AccuTemp STEAM 'n' HOLD, Model 208-D8-300
Electric Steamer Performance Test

Application of ASTM Standard
Test Method F 1484-99

FSTC Report 5011.99.75

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Executive Summary

Executive Summary

A year ago, the Food Service Technology Center (FSTC) evaluated a revolutionary countertop steamer, the STEAM 'n' HOLD, Model 208-D6-3.0, by AccuTemp. Of the steamers tested at the FSTC, this 6-kW steamer demonstrated some of the highest energy efficiencies when applied to a standardized test method. In this round of tests, an 8-kW model (the STEAM 'n' HOLD, Model 208-D8-300) is evaluated for performance improvements.

The 6-pan capacity AccuTemp STEAM 'n' HOLD is a new concept in countertop steam cooking. The vacuum cooking process allows the generation of steam at a lower temperature than the conventional atmospheric steamer. The boiler-less design eliminates the water feed and condensate drain, leaving a user-friendly and low maintenance machine. The thermostatic controls maintain food at a desired temperature until ready to serve.

The Food Service Technology Center (FSTC) tested the AccuTemp STEAM 'n' HOLD under the tightly controlled conditions of the American Society for Testing and Materials (ASTM) Standard Test Method for the Performance of Steam cookers.[1] Steamer performance is characterized by preheat energy consumption and duration, idle energy rate, cooking energy efficiency, production capacity, water consumption and condensate temperature from product testing. The spectrum of food product tests for steamers includes: full-load frozen green peas, light-load frozen green peas, full-load red potatoes and light-load red potatoes. Since the STEAM 'n' HOLD is without a condensate drain, the measurement of condensate temperature was not applied.

A summary of the test results is presented in Table ES-1. Figure ES-1 illustrates the STEAM 'n' HOLD, model 208-D8-300, cooking energy efficiency for different cooking scenarios. The production capacities are shown in Figure ES-2.

Table ES-1. Summary of the Performance: AccuTemp STEAM 'n' HOLD, Model 208-D8-300.

Preheat and Idle	
Rated Energy Input Rate (kW)	8.00
Measured Energy Input Rate (kW)	8.34
Preheat Time (min)	12.3
Preheat Energy (kWh)	1.71
Idle Energy Rate (kW)	1.2
Full-Load Frozen Green Peas (6 pans)	
Cook Time (min)	30.7
Cooking Energy Efficiency (%)	88.5
Production Capacity (lb/h)	94.0
Water Consumption Rate (gal/h)	< 0.2
Light-Load Frozen Green Peas (1 pan)	
Cook Time (min)	11.0
Cooking Energy Efficiency (%)	65.9
Water Consumption Rate (gal/h)	< 0.2
Full-Load Red Potatoes (6 pans)	
Cook Time (min)	28.6
Cooking Energy Efficiency (%)	67.2
Production Capacity (lb/h)	101.1
Water Consumption Rate (gal/h)	< 0.2
Light-Load Red Potatoes (1 pan)	
Cook Time (min)	26.1
Cooking Energy Efficiency (%)	32.0
Water Consumption Rate (gal/h)	< 0.2

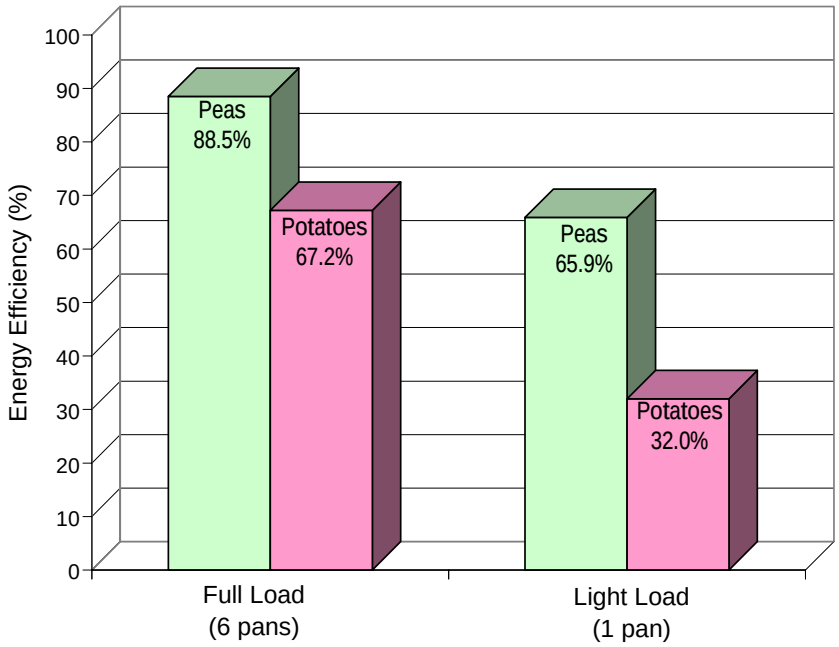


Figure ES-1.
Steamer Cooking Energy Efficiency Under Two Loading Scenarios.

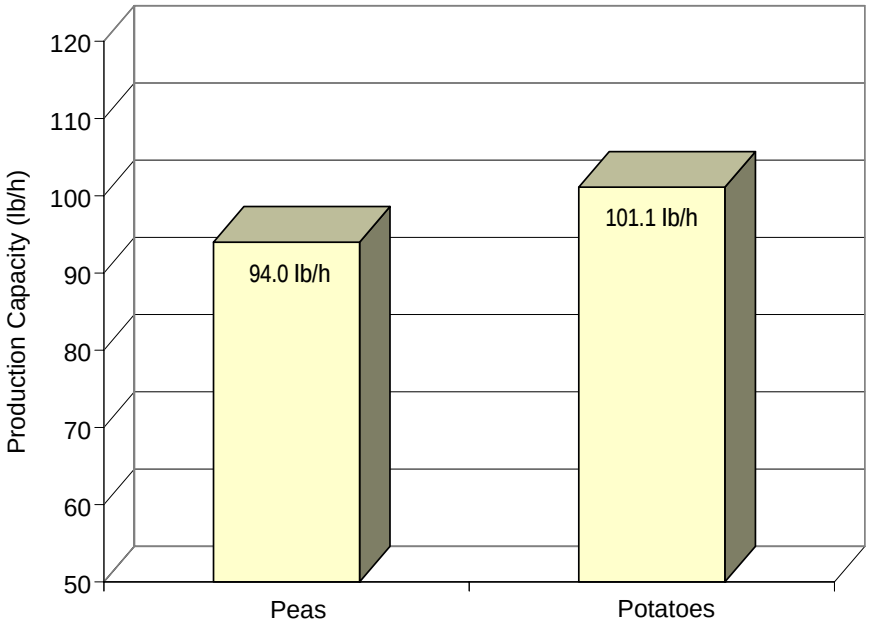


Figure ES-2.
Steamer Production Capacity.

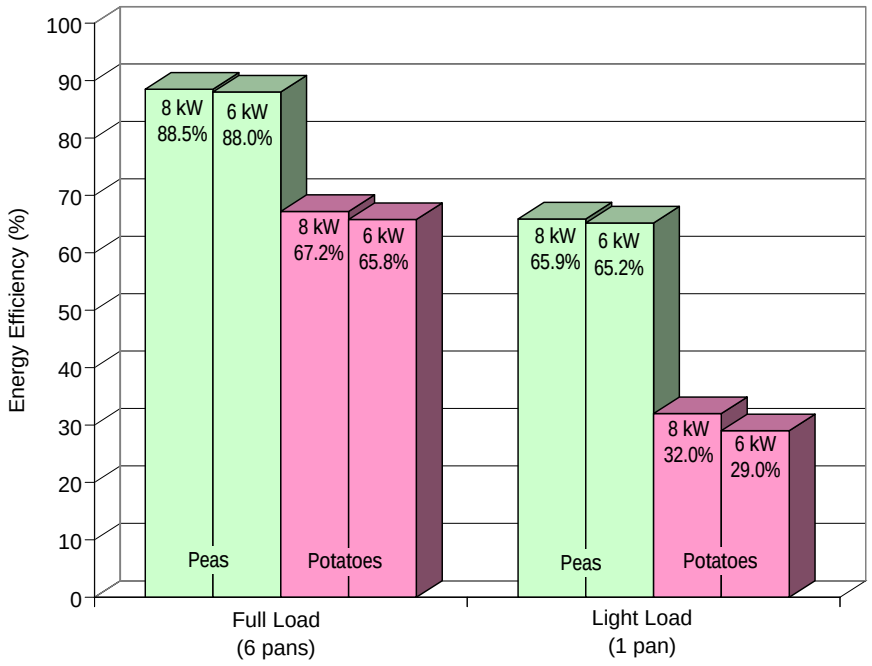


Figure ES-3.
Steamer Cooking Energy Efficiency Comparison: 8 kW Versus 6 kW Model.

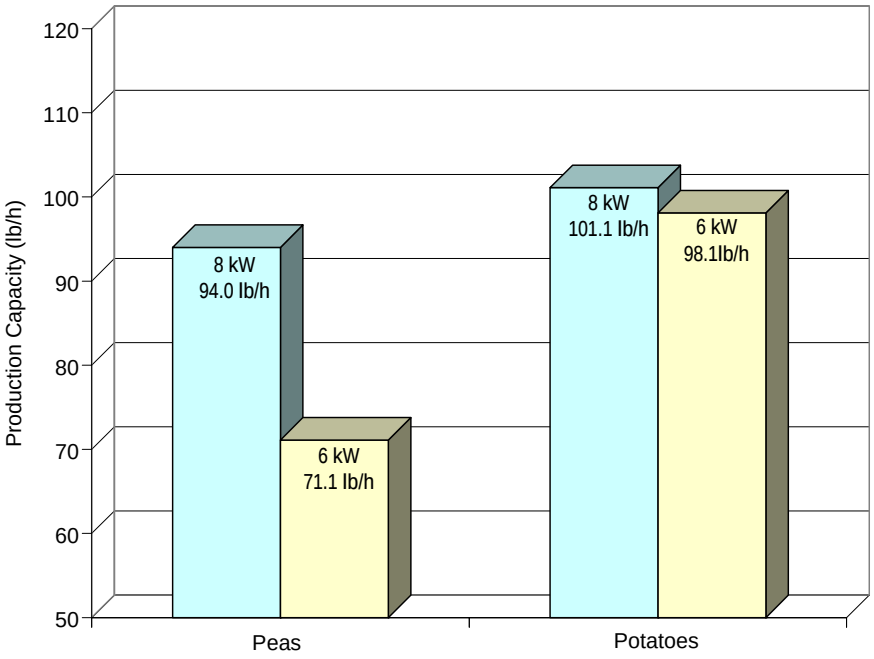
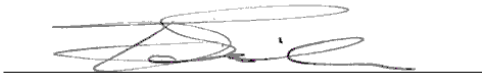


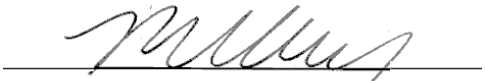
Figure ES-4.
Production Capacity Comparison: 8 kW Versus 6 kW Model.

Figures ES-3 and ES-4 show performance comparisons of the two STEAM 'n' HOLD models. Cooking energy efficiencies for the four cooking scenarios remain relatively constant for both rated energy inputs. The production capacity of the 8-kW model, when steaming frozen green peas, increased by 32.2% over the 6-kW model with a production rate of 94.0 lb/h. The 8-kW model production capacity, when steaming potatoes, only increased by 3.0% compared to the 6-kW model. This is an anticipated effect since potatoes are a "slow cooking" food product, independent of appliance energy input (see page 3-9: Performance Comparison: 8 kW versus 6 kW, for more detail).

Like it's 6 kW predecessor with identical design, this 8 kW model uses the water and energy efficiently. Unlike conventional, atmospheric steamers, the enclosed cavity minimizes the wasteful escape of excessive steam. The water consumption is minimal, at less than 3 gallons per day. Of the countertop steamers tested at the FSTC, the STEAM 'n' HOLD demonstrated some of the highest cooking energy efficiency performance of any steamer tested to date. While cooking "slow-to-cook" food product such as potatoes, the STEAM 'n' HOLD delivered an impressive 67.2% and 32.0% efficiency for full-load and light-load potatoes, respectively.

FSTC Manager 

Donald R. Fisher

Senior Program Manager 

Peter W. Turnbull

1 Introduction

Background

Steaming provides a fast-cook option for preparing large quantities of food while retaining vital nutrients in the cooked product. Beyond the capital cost, steamers should be evaluated with regard to long-term performance and operational costs characterized by cooking energy efficiency, production capacity and water consumption.

With support from the Electric Power Research Institute (EPRI) and the Gas Research Institute (GRI), Pacific Gas and Electric Company's Food Service Technology Center (FSTC) developed a uniform testing procedure to evaluate the performance of gas and electric steam cookers. This test procedure was submitted to the American Society for Testing and Materials (ASTM) and accepted as a standard test method in December 1993. In keeping with ASTM's policy that a standard be periodically reviewed, the FSTC revised the steamer test method in February 1999 under the Designation F 1484-99 [1] (originally published as F 1484-93[2]). Modification to the test method includes replacing the ice load test with frozen green peas to capture real-world application and reducing the three loading scenarios to two. Pacific Gas & Electric Company's *Development and Validation of a Uniform Testing Procedure for Steam Cooker* documents the developmental procedures and test results of several gas and electric steamers.[3]

The AccuTemp STEAM 'n' HOLD, model 208-D8-300, is a one-compartment, 6-pan capacity, electric, vacuum steamer that delivers 8 kW of cooking energy. The heating element is positioned under the cooking compartment, eliminating the need for a boiler. The thermostat control allows food to be cooked to a desired temperature and held until ready for serving. The STEAM 'n' HOLD was tested according to the ASTM procedure, and this report documents the results. The glossary in Appendix A provides a quick reference to the terms used in this report.

Introduction

Objectives

The objective of this report is to examine the operation and performance of the AccuTemp STEAM 'n' HOLD, model 208-D8-300, under the controlled conditions of the ASTM Standard Test Method. The scope of this testing is as follows:

1. Verify that the appliance is operating at the manufacturer's rated energy input.
2. Determine the preheat duration and energy consumption of the steamer.
3. Measure the idle energy rate.
4. Determine the cooking energy efficiency under four scenarios: full-load frozen green peas (6 pans), light-load frozen green peas (1 pan), full-load red potatoes (6 pans) and light-load red potatoes (1 pan).
5. Determine the production capacity and the water consumption rate of each loading scenario.

Appliance Description and Operation

The STEAM 'n' HOLD is a stainless-steel, natural-convection steamer powered by a 8-kW electric heating element. Steam is generated within the food compartment without a separate boiler. Water is added and drained manually at the beginning and end of the day, eliminating the need for water feed and drain hookups. The cooking chamber can accommodate six 12" x 20" x 2½" pans, four 12" x 20" x 4" pans, or three 12" x 20" x 6" pans. The unique timer/hold feature allows food to be cooked to the desired temperature and held until it is ready to be served.

Appliance specifications are listed in Table 1-1, and the manufacturer's literature is in Appendix B.

Figure 1-1.
Two STEAM 'n' HOLDs in Stacked Configuration.

Table 1-1. Appliance Specifications.

Manufacturer	AccuTemp Products, Inc.
Model	208-D8-300 STEAM 'n' HOLD™
Generic Appliance Type	1-compartment, natural-convection, electric, vacuum steamer.
Rated Input	8 kW
Technology	Boiler-less steamer with natural-convection, vacuum-sealed chamber.
Construction	Double-wall, stainless-steel. Interior 14 Ga. Exterior 22 Ga.
Controls	Main ON-OFF buttons. 60 minute mechanical timer with continuous steam and hold setting. Thermostat dial with temperature ranging from 140°F to 212 °F.
Compartment Capacity	6 (12" x 20" x 2½") pans 4 (12" x 20" x 4") pans 3 (12" x 20" x 6") pans
Dimensions	23" x 23 1/4" x 30"

2 Methods

Setup and Instrumentation

The steamer was installed in accordance with the manufacturer's instruction on a metal table under a 4-foot-deep canopy hood, with the lower edge of the hood 6 feet, 6 inches above the floor and a minimum of 6 inches inside the vertical front edge of the hood. The exhaust ventilation operated at a nominal rate of 150 cfm per linear foot of hood with the ambient temperature maintained between 75 ± 5°F. All test apparatus were installed in accordance with Section 9 of the ASTM test method.[1]

Power and energy were measured with a watt/watt-hour transducer that generated an analog signal for instantaneous power and a pulse for every 10 Wh. The transducer and thermocouples were connected to a computerized data acquisition unit that recorded data every 5 seconds. A voltage regulator, connected to the steamer, maintained a constant voltage for all tests. Figure 2-1 shows the STEAM 'n' HOLD instrumented with the data acquisition system and voltage regulator.

Figure 2-1.
The STEAM 'n' HOLD Instrumented For Testing.

Revisions to the ASTM Test Method

The steam cooker test method, originally published as F 1484-93, has been revised as F 1484-99. The ice-load test, due to its simplicity, repeatability, and reproducibility, was applied during the developmental phase of the test procedure as a quick indicator of steamer efficiency and productivity. However, ice-load test results do not always mirror the results of food products, particularly with respect to real-world cook times and associated production capacities. The F 1484-99 test method lists the ice-load test as an optional procedure.

The potato tests remain in the test method with two modifications. The method specified whole, U.S. No. 1, size B, red potatoes with an average weight of 0.14 ± 0.02 lb. Repetition of tests showed a higher average weight of around 0.16 lb. The revised test method calls for red potatoes weighing 0.16 ± 0.02 lb. The prescribed cook temperature of 205°F is high since the maximum attainable temperature of steam under atmospheric pressure is 212°F. Qualitative tests, using texture, taste, and consistency as criteria, showed that potatoes are cooked to an acceptable doneness at 195°F. The temperature of 195 ± 2°F was adopted as the potato cook temperature.

The three-loading scenarios described in the test method have been reduced to two scenarios (full- and light-load tests). The full-load test determines the steamer's peak cooking energy efficiency and production capacity while the light-load test (1 pan) evaluates partial-load performance.

Full- and light-load tests of frozen green peas are incorporated into the ASTM test method as a replacement for the ice-load tests. Since probing proves difficult and erroneous in measuring temperature of the small-sized green peas, a water-bath calorimeter is utilized to measure the final bulk temperature of the cooked green peas

Figure 2-2 shows the spectrum of products tested on the STEAM 'n' HOLD: frozen green peas, red potatoes and the optional ice pan.

Figure 2-2.
Products For Steamer Tests: Ice Pans (Optional), Frozen Green Peas and Red Potatoes.

Measured Energy Input, Preheat and Idle Rate

The energy input rate was determined by measuring the energy consumed by the steamer during a full preheat cycle. The maximum power draw during this period was reported as the measured energy input rate. Preheat tests recorded the time and energy required for the steamer to reach operating temperature from a cold start, as when turned on for the first time in a day. Recording began when the steamer was turned on and ended when it's elements first cycled off. An hour after the preheat cycle, idle energy consumption was monitored for a 2-hour period.

Green Peas Full- and Light Load Efficiency Tests

Individually flashed-frozen, grade A green peas represented one of two food products for steamer performance testing. Standard, perforated, stainless-steel hotel pans (12" x 20" x 2½") are specified for cooking the green peas. The STEAM 'n' HOLD required 6 pans of green peas for a full load, while 1 pan, placed on the center rack of the steamer cavity, is required for a light load, each pan containing 8.0 ± 0.2 lb of green peas. Pre-weighed green peas in perforated pans were stored in sealed plastic bags at 0 ± 5°F for at least 24 hours. The pans of peas were transferred into an insulated box and transported to the testing location where the plastic bags were removed, and the pan(s) of green peas were loaded into the steamer according to the loading time prescribed in section 10.7.6 of the ASTM test method.[1]

Red Potatoes Full- and Light Load Efficiency Tests

Freshly packed, size B, red potatoes served as the second food product for steamer performance testing. Again, the STEAM 'n' HOLD required 6 pans of red potatoes for a full load and 1 pan for a light load, each pan containing 8.0 ± 0.2 lb.

The red potatoes were loaded into perforated pans prior to the test and stabilized to a room temperature of 75 ± 5°F. The potatoes were cooked to 195°F using a predetermined cook time. The final bulk temperature was determined by randomly probing potatoes using a hand-held digital thermocouple meter within 3 minutes after cooking was terminated.

For the food-load scenarios, iterative cooking time determination tests were required to establish the time necessary for the food product to reach the doneness temperature of 180 ± 2°F (for frozen green peas) and 195 ± 2°F (for red potatoes). The testing process followed this sequence: three replicates full-load green pea test, three replicates of the light-load green pea test, three replicates full-load red potatoes test and three replicates of the light-load red potatoes test.

The replicates ensured that the reported cooking energy efficiency and production capacity results had an uncertainty of less than ±10%. The results from each test run were averaged, and the absolute uncertainty was calculated based on the standard deviation of the results.

The ASTM results reporting sheets appear in Appendix C, and the cooking energy efficiency data sheets appear in Appendix D.

3 Results

Manufacturer's Rated Input and Maximum Energy Input Rate

Measured energy input rate and the manufacturer's nameplate value were compared prior to any testing to ensure that the steamer was operating within its specified parameters. The STEAM 'n' HOLD drew a maximum input rate of 8.34 kW, 4.3% higher than the nameplate rate of 8.0 kW, but within the 5% tolerance of the ASTM standard.

Preheat and Idle Tests

Preheat Energy and Time

The cavity was manually filled with 3 gallons of water at 70 ± 5°F. The steamer performed the preheat cycle in "Fast Cook" mode with the timer at the "Continuous" setting. The preheat consumed 1.71 kWh during the 12.3 min period.

Idle Energy Rate

Following the preheat period, the steamer stabilized for one hour in the "Fast Cook/Continuous" setting. Thereafter, the energy consumption was monitored over a 2-hour period and the idle energy rate was calculated to be 1.2 kW.

Test Results

Figure 3-1 shows the cavity vacuum in conjunction with the water and compartment temperatures during the preheat and idle test. The cavity reached an approximate peak vacuum of 22" Hg during the preheat but diminished to zero during the idle period. Both the water and cavity retained temperatures in the range of 210-212°F during the idling period.

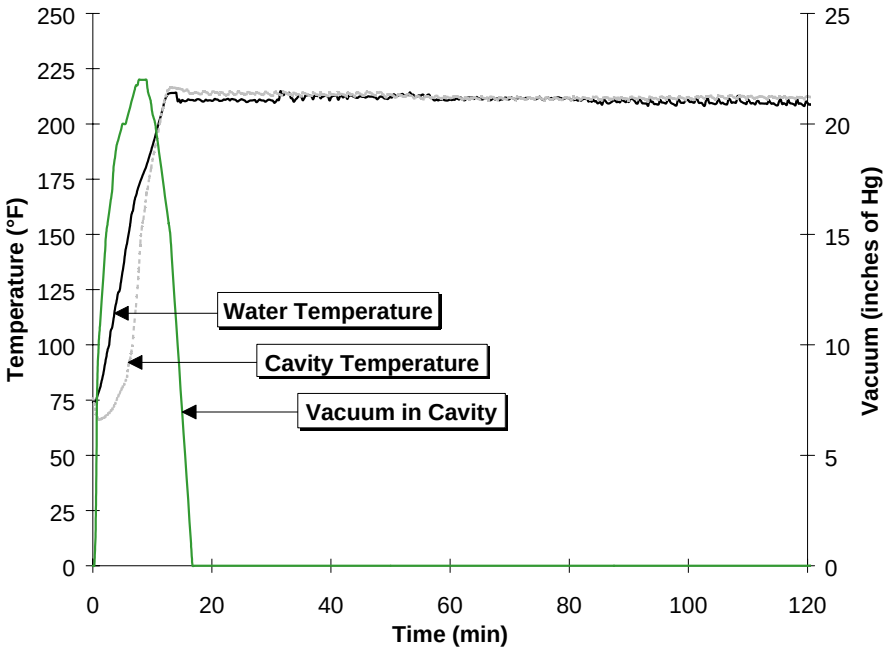


Figure 3-1. Preheat and Idle Characteristics.

Rated energy input, preheat energy and idle rate test results are summarized in Table 3-1.

Table 3-1. Average Input, Preheat and Idle Test Results.

Rated Energy Input Rate (kW)	8.0
Measured Energy Input Rate (kW)	8.34
Preheat	
Time (min)	12.3
Energy (kWh)	1.71
Idle Energy Rate	
Energy Rate (kW)	1.2

Results

Cooking Tests

The steamer was tested with two food products under two loading scenarios: full-load green peas (6 pans), light-load green peas (1 pan), full-load red potatoes (6 pans), and light-load red potatoes (1 pan). The optional full-load ice pan test was not performed. The energy consumption, elapsed cook time, ambient temperature and product temperature were monitored for the duration of each test at five-second intervals.

The STEAM 'n' HOLD does not employ a separate boiler, water connection or drain. Therefore, water consumption and condensate temperature were not monitored. Three gallons of water were poured into the bottom of the cooking compartment before testing began and emptied at the end of the day as directed by the manufacturer's instructions. Like the 6-kW model, water usage rate was less than 0.2 gal/h for the heaviest day of testing.

Full- and Light-Load Green Peas Test

Moisture content of the frozen green peas was 81% by weight corresponding to specific heats (Cp) of 0.44 Btu/lb°F for frozen and 0.85 Btu/lb°F for thawed peas.[3] The STEAM 'n' HOLD required 30.7 minutes to cook the full load of frozen green peas with a cooking energy efficiency of 88.5% and production capacity of 94.0 lb/h.

Typically, steamers are not loaded to full capacity. The light-load test emulates such a cooking scenario with a single pan of frozen green peas placed in the middle rack of the compartment. The cooking time for a single pan of peas was reduced dramatically to a repeatable 11.0 minutes. The one-pan loading scenario also reduced cooking energy efficiency and productivity, 65.9% and 43.6 lb/h, respectively.

Full- and Light-Load Potatoes Test

The red potatoes contained 84% moisture by weight with the specific heat (Cp) of 0.87 Btu/lb°F.[3] The full-load of potatoes required 30.7 minutes to reach the average bulk cook temperature of 195.2°F. The cooking efficiency and production capacity were 67.2% and 101.1 lb/h, respectively, slightly higher than the performance of the 6-kW model.

The single pan of red potatoes needed 26.1 minutes to achieve an average bulk temperature of 194.7°F. The light-load potato test delivered an energy efficiency of 32.0% and productivity of 18.5 lb/h.

Test Results

Cooking energy efficiency is defined as the quantity of energy consumed by the food expressed as a percentage of energy consumed by the steam cooker during the cooking event. The mathematical expression is therefore:

$$\text{Cooking Energy Efficiency \%} = \frac{E_{food}}{E_{steamer}} \times 100\%$$

Energy imparted into the cooked product is calculated by separating its various components. Since products must be cooked in stainless-steel hotel pans, the pan energy consumption is factored into the total energy equation.
The total energy equation for frozen green peas is:

$$E_{green\ peas} = E_{(heat\ pans)} + E_{(heat\ frozen\ peas)} + E_{(melt\ ice)} + E_{(heat\ thawed\ peas)}$$

The heat capacity changes as it transforms frozen green peas to a thawed state.

Steaming fresh red potatoes does not involve a phase change (ie. ice to water, frozen to thawed); therefore, the energy consumption is simplified to heating of the pans and the potatoes:

$$E_{red\ potatoes} = E_{(heat\ pans)} + E_{(heat\ potatoes)}$$

Appendix D lists the physical properties and measured values of each test run. Using the detailed equations provided in section 11 of the steamer ASTM Standard Test Method, the cooking energy efficiencies can readily be calculated.

The rate at which steam condenses on food depends on the surface temperature and area of the food. Therefore, frozen green peas (at 0°F) and red potatoes (at room temperature) represent two extremities in steam cooking. Frozen green peas, having large surface area to weight ratio, promote condensation. The energy transfer from steam to frozen food is high, resulting in greater cooking energy efficiency and productivity. Potatoes are “tough” to cook due to the slow nature of condensation. Steam that fails to condense on the potatoes goes unused, thus reducing efficiency. For both the full- and light-load scenarios, greater than 20% reduction in steamer cooking efficiencies were observed when comparing frozen green peas to fresh red potatoes: full load (88.5% - 67.2% = 21.3%) and light load (65.9% - 32.0% = 33.9%). Table 3-2 and 3-3 summarize the STEAM ‘n’ HOLD’s performance. Figures 3-2 and 3-3 illustrate these results in graphical format.

Table 3-2. Cooking Energy Efficiency and Production Capacity Test Results.

	Full Load Peas	Light Load Peas	Full Load Potatoes	Light Load Potatoes
Number of pans	6	1	6	1
Cook Time (min)	30.7	11.0	28.6	26.1
Ave. Cooking Energy Rate (kW)	8.3	5.1	5.0	1.9
Energy Efficiency (%)	88.5	65.9	67.2	32.0
Production Rate (lb/h)	94.0	43.6	101.1	18.5

Table 3-3. Water Consumption Test Results.

	Full Load Peas	Light Load Peas	Full Load Potatoes	Light Load Potatoes
Water Consumption (gal/h)*	< 0.2	< 0.2	< 0.2	< 0.2

* It was estimated that less than 0.2 gal/h of water was consumed during each cooking test.

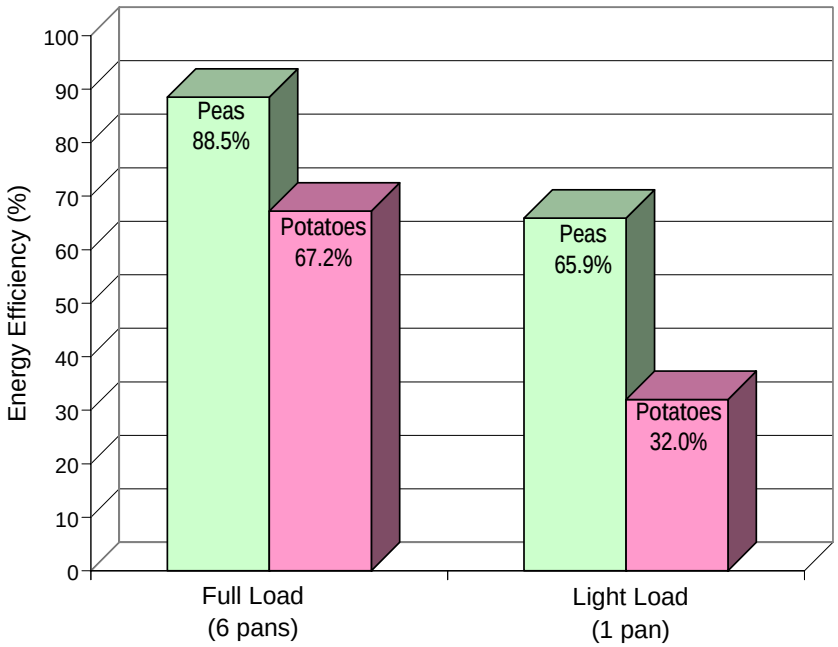


Figure 3-2.
Steamer Cooking Energy Efficiency Under Full- and Light Load Scenarios.

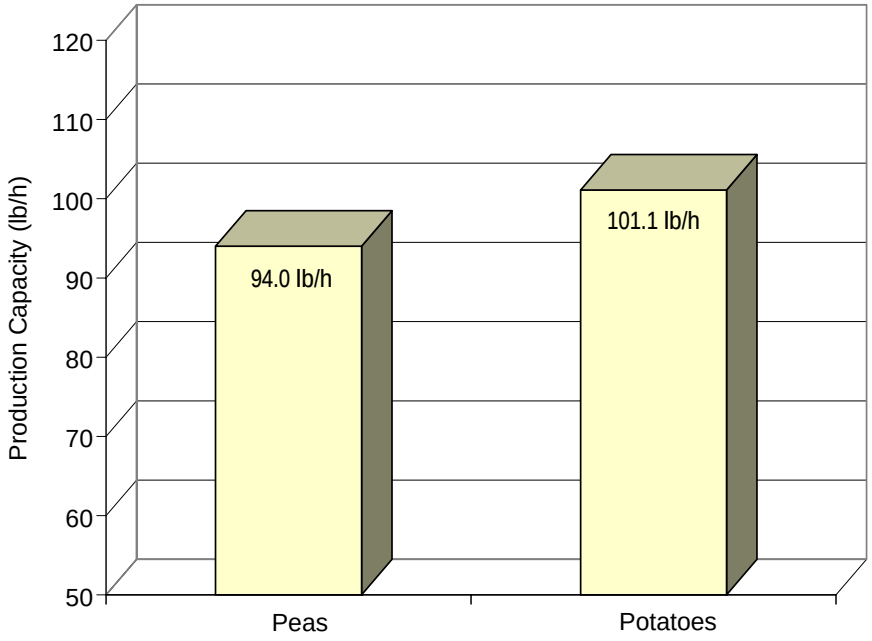


Figure 3-3.
Steamer Production Capacity.

Performance Comparison: 8 kW versus 6 kW Model

Across the board, the 8-kW model met or exceeded the performance set by the 6-kW model. Due to the extra two kilowatts, the 8-kW model was expected to have a quicker preheat time. Figure 3-4 shows the preheat time and idle energy rates of the two models. The 6-kW STEAM 'n' HOLD required 16.1 minutes to heat three gallons of water while the 8-kW model accomplished the same task in 12.3 minutes, reduction of 23.6%. During the idle period, the two models maintained relatively the same input rates: 1.2 and 1.1 kW.

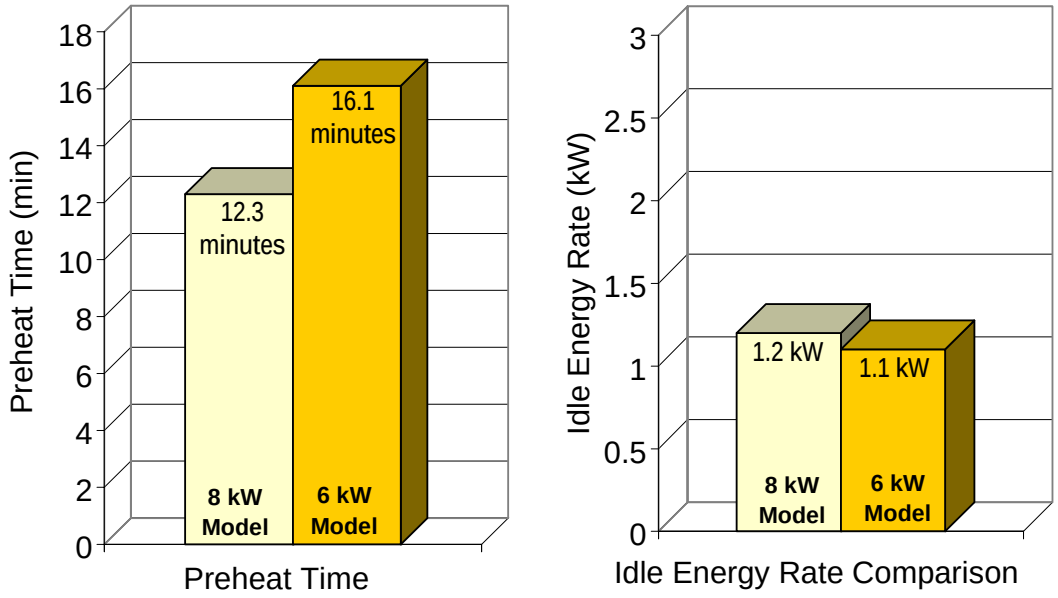


Figure 3-4. Preheat Time and Idle Energy Rate Comparison.

Given the two models share the same design and construction, efficiencies values were not expected to vary greatly. The near "closed-box" design allows steam to be generated only when the cavity temperature gets below the set thermostat temperature; therefore, steam is produced on an "as needed" basis regardless of the rated energy input.

Figure 3-5 summarizes the energy efficiencies of both STEAM ‘n’ HOLD models for the four product cooking scenarios. In all four processes, the energy efficiencies for the 8-kW model are slightly higher than the 6 k-W model, but within the 10% uncertainty of the averaged value.

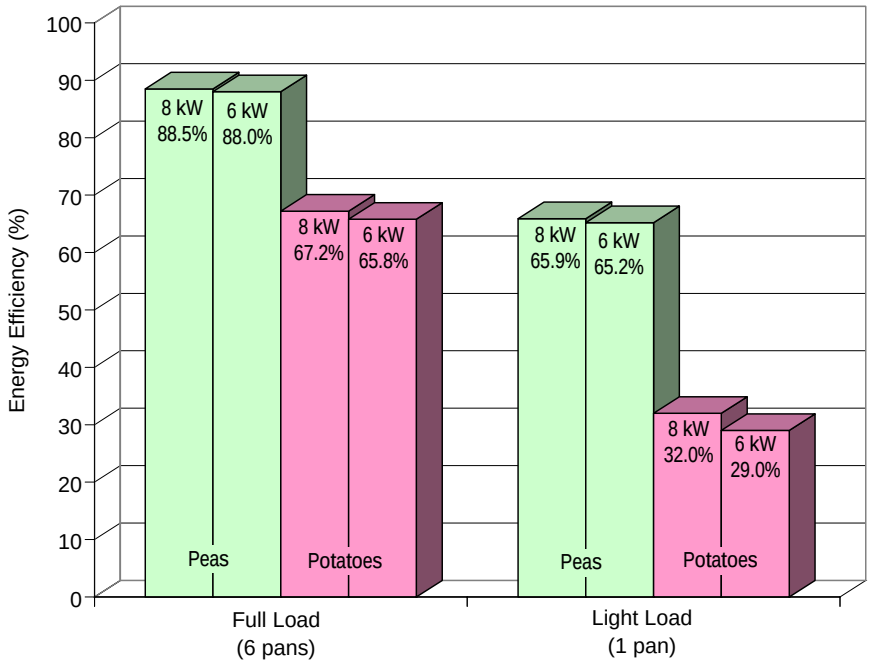


Figure 3-5.
Steamer Cooking Energy Efficiency Comparison: 8 kW Versus 6 kW Model.

The production capacities were predicted to increase with the green peas but not with the potatoes. The green peas exhibits a large surface area per weight ratio compared to the potatoes. Steam that exists in the cavity quickly condensed on the vastly available surface of the peas. The limiting factor to achieve product doneness for the frozen green peas is the energy input rate of the appliance—how fast can the steamer produce steam.

Potatoes are a magnitude or two larger than the peas; therefore, the same weight of potatoes (compared to the same weight of peas) have substantially less surface area. To reach an internal cook temperature of 195°F, the heat from the steam must penetrate the thermal mass of the potato.

The potato's resistance to heat transfer is the limiting factor to achieving product doneness; therefore, additional energy input will not lead to greater productivity.

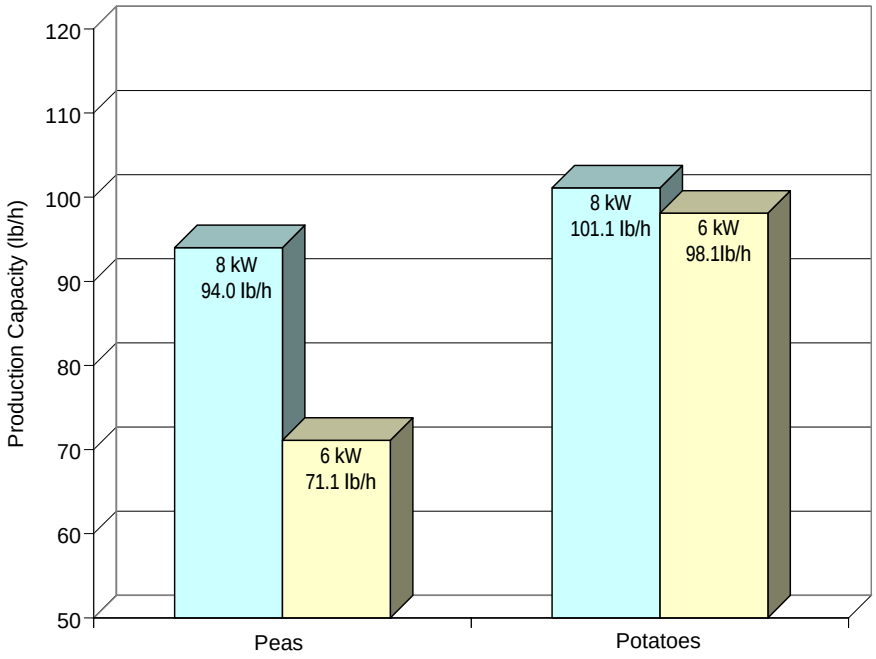


Figure 3-6.
Production Capacity Comparison: 8 kW Versus 6 kW Model.

Figure 3-6 supports the prescribed hypothesis. In cooking full-load frozen green peas, the 8-kW model was able to achieve a 94.0 lb/h production capacity, a 32.2% increase, over the 6-kW model. For the full-load potatoes, the 8-kW model showed only a 3.0% increase over its 6-kW twin.

4 Conclusions

The AccuTemp STEAM 'n' HOLD, Model 208-D8-300, steamer met and/or exceeded the performance of its predecessor, Model 208-D6-3.0. Sharing the same innovative design and construction as the 6-kW model, this 8-kW model retain the effective usage of water and energy. The lack of a boiler, water feed, and condensate drain eliminate calcium carbonate buildup problems and expensive chemical costs. The water consumption is virtually nil, requiring only 3 gallons a day.

The extra horsepower did not sacrifice energy efficiency but it did boost the performance of the preheat time and production capacity.

A year ago, the 6-kW model claimed the highest efficiencies among the electric, countertop steamers tested to date at the FSTC. The 8-kW model matched these energy efficiency numbers for all cooking scenarios prescribed by the steamer test method. In cooking frozen green peas, the 8-kW STEAM 'n' HOLD averaged efficiencies of 88.5% and 65.9% (full-load and light-load, respectively). For the "slow-to-cook" potatoes, efficiencies of 67.2% and 32.0% (full-load and light-load, respectively) were measured. The extra horsepower did not sacrifice energy efficiency but it did boost the performance of the preheat time and product capacity. The 6-kW model required 16.1 minutes from "cold-start" to "ready-to-cook" condition but the 8-kW model needed only 12.3 minutes, reduction of 23.6% in preheat time. The production capacity of frozen green peas increased by 32.2% over the 6-kW model with a high output rate of 94.1 lb/h.

5 References

1. American Society for Testing and Materials. 1999. *Standard Test Method for the Performance of Steam Cookers.* ASTM Designation F 1484-99, in *Annual Book of ASTM Standards,* Philadelphia: American Society for Testing and Materials.

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3. Food Service Technology Center. 1995. *Development and Application of a Uniform Testing Procedure for Steam Cookers.* Report 1022.95.19. Product and Services Department. San Francisco, California: Pacific Gas and Electric Company.

4. American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. 1994 ASHRAE Handbook. *Refrigeration Systems and Applications*. *I-P Edition*. Chapter 25: Commodity Storage Requirements. Atlanta, Georgia.

5. Foodservice Equipment Reports. *Lab Time! 3 Steamers Take the Test*. October 1997. Vol. 1. No. 10. Pp. 38-42. Gill Ashton Publishing, L.L.C, Ill.

A Glossary

Boiler
Self-contained electric, gas, or steam coil powered vessel wherein water is boiled to produce steam for the steam cooker. Also called a steam generator.

Boiler Idle Energy Rate
Idle Energy Rate
Idle Rate
Idle Energy Consumption Rate
Rate of energy consumed by the steam cooker while maintaining boiler operating pressure or temperature with no cooking taking place.

Boiler Preheat
Preheat
Process of bringing the boiler water from potable supply temperature to operating temperature (pressure).

Boiler Preheat Duration
Preheat Time
Preheat Period
Total time required for preheat, from preheat initiation at controls to when the steam cooker is ready to cook.

Boiler Preheat Energy
Preheat Energy Consumption
Amount of energy consumed by the steam cooker during a preheat.

Boiler Preheat Energy Rate
Preheat Energy Rate
The rate of appliance energy consumption while it is preheating to a predetermined temperature.

Condensate
A mixture of condensed steam and cooling water, exiting the steam cooker and directed to the floor drain.

Condensate Temperature
The temperature at which the condensate enters the floor drain.

Cooking Energy Efficiency
Energy Efficiency
Quantity of energy imparted to the specified food product expressed as a percentage of energy consumed by the steam cooker during the cooking event.

Cooking Energy Rate
Cooking Energy Consumption Rate
Average rate of energy consumption (kBtu/h or kW) during the cooking energy efficiency test. Refers to any loading scenario in the ice, pea or potato load tests.

Cook Time
Cooking Period
The period of time that the steamer is used for cooking.

Energy Input Rate
Peak rate at which a steamer consumes energy, typically reflects during preheat.

Frozen Green Peas Load
12 x 20 x 2½ in. (300 x 500 x 65 mm) hotel pan filled with 8.0±0.2 lb (3630±90 g) of frozen, grade A, green peas subsequently frozen to 0±5°F (-18±2°C). One of two food product used to determine cooking energy efficiency and production capacity.

Glossary

High-Pressure Steam Cooker
Steam cooker wherein cooking compartment operates between 10 and 15 psig (ASTM F1217-92 Classification Type III).

Idle Energy Consumption
Idle Energy Use
The amount of energy consumed by an appliance operating under an idle condition over the duration of an idle period.

Ice Load
12 x 20 x 2½ in. (300 x 500 x 65 mm) hotel pan filled with 8.0±0.2 lb (3630±90 g) of water and subsequently frozen to 0±5°F (-18±2°C). This is used to simulate a food product load in the ice load cooking energy efficiency and production capacity test.

Low-Pressure Steam Cooker
Steam cooker wherein cooking compartment operates between 3 and 9.9 psig (ASTM F1217-92 Classification Type II).

Maximum energy input rate
Measured Energy Input
Measured Peak Energy Input Rate
Peak Rate of Energy Input
Peak rate at which an appliance consumes energy.

Potato Load
12 x 20 x 2½ in. (300 x 500 x 65 mm) hotel pan filled with 8.0±0.2 lb (3.6±0.1 kg) of fresh, whole, US No. 1, size B, red potatoes. One of two food product used to determine cooking energy efficiency and production capacity.

Pressureless Steam Cooker
Steam cooker wherein cooking compartment operates between 0 and 2.9 psig (ASTM F1217-92 Classification Type I).

Production Capacity
Maximum rate (lb(kg)/h) at which steam cooker can bring the specified food product to a specified "cooked" condition.

Production Rate
Rate (lb(kg)/h) at which steam cooker brings the specified food product to a specified "cooked" condition.

Rated Energy Input Rate
Input Rating (ANSI definition)
Nameplate Energy Input Rate
Rated Input
The maximum or peak rate at which an appliance consumes energy as rated by the manufacturer and specified on the nameplate.

Steam Cooker
Cooking appliance wherein heat is imparted to food in a closed compartment by direct contact with steam. The compartment can be at or above atmospheric pressure. The steam can be static or circulated.

Water Consumption
Water consumed by the steam cooker. Includes both water used in the production of steam and cooling water (if applicable) for condensing/cooling unused steam.

B Appliance Specifications

Appendix B includes the product literature for the AccuTemp STEAM ‘n’ HOLD, Model 208-D8-300, steamer

C Results Reporting Sheets

Manufacturer: AccuTemp
Model: STEAM 'n' HOLD, 208-D8-300
Date: July 1999

Section 11.1 Test Steam Cooker

ASTM F 1216 Classification (check one for each classification)

_____ Type I - Zero to 2.9 psig compartment pressure
_____ Type II - Three to 9.9 psig compartment pressure
_____ Type III - Ten to 15 psig compartment pressure

_____ Size 1-3 - One Compartment, 3 full-size pan capacity
_____ Size 1-4 - One Compartment, 4 full-size pan capacity
_____ Size 1-5 - One Compartment, 5 full-size pan capacity
__✓__ Size 1-6 - One Compartment, 6 full-size pan capacity
_____ Size 2-6 - One Compartment, 6 full-size pan capacity
_____ Size 2-8 - Two Compartment, 8 full-size pan capacity
_____ Size 2-10 - Two Compartment, 10 full-size pan capacity
_____ Size 2-12 - Two Compartment, 12 full-size pan capacity
_____ Size 2-16 - Two Compartment, 16 full-size pan capacity
_____ Size 3-12 - Three Compartment, 12 full-size pan capacity
_____ Size 3-15 - Three Compartment, 15 full-size pan capacity
_____ Size 3-18 - Three Compartment, 18 full-size pan capacity
_____ Size 3-24 - Three Compartment, 24 full-size pan capacity

__✓__ Style A - Counter mounted
_____ Style B - Floor mounted on an open stand
_____ Style C - Floor mounted on a cabinet base
_____ Style D - Wall Mounted

_____ Class A - Direct connection to potable external steam source
_____ Class B - Self-contained steam coil steam generator
_____ Class C - Self-contained gas fired steam generator
__✓__ Class D - Self-contained electric steam generator

Description of operational characteristics: Approximately three gallons of water is manually poured in the bottom of the cooking compartment. Upon starting the preheat, a pump draws a vacuum within the stainless-steel chamber to reduce vapor pressure, inducing quicker steam generation. Food is cooked with natural-convection steam to a desired temperature and held until ready to be served.

Section 11.2 Apparatus

The steamer was installed on a metal table under a 4-foot-deep canopy hood that was 6 feet 6 inches above the floor. The hood operated at a nominal exhaust rate of 150 cfm per linear foot of hood. There was at least 6 inches of clearance between the vertical plane of the steamer and the edge of the hood.

The steamer was instrumented with an electric transducer to measure power and energy; a voltage regulator was used to maintain constant voltage for all tests. A computerized data acquisition system recorded test information at 10-seconds intervals for the red potato tests and 5-second intervals for the rest. All test apparatus were installed in accordance with Section 9 of the ASTM test method.

Section 11.4 Energy Input Rate

Test Voltage	208 ± 5.2 V
Measured	8.34 kW
Rated	8.00 kW
Percent Difference between Measured and Rated	4.3 %

Section 11.5 Boiler Preheat Energy Consumption and Duration

Test Voltage	208 ± 5.2 V
Energy Consumption	1.71 kWh
Duration	12.3 min

Section 11.6 Boiler Idle Energy Rate

Test Voltage	208 ± 5.2 V
Idle Energy Rate	1.2 kW

Section 11.8 Frozen Green Peas Cooking Time, Energy Efficiency, Energy Rate, Production Capacity, and Water Consumption Rate

Full Load:

Test Voltage	208 ± 5.2 V
Cooking Time	30.7 min
Cooking Energy Efficiency	88.5 ± 1.3 %
Cooking Energy Rate	8.3 ± 0.1 kW
Production Capacity	94.0 ± 2.8 lb/h
Water Consumption Rate	<0.2 gal/h

Light Load:

Test Voltage	208 ± 5.2 V
Cooking Time	11.0 min
Cooking Energy Efficiency	65.9 ± 2.5 %
Cooking Energy Rate	5.1 ± 0.2 kW
Production Rate	43.6 ± 0.2 lb/h
Water Consumption Rate	<0.2 gal/h

Section 11.9 Whole Red Potatoes Cooking Time, Energy Efficiency, Energy Rate, Production Capacity, and Water Consumption Rate

Full Load:

Test Voltage	208 ± 5.2 V
Cooking Time	28.6 min
Cooking Energy Efficiency	67.2 ± 5.2 %
Cooking Energy Rate	5.0 ± 0.5 kW
Production Capacity	101.1 ± 0.7 lb/h
Water Consumption Rate	<0.2 gal/h

Light Load:

Test Voltage	208 ± 5.2 V
Cooking Time	26.1 min
Cooking Energy Efficiency	32.0 ± 2.1 %
Cooking Energy Rate	1.9 ± 0.2 kW
Production Rate	18.5 ± 3.1 lb/h
Water Consumption Rate	<0.2 gal/h

D Cooking Energy Efficiency Data

Table D-1. Preheat and Idle Data

Measured Values	Replication 1	Replication 2	Replication 3
Preheat Time (min)	12.42	12.17	12.25
Preheat Energy (kWh)	1.73	1.70	1.69
Idle Time (min)	120.00	120.00	120.00
Idle Energy (kWh)	2.39	2.45	2.47
Calculated Values			
Preheat Energy Rate (kW)	8.36	8.38	8.28
Idle Energy Rate (kW)	1.20	1.23	1.24
Idle Factor (%)	14.30	14.60	14.90

Table D-2. Full-Load Peas Data

Measured Values	Replication 1	Replication 2	Replication 3
Number of Pan(s)	6	6	6
Cook Time (min)	31.00	30.50	30.5
Initial Water Temperature (°F)	41.43	44.29	42.93
Final Water Temperature (°F)	98.51	98.87	96.96
Frozen Food Temperature (°F)	-4.20	-4.50	-3.50
Weight of Empty Calorimeter (lb)	42.80	42.83	42.89
Weight of Full Calorimeter (lb)	150.68	150.98	150.16
Weight of Calorimeter Water (lb)	60.03	60.05	60.06
Weight of Cooked Food (lb)	47.85	48.10	47.21
Weight of Frozen Food (lb)	47.94	48.30	47.94
Weight of Stainless-Steel Pans (lb)	16.24	16.32	16.24
Moisture Content (%)	81	81	81
Condensate Temperature (°F)	NA	NA	NA
Water Consumption (gal/h)	<0.2	<0.2	<0.2
Calculated Values			
Moisture Weight in Food (lb)	38.83	39.12	38.83
Final Food Temperature (°F)	182.96	179.24	178.02
Cooking Energy (kWh)	4.25	4.20	4.20
Energy Consumed by Food (Btu)	12493.43	12434.67	12292.36
Energy Consumed by Pans (Btu)	333.99	328.95	325.16
Energy of Boiler Re-init (Btu)	0	0	0
Energy Consumed by the Steamer (Btu)	14505.25	14334.60	14334.60
Cooking Energy Rate (kW)	8.23	8.26	8.26
Productivity (lb/h)	92.79	95.02	94.31
Energy Efficiency (%)	88.43	89.04	88.02

Table D-3. Light-Load Peas Data

Measured Values	Replication 1	Replication 2	Replication 3
Number of Pan(s)	1	1	1
Cook Time (min)	11.00	11.00	11.00
Initial Water Temperature (°F)	43.84	45.33	37.44
Final Water Temperature (°F)	67.45	68.81	63.21
Frozen Food Temperature (°F)	-4.00	-2.90	0.00
Weight of Empty Calorimeter (lb)	42.77	42.80	42.79
Weight of Full Calorimeter (lb)	80.31	80.46	80.40
Weight of Calorimeter Water (lb)	30.01	30.03	29.94
Weight of Cooked Food (lb)	7.53	7.63	7.67
Weight of Frozen Food (lb)	7.98	7.99	8.00
Weight of Stainless-Steel Pans (lb)	2.42	2.78	2.79
Moisture Content (%)	81	81	81
Condensate Temperature (°F)	NA	NA	NA
Water Consumption (gal/h)	<0.2	<0.2	<0.2
Calculated Values			
Moisture Weight in Food (lb)	6.46	6.47	6.48
Final Food Temperature (°F)	178.41	177.80	181.83
Cooking Energy (kWh)	0.93	0.95	0.93
Energy Consumed by Food (Btu)	2047.79	2043.98	2063.38
Energy Consumed by Pans (Btu)	48.64	55.30	55.75
Energy of Boiler Re-init (Btu)	0.00	0.00	0.00
Energy Consumed by the Steamer (Btu)	3174.09	3242.35	3174.09
Cooking Energy Rate (kW)	5.07	5.18	5.07
Productivity (lb/h)	43.51	43.60	43.64
Energy Efficiency (%)	66.05	64.75	66.76

Table D-4. Full-Load Potatoes Data

Measured Values	Replication 1	Replication 2	Replication 3
Number of Pan(s)	6	6	6
Cook Time (min)	28.67	28.50	28.50
Temperature of Uncooked Potatoes (°F)	70.25	71.33	70.37
Temperature of Cooked Potatoes (°F)	194.10	196.28	195.12
Weight of Stainless-Steel Pans (lb)	15.63	15.63	15.63
Weight of Potatoes (lb)	48.14	48.02	48.11
Total Potato Count	280.00	299.00	275.00
Moisture Content (%)	84.07	84.07	84.07
Condensate Temperature (°F)	NA	NA	NA
Water Consumption (gal/h)	<0.2	<0.2	<0.2
Calculated Values			
Moisture Weight in Potatoes (lb)	40.47	40.37	40.45
Average Weight of Each Potatoes (lb)	0.17	0.16	0.17
Cooking Energy (kWh)	2.28	2.42	2.42
Energy Consumed by Potatoes (Btu)	5205.34	5237.25	5239.78
Energy Consumed by Pans (Btu)	212.94	214.82	214.49
Energy of Boiler Re-init (Btu)	0.00	0.00	0.00
Energy Consumed by the Steamer (Btu)	7781.64	8259.46	8259.46
Cooking Energy Rate (kW)	4.77	5.09	5.09
Productivity (lb/h)	100.77	101.09	101.29
Energy Efficiency (%)	69.63	66.01	66.04

Table D-5. Light-Load Potatoes Data

Measured Values	Replication 1	Replication 2	Replication 3
Number of Pan(s)	1	1	1
Cook Time (min)	24.17	26.92	27.25
Temperature of Uncooked Potatoes (°F)	69.02	70.08	70.18
Temperature of Cooked Potatoes (°F)	194.32	194.85	195.06
Weight of Stainless-Steel Pans (lb)	2.42	2.79	2.41
Weight of Potatoes (lb)	8.01	7.99	8.02
Total Potato Count	50.00	46.00	53.00
Moisture Content (%)	84.07	84.07	84.07
Condensate Temperature (°F)	NA	NA	NA
Water Consumption (gal/h)	<0.2	<0.2	<0.2
Calculated Values			
Moisture Weight in Potatoes (lb)	6.73	6.72	6.74
Average Weight of Each Potatoes (lb)	0.16	0.17	0.15
Cooking Energy (kWh)	0.81	0.84	0.85
Energy Consumed by Potatoes (Btu)	876.02	870.35	874.04
Energy Consumed by Pans (Btu)	33.35	38.30	33.07
Energy of Boiler Re-init (Btu)	0.00	0.00	0.00
Energy Consumed by the Steamer (Btu)	2764.53	2866.92	2901.05
Cooking Energy Rate (kW)	2.01	1.87	1.87
Productivity (lb/h)	19.88	17.81	17.65
Energy Efficiency (%)	32.89	31.69	31.27