Stellar Steam, Model Sirius
Gas Steamer Performance Test

Application of ASTM Standard
Test Method F 1484-04

FSTC Report # 5011.05.02

Food Service Technology Center

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Specific appreciation is extended to Stellar Steam for supplying the FSTC with a model Sirius boilerless, gas steamer for controlled testing in the appliance laboratory.

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Executive Summary

The Food Service Technology Center (FSTC) tested the Stellar Steam, Model Sirius boilerless, gas steamer under the 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 duration and energy consumption, idle energy rate, cooking energy rate and efficiency, production capacity, water consumption, and condensate temperature. Cooking tests were conducted with grade A frozen green peas and grade B red potatoes in accordance with ASTM test materials specifications for weight, size, and water content.[1] The steamer's cooking uniformity was determined by heating ice loads and examining their temperature profiles. The Sirius was equipped with an automatic water fill connection and the steamer's water consumption was monitored throughout all the tests.

The Stellar Steam, Model Sirius performed well compared to other gas steamers, exhibiting impressive heavy-load (6 pan) cooking-energy efficiencies for frozen green peas (62.7%) and red potatoes (44.6%). The Sirius also had modest cook times, achieving heavy-load production capacities of 52.3 lb/h for frozen green peas and 84.0 lb/h for red potatoes.

Cooking-energy efficiency is a measure of how much of the energy that an appliance consumes is actually delivered to the food product during the cooking process. Cooking-energy efficiency is therefore defined by the following relationship:

[1] American Society for Testing and Materials, 2004. Standard Test Method for the Performance of Steam Cookers. ASTM Designation F1484-04, in the Annual Book of ASTM Standards, West Conshohocken, PA.

$$\text{Cooking Energy Efficiency} = \frac{\text{Energy to Food}}{\text{Energy to Steamer}}$$

A summary of the ASTM test results is presented in Table ES-1.

Table ES-1. Summary of the Sirius Steamer Performance.

Rated Energy Input Rate (Btu/h)	26,000
Measured Energy Input Rate (Btu/h)	25,305
Preheat Time (min)	19.6
Preheat Energy (Btu)	8,259
Idle Energy Rate (Btu/h)	1,176
Frozen Green Peas	
Light-Load Cooking-Energy Efficiency (%)	40.9 ± 1.7
Heavy-Load Cooking-Energy Efficiency (%)	62.7 ± 1.4
Production Capacity (lb/h)	52.3 ± 2.1
Red Potatoes	
Light-Load Cooking-Energy Efficiency (%)	18.8 ± 1.1
Heavy-Load Cooking-Energy Efficiency (%)	44.6 ± 3.4
Production Capacity (lb/h)	84.0 ± 6.8
Ice Loads	
Cook Time (min)	83.7
Maximum Temperature Difference (°F)	18.1
Maximum Time Delay (min)	11.4

Beyond its respectable productivity and high cooking-energy efficiencies, the Sirius also exhibited low water usage. Typical water consumption during heavy-load cooking tests was approximately 1.0 gallon per hour (gal/h), which is much lower than the reservoir's 2.0 gallon capacity. Other steam cooking technologies, such as boiler-based or steam generator-type steamers, typically consume between 20 and 60 gal/h while cooking.

1 Introduction

Background

Steaming provides a fast-cooking option for preparing large quantities of food, while retaining vital nutrients in the cooked product. Steamers are versatile appliances that can be used to prepare almost any food that does not require a crust. Delicate vegetables, such as asparagus and broccoli, are cooked without damage; frozen foods are defrosted and cooked in one step; and hard-to-cook meats, such as beef ribs, can be par-cooked quickly with less weight loss than oven roasting.

Dedicated to the advancement of the food service industry, the Food Service Technology Center (FSTC) has focused on the development of standard test methods for commercial food service equipment since 1987. The primary component of the FSTC is a 10,000 square-foot appliance laboratory equipped with energy monitoring and data acquisition hardware, 60 linear feet of canopy exhaust hoods integrated with utility distribution systems, appliance setup and storage areas, and a state-of-the-art demonstration and training facility.

The test methods, approved and ratified by the American Society for Testing and Materials (ASTM), allow benchmarking of equipment so that users can make informed comparisons among available equipment choices. By collaborating with the Electric Power Research Institute (EPRI) and the Gas Technology Institute (GTI) through matching funding agreements, the test methods have remained unbiased to fuel choice. End-use customers and commercial appliance manufacturers consider the FSTC to be the national leader in commercial food service equipment testing and standards, sparking alliances with several major chain customers to date.

Since the development of the ASTM test method for steam cookers in 1993,[1] the FSTC has tested a wide range of gas and electric steamers.[2–24]

Introduction

The Stellar Steam Altair features a circulation fan in the top of the cooking compartment for convection steaming, a patented design that circulates the flue gases around the walls of the cooking compartment for additional radiant heating, and a proprietary catch plate for maintaining clean reservoir water.

The glossary in Appendix A is provided so that the reader has a quick reference to the terms used in this report.

Objectives

The objective of this report is to examine the operation and performance of the Stellar Steam, model Sirius steamer, 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 time and energy required to preheat the steamer to an operating condition.
3. Characterize the idle energy use of the steamer while maintaining a ready-to-cook state.
4. Determine the cooking-energy efficiency under four scenarios: heavy-load frozen green peas (6 pans), light-load frozen green peas (single-pan), heavy-load red potatoes (6 pans) and light-load red potatoes (single-pan).
5. Determine the production capacity, cooking energy rate and cook time for each loading scenario.
6. Characterize cooking uniformity by steaming ice loads.

Appliance Description

The Stellar Steam, model Sirius is a 6-pan capacity, single compartment, gas, boilerless steamer (Figure 1-1). The steamer is powered by 26,000 Btu/h gas burners located beneath the cooking compartment's water reservoir. Steam is generated within the cooking compartment without a separate boiler and water is automatically added from a supply water connection and drained manually. The cooking chamber can accommodate six, standard full-size, 2½-inch deep hotel pans. The Sirius has three cooking modes labeled I, II, and III. Mode I is

intended to be a standby or lower temperature cooking option. Users can select this setting to hold the internal temperature at 180°F or to steam delicate food products. Mode II is selected if regular steaming is required. In this mode, the steamer will maintain full saturation of the compartment and cycle it's burners on and off accordingly. In Mode III, the Sirius adds radiant heating to the features of Mode II. In this setting the steamer will maintain 230°F inside the compartment and is intended for frozen or dense food products. The Sirius also features a catch plate located directly above the reservoir water that separates any food particles from contacting the boiling water below. A direct, open connection is maintained between this plate and the drain line at all times. The ceiling of the compartment houses a small circulation fan that allows the steamer to cook with convection steaming.

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

Figure 1-1.
The Stellar Steam Sirius steamer.

Table 1-1. Appliance Specifications.

Manufacturer	Stellar Steam
Model	Sirius
Generic Appliance Type	Boilerless, 1-compartment, gas, atmospheric steamer with automatic water fill.
Rated Input	26,000 Btu/h
Technology	Boilerless steamer with convection fan.
Construction	Stainless-steel exterior; aluminum cast interior.
Interior	356.1 Aluminum cast with hard anodized finish
Exterior	304 Stainless-steel
Controls	Main dial with 4 modes: Off, I, II, III. 60 minute mechanical timer that does not control steaming.
Compartment Capacity	6 (12" x 20" x 2 1/2") pans
Dimensions	24" x 28.5" x 33.5" (w×d×h)

2 Methods

Setup and Instrumentation

The steamer was installed in accordance with the manufacturer's instructions and in accordance with Section 9 of the ASTM test method[1]: 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 at 75 ± 5°F.

Natural gas consumption was measured using a positive displacement-type gas meter that generated two pulses every 0.1ft³. The meter and thermocouples were connected to a computerized data acquisition unit that recorded data every 5 seconds. The higher-heating value of the gas was determined with a water bath calorimeter and all gas measurements were corrected to standard conditions. Figure 2-1 shows the Sirius instrumented with the data acquisition system.

Figure 2-1.
The Sirius instrumented for testing.

Non-Cooking Tests

The energy input rate was determined by measuring the energy consumed by the steamer during a complete preheat cycle. The maximum burner rate 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 when turned on for the first time in a day. An hour after the preheat cycle is completed, the steamer was placed in the "hold" mode (Mode I) and idle energy consumption was monitored over a 2-hour period.

Frozen Green Pea Efficiency Tests

Individually flash-frozen, grade A green peas (Figure 2-2) represented one of two food products for steamer performance testing. Standard full-size (12" x 20" x 2½"), perforated stainless-steel hotel pans were used for cooking the green peas. The Sirius required 6 pans of green peas for a full load, while a single pan placed on the center rack of the steamer cavity comprised a light load. Each pan contained 8.0 ± 0.01 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 prior to testing. 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]

Figure 2-2.
Frozen green pea load.

Since probing proves to be difficult and erroneous for measuring the temperature of small-sized green peas, a water-bath calorimeter was utilized to determine the final bulk temperature of the cooked green peas. The time required to cook the frozen peas to a bulk temperature of 180 ± 2°F was determined through an iterative process. Once the cook time was established, the test was replicated a minimum of three times to minimize the uncertainty in the test results.

Red Potato Efficiency Tests

Figure 2-3.
Red potato load.

Freshly packed, size B, red potatoes (Figure 2-3) served as the second food product for steamer performance testing. The Sirius required 6 pans of red potatoes for a full load and a single pan for a light load. Each pan contained exactly 50 red potatoes weighing 8.0 ± 0.2 pounds.

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 then cooked to 195 ± 2°F using a predetermined cook time. The final temperature was determined by directly probing a minimum of 3 potatoes per pan during testing and then randomly probing potatoes (using a hand-held, digital thermocouple meter) within 3 minutes after cooking was terminated. Again, the test was replicated a minimum of three times to minimize the uncertainty in the test results.

Ice-Load Cooking Uniformity Test

Figure 2-4.
Ice load.

The ice load test required 6 full-size solid steam pans of ice. Each pan contained 8.0 ± 0.2 pounds of ice, which had been stabilized in a freezer at 0 ± 5°F for approximately 12 hours. Each pan was instrumented with a thermocouple positioned at the geometric center of the ice. This was used to monitor ice load temperature during the test. When the first pan reached a final temperature of 170°F, the time was noted; the ice loads remained in the steamer and steaming did not cease until the last pan of ice reached 170°F, when the temperatures and final cook time were recorded. Three replications of this test were performed.

The ASTM results reporting sheets appear in Appendix C.

3 Results

Energy Input Rate

Researchers compared the manufacturer's nameplate value for energy input rate with that measured in the lab prior to any testing to ensure that the steamer was operating within its specified parameters. Researchers determined that the Sirius drew a maximum energy input rate of 25,305 Btu/h.

Preheat and Idle Tests

Preheat Energy and Time

The cavity was automatically filled with approximately 2 gallons of water at 70 ± 5°F. Mode III was then selected for preheating the compartment, as instructed by the user manual. Figure 3-1 illustrates the preheat and idle characteristics of the Sirius.

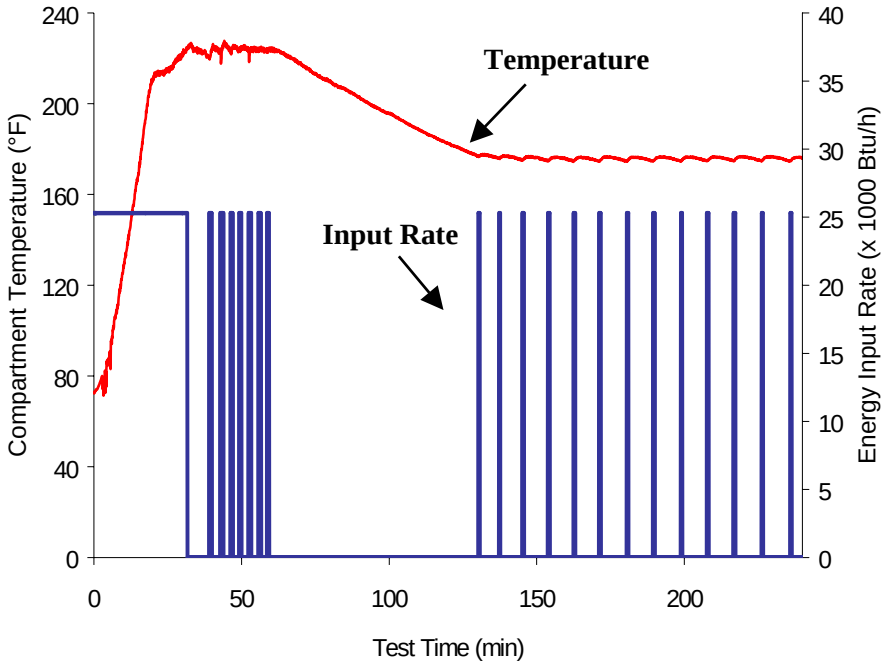

Figure 3-1.
Preheat and idle characteristics.

Results

Idle Energy Rate

Following the preheat period, the steamer was switched to Mode I (standby) and allowed to stabilize for one hour. Then, the steamer was monitored over a 2-hour period and the idle energy rate was determined to be 1,176 Btu/h.

Test Results

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 (Btu/h)	26,000
Measured Energy Input Rate (Btu/h)	25,305
Preheat to Operational Capacity:	
Time (min)	19.6
Energy (Btu)	8,260
Idle Energy Rate (Btu/h)	1,176

Cooking Tests

The steamer was tested using two different food products (green peas and red potatoes) under two loading scenarios—heavy (6 pans) and light (single pan). All cooking scenarios were conducted in Mode III (steaming plus radiant heat).

The Sirius does not employ a separate boiler, but does include an automatic fill water connection and an open drain. Approximately two gallons of water are automatically filled into the reservoir from the back of the cooking compartment before testing began. The steamer was emptied at the end of the day, as directed by the manufacturer's instructions. Typical water usage for

each cooking scenario was approximately 1 gal/h; this was true for both the frozen peas and potato tests.

Frozen Green Pea Tests

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 0.84 Btu/lb°F for thawed peas.[1] The Sirius required 55.1 minutes to cook a full load of frozen green peas and had a cooking-energy efficiency of 62.7% and a production capacity of 52.3 lb/h.

The light-load test required an average of 13.1 minutes when cooking a single pan of frozen green peas. Cooking-energy efficiency and productivity during the light-load tests were determined to be 40.9% and 36.7 lb/h, respectively.

Red Potato Tests

The red potatoes contained 84% moisture by weight with a specific heat (Cp) of 0.87 Btu/lb°F.[1] A full load of potatoes averaged 34.2 minutes to reach an average bulk cooked temperature of 195 ± 2°F. The cooking-energy efficiency and production capacity was 44.6% and 84.0 lb/h, respectively.

The single pan of red potatoes required 17.0 minutes to achieve an average bulk temperature of 195 ± 2°F. The light-load potato test resulted in a cooking-energy efficiency of 16.7% and a productivity of 28.2 lb/h.

Results Discussion

The rate at which steam condenses on food depends on the surface temperature and surface area of the food. Therefore, frozen green peas (at 0°F) and red potatoes (at room temperature) represent two extremes in steam cooking. Frozen green peas, having a large surface area to volume ratio, promote condensation. The heat transfer rate from steam to frozen food is high, resulting in greater cooking-energy efficiency and productivity. Potatoes

are “tough” to cook, due to a low surface to volume ratio and the slower rate of condensation.

Appendix D lists the physical properties of the test food product and measured values of each test run. Using the detailed equations provided in section 11 of the Steamer ASTM Standard Test Method 1484-04, the cooking energy efficiencies are calculated. Tables 3-2 through 3-3 summarize the Sirius’s cooking performance.

Table 3-2. Frozen Green Pea Cooking Test Results.

	Heavy-Load	Light-Load
Number of Pans	6	1
Cook Time (min)	55.1	13.1
Cooking Energy Rate (Btu/h)	22,432	23,900
Cooking-Energy Efficiency (%)	62.7 ± 1.4	40.9 ± 1.7
Production Rate (lb/h)	52.3 ± 2.1	36.7 ± 1.0
Energy Consumption (Btu/lb)	429	651

Table 3-3. Red Potato Cooking Test Results.

	Heavy-Load	Light-Load
Number of Pans	6	1
Cook Time (min)	34.2	16.0
Cooking Energy Rate (Btu/h)	21,112	17,123
Cooking-Energy Efficiency (%)	44.6 ± 3.4	19.6 ± 3.4
Production Rate (lb/h)	84.0 ± 6.8	30.3 ± 7.0
Energy Consumption (Btu/lb)	252	564

Figure 3-2 illustrates the relationship between cooking-energy efficiency and production rate for this steamer, when cooking two different types of food product. The upper line represents the part-load efficiency curve for the steamer when cooking frozen vegetables and the lower curve represents the steamer's part-load efficiency while cooking more stubborn food products. Steamer production rate is a function of the cook time. Appendix D contains a table of the test data for each replicate of the cooking tests.

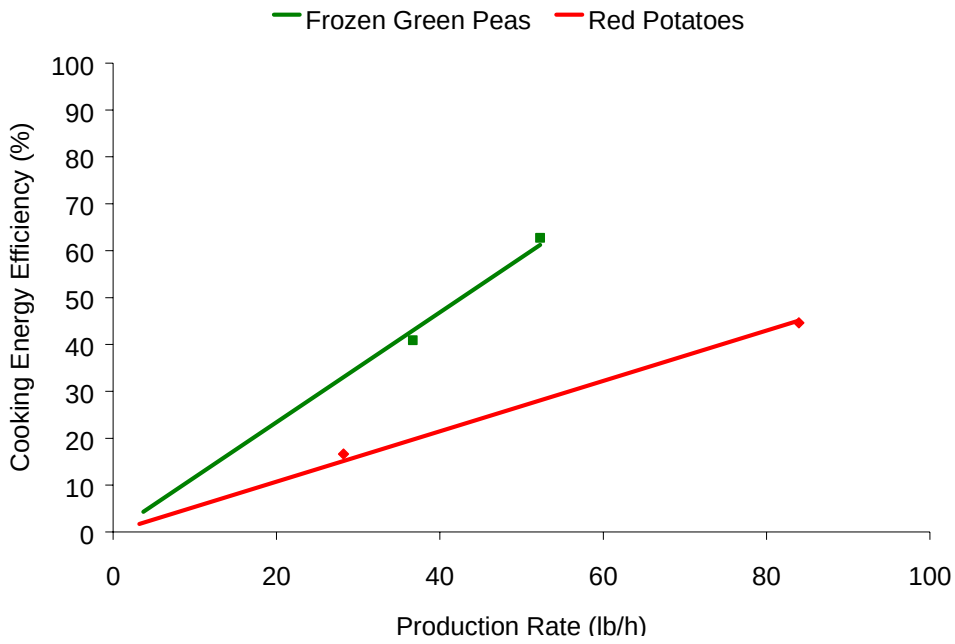

Figure 3-2.
Steamer part-load cooking-energy efficiency.

Note: Light-load = single pan/load; Heavy-load = 6 pans/load.

Figures 3-2 and 3-3 illustrate the relationship between the steamer's cooking-energy efficiency and the production rate for different types of food product for different test scenarios. Heavy loads exhibit higher efficiencies due to better use of the available compartment space, as opposed to light-load single pan tests, where most of the space in the steamer compartment is empty. Furthermore, Figure 3-3 shows that the frozen green peas have higher

cooking-energy efficiencies than the red potatoes due to their higher surface-to-volume ratio.

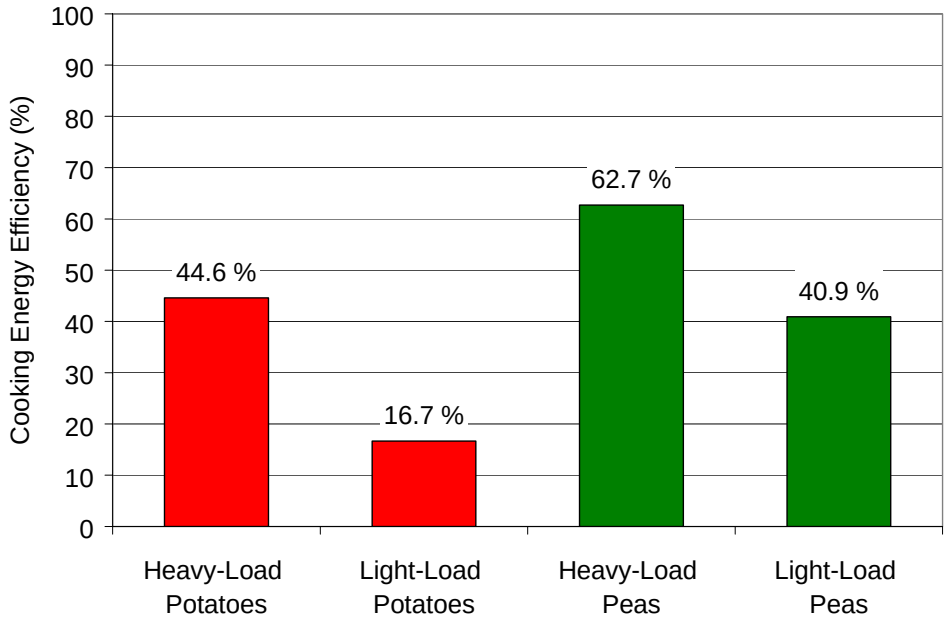

Figure 3-3. Comparison of steamer cooking-energy efficiencies.

Note: Light-load = single pan/load; Heavy-load = 6 pans/load.

Figure 3-4 represents the cooking energy rate for two different food products at the two test load scenarios. The upper line represents the steamer's energy consumption rate when cooking frozen vegetables, while the lower curve represents the steamer's energy consumption rate while cooking more stubborn food products. All thermostatically controlled electric steamers with the ability to cycle its elements will exhibit similar cooking energy rate profiles for frozen vs. fresh food products; these steamers will operate at higher average energy rates for frozen foods than for fresh products. However, because there is minimal cycling during the cooking tests, the energy rate profiles appear flattened with little variance between the heavy and light-load scenarios.

This graph can be used as a tool to estimate the daily energy consumption and probable demand for the steamer in a real-world operation, based on the type of usage. The average energy consumption rates at 15, 30, and 60 pounds per hour of frozen vegetables are all going to be constant at approximately the measured maximum input rate for the steamer (in this case the average input rate for all loading scenarios will be 23,000 Btu/h).

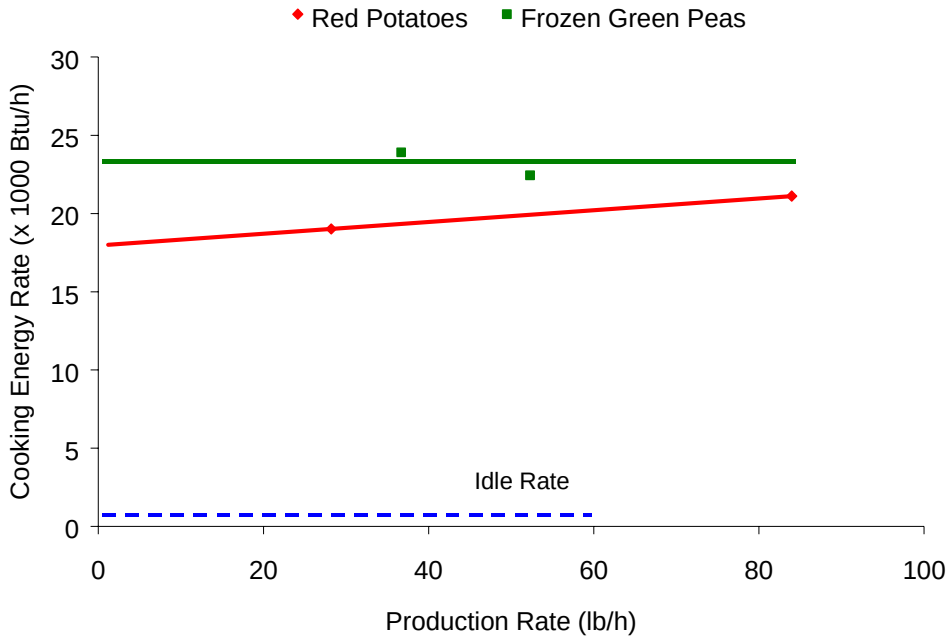

Figure 3-4.
Steamer cooking energy consumption profile.

Note: Light-load = single pan/load; Heavy-load = 6 pans/load.

Ice-Load Uniformity Test

The ice-load uniformity test was designed to emulate frozen vegetables, while allowing researchers to accurately monitor simulated food temperature during the cooking event. For each test, 6 pans (full-load) of ice were used to determine the steaming uniformity within the compartment. The last pan reached 170°F in 83.7 minutes. At this time, the maximum temperature difference between the hottest and coldest pan was found to be 18.1°F. On average, the last pan to reach the 170°F endpoint required an additional 11.4 minutes beyond the cook time of the fastest pan. Table 3-4 summarizes the

average results of the ice-load uniformity tests and Figure 3-5 shows the individual pan temperatures during a single ice-load test. Note that the final temperatures are averages of at least three replications and reflect the variations in results from each test.

Table 3-4. Ice-Load Uniformity Test Results.

Number of Pans	6
Cook Time (min)	83.7
Initial Ice-Load Temperature (°F)	-1.7
Final Ice-Load Temperatures (°F):	
Pan 1 (Top)	188.2
Pan 2	185.7
Pan 3	186.0
Pan 4	182.0
Pan 5	170.1
Pan 6 (Bottom)	178.1
Maximum Temperature Difference (°F)	18.1
Maximum Time Delay* (min)	11.4

* Time required for ice load in last pan to reach 170°F after first pan reaches the endpoint.

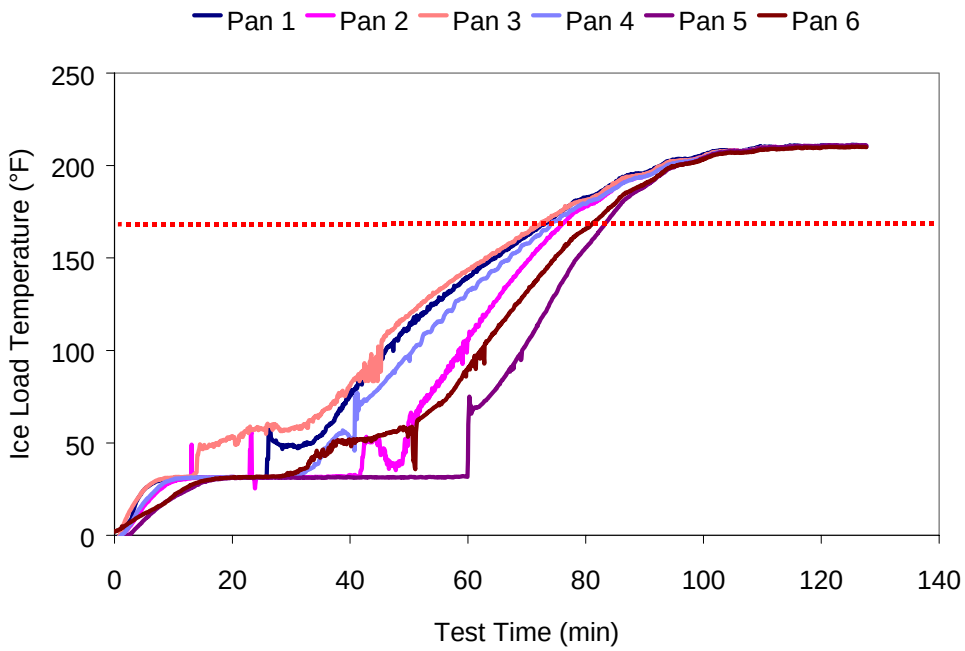

Figure 3-5.
Ice-load temperature profile.

4 Conclusions

The Stellar Sirius is an energy efficient and productive steamer and is the first EnergyStar qualified gas, boilerless steamer. With its innovative heating strategies, the unit was able to obtain impressive cooking-energy efficiencies and minimal water consumption. The Sirius includes a modest 26,000 Btu/h burner arrangement underneath the compartment, yielding 52.3 lb/h of frozen vegetables and 84.0 lb/h of potatoes, while maintaining cooking-energy efficiencies above 40% throughout. During heavy-load cooking tests in Mode III, the Sirius performed quite well due to inventive designs in flue gas recuperation and supply water preheat.

While the cooking tests revealed the steamer's ability to perform with minimal energy input, the Sirius also exhibited a low idle rate of 1,176 Btu/h. This is a credit to the sound design of the steamer – its ability to minimize heat loss that allows it to maintain a steady, standby temperature within the cooking compartment. Furthermore, ice load tests revealed that the Sirius maintains pan-to-pan temperature uniformity inside the compartment when challenged with frozen food products. The average temperature difference between the coldest and hottest pan was 18.1°F. The steamer's low, 1,126 Btu/h idle rate and 44.6% heavy-load potato cooking-energy efficiency place it securely among the top performing gas steamers.[2–24]

While the Sirius was challenged with a series of heavy and light-load cooking scenarios, the steamer consumed approximately 1.0 gallon of water per hour. Researchers recorded mimimal refilling of the steamer through the automatic fill connection during all the tests. Steam-generator and boiler-based steamers typically consume between 20 and 60 gal/h while cooking, compared to less than 1.0 gal/h for the Sirius.[2-24]

Throughout the rigorous ASTM tests, the Sirius exhibited strong performance, especially considering its 26,000 Btu/h input rate. In addition, the Sirius

provides three modes of cooking to accommodate various steaming requirements, automatic reservoir fill connection, and a two-inch deep reservoir. Due to its impressive design features (convection fan, supply water preheat, flue heat recuperation), the Sirius is the first gas boilerless steamer to qualify as an EnergyStar appliance. The Stellar Steam Sirius is an ideal candidate for facilities looking to reduce operating costs without sacrificing performance. With its low energy consumption, high cooking-energy efficiencies, and minimal water usage, it is a fine choice for kitchens looking to save on their gas bill.

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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 Preheat
Preheat

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

Condensate

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

Condensate Temperature (°F)

The temperature at which the condensate enters the floor drain.

Cooking Energy (kWh or kBtu)

The total energy consumed by an appliance as it is used to cook a specified food product.

Cooking Energy Consumption Rate
(kW or kBtu/h)

The average rate of energy consumption during the cooking period.

Cooking-Energy Efficiency (%)

The quantity of energy input to the food products; expressed as a percentage of the quantity of energy input to the appliance during the heavy- and light-load tests.

Duty Cycle (%)
Load Factor

The average energy consumption rate (based on a specified operating period for the appliance) expressed as a percentage of the measured energy input rate.

$$\text{Duty Cycle} = \frac{\text{Average Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Energy Input Rate (kW or kBtu/h)
Energy Consumption Rate
Energy Rate

The peak rate at which an appliance will consume energy, typically reflected during preheat.

Frozen Green Peas Load

12 x 20 x 2½ in. hotel pan filled with 8.0 ± 0.01 lb of frozen, grade A, green peas subsequently frozen to 0±5°F. One of two food products 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).

Heating Value (Btu/ft^3)
Heating Content

The quantity of heat (energy) generated by the combustion of fuel. For natural gas, this quantity varies depending on the constituents of the gas.

Ice Load

12 x 20 x 2½ in. hotel pan filled with 8.0 ± 0.2 lb of water and subsequently frozen to 0±5°F. This is used to simulate a food product load in the ice load cooking uniformity test.

Idle Energy Rate (kW or Btu/h)
Idle Energy Input Rate
Idle Rate

The rate of appliance energy consumption while it is "holding" or maintaining a stabilized operating condition or temperature.

Idle Temperature (°F, Setting)

The temperature of the cooking cavity/surface (selected by the appliance operator or specified for a controlled test) that is maintained by the appliance under an idle condition.

Idle Duty Cycle (%)
Idle Energy Factor

The idle energy consumption rate expressed as a percentage of the measured energy input rate.

$$\text{Idle Duty Cycle} = \frac{\text{Idle Energy Consumption Rate}}{\text{Measured Energy Input Rate}} \times 100$$

Low-Pressure Steam Cooker

Steam cooker wherein the cooking compartment operates between 3 and 9.9 psig.

Measured Input Rate (kW or Btu/h)
Measured Energy Input Rate
Measured Peak Energy Input Rate

The maximum or peak rate at which an appliance consumes energy, typically reflected during appliance preheat (i.e., the period of operation when all burners or elements are "on").

Pilot Energy Rate (kBtu/h)
Pilot Energy Consumption Rate

The rate of energy consumption by the standing or constant pilot while the appliance is not being operated (i.e., when the thermostats or control knobs have been turned off by the food service operator).

Potato Load

12 x 20 x 2½ in. hotel pan filled with 8.0 ± 0.2 lb of fresh, whole, US No. 1, size B, red potatoes. One of two food products used to determine cooking-energy efficiency and production capacity.

Preheat Energy (kWh or Btu)
Preheat Energy Consumption

The total amount of energy consumed by an appliance during the preheat period.

Preheat Rate (°F/min)

The rate at which the cooking surface heats during a preheat.

Glossary

Preheat Time (minute)
Preheat Period

The time required for an appliance to heat from the ambient room temperature (75 ± 5°F) to a specified (and calibrated) operating temperature or thermostat set point.

Production Capacity (lb/h)

The maximum production rate of an appliance while cooking a specified food product in accordance with the heavy-load cooking test.

Production Rate (lb/h)
Productivity

The average rate at which an appliance brings a specified food product to a specified "cooked" condition.

Rated Energy Input Rate
(kW, W or Btu/h, Btu/h)
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.

Test Method

A definitive procedure for the identification, measurement, and evaluation of one or more qualities, characteristics, or properties of a material, product, system, or service that produces a test result.

Typical Day

A sampled day of average appliance usage based on observations and/or operator interviews, used to develop an energy cost model for the appliance.

Water Consumption (gal/h)

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 Stellar Steam, model Sirius gas steamer.

Manufactured by *Colburn***Treat**

Job Name: _____

Item No.: _____ Quantity: _____

Model: Sirius II _____ *(size)*

SIRIUS II
Gas Convection Boilerless Steamer

Specifications: Sirius II (all sizes)

Unit shall be Stellar Steam convection/circulating boilerless steam oven with automatic waterfill. Unit shall include internally preheated water for fast recovery, clean water reservoir system and rear drain. Sirius II models shall be efficiently heated by burners external to the water reservoir. Sirius steamers shall use 26,000 Btu per compartment. Operation shall be from steam generated in the cooking compartment. The walls and ceiling of the cooking compartment shall be heated to reduce steam condensing on these surfaces and shall reheat and revitalize partially condensed steam (US Patents 6,467,402 & 6,310,325). Steamer cavity shall have dual-direction convection fan that increases steam velocity and provides efficient steam distribution throughout the cavity by pulling steam past the cooking pans, then forcing it against the heated cooking chamber walls to be reheated. Cooking compartment shall be cast aluminum with a food-grade non-stick hard anodized finish. Cooking compartment acts as a heat sink, allowing for heat retention, quick recovery and reduced energy consumption. Standard controls shall be in English and Spanish with three cooking modes: slow cook, Super Steam and Steam Plus. A Clean Probe indicator light, Heating indicator light and a 60-minute mechanical timer shall be included. The control panel shall pull out in drawer fashion for easy service access. The door shall be field reversible and shall be insulated. Safety shut offs are provided by a hidden magnetic door switch, low water/high limit heat switch, temperature probe, water sensing probe and waterfill timer.

Standard features:

- Controls:
  - 4-position cooking mode selector: Off and three cooking positions
  - Clean Probe indicator light
  - Heating indicator light
  - 60-minute timer – does not control cooking functions
- Internally preheated incoming water for quick recovery
- Clean water reservoir system keeps food out of the water
- Condensate trough plumbed to drain at rear
- Redundant safety systems
- Construction
  - 304 Stainless, #4 finish (cabinet)
  - 356.1 Aluminum cast cooking compartment with hard-anodized finish
- UL/CUL Safety & Sanitary (NSF-4)
- Two year parts and labor warranty

Sirius II 6

Specify Natural or LP Gas

Options

- ☐ CA - Heavy duty casters (2 with brakes)
- ☐ HWS-4, HWS-6 - Left side heat and water shield
- ☐ PP-4, PP-6 - Prison package (tamperproof screws, locked controls, flanged feet)
- ☐ SKG – stacking kit, gas steamers, to use when adding a second compartment to an existing steamer in the field

Stands

Note: stacked steamers (double compartment) do not require stands. Rugged frame construction allows steamers to be stacked on each other.

- ☐ MSS – mobile stand with shelf
- ☐ SSS – stationary stand with shelf
- ☐ PRM – pan rack assembly for MSS & SSS stands, holds 14 2½" pans
- ☐ EST – economy stand, shipped disassembled
- ☐ ESTM – mobile economy stand, shipped disassembled
- ☐ STSS – 12" high stand for 6- and 8-pan steamers only

by *Colburn***Treat**
276 E Allen Street, Suite 5, Winooski, VT 05404
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tel: 802-654-8603 fax:802-654-8618

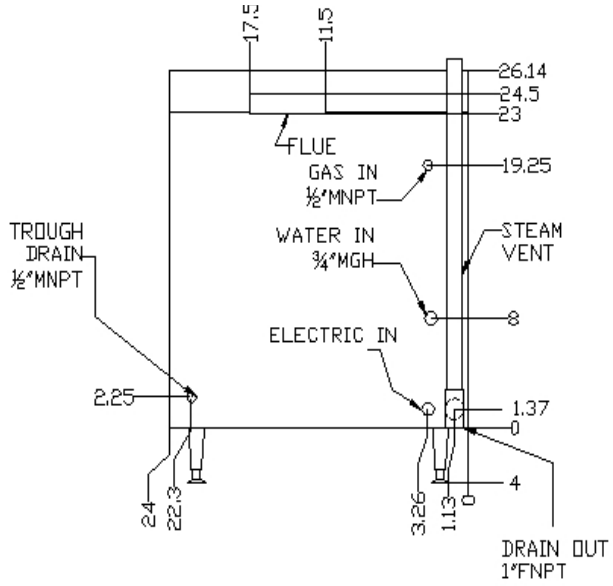
Manufactured in USA
7/04 Printed in USA

Connections for all Sirius II sizes

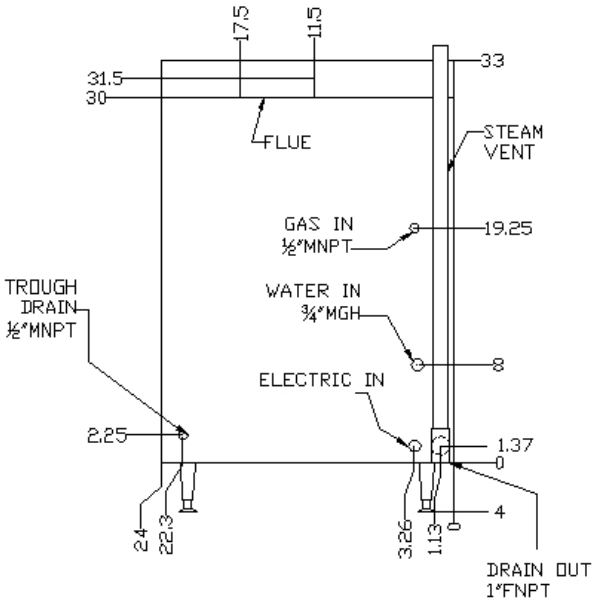
- **Gas**: ½" NPT male, 26,000 Btu supplied
  Gas Pressure:
  - 7" WC required, natural gas, not to exceed 13.5"
  - 11" WC required, propane gas, not to exceed 13.5"
- **Electrical**: 120V cord & plug set included.
  - Connect to 15 amp electrical outlet
- **Water in**: ¾" male garden hose
- **Trough drain**: ½" MNTP to indirect waste
- **Main Drain**: 1" FNPT to indirect waste

Proper venting and make up air must be provided. Consult local codes.

Specify natural or propane gas.



Sirius II 4-pan rear view



Sirius II 6-pan rear view

Model	Made up of	12x20x2½" pan capacity	12x20x4" pan capacity	Height (all are 24 W x 28.5 D)	Ship Wt (Class 85)
Sirius II 4	Single compartment	4	2	26.5 + 4" legs	225 lbs
Sirius II 6	Single compartment	6	4	33.5 + 4" legs	250 lbs
Sirius II 8	2 Sirius II 4	8	4	57 + 6-9 adj. legs	450 lbs
Sirius II 10	Sirius II 4 (top) + Sirius II 6 (bottom)	10	6	64 + 6-9" adj. legs	475 lbs
Sirius II 12	2 Sirius II 6	12	8	71 + 6-9" adj. legs	500 lbs

Notes:

1. Each single compartment has two rear drain connections (one main drain, one condensate trough drain)
2. Each stacked steamer (two compartments) has a single main drain and two condensate trough drains
3. Each compartment, stacked or single, requires a separate power connection
4. Each compartment, stacked or single, requires a separate gas connection
5. Each compartment, stacked or single, requires a separate water connection
6. Water pressure should be set to fill reservoir in 45 seconds
7. 4" clearance left, right and rear is recommended
8. Location near a floor drain is recommended
9. Stacked units require 4" stacking collar between units (included when 8-, 10-, or 12-pan units are ordered)
10. Single and stacked units require hood for ventilation of flue products.

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C Results Reporting Sheets

Manufacturer:	Stellar Steam
Model:	Sirius
Date:	January 2005

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 - Two 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: The steamer has an automatic water fill connection and an open drain connection. Approximately 2.0 gallons of water automatically fill the reservoir prior to operation and manually drained at the end of the day. Users can choose to operate the steamer in three different modes: I, II, and III, with each one representing varying degrees of steaming and temperatures within the compartment. Mode I also represents a standby setting where users can hold the compartment at 180°F during periods of idling. All cooking tests were conducted using the steamer's Mode III setting.

Apparatus

The steamer was installed in accordance with the manufacturer's instructions 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]

The steamer was instrumented with a positive displacement residential type gas meter, with a resolution of 0.1 ft^3. A computerized data acquisition system recorded test information at 5-second intervals for the entire test method application. All test apparatus were installed in accordance with Section 9 of the ASTM test method.

Energy Input Rate

Higher-heating value	1,022 Btu/ft^3
Measured	25,305 Btu/h
Rated	26,000 Btu/h
Percent Difference between Measured and Rated	2.7%

Appliance Preheat Energy Consumption and Duration

Higher-heating value	1,022 Btu/ft^3
Energy Consumption	8,259.3 Btu
Duration	19.6 min

Appliance Idle Energy Rate

Higher-heating value	1,022 Btu/ft³
Idle Energy Rate	1,175.7 Btu/h

<u>Frozen Green Peas</u> Cooking Time, Energy Efficiency, Energy Rate, Production Capacity, and Water Consumption Rate

Heavy-Load:

Higher-heating value	1,022 Btu/ft³
Cooking Time	55.1 min
Cooking-Energy Efficiency	62.7 ± 1.4 %
Cooking Energy Rate	22,432 ± 1,170 Btu/h
Production Capacity	52.3 ± 2.1 lb/h
Water Consumption Rate	1.1gal/h

Light-Load:

Higher-heating value	1,022 Btu/ft³
Cooking Time	13.1 min
Cooking-Energy Efficiency	40.9 ± 1.7 %
Cooking Energy Rate	23,900 ± 689 Btu/h
Production Rate	36.7 ± 1.0 lb/h
Water Consumption Rate	1.2 gal/h

<u>Whole Red Potatoes</u> Cooking Time, Energy Efficiency, Energy Rate, Production Capacity, and Water Consumption Rate

Heavy-Load:

Higher-heating value	1,022 Btu/ft³
Cooking Time	34.2 min
Cooking-Energy Efficiency	44.6 ± 3.4%
Cooking Energy Rate	21,112 ± 1,485 Btu/h
Production Capacity	84.0 ± 6.8 lb/h
Water Consumption Rate	1.1 gal/h

Light-Load:

Higher-heating value	1,022 Btu/ft³
Cooking Time	17.0 min
Cooking-Energy Efficiency	16.7 ± 1.6 %
Cooking Energy Rate	19,014 ± 1,208 Btu/h
Production Capacity	28.2 ± 1.4 lb/h
Water Consumption Rate	1.3 gal/h

<u>Ice-Loads</u> Cooking Time, Temperature Uniformity

Higher-heating value		1,022 Btu/ft³
Cooking Time		83.7 min
Initial Average Temperature		-1.7 °F
Average Final Ice Load Temperatures	Pan 1	188.2 °F
	Pan 2	185.7 °F
	Pan 3	186.0 °F
	Pan 4	182.0 °F
	Pan 5	170.1 °F
	Pan 6	178.1 °F
Maximum Temperature Difference		18.1 °F
Maximum Time Delay		11.4 min

D Cooking-Energy Efficiency Data

Table D-1. Specific Heat and Latent Heat.

Specific Heat (Btu/lb, °F)	
Ice	0.50
Solids	0.20
Frozen Green Peas	0.84
Red Potatoes	0.87
Latent Heat (Btu/lb)	
Fusion, Water	144
Vaporization, Water	970

Cooking-Energy Efficiency Data

Table D-2. Heavy-Load Peas Data

	Replication 1	Replication 2	Replication 3
Measured Values			
Number of Pan(s)	6	6	6
Cook Time (min)	55.0	56.0	54.3
Initial Water Temperature (°F)	40.2	40.2	38.2
Final Water Temperature (°F)	98.0	98.3	98.1
Frozen Food Temperature (°F)	0.0	0.0	0.0
Weight of Empty Calorimeter (lb)	44.7	44.7	44.7
Weight of Full Calorimeter (lb)	155.5	155.2	155.2
Weight of Calorimeter Water (lb)	60	60	60
Weight of Cooked Food (lb)	50.8	50.5	50.5
Weight of Frozen Food (lb)	48	48	48
Weight of Stainless-Steel Pans (lb)	15.7	15.7	15.7
Moisture Content (%)	81	81	81
Condensate Temperature (°F)	n/a	n/a	n/a
Water Consumption (gal/h)	1.2	1.2	1.0
Calculated Values			
Moisture Weight in Green Peas (lb)	38.9	38.9	38.9
Final Food Temperature (°F)	179.3	180.6	182.8
Cooking Energy (Btu)	20,312	20,684	20,775
Energy Consumed by Green Peas (Btu)	12,559	12,570	12,672
Energy to Food (Btu/lb)	262.6	261.9	264.0
Energy Consumed by Pans (Btu)	309.5	311.9	315.8
Energy of Boiler Re-init (Btu)	n/a	n/a	n/a
Energy Consumed by the Steamer (Btu)	20,312	20,864	20,775
Energy to Steamer (Btu/lb of food cooked)	423.2	430.9	432.8
Cooking Energy Rate (Btu/h)	22,158	22,161	22,977
Productivity (lb/h)	52.4	51.4	53.1
Energy Efficiency (%)	63.4	62.3	62.5

Cooking-Energy Efficiency Data

Table D-3. Light-Load Peas Data

	Replication 1	Replication 2	Replication 3
Measured Values			
Number of Pan(s)	1	1	1
Cook Time (min)	13.3	13.0	13.0
Initial Water Temperature (°F)	40.4	41.8	41.1
Final Water Temperature (°F)	98.1	98.9	98.2
Frozen Food Temperature (°F)	0.0	0.0	0.0
Weight of Empty Calorimeter (lb)	44.7	44.7	44.7
Weight of Full Calorimeter (lb)	60.9	63.0	63.0
Weight of Calorimeter Water (lb)	10.0	10.0	10.0
Weight of Cooked Food (lb)	8.2	8.3	8.3
Weight of Frozen Food (lb)	8.0	8.0	8.0
Weight of Stainless-Steel Pans (lb)	2.4	2.8	2.4
Moisture Content (%)	81	81	81
Condensate Temperature (°F)	n/a	n/a	n/a
Water Consumption (gal/h)	1.0	1.6	1.1
Calculated Values			
Moisture Weight in Green Peas (lb)	6.5	6.5	6.5
Final Food Temperature (°F)	181.9	180.5	180.2
Cooking Energy (Btu)	5,252	5,135	5,247
Energy Consumed by Green Peas (Btu)	2,078	2,085	2,078
Energy to Food (Btu/lb)	259.7	260.7	259.7
Energy Consumed by Pans (Btu)	48.5	55.4	48.0
Energy of Boiler Re-init (Btu)	n/a	n/a	n/a
Energy Consumed by the Steamer (Btu)	5,252	5,135	5,247
Energy to Steamer (Btu/lb of food cooked)	656.5	641.9	655.9
Cooking Energy Rate (Btu/h)	23,783	23,699	24,217
Productivity (lb/h)	36.2	36.9	36.9
Energy Efficiency (%)	40.5	41.7	40.5

Cooking-Energy Efficiency Data

Table D-4. Heavy-Load Potatoes Data

	Replication 1	Replication 2	Replication 3
Measured Values			
Number of Pan(s)	6	6	6
Cook Time (min)	35.7	33.8	33.7
Temperature of Uncooked Potatoes (°F)	71.1	71.0	73.8
Temperature of Cooked Potatoes (°F)	195.1	195.0	195.0
Weight of Stainless-Steel Pans (lb)	15.7	15.7	15.7
Weight of Potatoes (lb)	48.0	48.1	48.0
Total Potato Count	300	300	300
Moisture Content (%)	84	84	84
Condensate Temperature (°F)	n/a	n/a	n/a
Water Consumption (gal/h)	1.1	1.2	1.0
Calculated Values			
Moisture Weight in Potatoes (lb)	40.3	40.4	40.4
Average Weight of Each Potato (lb)	0.16	0.16	0.16
Cooking Energy (Btu)	12,266	11,766	12,223
Energy Consumed by Potatoes (Btu)	5,180	5,185	5,071
Energy to Food (Btu/lb)	107.9	108.0	105.6
Energy Consumed by Pans (Btu)	252.2	241.2	240.9
Energy of Boiler Re-init (Btu)	n/a	n/a	n/a
Energy Consumed by the Steamer (Btu)	12,266	11,766	12,223
Energy to Steamer (Btu/lb of food cooked)	255.6	245.1	254.7
Cooking Energy Rate (Btu/h)	20,635	20,918	21,784
Productivity (lb/h)	80.8	85.4	85.7
Energy Efficiency (%)	44.3	46.1	43.5

Cooking-Energy Efficiency Data

Table D-5. Light-Load Potatoes Data

	Replication 1	Replication 2	Replication 3
Measured Values			
Number of Pan(s)	1	1	1
Cook Time (min)	17.3	16.7	17.0
Temperature of Uncooked Potatoes (°F)	72.2	71.7	70.6
Temperature of Cooked Potatoes (°F)	194.9	195.2	195.1
Weight of Stainless-Steel Pans (lb)	2.4	2.8	2.4
Weight of Potatoes (lb)	8.0	8.0	8.0
Total Potato Count	50	50	50
Moisture Content (%)	84	84	84
Condensate Temperature (°F)	n/a	n/a	n/a
Water Consumption (gal/h)	1.4	1.3	1.1
Calculated Values			
Moisture Weight in Potatoes (lb)	6.7	6.7	6.7
Average Weight of Each Potato (lb)	0.16	0.16	0.16
Cooking Energy (Btu)	5,616	5,311	5,237
Energy Consumed by Potatoes (Btu)	853.5	858.6	869.1
Energy to Food (Btu/lb)	106.7	107.3	108.6
Energy Consumed by Pans (Btu)	41.0	46.1	38.4
Energy of Boiler Re-init (Btu)	n/a	n/a	n/a
Energy Consumed by the Steamer (Btu)	5,616	5,311	5,237
Energy to Steamer (Btu/lb of food cooked)	702.0	663.9	654.6
Cooking Energy Rate (Btu/h)	19,439	19,121	18,483
Productivity (lb/h)	27.6	28.8	28.3
Energy Efficiency (%)	15.9	17.0	17.3

Cooking-Energy Efficiency Data

Table D-6. Frozen Green Pea Cooking-Energy Efficiency and Production Capacity Statistics.

	Cooking-Energy Efficiency		Production Capacity
	Heavy Load	Light Load	
Replicate #1	63.4	40.5	52.4
Replicate #2	62.3	41.7	51.4
Replicate #3	62.5	40.5	53.1
Average	62.7	40.9	52.3
Standard Deviation	0.6	0.7	0.8
Absolute Uncertainty	1.4	1.7	2.1
Percent Uncertainty	2.2%	4.2%	4.0%

Table D-7. Red Potato Cooking-Energy Efficiency and Production Capacity Statistics.

	Cooking-Energy Efficiency		Production Capacity
	Heavy Load	Light Load	
Replicate #1	44.3	15.9	80.8
Replicate #2	46.1	17.0	85.4
Replicate #3	43.5	17.3	85.7
Average	44.6	16.7	84.0
Standard Deviation	1.4	0.6	2.7
Absolute Uncertainty	3.4	1.6	6.8
Percent Uncertainty	7.6%	9.3%	8.1%