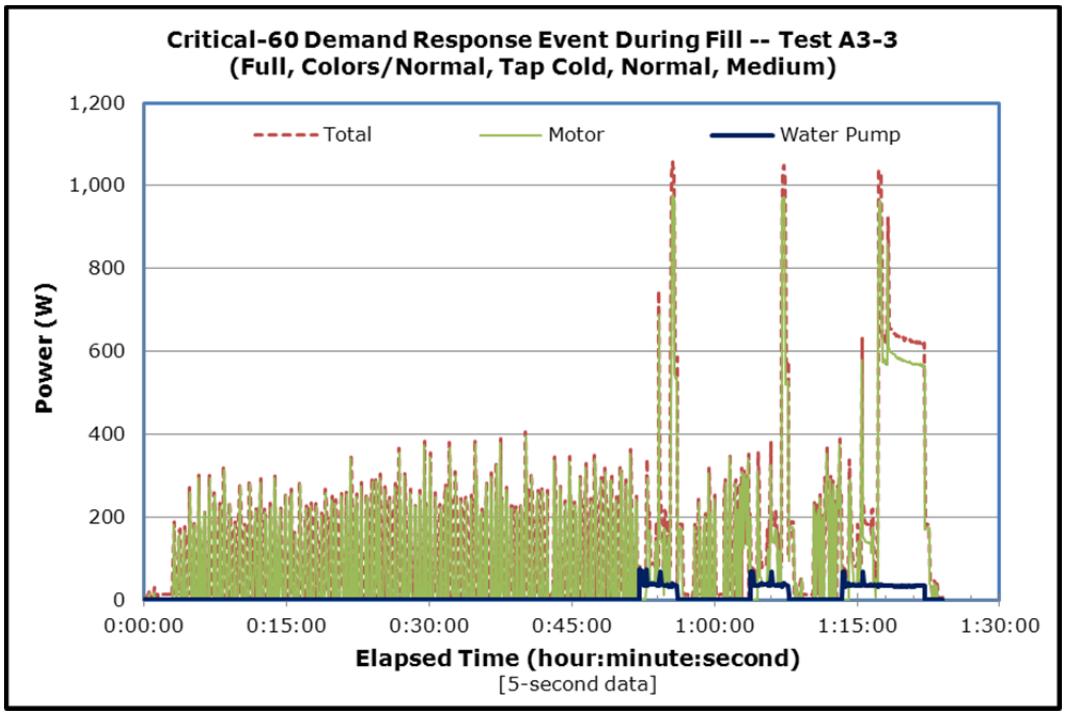

FIGURE 94. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST A3 [A3-3]

TABLE 51. SUMMARY DATA FOR ALL DEMAND RESPONSE A3 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST A3-1	DEMAND RESPONSE TEST A3-2	DEMAND RESPONSE TEST A3-3
Washer's Operating Duration (hour:minute:second)	1:30:00	1:23:20	1:24:00
Power			
Average Water Pump Power (W)	9	8	8
Maximum Water Pump Power (W)	71	93	75
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	123	131	129
Maximum Motor Power (W)	980	974	976
Average Total Power (W)	140	147	144
Maximum Total Power (W)	1,051	1,051	1,056
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	14	11	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	184	183	180
Total Energy (Wh)	210	205	202
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	81	77	76
Water Properties			
Average Cold Water Temperature (ºF)	76	76	75
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	18.56	19.04	19.14
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE A4

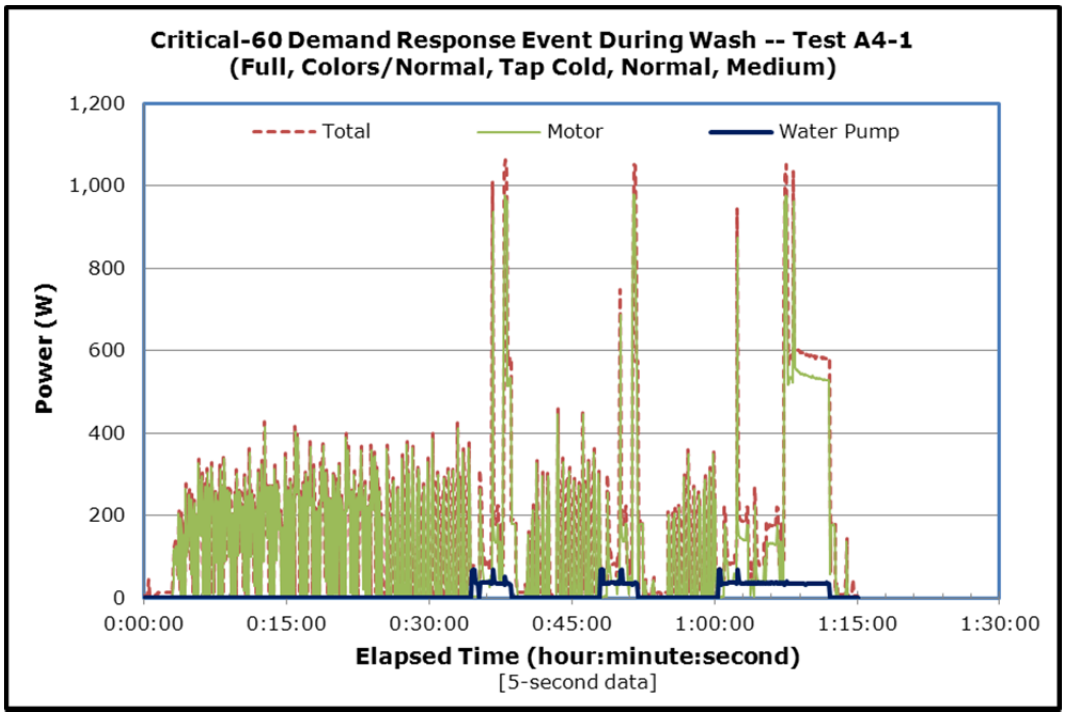

FIGURE 95. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST A4 [A4-1]

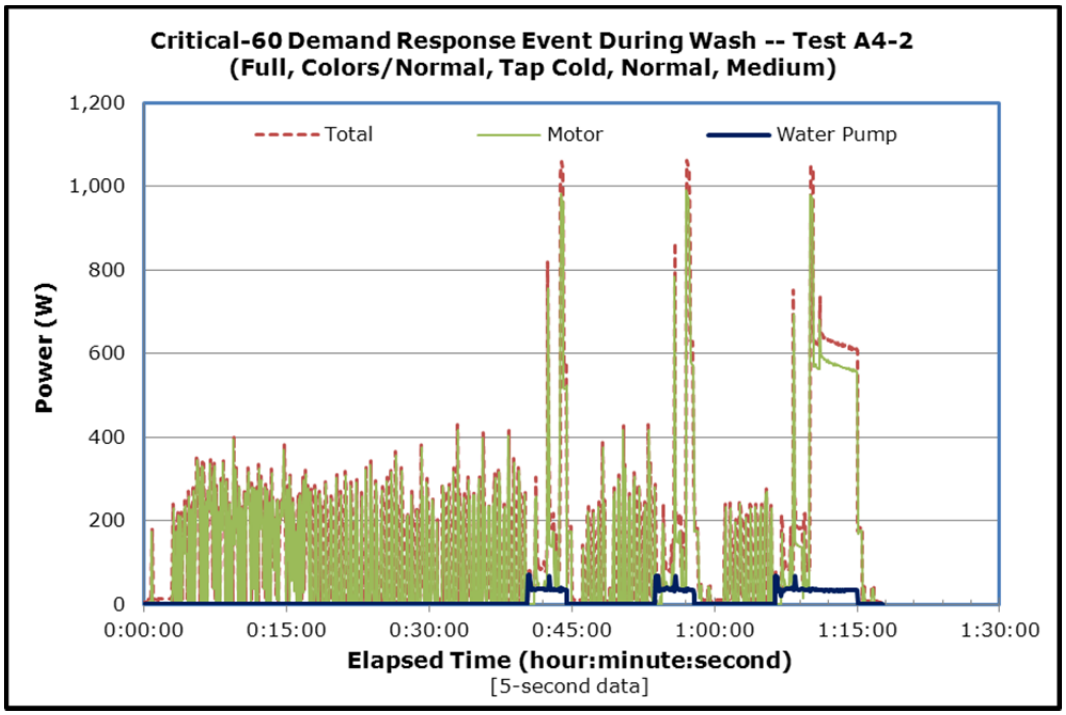

FIGURE 96. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST A4 [A4-2]

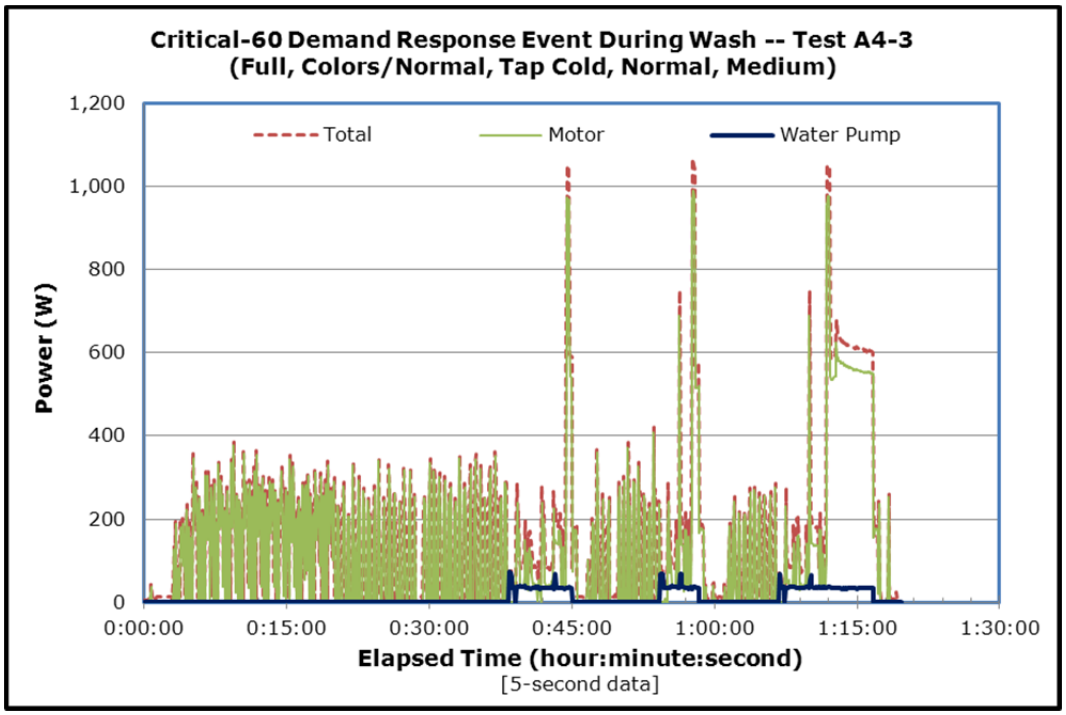

FIGURE 97. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST A4 [A4-3]

TABLE 52. SUMMARY DATA FOR ALL DEMAND RESPONSE A4 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST A4-1	DEMAND RESPONSE TEST A4-2	DEMAND RESPONSE TEST A4-3
Washer's Operating Duration (hour:minute:second)	1:15:05	1:17:40	1:19:40
Power			
Average Water Pump Power (W)	10	8	10
Maximum Water Pump Power (W)	70	72	73
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	153	144	140
Maximum Motor Power (W)	978	992	989
Average Total Power (W)	172	160	158
Maximum Total Power (W)	1,064	1,061	1,067
Minimum Total Power (W)	5	5	4
Energy			
Water Pump Energy (Wh)	12	11	13
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	192	186	186
Total Energy (Wh)	215	208	210
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	74	74	76
Water Properties			
Average Cold Water Temperature (ºF)	73	74	75
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	19.06	18.97	18.53
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE A5

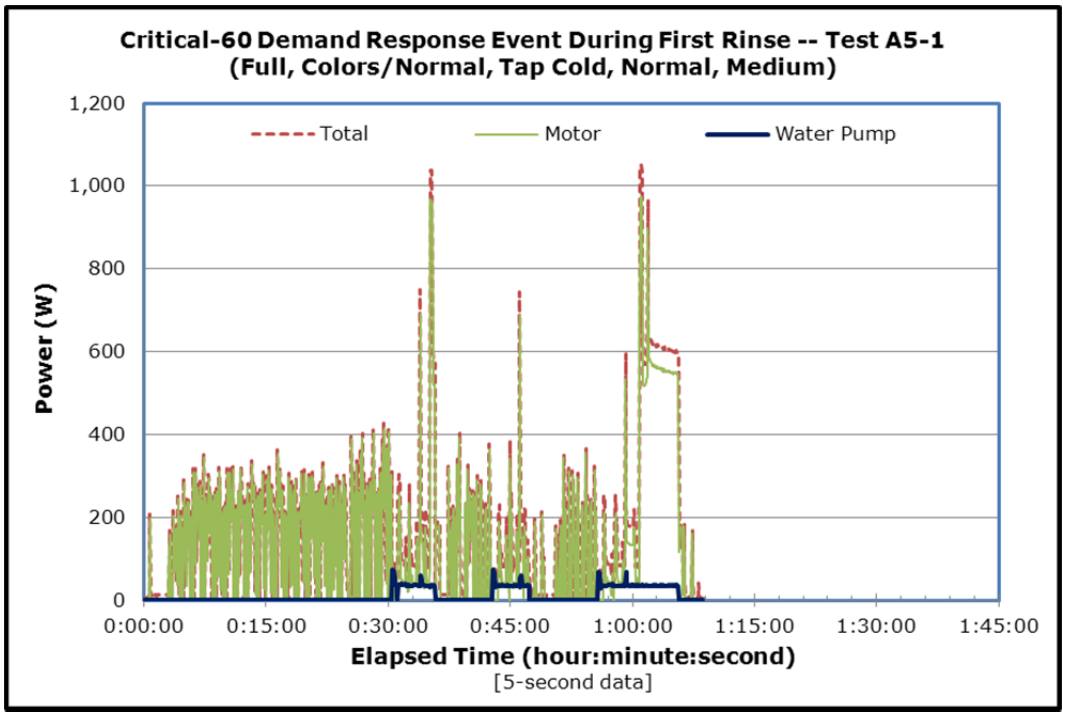

FIGURE 98. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST A5 [A5-1]

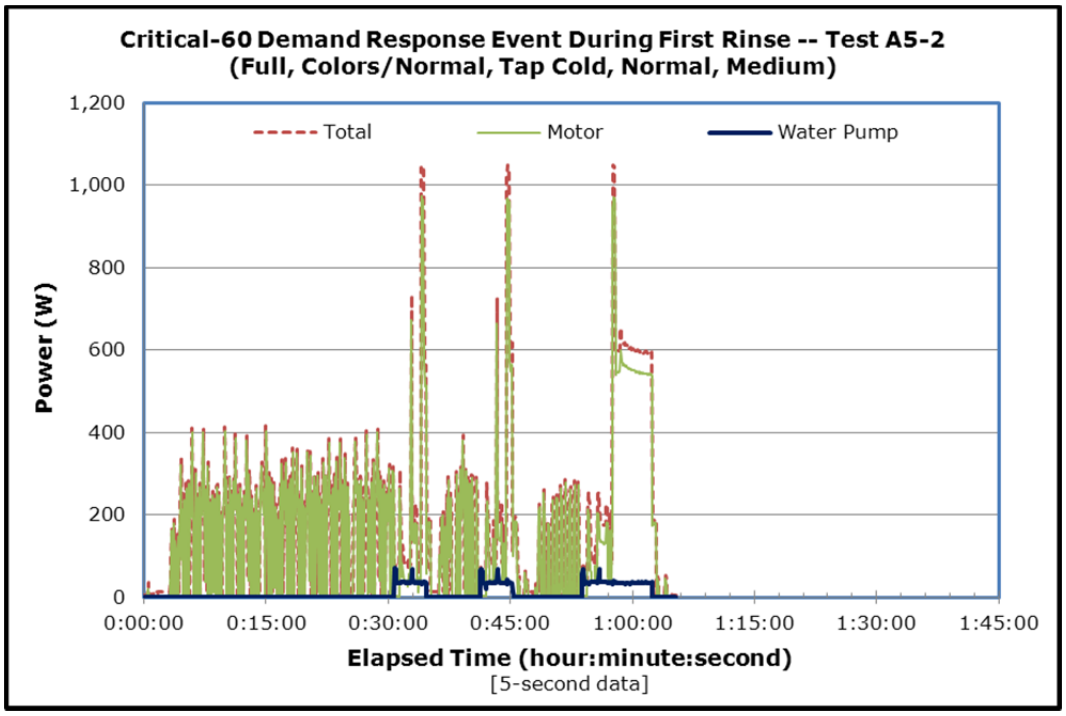

FIGURE 99. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST A5 [A5-2]

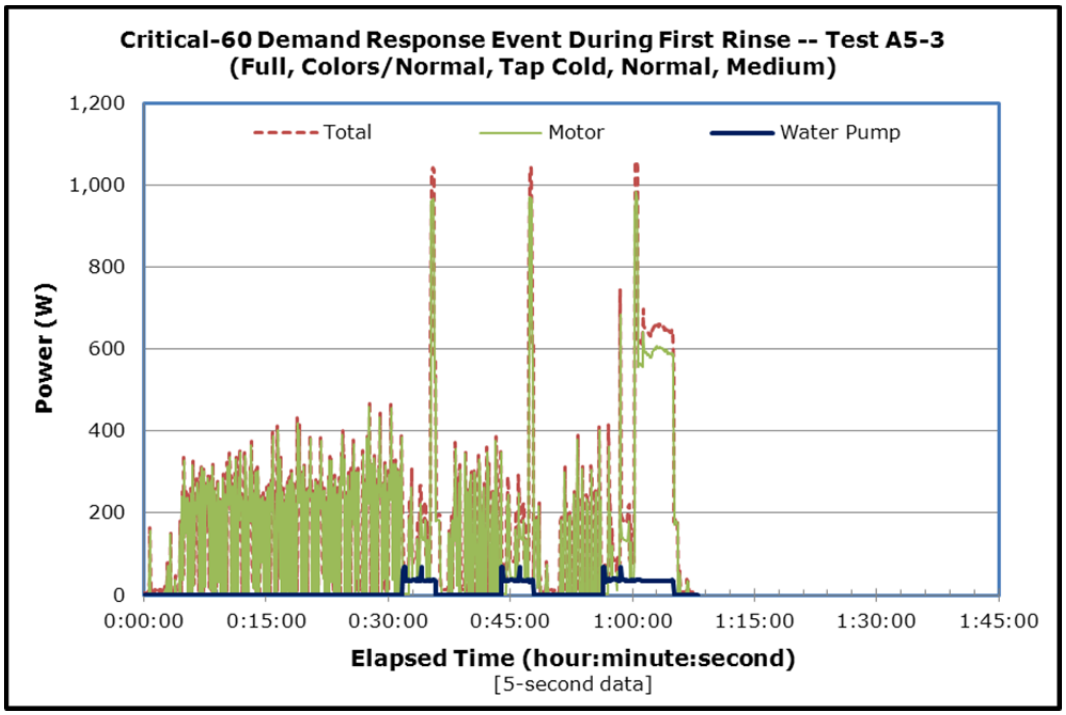

FIGURE 100. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST A5 [A5-3]

TABLE 53. SUMMARY DATA FOR ALL DEMAND RESPONSE A5 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST A5-1	DEMAND RESPONSE TEST A5-2	DEMAND RESPONSE TEST A5-3
Washer's Operating Duration (hour:minute:second)	1:08:40	1:05:20	1:08:00
Power			
Average Water Pump Power (W)	11	10	9
Maximum Water Pump Power (W)	75	70	70
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	157	170	170
Maximum Motor Power (W)	975	973	983
Average Total Power (W)	176	188	188
Maximum Total Power (W)	1,051	1,048	1,060
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	12	11	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	180	185	192
Total Energy (Wh)	202	205	213
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	75	77	77
Water Properties			
Average Cold Water Temperature (ºF)	74	76	73
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	17.63	18.07	18.49
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE A6

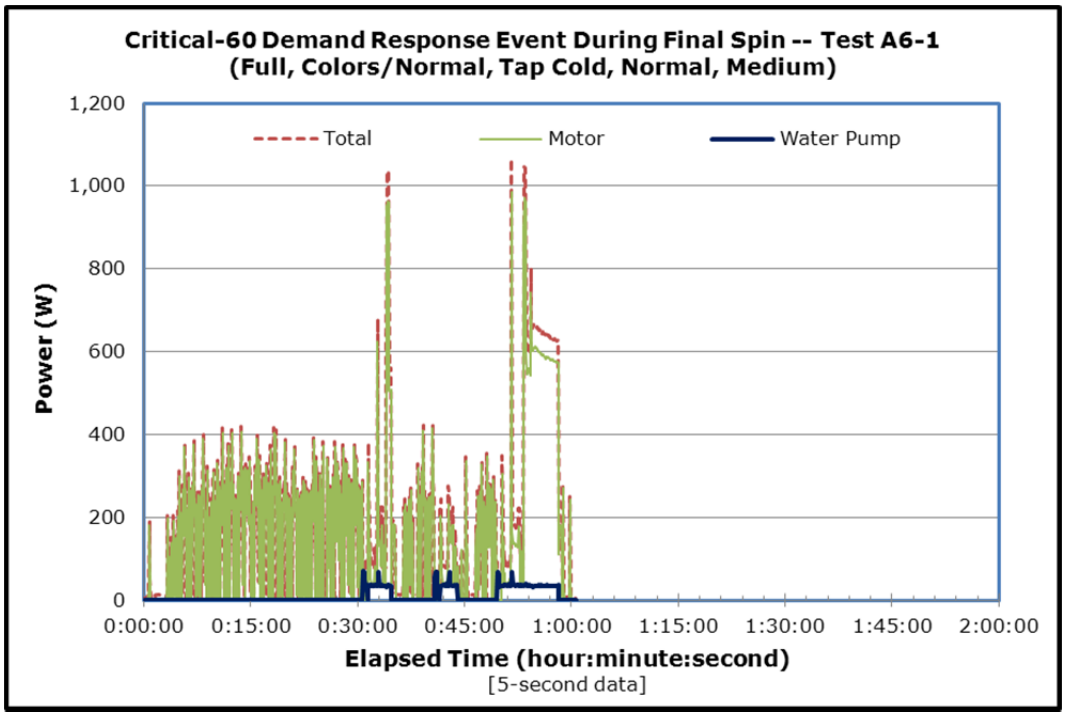

FIGURE 101. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST A6 [A6-1]

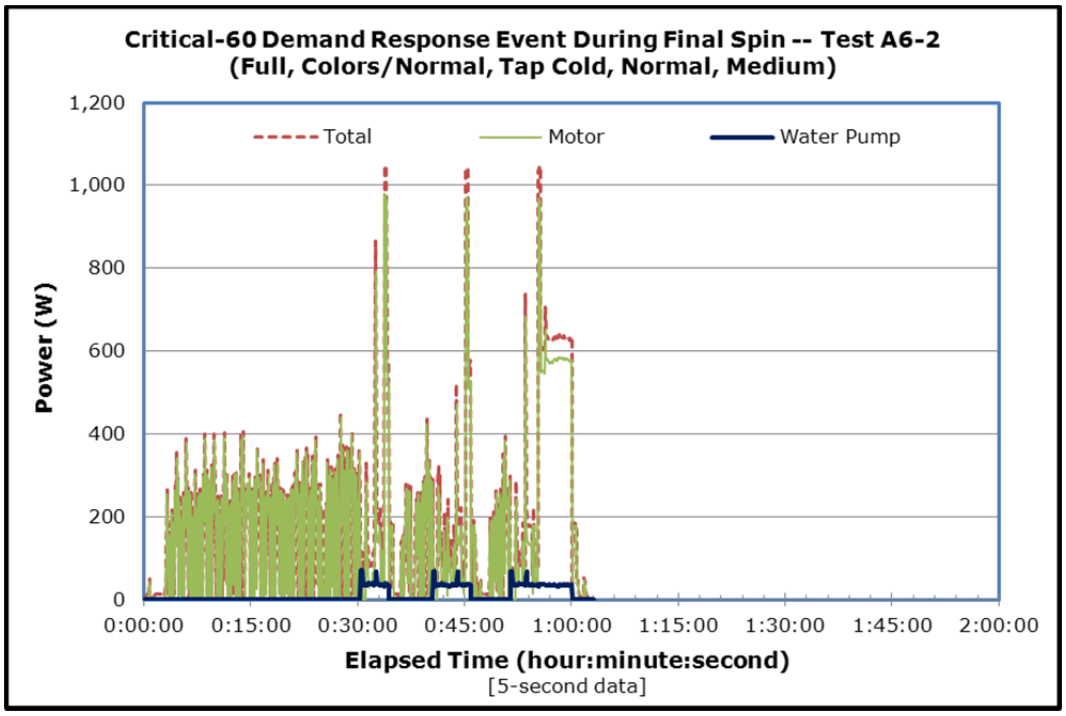

FIGURE 102. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST A6 [A6-2]

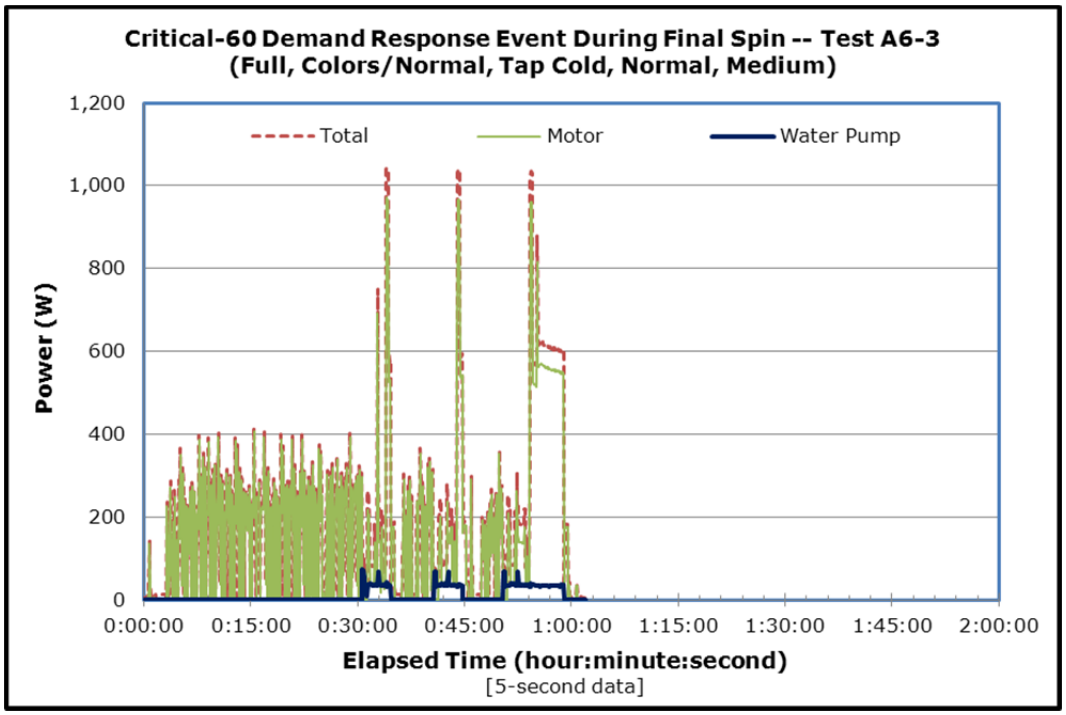

FIGURE 103. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST A6 [A6-3]

TABLE 54. SUMMARY DATA FOR ALL DEMAND RESPONSE A6 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST A6-1	DEMAND RESPONSE TEST A6-2	DEMAND RESPONSE TEST A6-3
Washer's Operating Duration (hour:minute:second)	1:00:35	1:03:05	1:01:55
Power			
Average Water Pump Power (W)	10	11	10
Maximum Water Pump Power (W)	70	73	73
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	182	180	180
Maximum Motor Power (W)	986	979	972
Average Total Power (W)	201	200	199
Maximum Total Power (W)	1,067	1,049	1,043
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	10	11	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	184	190	186
Total Energy (Wh)	203	210	206
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	78	78	76
Water Properties			
Average Cold Water Temperature (ºF)	74	77	74
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	17.89	18.80	18.56
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE A7

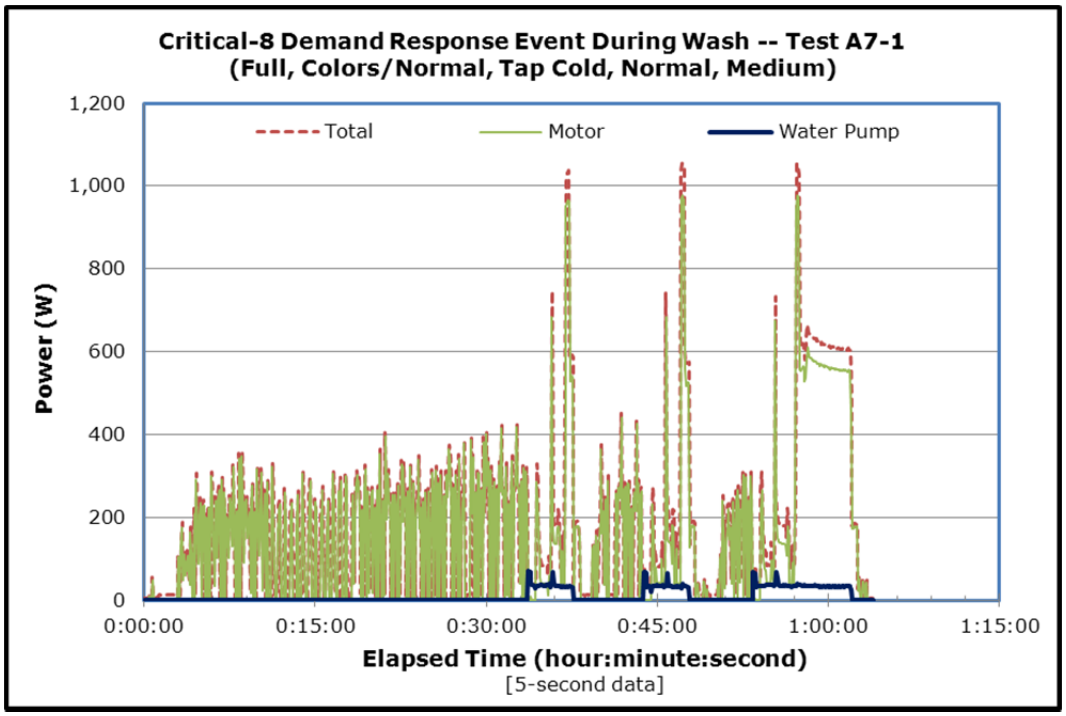

FIGURE 104. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST A7 [A7-1]

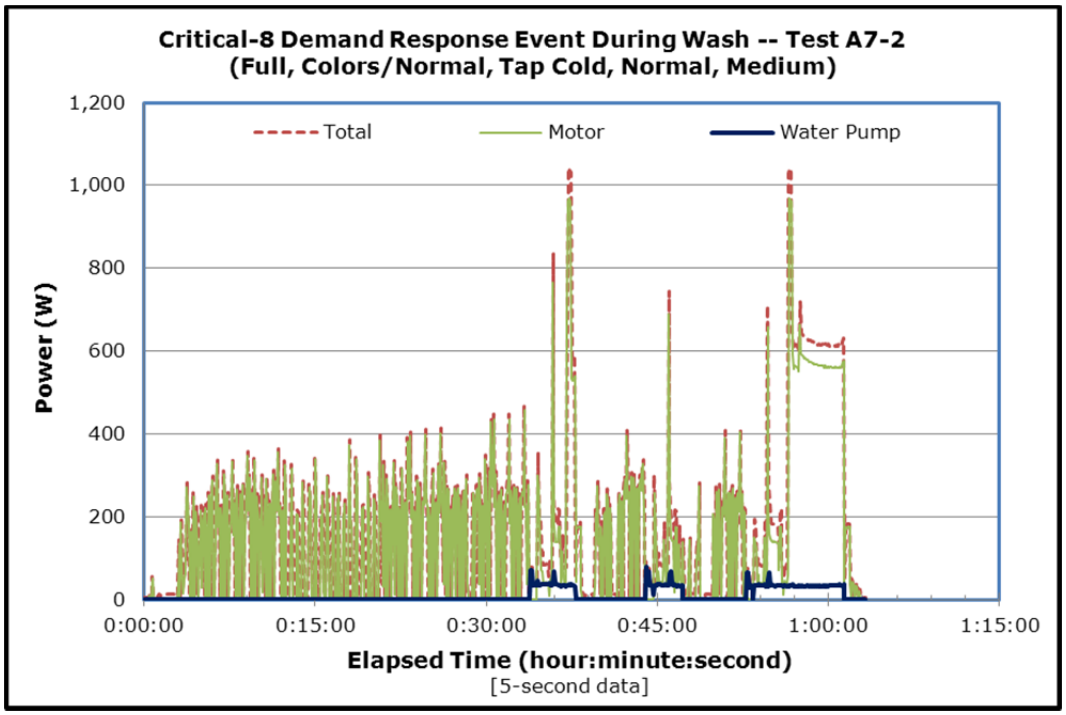

FIGURE 105. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST A7 [A7-2]

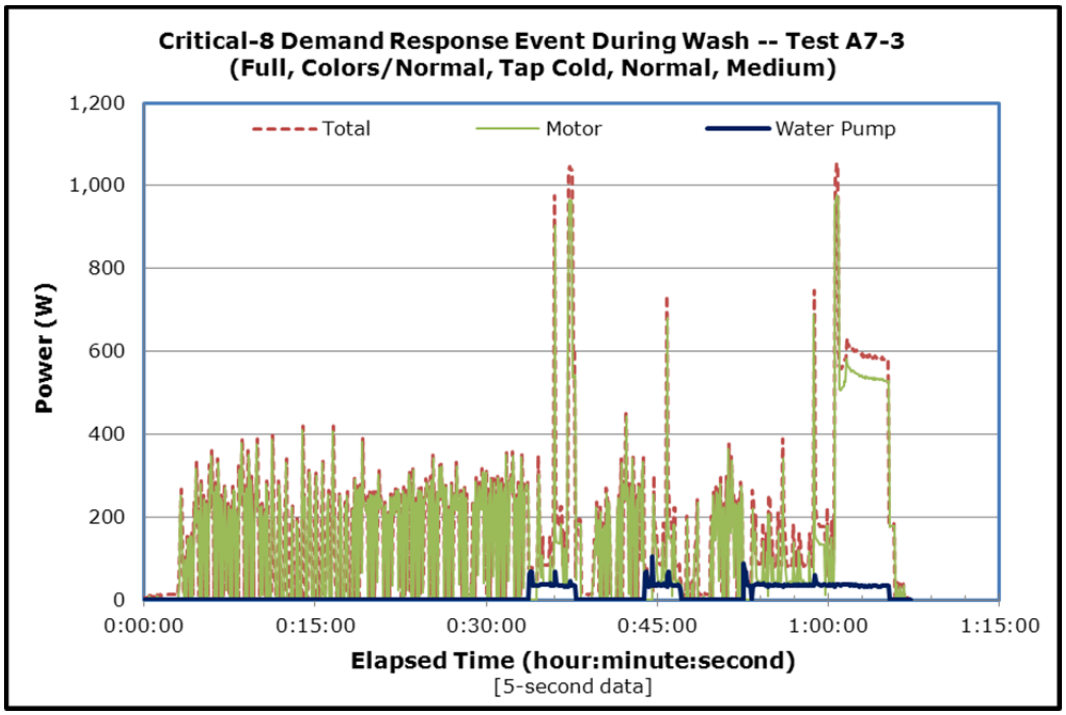

FIGURE 106. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST A7 [A7-3]

TABLE 55. SUMMARY DATA FOR ALL DEMAND RESPONSE A7 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST A7-1	DEMAND RESPONSE TEST A7-2	DEMAND RESPONSE TEST A7-3
Washer's Operating Duration (hour:minute:second)	1:03:55	1:03:15	1:07:10
Power			
Average Water Pump Power (W)	10	9	11
Maximum Water Pump Power (W)	71	80	106
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	175	166	160
Maximum Motor Power (W)	977	968	978
Average Total Power (W)	194	184	180
Maximum Total Power (W)	1,055	1,044	1,055
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	10	10	13
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	187	175	180
Total Energy (Wh)	207	194	202
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	77	76	79
Water Properties			
Average Cold Water Temperature (ºF)	78	75	73
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	18.62	18.03	17.83
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE A8

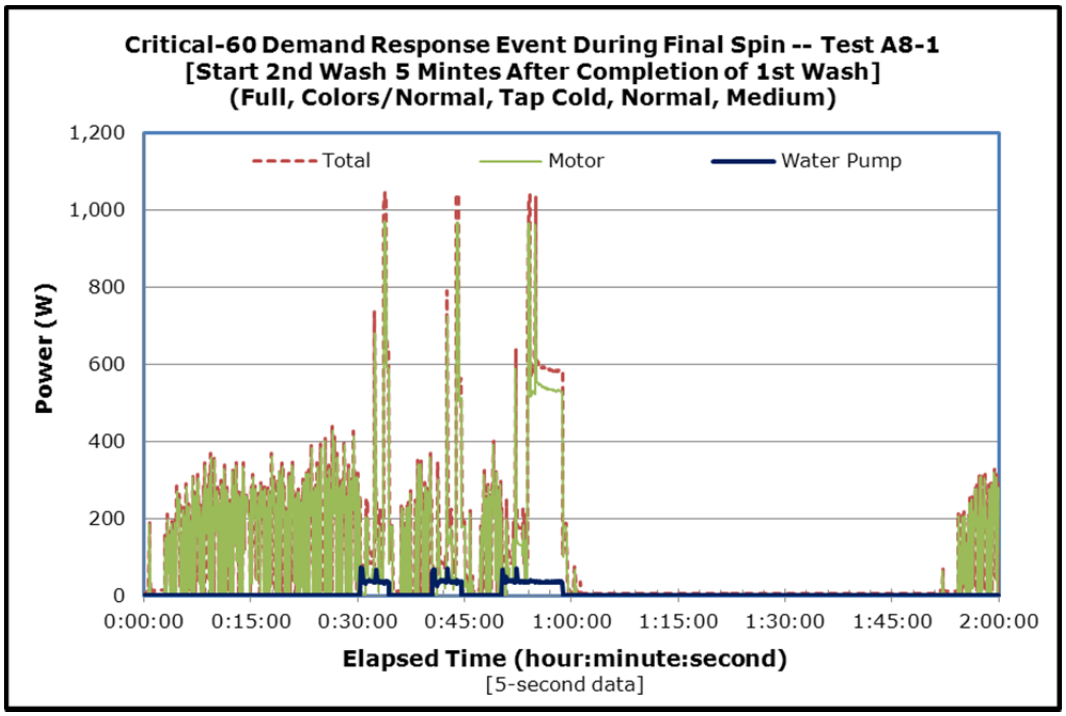

FIGURE 107. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST A8 [A8-1]

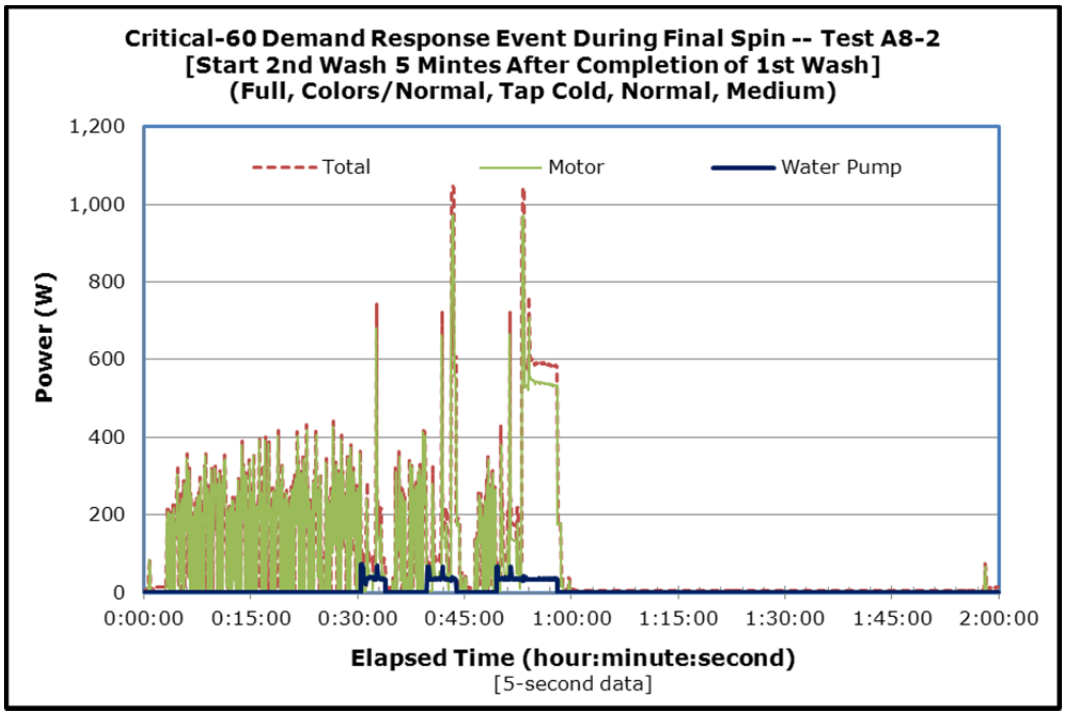

FIGURE 108. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST A8 [A8-2]

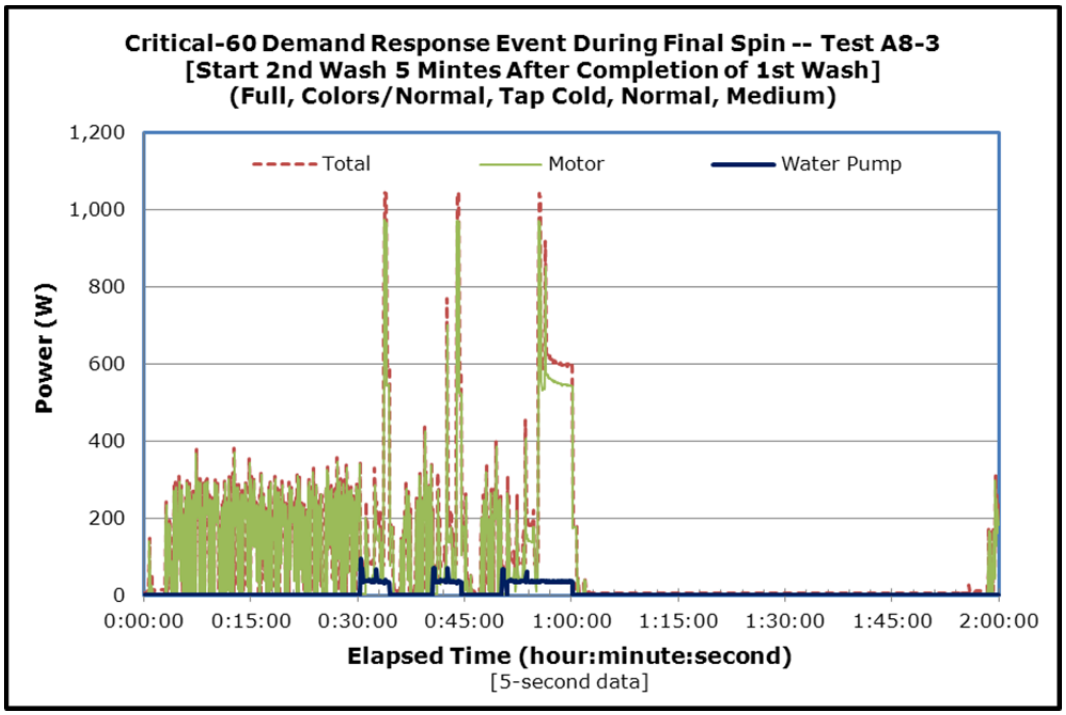

FIGURE 109. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST A8 [A8-3]

TABLE 56. SUMMARY DATA FOR ALL DEMAND RESPONSE A8 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST A8-1	DEMAND RESPONSE TEST A8-2	DEMAND RESPONSE TEST A8-3
Washer's Operating Duration (hour:minute:second)	1:01:45	1:00:55	1:03:05
Power			
Average Water Pump Power (W)	10	10	11
Maximum Water Pump Power (W)	72	72	95
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	181	171	174
Maximum Motor Power (W)	971	972	972
Average Total Power (W)	201	190	194
Maximum Total Power (W)	1,043	1,047	1,044
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	11	10	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	187	174	183
Total Energy (Wh)	207	193	204
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	77	79	77
Water Properties			
Average Cold Water Temperature (ºF)	75	75	75
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	18.72	18.27	18.37
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE C1

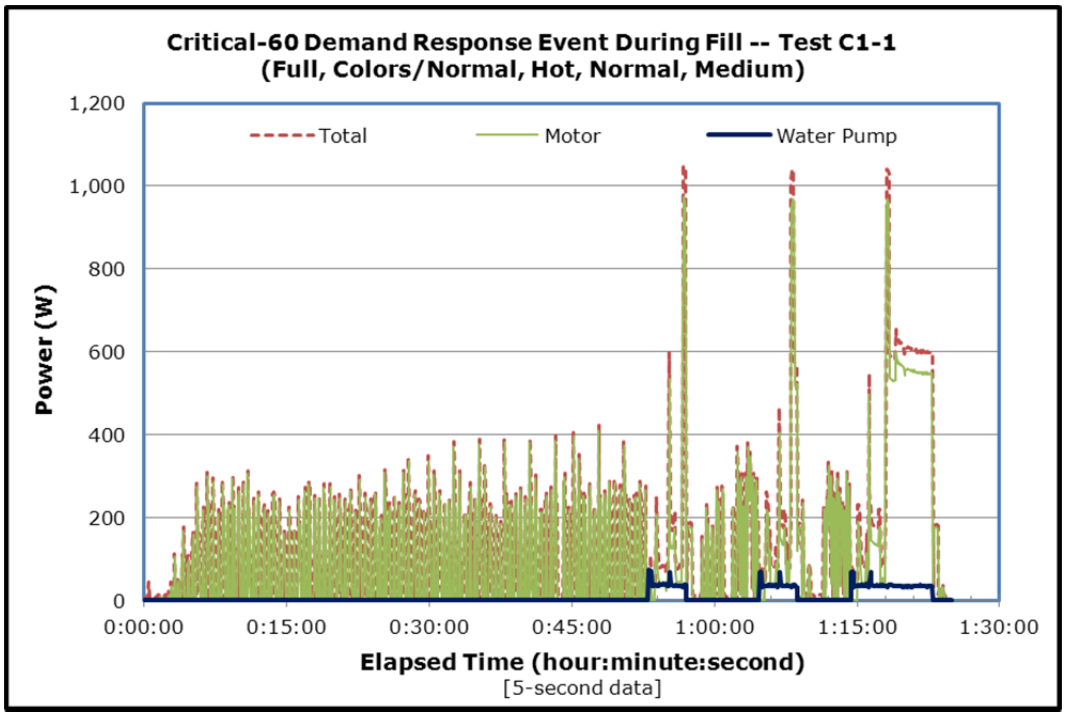

FIGURE 110. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST C1 [C1-1]

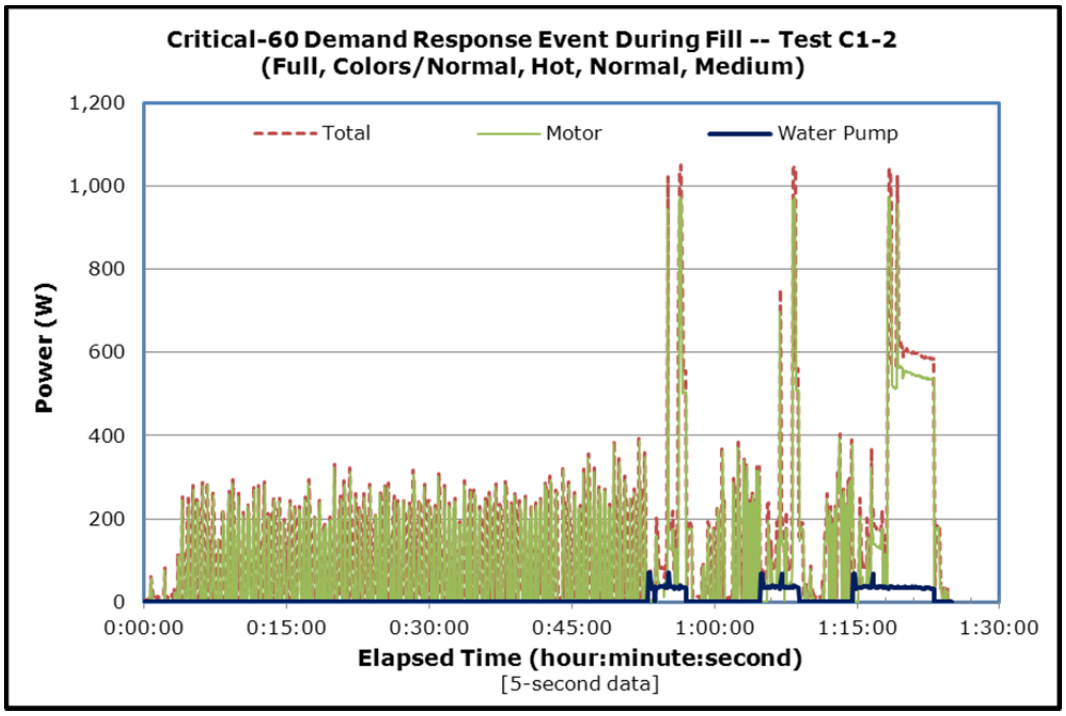

FIGURE 111. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST C1 [C1-2]

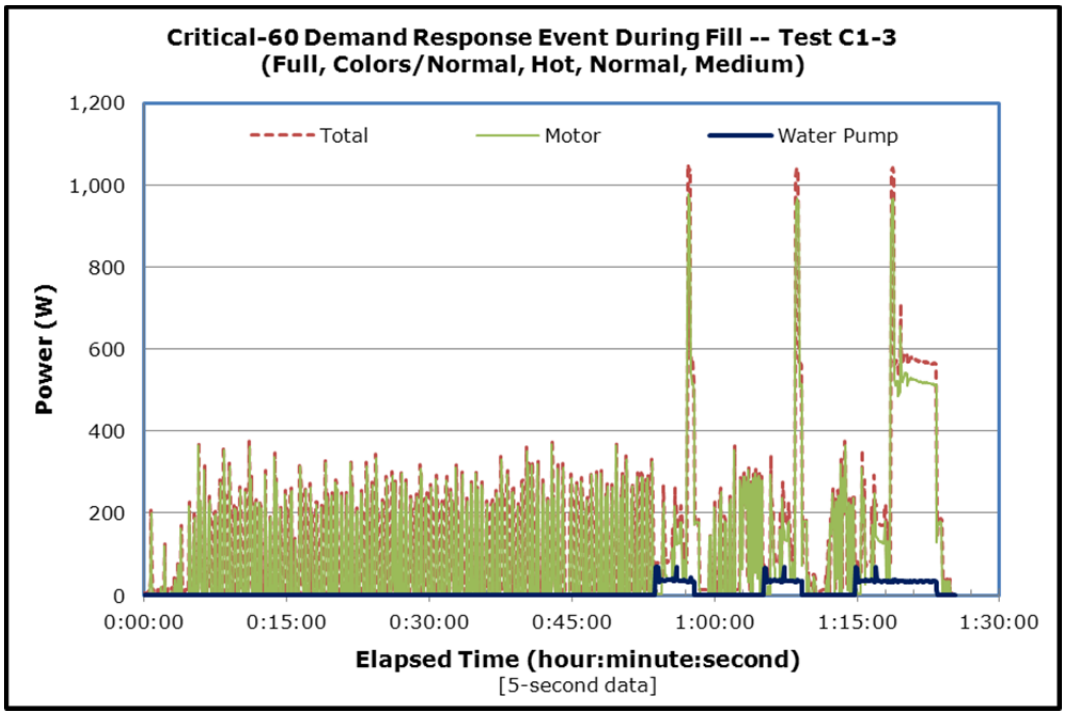

FIGURE 112. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST C1 [C1-3]

TABLE 57. SUMMARY DATA FOR ALL DEMAND RESPONSE C1 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST C1-1	DEMAND RESPONSE TEST C1-2	DEMAND RESPONSE TEST C1-3
Washer's Operating Duration (hour:minute:second)	1:24:55	1:25:00	1:25:20
Power			
Average Water Pump Power (W)	7	7	7
Maximum Water Pump Power (W)	73	71	70
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	122	124	124
Maximum Motor Power (W)	973	973	976
Average Total Power (W)	137	140	139
Maximum Total Power (W)	1,050	1,049	1,050
Minimum Total Power (W)	5	5	4
Energy			
Water Pump Energy (Wh)	10	10	10
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	173	176	176
Total Energy (Wh)	194	198	198
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	78	79	78
Water Properties			
Average Cold Water Temperature (ºF)	76	75	77
Average Cold Water Pressure (psig)	35	35	35
Total Cold Water Flow (gallons)	12.66	12.88	12.60
Average Warm/Hot Water Temperature (ºF)	114	115	114
Average Warm/Hot Water Pressure (psig)	34	34	34
Total Warm/Hot Water Flow (gallons)	5.85	5.47	6.05

DEMAND RESPONSE G1

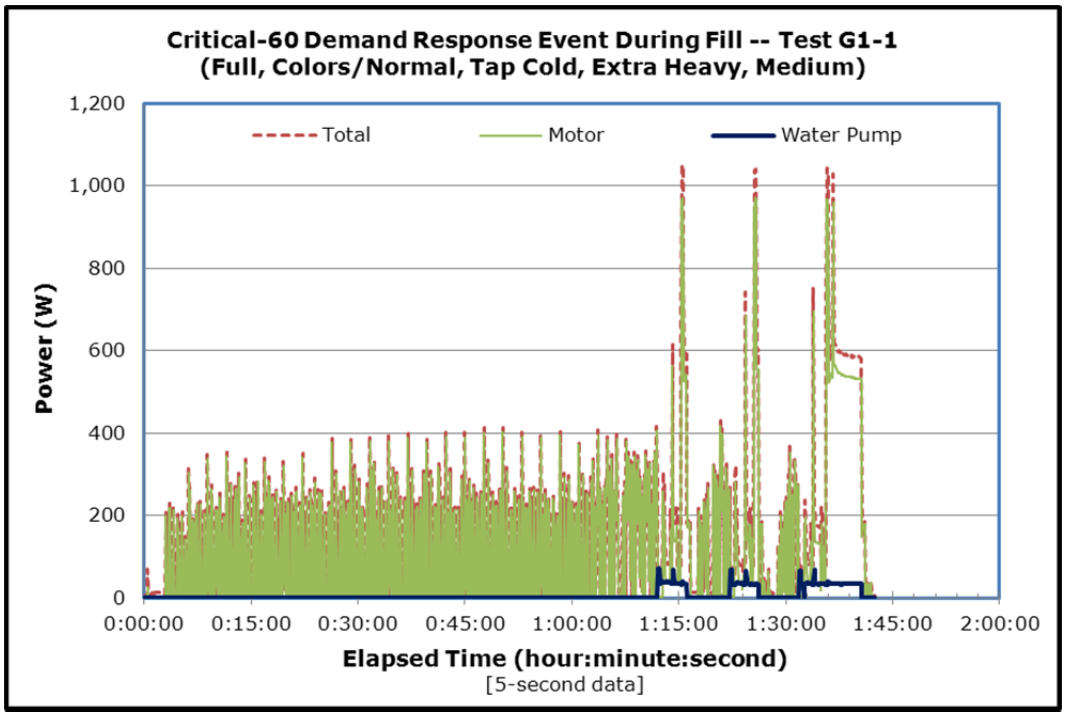

FIGURE 113. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST G1 [G1-1]

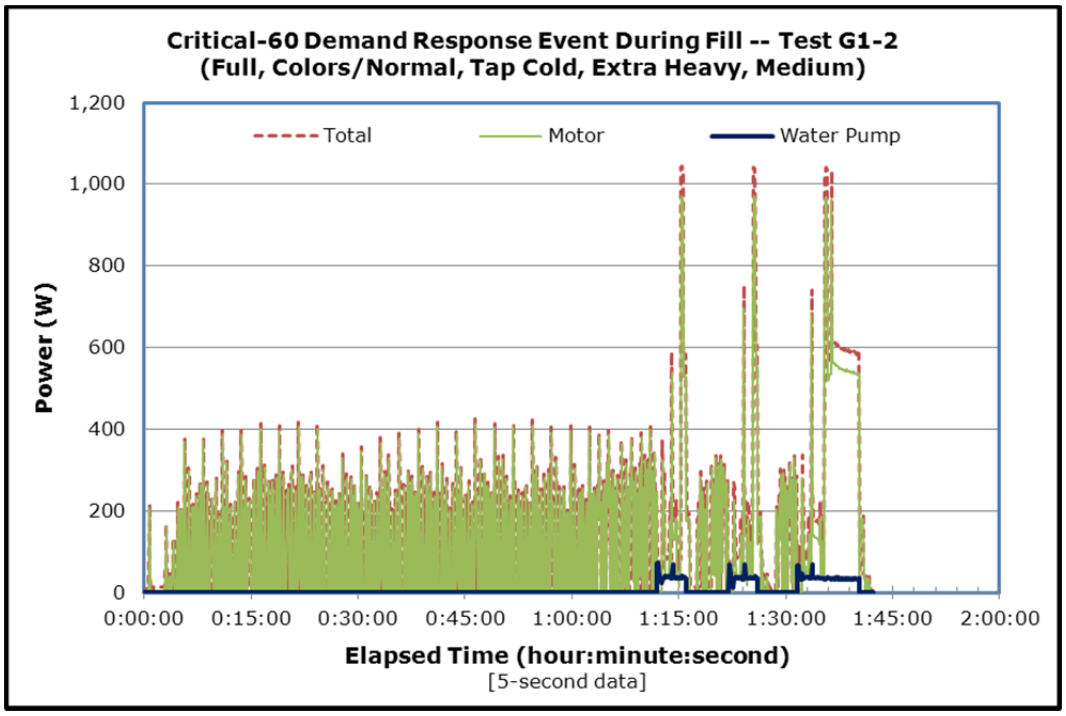

FIGURE 114. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST G1 [G1-2]

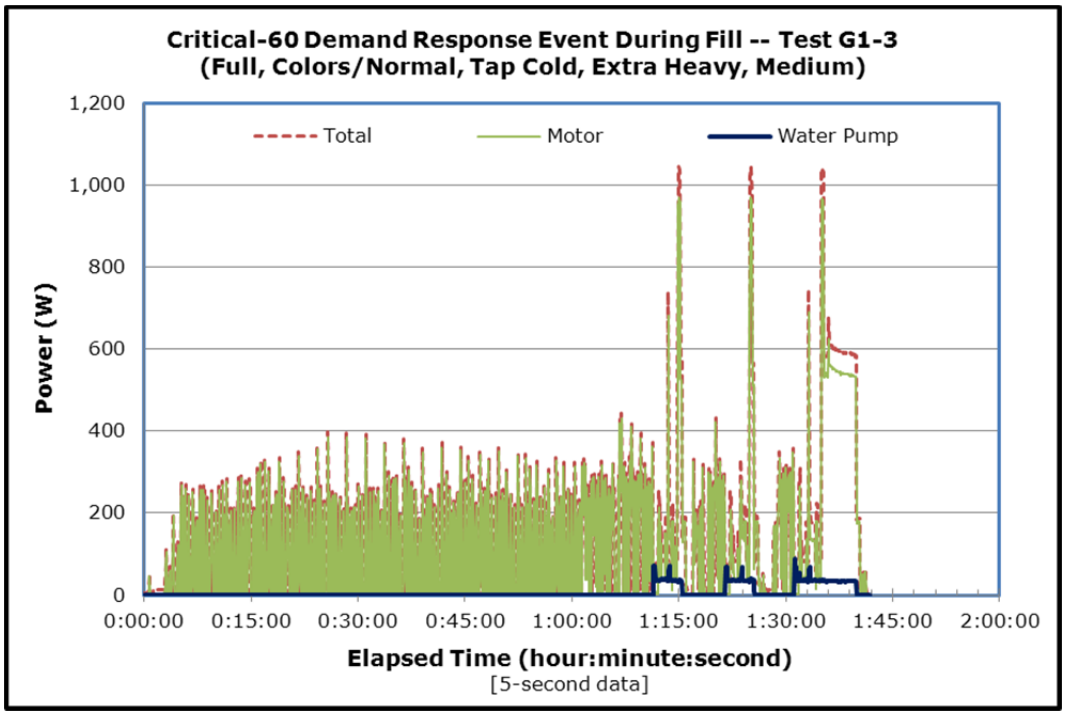

FIGURE 115. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST G1 [G1-3]

TABLE 58. SUMMARY DATA FOR ALL DEMAND RESPONSE G1 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST G1-1	DEMAND RESPONSE TEST G1-2	DEMAND RESPONSE TEST G1-3
Washer's Operating Duration (hour:minute:second)	1:42:30	1:42:15	1:41:45
Power			
Average Water Pump Power (W)	6	6	6
Maximum Water Pump Power (W)	72	72	88
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	131	132	131
Maximum Motor Power (W)	971	971	970
Average Total Power (W)	145	146	145
Maximum Total Power (W)	1,051	1,043	1,045
Minimum Total Power (W)	4	4	4
Energy			
Water Pump Energy (Wh)	10	10	11
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	224	225	222
Total Energy (Wh)	247	249	245
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	76	77	78
Water Properties			
Average Cold Water Temperature (ºF)	74	74	75
Average Cold Water Pressure (psig)	35	35	35
Total Cold Water Flow (gallons)	18.66	18.43	18.72
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE I1

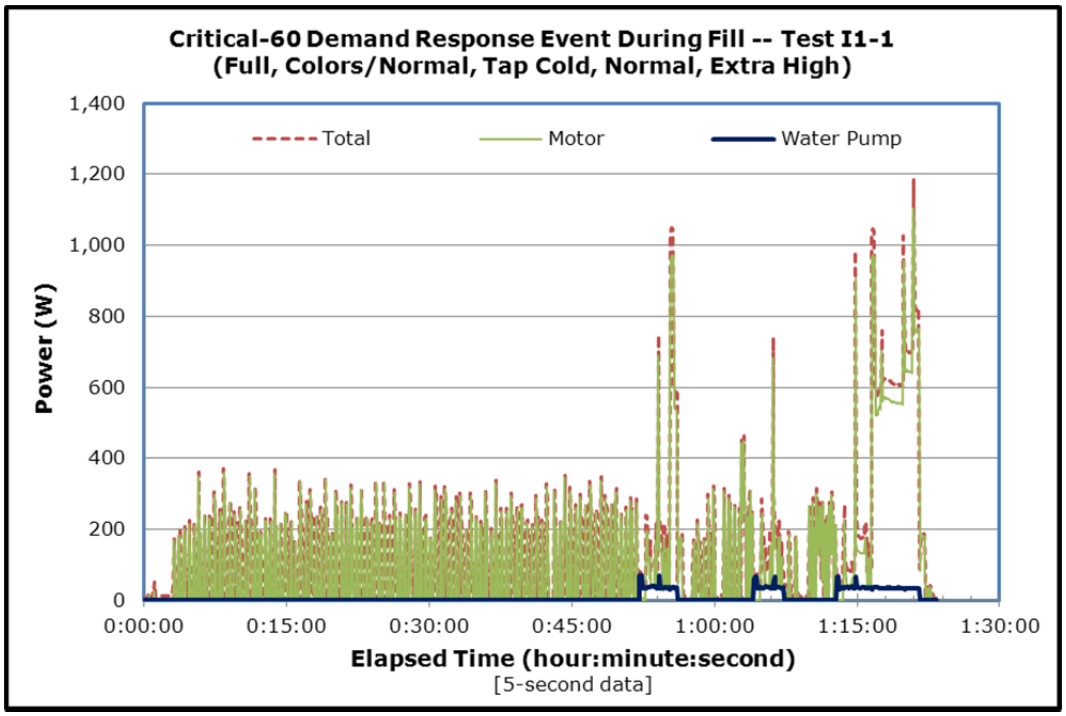

FIGURE 116. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST I1 [I1-1]

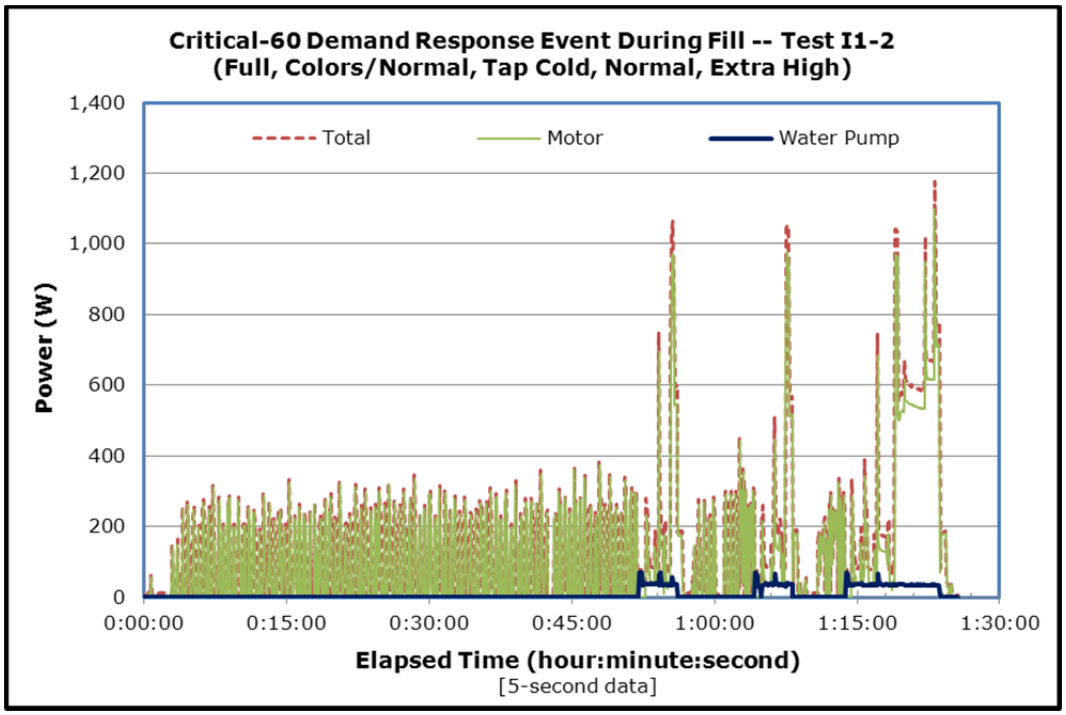

FIGURE 117. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST I1 [I1-2]

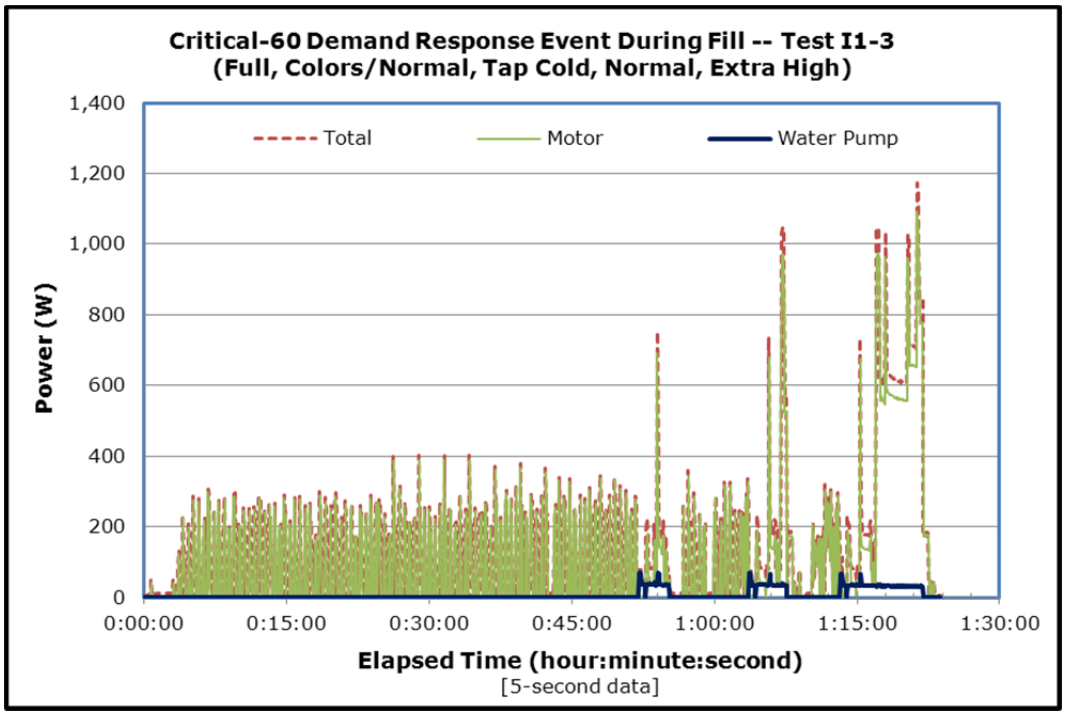

FIGURE 118. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST I1 [I1-3]

TABLE 59. SUMMARY DATA FOR ALL DEMAND RESPONSE I1 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST I1-1	DEMAND RESPONSE TEST I1-2	DEMAND RESPONSE TEST I1-3
Washer's Operating Duration (hour:minute:second)	1:23:25	1:25:35	1:23:45
Power			
Average Water Pump Power (W)	7	8	7
Maximum Water Pump Power (W)	72	71	71
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	127	128	124
Maximum Motor Power (W)	1,104	1,099	1,093
Average Total Power (W)	142	144	139
Maximum Total Power (W)	1,184	1,177	1,172
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	10	11	10
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	176	182	173
Total Energy (Wh)	198	205	194
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	76	78	78
Water Properties			
Average Cold Water Temperature (ºF)	75	75	76
Average Cold Water Pressure (psig)	34	34	34
Total Cold Water Flow (gallons)	17.71	18.93	17.67
Average Warm/Hot Water Temperature (ºF)	----	----	----
Average Warm/Hot Water Pressure (psig)	----	----	----
Total Warm/Hot Water Flow (gallons)	----	----	----

DEMAND RESPONSE I2

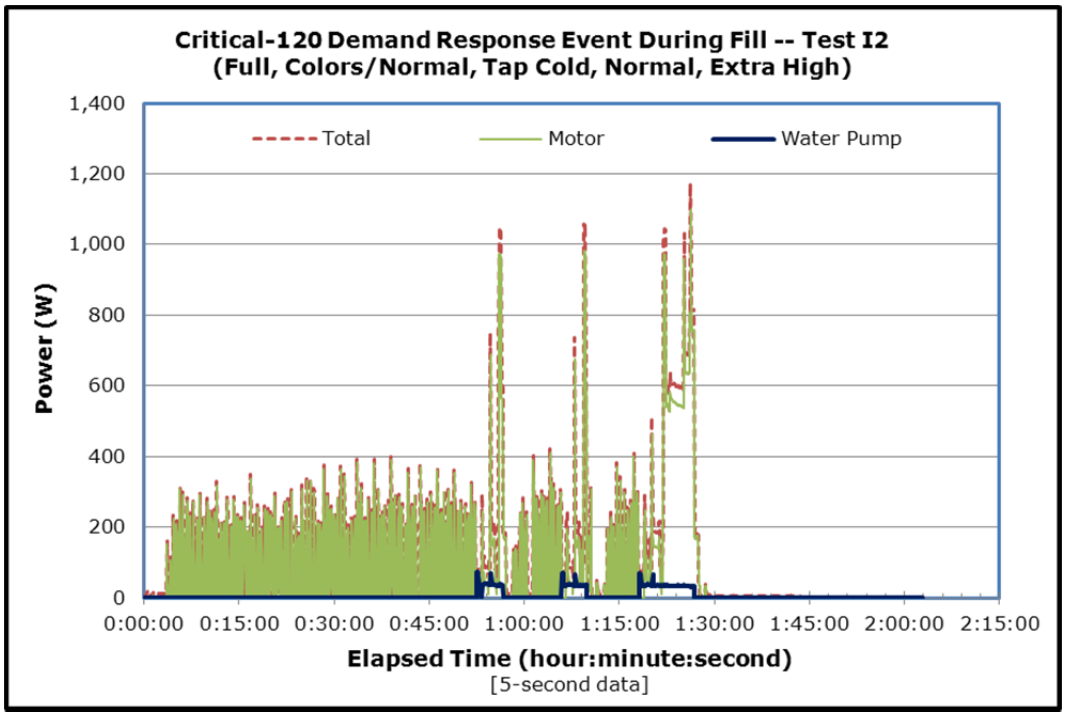

FIGURE 119. POWER PROFILE FOR A COMPLETE WASH CYCLE – DEMAND RESPONSE TEST I2

TABLE 60. SUMMARY DATA FOR DEMAND RESPONSE I2 TEST

DATA CATEGORY	DEMAND RESPONSE TEST I2
Washer's Operating Duration (hour:minute:second)	1:29:45
Power	
Average Water Pump Power (W)	7
Maximum Water Pump Power (W)	74
Average Heater Power (W)	0
Maximum Heater Power (W)	0
Average Motor Power (W)	121
Maximum Motor Power (W)	1,098
Average Total Power (W)	136
Maximum Total Power (W)	1,175
Minimum Total Power (W)	5
Energy	
Water Pump Energy (Wh)	11
Heater Energy (Wh)	0
Motor Energy (Wh)	181
Total Energy (Wh)	203
Controlled Environment Test Room	
Average Dry-Bulb Temperature (ºF)	73
Water Properties	
Average Cold Water Temperature (ºF)	69
Average Cold Water Pressure (psig)	35
Total Cold Water Flow (gallons)	18.43
Average Warm/Hot Water Temperature (ºF)	----
Average Warm/Hot Water Pressure (psig)	----
Total Warm/Hot Water Flow (gallons)	----

DEMAND RESPONSE J1

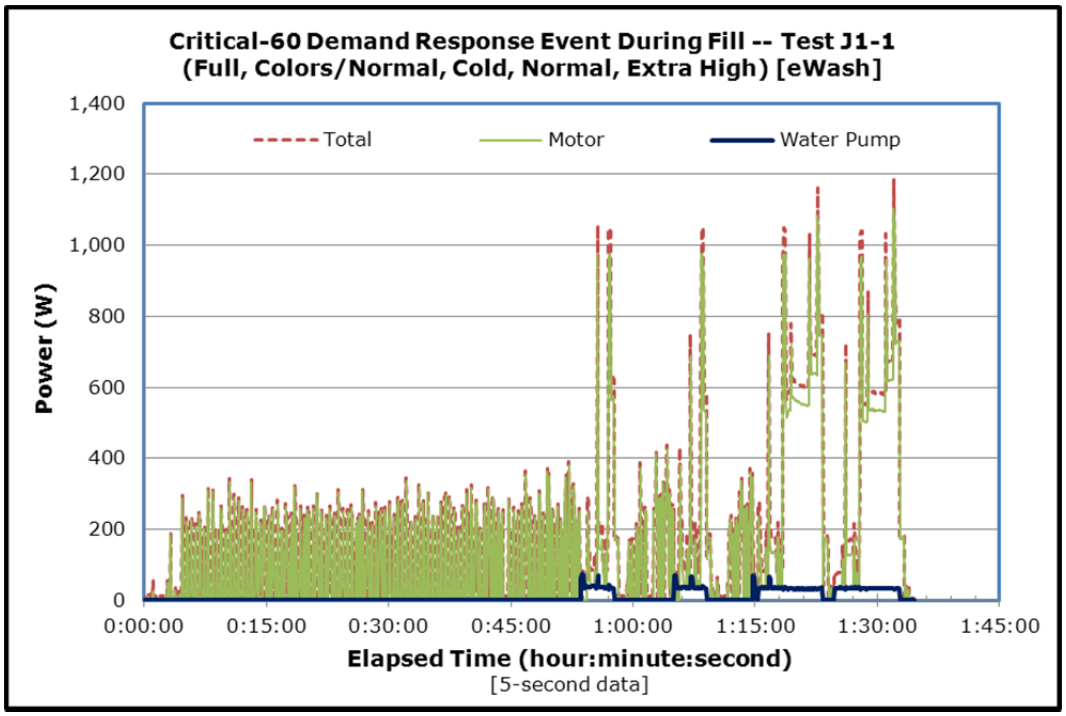

FIGURE 120. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST J1 [J1-1]

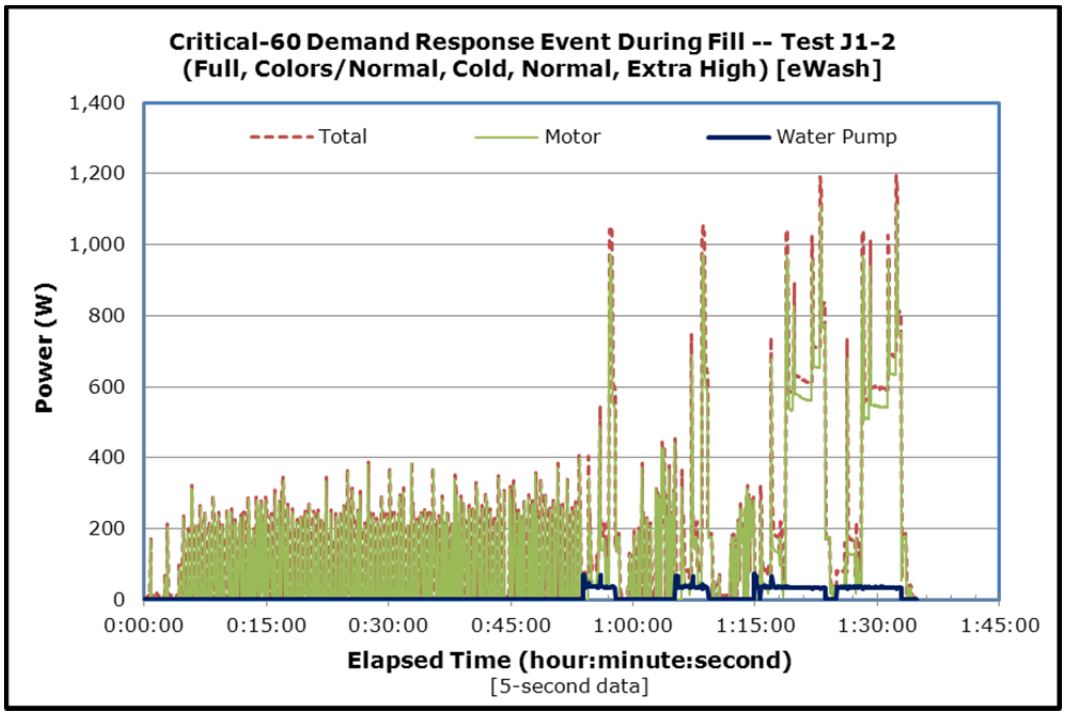

FIGURE 121. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST J1 [J1-2]

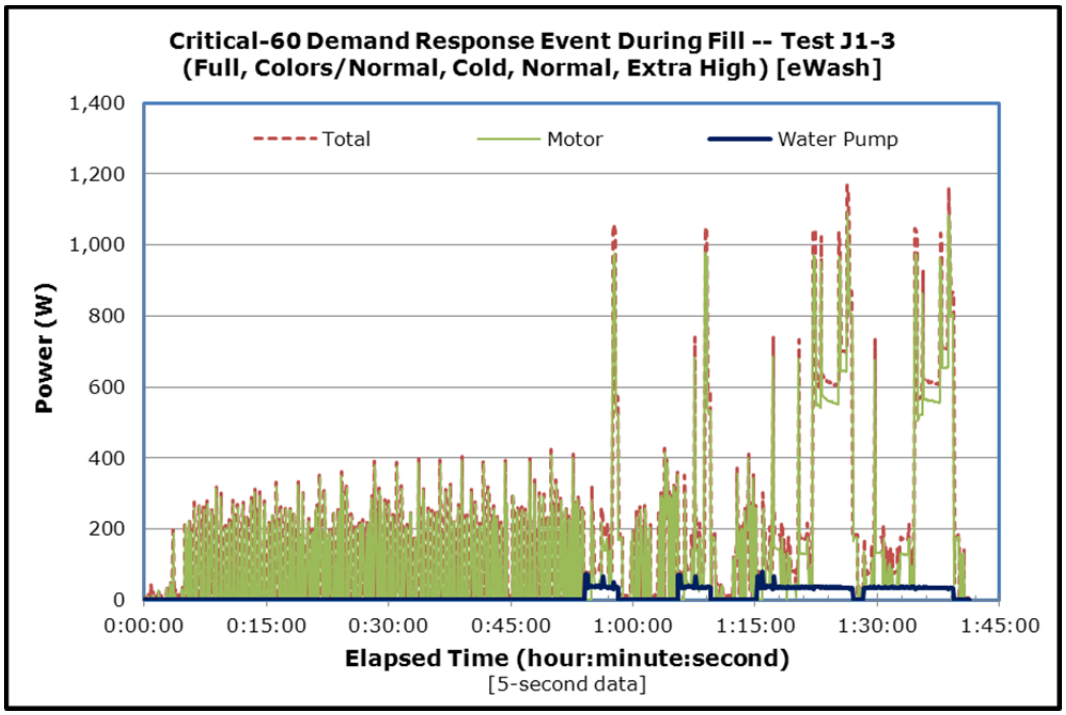

FIGURE 122. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST J1 [J1-3]

TABLE 61. SUMMARY DATA FOR ALL DEMAND RESPONSE J1 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST J1-1	DEMAND RESPONSE TEST J1-2	DEMAND RESPONSE TEST J1-3
Washer's Operating Duration (hour:minute:second)	1:34:30	1:34:50	1:41:15
Power			
Average Water Pump Power (W)	9	10	11
Maximum Water Pump Power (W)	72	72	79
Average Heater Power (W)	0	0	0
Maximum Heater Power (W)	0	0	0
Average Motor Power (W)	155	157	152
Maximum Motor Power (W)	1,103	1,115	1,089
Average Total Power (W)	173	175	172
Maximum Total Power (W)	1,183	1,194	1,168
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	15	15	19
Heater Energy (Wh)	0	0	0
Motor Energy (Wh)	244	248	256
Total Energy (Wh)	273	277	290
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	77	78	77
Water Properties			
Average Cold Water Temperature (ºF)	75	77	75
Average Cold Water Pressure (psig)	34	34	35
Total Cold Water Flow (gallons)	18.57	18.89	18.78
Average Warm/Hot Water Temperature (ºF)	77	78	75
Average Warm/Hot Water Pressure (psig)	35	35	35
Total Warm/Hot Water Flow (gallons)	0.27	0.27	0.24

DEMAND RESPONSE J2

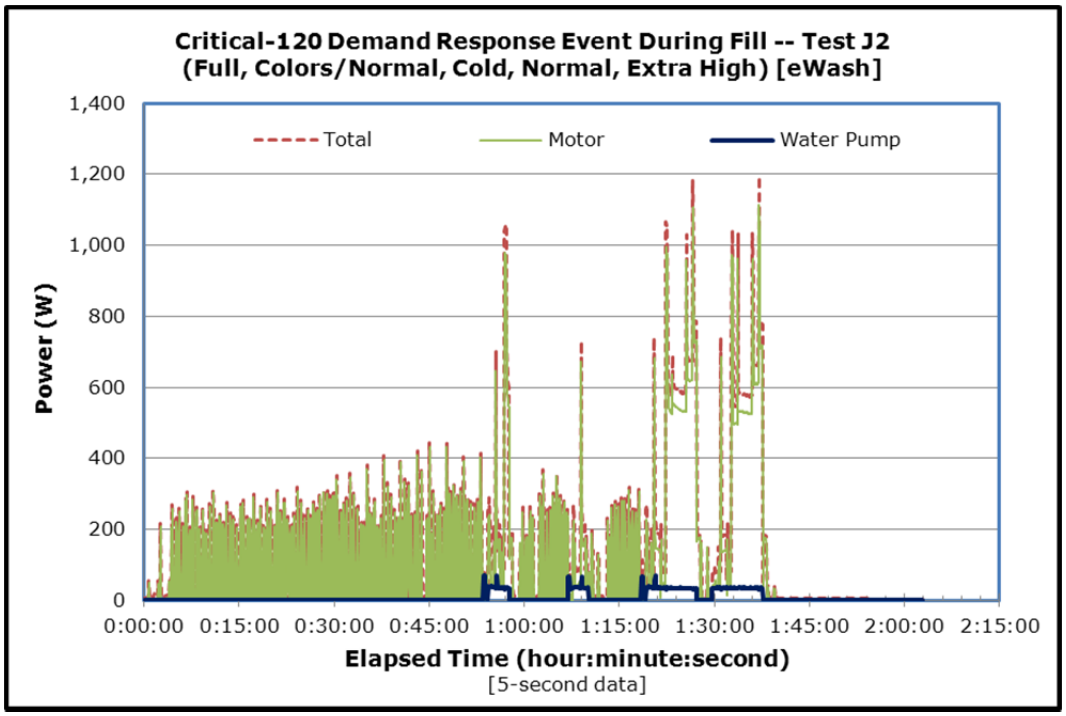

FIGURE 123. POWER PROFILE FOR A COMPLETE WASH CYCLE – DEMAND RESPONSE TEST J2

TABLE 62. SUMMARY DATA FOR DEMAND RESPONSE J2 TEST

DATA CATEGORY	DEMAND RESPONSE TEST J2
Washer's Operating Duration (hour:minute:second)	1:40:35
Power	
Average Water Pump Power (W)	9
Maximum Water Pump Power (W)	71
Average Heater Power (W)	0
Maximum Heater Power (W)	0
Average Motor Power (W)	140
Maximum Motor Power (W)	1,113
Average Total Power (W)	158
Maximum Total Power (W)	1,193
Minimum Total Power (W)	5
Energy	
Water Pump Energy (Wh)	15
Heater Energy (Wh)	0
Motor Energy (Wh)	235
Total Energy (Wh)	264
Controlled Environment Test Room	
Average Dry-Bulb Temperature (ºF)	75
Water Properties	
Average Cold Water Temperature (ºF)	72
Average Cold Water Pressure (psig)	36
Total Cold Water Flow (gallons)	17.85
Average Warm/Hot Water Temperature (ºF)	113
Average Warm/Hot Water Pressure (psig)	35
Total Warm/Hot Water Flow (gallons)	0.31

DEMAND RESPONSE K1

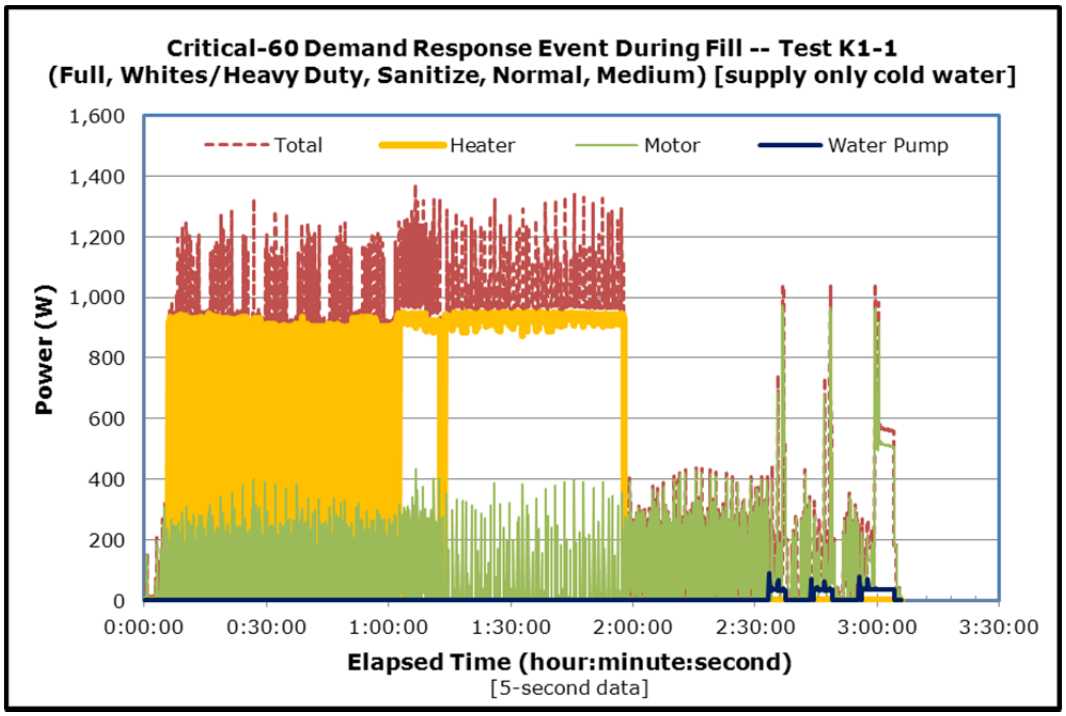

FIGURE 124. POWER PROFILE FOR A COMPLETE WASH CYCLE – FIRST DEMAND RESPONSE TEST K1 [K1-1]

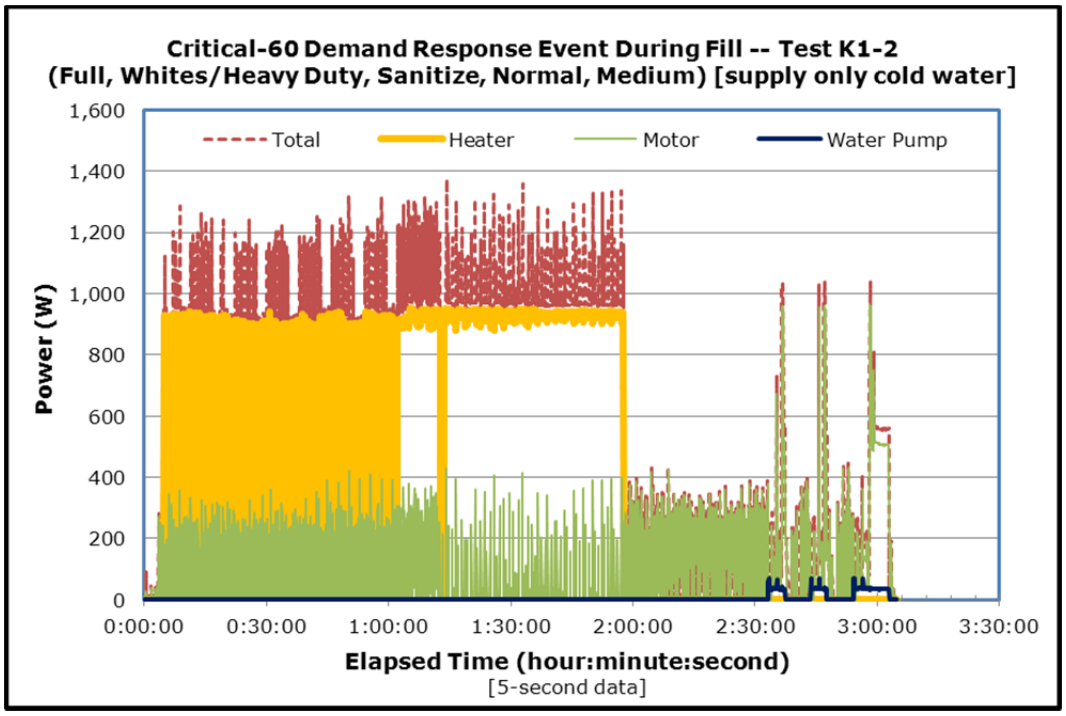

FIGURE 125. POWER PROFILE FOR A COMPLETE WASH CYCLE – SECOND DEMAND RESPONSE TEST K1 [K1-2]

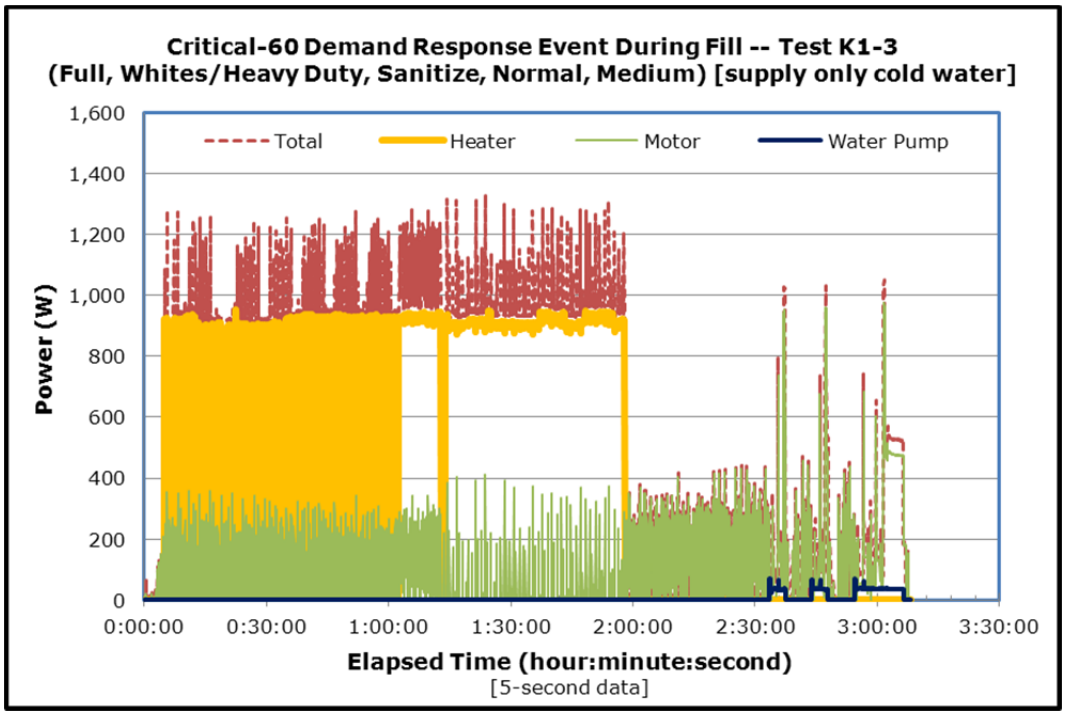

FIGURE 126. POWER PROFILE FOR A COMPLETE WASH CYCLE – THIRD/FINAL DEMAND RESPONSE TEST K1 [K1-3]

TABLE 63. SUMMARY DATA FOR ALL DEMAND RESPONSE K1 TESTS

DATA CATEGORY	DEMAND RESPONSE TEST K1-1	DEMAND RESPONSE TEST K1-2	DEMAND RESPONSE TEST K1-3
Washer's Operating Duration (hour:minute:second)	3:06:00	3:04:45	3:08:15
Power			
Average Water Pump Power (W)	4	3	4
Maximum Water Pump Power (W)	91	71	69
Average Heater Power (W)	407	411	399
Maximum Heater Power (W)	951	951	952
Average Motor Power (W)	117	120	115
Maximum Motor Power (W)	971	965	975
Average Total Power (W)	542	548	532
Maximum Total Power (W)	1,371	1,372	1,331
Minimum Total Power (W)	5	5	5
Energy			
Water Pump Energy (Wh)	11	11	13
Heater Energy (Wh)	1,263	1,266	1,253
Motor Energy (Wh)	363	369	360
Total Energy (Wh)	1,682	1,687	1,671
Controlled Environment Test Room			
Average Dry-Bulb Temperature (ºF)	78	79	78
Water Properties			
Average Cold Water Temperature (ºF)	79	79	77
Average Cold Water Pressure (psig)	39	64	62
Total Cold Water Flow (gallons)	12.38	12.59	12.56
Average Warm/Hot Water Temperature (ºF)	76	79	77
Average Warm/Hot Water Pressure (psig)	36	36	36
Total Warm/Hot Water Flow (gallons)	6.26	6.27	6.24

APPENDIX C – ADDITIONAL COMPARATIVE TABLES

Table 64 through Table 78 compare component-level and total power and energy obtained for baseline and DR test runs discussed in the "Results" section of this report. The data are for every stage of the wash cycle. Where applicable, DR and non-DR periods are identified.

TABLE 64. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A1

		BASELINE TEST A (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM)			DEMAND RESPONSE TEST A1 (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM) [HIGH-8 EVENT INITIATED BEFORE STARTING THE WASHER]		
DATA CATEGORY	STAGE OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	30	0	35	43	0	48
Average Power (W)		3	0	12	5	0	13
Duration (minutes)		2.5	0.0	2.7	2.3	0.0	2.5
Energy (Wh)		0	0	1	0	0	1
Maximum Power (W)	Agitate (wash)	396	0	407	437	0	449
Average Power (W)		175	0	182	172	0	180
Duration (minutes)		27.4	0.0	27.4	27.4	0.0	27.4
Energy (Wh)		80	0	83	79	0	82
Maximum Power (W)	1st drain & spin	988	74	1,060	970	71	1,043
Average Power (W)		191	39	239	212	39	262
Duration (minutes)		5.3	5.3	5.3	4.0	4.0	4.0
Energy (Wh)		17	3	21	14	3	17
Maximum Power (W)	1st rinse	361	0	371	423	0	435
Average Power (W)		121	0	130	129	0	138
Duration (minutes)		6.2	0.0	6.2	6.2	0.0	6.2
Energy (Wh)		12	0	13	13	0	14
Maximum Power (W)	2nd drain & spin	963	69	1,041	971	69	1,049
Average Power (W)		238	40	289	213	39	263
Duration (minutes)		4.0	4.0	4.0	4.0	4.0	4.0
Energy (Wh)		16	3	19	14	3	18
Maximum Power (W)	2nd rinse	341	0	356	312	0	321
Average Power (W)		103	0	112	103	0	111
Duration (minutes)		5.7	0.0	5.7	5.7	0.0	5.7
Energy (Wh)		10	0	11	10	0	11
Maximum Power (W)	Final drain & spin	962	68	1,037	963	69	1,038
Average Power (W)		361	38	412	376	37	427
Duration (minutes)		10.0	10.0	10.0	8.8	8.8	8.8

Data Category	Stage of Wash Cycle	Baseline Test A (Full, Colors/Normal, Tap Cold, Normal, Medium) Motor	Water Pump	Total	Demand Response Test A1 (Full, Colors/Normal, Tap Cold, Normal, Medium) [High-8 event initiated before starting the washer] Motor	Water Pump	Total
Energy (Wh)		60	6	69	55	5	62
Maximum Power (W)	Final tumble	177	0	183	180	0	187
Average Power (W)		83	0	88	73	0	79
Duration (minutes)		1.4	0.0	1.4	1.4	0.0	1.4
Energy (Wh)		2	0	2	2	0	2

Table 65. Comparison of Stages of a Wash Cycle – Baseline Test A and Demand Response Test A2

Data Category	Stage of Wash Cycle	Baseline Test A (Full, Colors/Normal, Tap Cold, Normal, Medium) Motor	Water Pump	Total	Demand Response Test A2 (Full, Colors/Normal, Tap Cold, Normal, Medium) [Critical-8 event initiated before starting the washer] Motor	Water Pump	Total
Maximum Power (W)	Fill	30	0	35	19	0	25
Average Power (W)		3	0	12	3	0	11
Duration (minutes)		2.5	0.0	2.7	2.3	0.0	2.6
Energy (Wh)		0	0	1	0	0	0
Maximum Power (W)	Agitate (wash)	396	0	407	414	0	426
Average Power (W)		175	0	182	177	0	184
Duration (minutes)		27.4	0.0	27.4	27.3	0.0	27.3
Energy (Wh)		80	0	83	80	0	84
Maximum Power (W)	1st drain & spin	988	74	1,060	970	71	1,042
Average Power (W)		191	39	239	211	39	260
Duration (minutes)		5.3	5.3	5.3	4.1	4.0	4.1
Energy (Wh)		17	3	21	14	3	18
Maximum Power (W)	1st rinse	361	0	371	418	0	430
Average Power (W)		121	0	130	124	0	133
Duration (minutes)		6.2	0.0	6.2	6.1	0.0	6.1
Energy (Wh)		12	0	13	13	0	13
Maximum Power (W)	2nd drain & spin	963	69	1,041	989	69	1,069
Average Power (W)		238	40	289	211	39	261
Duration (minutes)		4.0	4.0	4.0	4.0	4.0	4.0
Energy (Wh)		16	3	19	14	3	17
Maximum Power (W)	2nd rinse	341	0	356	415	0	427
Average Power (W)		103	0	112	110	0	118
Duration (minutes)		5.7	0.0	5.7	5.8	0.0	5.8

Data Category	Stage of Wash Cycle	Baseline Test A (full, colors/normal, tap cold, normal, medium)			Demand Response Test A2 (full, colors/normal, tap cold, normal, medium) [critical-8 event initiated before starting the washer]		
		Motor	Water Pump	Total	Motor	Water Pump	Total
Energy (Wh)		10	0	11	11	0	11
Maximum Power (W)	Final drain & spin	962	68	1,037	971	69	1,046
Average Power (W)		361	38	412	376	37	427
Duration (minutes)		10.0	10.0	10.0	8.6	8.5	8.6
Energy (Wh)		60	6	69	54	5	61
Maximum Power (W)	Final tumble	177	0	183	264	0	272
Average Power (W)		83	0	88	106	0	112
Duration (minutes)		1.4	0.0	1.4	1.4	0.0	1.4
Energy (Wh)		2	0	2	2	0	3

TABLE 66. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A3

		BASELINE TEST A (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM)			DEMAND RESPONSE TEST A3 (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM) [CRITICAL-60 EVENT DURING FILL]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	30	0	35	Prior to DR	25	0	45
Average Power (W)		3	0	12		3	0	13
Duration (minutes)		2.5	0.0	2.7		2.1	0.0	2.2
Energy (Wh)		0	0	1		0	0	0
Maximum Power (W)					During DR	88	0	95
Average Power (W)						16	0	26
Duration (minutes)						0.5	0.0	0.5
Energy (Wh)						0	0	0
Maximum Power (W)	Agitate (wash)	396	0	407	During DR	360	0	371
Average Power (W)		175	0	182		96	0	102
Duration (minutes)		27.4	0.0	27.4		46.7	0.0	46.7
Energy (Wh)		80	0	83		74	0	80
Maximum Power (W)	1st drain & spin	988	74	1,060	During DR	974	73	1,051
Average Power (W)		191	39	239		206	41	258
Duration (minutes)		5.3	5.3	5.3		4.0	4.0	4.0
Energy (Wh)		17	3	21		14	3	17
Maximum Power (W)	1st rinse	361	0	371	During DR	321	0	331
Average Power (W)		121	0	130		81	0	89
Duration (minutes)		6.2	0.0	6.2		8.8	0.0	8.8
Energy (Wh)		12	0	13		12	0	13
Maximum Power (W)					After DR	337	0	346
Average Power (W)						99	0	106
Duration (minutes)						0.5	0.0	0.5
Energy (Wh)						1	0	1
Maximum Power (W)	2nd drain & spin	963	69	1,041	After DR	971	75	1,046
Average Power (W)		238	40	289		199	40	250
Duration (minutes)		4.0	4.0	4.0		4.1	4.1	4.1
Energy (Wh)		16	3	19		14	3	17
Maximum Power (W)	2nd rinse	341	0	356	After DR	339	0	349
Average Power (W)		103	0	112		106	0	115
Duration (minutes)		5.7	0.0	5.7		5.5	0.0	5.5
Energy (Wh)		10	0	11		10	0	11
Maximum Power (W)	Final drain & spin	962	68	1,037	After DR	973	93	1,047
Average Power (W)		361	38	412		387	37	438
Duration (minutes)		10.0	10.0	10.0		8.8	8.7	8.8
Energy (Wh)		60	6	69		56	5	64
Maximum Power (W)	Final	177	0	183	After DR	176	0	183
Average Power (W)		83	0	88		74	0	80

		Baseline Test A (full, colors/normal, tap cold, normal, medium)				Demand Response Test A3 (full, colors/normal, tap cold, normal, medium) [critical-60 event during fill]		
Data Category	Stages of Wash Cycle	Motor	Water Pump	Total	DR or Non-DR Period	Motor	Water Pump	Total
Duration (minutes)	tumble	1.4	0.0	1.4		1.4	0.0	1.4
Energy (Wh)		2	0	2		2	0	2

TABLE 67. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A4

		BASELINE TEST A (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM)			DEMAND RESPONSE TEST A4 (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM) [CRITICAL-60 EVENT DURING WASH]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	30	0	35	Prior to DR	174	0	181
Average Power (W)		3	0	12		8	0	17
Duration (minutes)		2.5	0.0	2.7		2.3	0.0	2.5
Energy (Wh)		0	0	1		0	0	1
Maximum Power (W)	Agitate (wash)	396	0	407	Prior to DR	394	0	406
Average Power (W)		175	0	182		171	0	179
Duration (minutes)		27.4	0.0	27.4		13.5	0.0	13.5
Energy (Wh)		80	0	83		39	0	40
Maximum Power (W)					During DR	418	0	430
Average Power (W)						99	0	105
Duration (minutes)						23.9	0.0	23.9
Energy (Wh)						39	0	42
Maximum Power (W)	1st drain & spin	988	74	1,060	During DR	982	72	1,059
Average Power (W)		191	39	239		204	40	254
Duration (minutes)		5.3	5.3	5.3		4.1	4.1	4.1
Energy (Wh)		17	3	21		14	3	17
Maximum Power (W)	1st rinse	361	0	371	During DR	418	0	429
Average Power (W)		121	0	130		84	0	92
Duration (minutes)		6.2	0.0	6.2		9.3	0.0	9.3
Energy (Wh)		12	0	13		13	0	14
Maximum Power (W)	2nd drain & spin	963	69	1,041	During DR	992	70	1,061
Average Power (W)		238	40	289		218	39	268
Duration (minutes)		4.0	4.0	4.0		4.1	4.1	4.1
Energy (Wh)		16	3	19		15	3	18
Maximum Power (W)	2nd rinse	341	0	356	During DR	269	0	277
Average Power (W)		103	0	112		62	0	69
Duration (minutes)		5.7	0.0	5.7		8.5	0.0	8.5
Energy (Wh)		10	0	11		9	0	10
Maximum Power (W)	Final drain & spin	962	68	1,037	During DR	978	68	1,047
Average Power (W)		361	38	412		384	37	435
Duration (minutes)		10.0	10.0	10.0		8.7	8.7	8.7
Energy (Wh)		60	6	69		56	5	63
Maximum Power (W)	Final tumble	177	0	183	During DR	178	0	184
Average Power (W)		83	0	88		67	0	73
Duration (minutes)		1.4	0.0	1.4		1.4	0.0	1.4
Energy (Wh)		2	0	2		2	0	2
Maximum Power (W)					After DR	39	0	45
Average Power (W)						14	0	20

		Baseline Test A (full, colors/normal, tap cold, normal, medium)				Demand Response Test A4 (full, colors/normal, tap cold, normal, medium) [critical-60 event during wash]		
ata Category	Stages of Wash Cycle	Motor	Water Pump	Total	DR or Non-DR Period	Motor	Water Pump	Total
Duration (minutes)						0.8	0.0	0.8
Energy (Wh)						0	0	0

TABLE 68. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A5

		BASELINE TEST A (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM)			DEMAND RESPONSE TEST A5 (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM) [CRITICAL-60 EVENT DURING FIRST RINSE]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	30	0	35	Prior to DR	37	0	43
Average Power (W)		3	0	12		4	0	13
Duration (minutes)		2.5	0.0	2.7		2.7	0.0	2.8
Energy (Wh)		0	0	1		0	0	1
Maximum Power (W)	Agitate (wash)	396	0	407	Prior to DR	404	0	416
Average Power (W)		175	0	182		177	0	185
Duration (minutes)		27.4	0.0	27.4		27.4	0.0	27.4
Energy (Wh)		80	0	83		81	0	84
Maximum Power (W)	1st drain and spin	988	74	1,060	Prior to DR	973	70	1,043
Average Power (W)		191	39	239		194	39	243
Duration (minutes)		5.3	5.3	5.3		4.0	4.0	4.0
Energy (Wh)		17	3	21		13	3	16
Maximum Power (W)	1st rinse	361	0	371	Prior to DR	382	0	393
Average Power (W)		121	0	130		109	0	119
Duration (minutes)		6.2	0.0	6.2		4.7	0.0	4.7
Energy (Wh)		12	0	13		8	0	9
Maximum Power (W)					During DR	308	0	317
Average Power (W)						120	0	127
Duration (minutes)						1.9	0.0	1.9
Energy (Wh)						4	0	4
Maximum Power (W)	2nd drain & spin	963	69	1,041	During DR	966	68	1,048
Average Power (W)		238	40	289		211	38	260
Duration (minutes)		4.0	4.0	4.0		4.1	4.1	4.1
Energy (Wh)		16	3	19		14	3	18
Maximum Power (W)	2nd rinse	341	0	356	During DR	278	0	286
Average Power (W)		103	0	112		68	0	76
Duration (minutes)		5.7	0.0	5.7		8.4	0.0	8.4
Energy (Wh)		10	0	11		10	0	11
Maximum Power (W)	Final drain & spin	962	68	1,037	During DR	970	69	1,047
Average Power (W)		361	38	412		368	37	418
Duration (minutes)		10.0	10.0	10.0		8.7	8.7	8.7
Energy (Wh)		60	6	69		53	5	60
Maximum Power (W)	Final tumble	177	0	183	During DR	181	0	188
Average Power (W)		83	0	88		36	0	42
Duration (minutes)		1.4	0.0	1.4		2.4	0.0	2.9
Energy (Wh)		2	0	2		2	0	2

TABLE 69. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A6

		BASELINE TEST A (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM)			DEMAND RESPONSE TEST A6 (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM) [CRITICAL-60 EVENT DURING FINAL SPIN]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	30	0	35	Prior to DR	43	0	49
Average Power (W)		3	0	12		4	0	13
Duration (minutes)		2.5	0.0	2.7		2.4	0.0	2.6
Energy (Wh)		0	0	1		0	0	1
Maximum Power (W)	Agitate (wash)	396	0	407	Prior to DR	442	0	454
Average Power (W)		175	0	182		179	0	186
Duration (minutes)		27.4	0.0	27.4		27.3	0.0	27.3
Energy (Wh)		80	0	83		81	0	85
Maximum Power (W)	1st drain & spin	988	74	1,060	Prior to DR	979	73	1,049
Average Power (W)		191	39	239		204	41	255
Duration (minutes)		5.3	5.3	5.3		4.0	4.0	4.0
Energy (Wh)		17	3	21		14	3	17
Maximum Power (W)	1st rinse	361	0	371	Prior to DR	424	0	436
Average Power (W)		121	0	130		126	0	135
Duration (minutes)		6.2	0.0	6.2		6.2	0.0	6.2
Energy (Wh)		12	0	13		13	0	14
Maximum Power (W)	2nd drain & spin	963	69	1,041	Prior to DR	969	69	1,042
Average Power (W)		238	40	289		175	38	223
Duration (minutes)		4.0	4.0	4.0		5.3	5.3	5.3
Energy (Wh)		16	3	19		16	3	20
Maximum Power (W)	2nd rinse	341	0	356	Prior to DR	385	0	396
Average Power (W)		103	0	112		105	0	114
Duration (minutes)		5.7	0.0	5.7		5.6	0.0	5.6
Energy (Wh)		10	0	11		10	0	11
Maximum Power (W)	Final drain & spin	962	68	1,037	Prior to DR	970	69	1,043
Average Power (W)		361	38	412		244	39	294
Duration (minutes)		10.0	10.0	10.0		5.3	5.3	5.3
Energy (Wh)		60	6	69		21	3	26
Maximum Power (W)					During DR	584	37	639
Average Power (W)						579	35	631
Duration (minutes)						3.4	3.4	3.4
Energy (Wh)						33	2	36
Maximum Power (W)	Final tumble	177	0	183	During DR	180	0	187
Average Power (W)		83	0	88		37	0	42
Duration (minutes)		1.4	0.0	1.4		2.5	0.0	3.0
Energy (Wh)		2	0	2		2	0	2

TABLE 70. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A7

		BASELINE TEST A (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM)			DEMAND RESPONSE TEST A7 (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM) [CRITICAL-8 EVENT DURING WASH]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	30	0	35	Prior to DR	50	0	56
Average Power (W)		3	0	12		4	0	13
Duration (minutes)		2.5	0.0	2.7		2.4	0.0	2.5
Energy (Wh)		0	0	1		0	0	1
Maximum Power (W)	Agitate (wash)	396	0	407	Prior to DR	349	0	359
Average Power (W)		175	0	182		150	0	159
Duration (minutes)		27.4	0.0	27.4		6.5	0.0	6.5
Energy (Wh)		80	0	83		16	0	17
Maximum Power (W)					During DR	324	0	334
Average Power (W)						104	0	111
Duration (minutes)						9.0	0.0	9.0
Energy (Wh)						16	0	17
Maximum Power (W)					After DR	417	0	430
Average Power (W)						190	0	198
Duration (minutes)						15.2	0.0	15.2
Energy (Wh)						48	0	50
Maximum Power (W)	1st drain & spin	988	74	1,060	After DR	965	71	1,037
Average Power (W)		191	39	239		208	38	257
Duration (minutes)		5.3	5.3	5.3		4.0	4.0	4.0
Energy (Wh)		17	3	21		14	3	17
Maximum Power (W)	1st rinse	361	0	371	After DR	441	0	454
Average Power (W)		121	0	130		129	0	138
Duration (minutes)		6.2	0.0	6.2		6.2	0.0	6.2
Energy (Wh)		12	0	13		13	0	14
Maximum Power (W)	2nd drain & spin	963	69	1,041	After DR	977	67	1,055
Average Power (W)		238	40	289		208	38	256
Duration (minutes)		4.0	4.0	4.0		4.0	4.0	4.0
Energy (Wh)		16	3	19		14	3	17
Maximum Power (W)	2nd rinse	341	0	356	After DR	302	0	311
Average Power (W)		103	0	112		101	0	110
Duration (minutes)		5.7	0.0	5.7		5.6	0.0	5.6
Energy (Wh)		10	0	11		9	0	10
Maximum Power (W)	Final drain & spin	962	68	1,037	After DR	977	68	1,054
Average Power (W)		361	38	412		378	36	428
Duration (minutes)		10.0	10.0	10.0		8.7	8.7	8.7
Energy (Wh)		60	6	69		55	5	62
Maximum Power (W)	Final	177	0	183	After DR	179	0	186
Average Power (W)		83	0	88		77	0	83

		Baseline Test A (full, colors/normal, tap cold, normal, medium)				Demand Response Test A7 (full, colors/normal, tap cold, normal, medium) [critical-8 event during wash]		
Data Category	Stages of Wash Cycle	Motor	Water Pump	Total	DR or Non-DR Period	Motor	Water Pump	Total
Duration (minutes)	tumble	1.4	0.0	1.4		1.4	0.0	1.4
Energy (Wh)		2	0	2		2	0	2

TABLE 71. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST A AND DEMAND RESPONSE TEST A8

		BASELINE TEST A (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM)			DEMAND RESPONSE TEST A8 (FULL, COLORS/NORMAL, TAP COLD, NORMAL, MEDIUM) [CRITICAL-60 EVENT DURING FINAL SPIN AND RESTART AFTER FIRST WASH LOAD COMPLETED]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	30	0	35	Prior to DR	184	0	192
Average Power (W)		3	0	12		11	0	20
Duration (minutes)		2.5	0.0	2.7		2.3	0.0	2.5
Energy (Wh)		0	0	1		0	0	1
Maximum Power (W)	Agitate (wash)	396	0	407	Prior to DR	427	0	439
Average Power (W)		175	0	182		177	0	184
Duration (minutes)		27.4	0.0	27.4		27.4	0.0	27.4
Energy (Wh)		80	0	83		81	0	84
Maximum Power (W)	1st drain & spin	988	74	1,060	Prior to DR	971	72	1,043
Average Power (W)		191	39	239		214	40	265
Duration (minutes)		5.3	5.3	5.3		4.0	4.0	4.0
Energy (Wh)		17	3	21		14	3	18
Maximum Power (W)	1st rinse	361	0	371	Prior to DR	358	0	369
Average Power (W)		121	0	130		124	0	133
Duration (minutes)		6.2	0.0	6.2		6.1	0.0	6.1
Energy (Wh)		12	0	13		13	0	13
Maximum Power (W)	2nd drain & spin	963	69	1,041	Prior to DR	968	69	1,042
Average Power (W)		238	40	289		200	39	249
Duration (minutes)		4.0	4.0	4.0		4.1	4.1	4.1
Energy (Wh)		16	3	19		14	3	17
Maximum Power (W)	2nd rinse	341	0	356	Prior to DR	390	0	401
Average Power (W)		103	0	112		115	0	124
Duration (minutes)		5.7	0.0	5.7		5.7	0.0	5.7
Energy (Wh)		10	0	11		11	0	12
Maximum Power (W)	Final drain & spin	962	68	1,037	Prior to DR	198	68	246
Average Power (W)		361	38	412		51	41	98
Duration (minutes)		10.0	10.0	10.0		1.5	1.5	1.5
Energy (Wh)		60	6	69		1	1	2
Maximum Power (W)	Final drain & spin				During DR	964	69	1,039
Average Power (W)						433	36	484
Duration (minutes)						7.1	7.1	7.1
Energy (Wh)						51	4	57
Maximum Power (W)	Final tumble	177	0	183	During DR	179	0	186
Average Power (W)		83	0	88		47	0	54
Duration (minutes)		1.4	0.0	1.4		2.5	0.0	2.5
Energy (Wh)		2	0	2		2	0	2

TABLE 72. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST C AND DEMAND RESPONSE TEST C1

		BASELINE TEST C (FULL, COLORS/NORMAL, HOT, NORMAL, MEDIUM)			DEMAND RESPONSE TEST C1 (FULL, COLORS/NORMAL, HOT, NORMAL, MEDIUM) [CRITICAL-60 EVENT DURING FILL]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	138	0	145	Prior to DR	77	0	83
Average Power (W)		11	0	20		10	0	19
Duration (minutes)		3.4	0.0	3.5		1.8	0.0	2.0
Energy (Wh)		1	0	1		0	0	1
Maximum Power (W)					During DR	112	0	119
Average Power (W)						10	0	19
Duration (minutes)						1.5	0.0	1.5
Energy (Wh)						0	0	0
Maximum Power (W)	Agitate (wash)	419	0	431	During DR	389	0	401
Average Power (W)		176	0	183		88	0	94
Duration (minutes)		27.4	0.0	27.4		49.1	0.0	49.1
Energy (Wh)		81	0	84		72	0	77
Maximum Power (W)	1st drain & spin	962	70	1,043	During DR	971	71	1,049
Average Power (W)		205	41	256		209	38	258
Duration (minutes)		4.1	4.1	4.1		4.0	3.9	4.0
Energy (Wh)		14	3	17		14	3	17
Maximum Power (W)	1st rinse	322	0	331	During DR	365	0	375
Average Power (W)		123	0	132		59	0	68
Duration (minutes)		6.1	0.0	6.1		5.4	0.0	5.4
Energy (Wh)		13	0	13		5	0	6
Maximum Power (W)	1st rinse				After DR	372	0	383
Average Power (W)						164	0	171
Duration (minutes)						2.4	0.0	2.4
Energy (Wh)						7	0	7
Maximum Power (W)	2nd drain & spin	980	67	1,059	After DR	972	68	1,046
Average Power (W)		208	40	258		193	39	243
Duration (minutes)		4.0	4.0	4.0		4.0	4.0	4.0
Energy (Wh)		14	3	17		13	3	16
Maximum Power (W)	2nd rinse	387	0	397	After DR	394	0	405
Average Power (W)		114	0	122		114	0	123
Duration (minutes)		5.8	0.0	5.8		5.7	0.0	5.7
Energy (Wh)		11	0	12		11	0	12
Maximum Power (W)	Final drain & spin	978	70	1,054	After DR	973	69	1,043
Average Power (W)		337	38	388		368	37	419
Duration (minutes)		9.9	9.9	9.9		8.6	8.6	8.6
Energy (Wh)		56	6	64		53	5	60

		Baseline Test C (full, colors/normal, hot, normal, medium)				Demand Response Test C1 (full, colors/normal, hot, normal, medium) [critical-60 event during fill]		
Data Category	Stages of Wash Cycle	Motor	Water Pump	Total	DR or Non-DR Period	Motor	Water Pump	Total
Maximum Power (W)	Final tumble	179	0	185	After DR	180	0	187
Average Power (W)		71	0	77		76	0	81
Duration (minutes)		1.4	0.0	1.4		1.4	0.0	1.4
Energy (Wh)		2	0	2		2	0	2

TABLE 73. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST G AND DEMAND RESPONSE TEST G1

		BASELINE TEST G (FULL, COLORS/NORMAL, TAP COLD, EXTRA HEAVY, MEDIUM)			DEMAND RESPONSE TEST G1 (FULL, COLORS/NORMAL, TAP COLD, EXTRA HEAVY, MEDIUM) [CRITICAL-60 EVENT DURING FILL			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	139	0	146	Prior to DR	27	0	69
Average Power (W)		9	0	18		3	0	14
Duration (minutes)		2.7	0.0	2.8		1.8	0.0	1.9
Energy (Wh)		0	0	1		0	0	0
Maximum Power (W)					During DR	2	0	13
Average Power (W)						2	0	12
Duration (minutes)						0.7	0.0	0.7
Energy (Wh)						0	0	0
Maximum Power (W)	Agitate (wash)	438	0	450	During DR	402	0	414
Average Power (W)		182	0	189		90	0	97
Duration (minutes)		42.3	0.0	42.3		59.3	0.0	59.3
Energy (Wh)		128	0	133		89	0	96
Maximum Power (W)					After DR	405	0	417
Average Power (W)						181	0	189
Duration (minutes)						9.7	0.0	9.7
Energy (Wh)						29	0	30
Maximum Power (W)	1st drain & spin	968	71	1,047	After DR	971	72	1,051
Average Power (W)		198	41	248		212	40	263
Duration (minutes)		4.1	4.1	4.1		4.1	4.1	4.1
Energy (Wh)		13	3	17		14	3	18
Maximum Power (W)	1st rinse	429	0	441	After DR	418	0	430
Average Power (W)		129	0	138		123	0	132
Duration (minutes)		6.1	0.0	6.1		6.1	0.0	6.1
Energy (Wh)		13	0	14		13	0	13
Maximum Power (W)	2nd drain & spin	965	68	1,041	After DR	970	69	1,041
Average Power (W)		211	40	261		206	37	254
Duration (minutes)		4.0	4.0	4.0		4.0	4.0	4.0
Energy (Wh)		14	3	17		14	2	17
Maximum Power (W)	2nd rinse	369	0	379	After DR	353	0	368
Average Power (W)		112	0	121		98	0	107
Duration (minutes)		5.7	0.0	5.7		5.7	0.0	5.7
Energy (Wh)		11	0	11		9	0	10
Maximum Power (W)	Final drain & spin	980	68	1,054	After DR	967	67	1,042
Average Power (W)		375	37	425		367	36	416
Duration (minutes)		8.7	8.6	8.7		8.8	8.7	8.8
Energy (Wh)		54	5	61		53	5	61
Maximum Power (W)	Final	182	0	188	After DR	179	0	185
Average Power (W)		75	0	80		75	0	81

		Baseline Test G (full, colors/normal, tap cold, extra heavy, medium)				Demand Response Test G1 (full, colors/normal, tap cold, extra heavy, medium) [critical-60 event during fill		
Data Category	Stages of Wash Cycle	Motor	Water Pump	Total	DR or Non-DR Period	Motor	Water Pump	Total
Duration (minutes)	tumble	1.4	0.0	1.4		1.4	0.0	1.4
Energy (Wh)		2	0	2		2	0	2

TABLE 74. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST I AND DEMAND RESPONSE TEST I1

		BASELINE TEST I (FULL, COLORS/NORMAL, TAP COLD, NORMAL, EXTRA HIGH)			DEMAND RESPONSE TEST I1 (FULL, COLORS/NORMAL, TAP COLD, NORMAL, EXTRA HIGH) [CRITICAL-60 EVENT DURING FILL]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	81	0	87	Prior to DR	56	0	63
Average Power (W)		5	0	14		5	0	14
Duration (minutes)		2.5	0.0	2.6		1.8	0.0	2.0
Energy (Wh)		0	0	1		0	0	0
Maximum Power (W)					During DR	2	0	13
Average Power (W)						2	0	12
Duration (minutes)						0.5	0.0	0.5
Energy (Wh)						0	0	0
Maximum Power (W)	Agitate (wash)	413	0	425	During DR	373	0	384
Average Power (W)		177	0	184		89	0	96
Duration (minutes)		27.4	0.0	27.4		49.1	0.0	49.1
Energy (Wh)		81	0	84		73	0	78
Maximum Power (W)	1st drain & spin	966	73	1,046	During DR	970	71	1,065
Average Power (W)		208	41	259		203	41	254
Duration (minutes)		4.0	4.0	4.0		4.1	4.1	4.1
Energy (Wh)		14	3	17		14	3	17
Maximum Power (W)	1st rinse	392	0	402	During DR	293	0	302
Average Power (W)		122	0	131		73	0	81
Duration (minutes)		6.2	0.0	6.2		6.3	0.0	6.3
Energy (Wh)		13	0	13		8	0	9
Maximum Power (W)					After DR	443	0	456
Average Power (W)						192	0	200
Duration (minutes)						1.8	0.0	1.8
Energy (Wh)						6	0	6
Maximum Power (W)	2nd drain & spin	967	68	1,047	After DR	977	70	1,054
Average Power (W)		202	39	251		203	39	252
Duration (minutes)		4.0	4.0	4.0		4.0	3.9	4.0
Energy (Wh)		13	3	17		14	3	17
Maximum Power (W)	2nd rinse	323	0	332	After DR	326	0	336
Average Power (W)		111	0	120		102	0	110
Duration (minutes)		5.7	0.0	5.7		5.6	0.0	5.6
Energy (Wh)		11	0	11		9	0	10
Maximum Power (W)	Final drain & spin	1,120	68	1,199	After DR	1,099	69	1,177
Average Power (W)		380	37	431		343	36	393
Duration (minutes)		10.1	10.1	10.1		10.0	10.0	10.0
Energy (Wh)		64	6	72		57	6	65
Maximum Power (W)	Final	179	0	186	After DR	180	0	187
Average Power (W)		88	0	94		89	0	95

		Baseline Test I (full, colors/normal, tap cold, normal, extra high)				Demand Response Test I1 (full, colors/normal, tap cold, normal, extra high) [critical-60 event during fill]		
Data Category	Stages of Wash Cycle	Motor	Water Pump	Total	DR or Non-DR Period	Motor	Water Pump	Total
Duration (minutes)	tumble	1.3	0.0	1.3		1.3	0.0	1.3
Energy (Wh)		2	0	2		2	0	2

TABLE 75. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST I AND DEMAND RESPONSE TEST I2

		BASELINE TEST I (FULL, COLORS/NORMAL, TAP COLD, NORMAL, EXTRA HIGH)			DEMAND RESPONSE TEST I2 (FULL, COLORS/NORMAL, TAP COLD, NORMAL, EXTRA HIGH) [CRITICAL-120 EVENT DURING FILL]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	81	0	87	Prior to DR	9	0	18
Average Power (W)		5	0	14		2	0	11
Duration (minutes)		2.5	0.0	2.6		1.8	0.0	2.1
Energy (Wh)		0	0	1		0	0	0
Maximum Power (W)					During DR	2	0	13
Average Power (W)						2	0	13
Duration (minutes)						0.9	0.0	0.9
Energy (Wh)						0	0	0
Maximum Power (W)	Agitate (wash)	413	0	425	During DR	390	0	401
Average Power (W)		177	0	184		88	0	95
Duration (minutes)		27.4	0.0	27.4		49.1	0.0	49.1
Energy (Wh)		81	0	84		72	0	78
Maximum Power (W)	1st drain & spin	966	73	1,046	During DR	972	74	1,049
Average Power (W)		208	41	259		196	40	246
Duration (minutes)		4.0	4.0	4.0		4.1	4.0	4.1
Energy (Wh)		14	3	17		13	3	17
Maximum Power (W)	1st rinse	392	0	402	During DR	413	0	424
Average Power (W)		122	0	131		86	0	94
Duration (minutes)		6.2	0.0	6.2		9.3	0.0	9.3
Energy (Wh)		13	0	13		13	0	14
Maximum Power (W)	2nd drain & spin	967	68	1,047	During DR	985	70	1,056
Average Power (W)		202	39	251		178	40	228
Duration (minutes)		4.0	4.0	4.0		4.0	4.0	4.0
Energy (Wh)		13	3	17		12	3	15
Maximum Power (W)	2nd rinse	323	0	332	During DR	399	0	411
Average Power (W)		111	0	120		71	0	78
Duration (minutes)		5.7	0.0	5.7		8.3	0.0	8.3
Energy (Wh)		11	0	11		10	0	11
Maximum Power (W)	Final drain & spin	1,120	68	1,199	During DR	1,098	69	1,175
Average Power (W)		380	37	431		404	36	455
Duration (minutes)		10.1	10.1	10.1		8.7	8.7	8.7
Energy (Wh)		64	6	72		58	5	66
Maximum Power (W)	Final tumble	179	0	186	During DR	176	0	183
Average Power (W)		88	0	94		50	0	56
Duration (minutes)		1.3	0.0	1.3		2.4	0.0	2.4
Energy (Wh)		2	0	2		2	0	2

TABLE 76. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST J AND DEMAND RESPONSE TEST J1

		BASELINE TEST J (FULL, COLORS/NORMAL, COLD, NORMAL, EXTRA HIGH)			DEMAND RESPONSE TEST J1 (FULL, COLORS/NORMAL, COLD, NORMAL, EXTRA HIGH) [CRITICAL-60 EVENT DURING FILL]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	192	0	200	Prior to DR	25	0	54
Average Power (W)		16	0	24		3	0	13
Duration (minutes)		3.9	0.0	4.1		1.9	0.0	2.0
Energy (Wh)		1	0	2		0	0	0
Maximum Power (W)					During DR	187	0	195
Average Power (W)						14	0	23
Duration (minutes)						2.2	0.0	2.2
Energy (Wh)						0	0	1
Maximum Power (W)	Agitate (wash)	421	0	432	During DR	379	0	390
Average Power (W)		186	0	193		89	0	95
Duration (minutes)		27.4	0.0	27.4		49.0	0.0	49.0
Energy (Wh)		85	0	88		73	0	78
Maximum Power (W)	1st drain & spin	965	72	1,045	During DR	977	72	1,058
Average Power (W)		214	40	265		219	41	271
Duration (minutes)		4.0	4.0	4.0		4.1	4.1	4.1
Energy (Wh)		14	3	18		15	3	18
Maximum Power (W)	1st rinse	367	0	378	During DR	372	0	388
Average Power (W)		124	0	133		60	0	69
Duration (minutes)		6.2	0.0	6.2		4.8	0.0	4.8
Energy (Wh)		13	0	14		5	0	5
Maximum Power (W)					After DR	426	0	438
Average Power (W)						209	0	217
Duration (minutes)						2.6	0.0	2.6
Energy (Wh)						9	0	9
Maximum Power (W)	2nd drain & spin	968	68	1,042	After DR	975	69	1,049
Average Power (W)		210	39	260		217	39	267
Duration (minutes)		4.1	4.1	4.1		4.0	4.0	4.0
Energy (Wh)		14	3	18		14	3	18
Maximum Power (W)	2nd rinse	326	0	335	After DR	359	0	370
Average Power (W)		102	0	110		108	0	117
Duration (minutes)		5.7	0.0	5.7		5.7	0.0	5.7
Energy (Wh)		10	0	10		10	0	11
Maximum Power (W)	Final drain & spin	1,103	69	1,181	After DR	1,103	69	1,183
Average Power (W)		404	37	455		412	35	462
Duration (minutes)		16.7	16.7	16.7		16.6	16.5	16.6
Energy (Wh)		112	10	127		114	10	128
Maximum Power (W)	Final	183	0	189	After DR	178	0	185
Average Power (W)		85	0	91		83	0	89

		Baseline Test J (full, colors/normal, cold, normal, extra high)				Demand Response Test J1 (full, colors/normal, cold, normal, extra high) [critical-60 event during fill]		
Data Category	Stages of Wash Cycle	Motor	Water Pump	Total	DR or Non-DR Period	Motor	Water Pump	Total
Duration (minutes)	tumble	2.8	0.0	2.8		2.8	0.0	2.8
Energy (Wh)		4	0	4		4	0	4

TABLE 77. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST J AND DEMAND RESPONSE TEST J2

		BASELINE TEST J (FULL, COLORS/NORMAL, COLD, NORMAL, EXTRA HIGH)			DEMAND RESPONSE TEST J2 (FULL, COLORS/NORMAL, COLD, NORMAL, EXTRA HIGH) [CRITICAL-120 EVENT DURING FILL]			
DATA CATEGORY	STAGES OF WASH CYCLE	MOTOR	WATER PUMP	TOTAL	DR OR NON-DR PERIOD	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	192	0	200	Prior to DR	49	0	56
Average Power (W)		16	0	24		6	0	14
Duration (minutes)		3.9	0.0	4.1		1.9	0.0	2.1
Energy (Wh)		1	0	2		0	0	1
Maximum Power (W)					During DR	209	0	218
Average Power (W)						22	0	32
Duration (minutes)						1.9	0.0	1.9
Energy (Wh)						1	0	1
Maximum Power (W)	Agitate (wash)	421	0	432	During DR	433	0	445
Average Power (W)		186	0	193		92	0	98
Duration (minutes)		27.4	0.0	27.4		49.1	0.0	49.1
Energy (Wh)		85	0	88		75	0	80
Maximum Power (W)	1st drain & spin	965	72	1,045	During DR	978	71	1,054
Average Power (W)		214	40	265		215	38	264
Duration (minutes)		4.0	4.0	4.0		4.1	4.0	4.1
Energy (Wh)		14	3	18		15	3	18
Maximum Power (W)	1st rinse	367	0	378	During DR	358	0	368
Average Power (W)		124	0	133		81	0	89
Duration (minutes)		6.2	0.0	6.2		9.3	0.0	9.3
Energy (Wh)		13	0	14		12	0	14
Maximum Power (W)	2nd drain & spin	968	68	1,042	During DR	673	69	732
Average Power (W)		210	39	260		89	40	137
Duration (minutes)		4.1	4.1	4.1		3.3	3.3	3.3
Energy (Wh)		14	3	18		5	2	7
Maximum Power (W)	2nd rinse	326	0	335	During DR	310	0	320
Average Power (W)		102	0	110		65	0	73
Duration (minutes)		5.7	0.0	5.7		8.3	0.0	8.3
Energy (Wh)		10	0	10		9	0	10
Maximum Power (W)	Final drain & spin	1,103	69	1,181	During DR	1,113	69	1,193
Average Power (W)		404	37	455		409	35	460
Duration (minutes)		16.7	16.7	16.7		16.8	16.7	16.8
Energy (Wh)		112	10	127		114	10	128
Maximum Power (W)	Final tumble	183	0	189	During DR	177	0	184
Average Power (W)		85	0	91		52	0	58
Duration (minutes)		2.8	0.0	2.8		4.9	0.0	4.9
Energy (Wh)		4	0	4		4	0	5

TABLE 78. COMPARISON OF STAGES OF A WASH CYCLE – BASELINE TEST K AND DEMAND RESPONSE TEST K1

		BASELINE TEST K (FULL, WHITES/HEAVY DUTY, SANITIZE, NORMAL, MEDIUM)				DEMAND RESPONSE TEST K1 (FULL, WHITES/HEAVY DUTY, SANITIZE, NORMAL, MEDIUM) [CRITICAL-60 EVENT DURING FILL]				
DATA CATEGORY	STAGES OF WASH CYCLE	HEATER	MOTOR	WATER PUMP	TOTAL	[illegible]N-DR	HEATER	MOTOR	WATER PUMP	TOTAL
Maximum Power (W)	Fill	0	250	0	258	Prior to DR	0	150	0	158
Average Power (W)		0	15	0	23		0	15	0	24
Duration (minutes)		0.0	3.7	0.0	3.8		0.0	1.8	0.0	1.9
Energy (Wh)		0	1	0	1		0	0	0	1
Maximum Power (W)						During DR	0	198	0	206
Average Power (W)							0	31	0	41
Duration (minutes)							0.0	1.8	0.0	1.8
Energy (Wh)							0	1	0	1
Maximum Power (W)	Agitate (wash) [with Heating]	951	411	0	1,355	During DR	948	400	0	1,328
Average Power (W)		904	90	0	1,017		434	90	0	538
Duration (minutes)		72.6	74.8	0.0	74.8		27.7	58.2	0.0	58.2
Energy (Wh)		1,127	112	0	1,268		420	87	0	521
Maximum Power (W)						After DR	951	433	0	1,371
Average Power (W)							911	61	0	994
Duration (minutes)							54.4	55.5	0.0	55.5
Energy (Wh)							843	56	0	920
Maximum Power (W)	Agitate without Heating	0	452	0	464	After DR	0	429	0	442
Average Power (W)		0	191	0	198		0	191	0	199
Duration (minutes)		0.0	45.5	0.0	45.5		0.0	35.4	0.0	35.4
Energy (Wh)		0	145	0	150		0	113	0	117
Maximum Power (W)	1st drain & spin	0	963	69	1,039	After DR	0	971	91	1,042
Average Power (W)		0	204	39	254		0	193	40	241
Duration (minutes)		0.0	4.1	4.1	4.1		0.0	4.1	4.1	4.1
Energy (Wh)		0	14	3	17		0	13	3	16
Maximum Power (W)	1st rinse	0	447	0	460	After DR	0	418	0	430
Average Power (W)		0	125	0	134		0	119	0	128
Duration (minutes)		0.0	6.5	0.0	6.5		0.0	6.3	0.0	6.3
Energy (Wh)		0	14	0	15		0	12	0	13
Maximum Power (W)	2nd drain & spin	0	968	68	1,045	After DR	0	965	69	1,038
Average Power (W)		0	203	38	251		0	157	37	203
Duration (minutes)		0.0	4.1	4.0	4.1		0.0	5.3	5.3	5.3
Energy (Wh)		0	14	3	17		0	14	3	18
Maximum Power (W)	2nd rinse	0	458	0	470	After DR	0	343	0	353
Average Power (W)		0	127	0	136		0	124	0	133
Duration (minutes)		0.0	6.7	0.0	6.7		0.0	6.5	0.0	6.5
Energy (Wh)		0	14	0	15		0	13	0	14
Maximum Power (W)	Final drain & spin	0	968	68	1,044	After DR	0	966	78	1,038
Average Power (W)		0	328	37	377		0	343	37	393
Duration (minutes)		0.0	10.0	10.0	10.0		0.0	8.7	8.6	8.7
Energy (Wh)		0	55	6	63		0	50	5	57
Maximum Power (W)		0	184	0	190		0	186	0	193

Data Category	Stages of Wash Cycle	Baseline Test K (full, whites/heavy duty, sanitize, normal, medium)				Cycle	Demand Response Test K1 (full, whites/heavy duty, sanitize, normal, medium) [critical-60 event during fill]			
		Heater	Motor	Water Pump	Total	n-DR	Heater	Motor	Water Pump	Total
Average Power (W)	Final tumble	0	77	0	82	After DR	0	86	0	92
Duration (minutes)		0.0	1.4	0.0	1.4		0.0	1.4	0.0	1.4
Energy (Wh)		0	2	0	2		0	2	0	2