Middleby Marshall, Model PS570
Conveyor Oven Performance Test

Application of ASTM Standard Test Method F 1817-97

CKVL Report 0011107

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Executive Summary

The Middleby Marshall PS570 gas conveyor oven is a stackable unit capable of high-volume cooking. The oven is equipped with a 70-inch long by 32-inch wide, variable-speed conveyor, which passes through a high-velocity impingement bake zone using a natural gas burner rated at 170,000 Btu/h. The latest generation of the Middleby Marshall PS570 uses a modulating gas supply valve, in place of the traditional solenoid valve, for improved oven response and control.

The PS570 oven was tested at the Commercial Kitchen Ventilation Laboratory (CKV Lab) located in Wood Dale, Illinois, which operates in conjunction with the Food Service Technology Center (FSTC) in San Ramon, CA. The objective of this testing was to examine the operation and performance of the Middleby Marshall gas conveyor oven, model PS570, under controlled conditions. The oven was tested during idle and cooking conditions, using the American Society for Testing Materials (ASTM) Standard F1817-97 *Standard Test Method for the Performance of Conveyor Ovens* and the ASTM F1704-99 *Standard Test Method for the Performance of Commercial Kitchen Ventilation*. Oven performance is characterized by preheat energy consumption and duration, idle energy rate, cooking-energy efficiency and production capacity. In addition, calculation of the heat gain to space assesses the impact of the oven on the kitchen environment.

The oven configuration consisted of three PS570 conveyor ovens stacked one-on-top of the other. All testing was performed with the top oven operating at a calibrated temperature of 475°F, while the two lower ovens were not in operation. The ovens were placed under a 10-foot by 5-foot wall-mounted canopy hood. The hood was 78 inches above the floor, centered left-to-right over the oven, with a 9-inch front overhang.

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The oven preheated to 465 °F in 15.1 minutes. The soft landing temperature control allowed a rapid temperature increase to 425°F and then gently reduced the burner input, allowing the oven to finish the preheat without overshooting the setpoint. Once the oven had stabilized at the setpoint operating temperature, the idle energy consumption was measured and the idle energy consumption rate was calculated at 40,600 Btu/h, which is 25.1% of the oven's measured energy input rate.

Cooking-energy efficiency and production capacity results were obtained from the cooking of standardized test pizzas under light and heavy load testing scenarios. The PS570 was capable of high throughput, displaying a production capacity of 219 pizzas per hour. The test setup is shown in Figure ES-1and the test data is summarized in Table ES-1.

Figure ES-1. Middleby Marshall PS570 test set-up.

Executive Summary

Table ES-1. Summary of Performance: Middleby Marshall, Single Deck, Gas Conveyor Oven.

Middleby Marshall Conveyor Oven	PS570
Cook Chamber Finger Configuration	Standard
Gas Valve Configuration	Modulating
Oven Cavity Size (L x W)	70 L x 32 W
Oven Cavity Size (sq. ft)	15.6
Conveyor Speed Setpoint (mm:ss)	3:30
ASTM Measured Cook Time (mm:ss)	4:02
Preheat and Idle Rate Tests	
Rated Energy Input Rate (Btu/h)	170,000
Measured Energy Input Rate (Btu/h)	162,000
Fan/Control Energy Rate (kW)	1.12
Preheat Time (minutes)	15.1
Preheat Energy (Btu)	36,900
Idle Energy Rate (Btu/h)	40,600
Light Load Cooking Tests	
Gas Cooking Energy Rate (Btu/h)	49,990
Electric Cooking Energy Rate (kW)	1.03
Energy Efficiency (%)	11.2 ± 1.1
Heavy Load Cooking Tests	
Gas Cooking Energy Rate (Btu/h)	84,140
Electric Cooking Energy Rate (kW)	1.01
Energy Efficiency (%)	47.4 ± 3.4
Production Capacity (Pizzas/Hour)	219 ± 4.3

Executive Summary

In addition to the prescribed ASTM testing, the improved temperature control of the new modulating gas control system was evaluated by retrofitting the oven with a solenoid gas control valve used in previous oven designs. The modulating gas control reduced the bandwidth of the temperature swing by 10.6°F, holding the oven's centerpoint temperature at 474 ± 0.7°F, as compared to the old solenoid valve which held the oven temperature at 475 ± 6.0°F.

Heat gain testing was performed with the top deck idling at the calibrated temperature setpoint of 475°F. Test results showed the heat gain to space was 1,800 Btu/h during proper hood capture and containment conditions.

1 Introduction

Background

Conveyor ovens allow for the rapid cooking of food products with consistency and ease of operator use. Beyond the initial capital cost, conveyor ovens can be evaluated with regards to long-term operational cost and performance as characterized by cooking-energy efficiency, idle energy consumption and production capacity.

Controlled testing of a Middleby Marshall conveyor oven was performed according to the ASTM F1817-97 *Standard Test Method for the Performance of Conveyor Ovens.*[1] Additionally, testing of heat gain to space was performed using the ASTM F-1704-99 *Standard Test Method for the Performance of Commercial Kitchen Ventilation.*[2]

The test data provides key information to determine the cost of operation and the percentage of total kitchen productivity a single appliance can deliver. Better-informed decisions can then be made for equipment purchases, kitchen layout, energy demand of the kitchen, and customer capacity during peak demand. Also, improved kitchen strategies can be implemented using the test information to reduce energy costs while still maintaining optimal cooking production. For example, using the preheat time information to schedule start up of an appliance when it is needed can reduce the amount of appliance idle time.

Other Food Service Technology Center reports document results of applying the ASTM test method for conveyor ovens to different models.[3,4] The glossary in Appendix A provides a quick reference to the terms used in this report

Objective

The objective of this report is to examine the operation and performance of the Middleby Marshall gas conveyor oven, model PS570, under the con-

trolled conditions of the ASTM Standard Test Methods. The scope of this testing is as follows:

- Accuracy of the thermostat is checked at a setting of 475°F and the thermostat is adjusted if necessary.
- Energy input rate is determined to confirm that the oven is operating within 5% of the nameplate energy input rate.
- The amount of time and energy required to preheat the oven to 475°F are determined.
- Idle energy rate is measured at a calibrated thermostat setpoint of 475°F.
- Cooking-energy efficiency and production rate are determined during light and heavy load cooking tests using pizza as a food product.
- The maximum production capacity of the appliance is determined during heavy load cook testing.
- Heat gain to space is determined for the appliance idling in the specified kitchen environment.

Appliance Description

The Middleby Marshall PS570S conveyor oven is a single deck oven that can be stacked with other PS570 units in a multi-deck configuration. For the purposes of this testing, the PS570 was tested in a three-deck configuration (Figure 1-1), with only the top deck in operation. The oven has a stainless steel exterior and is gas-fired, includes electronic controls and employs a modulating gas control valve for improved temperature control. When running, the oven draws heated air through a fan which forces it into the oven cavity through air distribution fingers, located above and below the stainless steel wire conveyor belt. These fingers can be configured in various ways to provide the end user with a customized delivery of heat to the food product.

For each deck, gas input is rated at 170,000 Btu/h and electrical input is rated at 12 amps at 208V, single phase. Overall dimensions of the assembled three-deck oven are 106 inches wide, 61 ¾ inches deep, and 62 ½ inches

high. The cooking zone for each deck measures 70 inches long by 32 inches wide. Appliance specifications are listed in Table 1-1, and the manufacturer's literature is included in Appendix B.

Figure 1-1.
The PS570S conveyor oven in a triple-stacked configuration.

Table 1-1. Appliance Specifications.

Manufacturer	Middleby Marshall, Inc.
Model	PS570
Generic Appliance Type	Conveyor Oven
Rated Input	170,000 Btu/h
Technology	Air Impingement
Construction	Stainless Steel Exterior
Controls	Electronic Temperature Control, Microprocessor Belt Control, Modulating Gas Control
Belt Width	32"
Dimensions	106" x 61 ¾" x 62 ½"

2 Methods

Setup and Instrumentation

The PS570 conveyor oven was installed in accordance with the ASTM *Standard Test Method for Conveyor Ovens.*[1] The triple-deck oven was positioned under a 10-foot by 5-foot wall mounted canopy hood, with the lower edge of the hood mounted at 78 inches above the floor. The oven was located nine inches inside the front edge of the hood, and was centered left to right. The exhaust ventilation operated at a nominal rate of 3,000 CFM, or 300 CFM per linear foot of hood.

Gas consumption was measured using a positive displacement gas meter and power and energy were measured with a watt/watt-hour transducer. Temperature measurement of the cooked pizzas as well as measurement of the oven cavity temperatures was accomplished using a Fluke Hydra data acquisition system configured for type K thermocouples. The data acquisition system recorded data at 5-second intervals.

Energy Input Rate and Thermostat Calibration

The energy input rate was determined by measuring the energy consumed by the oven from the time it was first turned on until the time the oven started throttling down the gas input. The energy consumed and the time elapsed were used to calculate the maximum energy input rate. Thermostat calibration was verified by installing a thermocouple in the center of the oven cavity, 2-inches above the conveyor. The oven was then turned on and the temperature setpoint adjusted until a 475°F average cooking chamber temperature was obtained.

Preheat and Idle Rate Tests

Preheat tests recorded the time and energy required for the oven to increase the cavity temperature from ambient conditions (75 ± 5°F) to the operating temperature of 465°F. Although the specified operating temperature is 475°F, research performed at the Food Service Technology Center has de-

termined that a conveyor oven is sufficiently preheated and ready to cook when the oven temperature is within 10°F of the thermostat setpoint.

After the oven was preheated, it was operated for one hour, which allowed the oven cavity, exhaust ventilation temperatures, appliance and hood surface temperatures to stabilize at steady state conditions. At the end of the stabilization, the idle energy consumption was monitored for a 2-hour period.

Temperature Mapping

A temperature measurement grid was constructed to monitor the oven cavity temperature in 10 additional locations to supplement the ASTM specified temperature measurement location. The grid consisted of 11 type K thermocouples attached to two stainless steel wire oven racks. The racks were placed on the oven conveyor in the center of the cavity, consistently locating the thermocouples 2-inches above the conveyor. The oven conveyor was switched off, and the thermocouples remained in position for the duration of the thermal map testing.

Light-Load Pizza Tests

Light-load pizza tests are used to calculate cooking-energy efficiency under partial loading conditions, such as when the oven is cooking pizzas intermittently or at a rate below it's maximum capacity.

Cooking-energy efficiency tests were performed with a uniform test pizza as the food product. Pizza crusts were 12-inch diameter, par-baked crusts, weighing 0.9 ± 0.2 pounds and having a moisture content of 36 ± 2% by weight. Pizza sauce was a simple, tomato-based sauce with a moisture content of 87 ± 3% by weight. Pizza cheese was part-skim, low moisture, shredded mozzarella cheese with a moisture content of 50 ± 2% by weight. The ingredients were tested for proper moisture content using gravimetric moisture analysis.

The pizzas were comprised of a pizza crust, sauce, and cheese according to the following: 0.25 lb of pizza sauce spread uniformly on top of a pizza crust

to within 0.5 inch of the edge, and 0.375 lb of pizza cheese, spread uniformly over the pizza sauce. The pizzas were then placed on sheet pans, and covered with plastic wrap. The pizzas were stabilized in a refrigerator for a minimum of 18 hours before testing to ensure temperature uniformity of 39 ± 1°F.

Pizza doneness requires a final pizza temperature of 195 ± 3°F. Cooked pizzas were placed on an insulated surface during temperature determination to isolate them from the worktable and avoid influencing the pizza temperature. This final pizza temperature was measured by placing six hypodermic-style thermocouple probes on the surface of the pizza, located 3 inches from the center of the pizza, and equidistant from each other. The probes were allowed to penetrate the cheese and rest in the crust-sauce interface. The highest recorded average temperature of the 6 probes was then used to determine the temperature of each pizza tested. For purposes of testing, the oven cavity size of 32 inches by 70 inches is rounded down to the nearest foot, in this case to 2 feet by 5 feet. This dictated that 4 rows of 2 pizzas (8 total) were needed for each run of the light load tests, half of which were used to stabilize the oven. The pizzas were removed from the refrigerator and loaded onto the oven conveyor belt so that no more than 1 minute elapsed before the cooking process began. Each row was placed on the conveyor with the pizzas equidistant from the center of the conveyor. All pizzas were measured for a final weight and temperature for use in the energy efficiency calculations.

Heavy-Load Pizza Tests

The heavy load pizza tests were used to calculate cooking-energy efficiency and production capacity when the oven is under maximum loading conditions. The heavy load tests required preparation of 20 rows of 2 pizzas (40 total) for each test run, half of which were used to stabilize the oven. The pizzas were prepared, pre-weighed and stabilized as in the light load tests. The pizza rows were placed one after the other on the oven conveyor such that the leading edge of the new row of pizzas was directly next to the trailing edge of the previous row. All pizzas were measured after cooking for final weight and temperature, for use in the energy efficiency calculations.

Both light and heavy load tests were performed in triplicate to ensure 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.

Appendix C contains the ASTM results reporting sheets for this oven.

Heat Gain to Space Testing

Heat gain to space is calculated indirectly, using the ASTM *Standard Test Method for the Performance of Commercial Kitchen Ventilation*.[2] Heat from the appliance is transferred to the kitchen space primarily by radiation and secondarily by a combination of conduction and convection. This test method is based on the difference between the energy added to and removed from the space during the test period, while the appliance was operated in an idle mode.

3 Results

Energy Input Rate and Thermostat Calibration

The energy input rate was measured and compared with the manufacturer's nameplate value to ensure the oven was operated within its specified parameters. The maximum measured energy input rate was 162,000 Btu/h, which is 4.7% lower than the nameplate rating of 170,000 Btu/h and within the 5% tolerance of the ASTM standard. The oven cavity temperature was monitored to verify that the oven operated at 475 ± 5°F. The oven thermostat was adjusted to 486°F resulting in an oven cavity temperature averaging 475°F at the ASTM specified thermocouple location.

Preheat and Idle Rate Tests

Time and energy were monitored starting from the time the blower and heat switches were turned on. Any time that elapsed before the igniting of the burners is included in the test. The oven had a soft-landing thermostat, so after 11.05 minutes and at a temperature of approximately 425°F, the oven began to reduce its gas input. This soft-landing extended the length of the preheat cycle, but also prevented the oven from over-shooting the temperature set point. The preheat test ended at the specified temperature of 465°F and consumed 36,900 Btu over a time of 15.1 minutes.

The oven stabilized for one hour following the preheat test and then the energy consumption was monitored over a 2-hour period. The recorded idle energy rate was 40,600 Btu/h, which is 23.9% of the rated input for the oven. The oven's preheat curve is shown in Figure 3-1. The rated energy input, preheat energy, and idle rate test results are summarized in Table 3-1.

Results

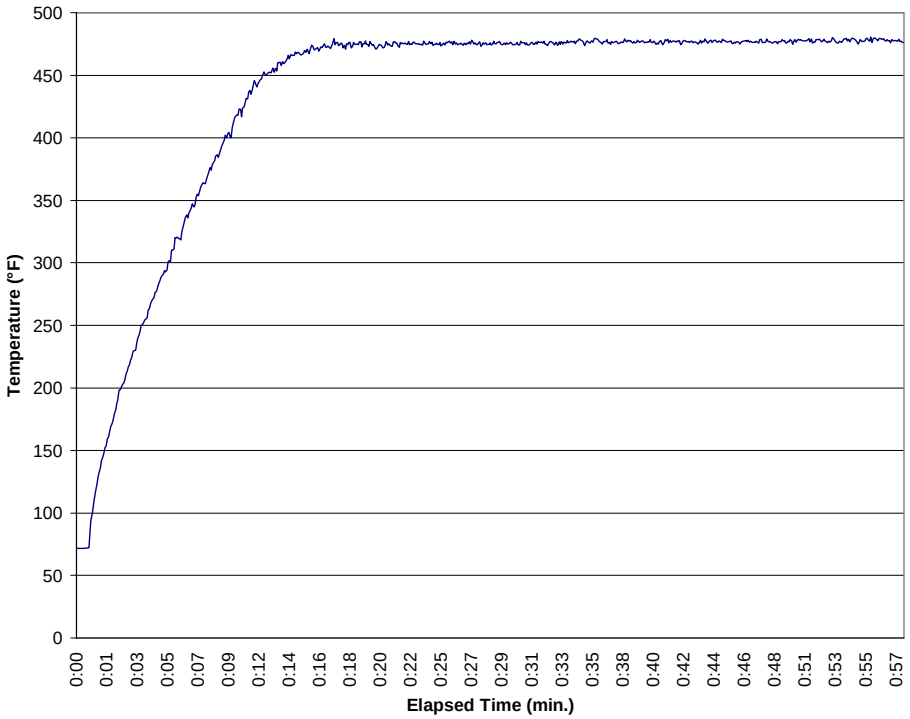

Figure 3-1. Preheat characteristics.

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

Rated Energy Input Rate (Btu/h)	170,000
Measured Energy Input Rate (Btu/h)	162,000
Preheat Time (min)	15.1
Preheat Energy (Btu)	36,900
Idle Energy Rate (Btu/h)	40,600
Idle Duty Cycle (%)	25.1

Temperature Mapping

A temperature measurement grid was constructed to monitor oven cavity temperatures in 10 additional locations to supplement the ASTM-specified temperature measurement location. The thermal mapping allowed engineers to compare the performance of the new Middleby Marshall oven, which fea-

tures a modulating gas control, with Middleby Marshall's previous design that used a solenoid gas valve to control the burners.

Temperature measurement during the last 10 minutes of warmup showed temperature variation at 11 locations inside the bake zone. The variation was due to the oven's adjustable finger design, which allows customized temperature profiles to accommodate a user's particular baking requirements. During idle conditions, the modulating gas control reduced the bandwidth of the temperature swing by 10.6°F, holding the oven's centerpoint temperature at 474 ± 0.7°F. Middleby Marshall's old design held the oven temperature at 475 ± 6.0°F.

Figure 3-2 shows the temperature grid layout, as well as the average temperature results at each location for each gas control valve. Figures 3-3 and 3-4 graphically show warmup curves with the solenoid valve's sawtooth pattern and the modulating gas valve's relatively flat line pattern.

Oven Rear

Oven Entry **Oven Exit**

Position	**6**	**7**	**8**	**9**	**10**
Solenoid Valve (°F)	446	486	478	464	427
Modulating Valve(°F)	456	478	481	462	431
Position			**11 (ASTM)**		
Solenoid Valve (°F)			475		
Modulating Valve(°F)			474		
Position	**1**	**2**	**3**	**4**	**5**
Solenoid Valve (°F)	461	480	464	459	437
Modulating Valve(°F)	462	479	457	456	437

Figure 3-2. Temperature map layout and test results.

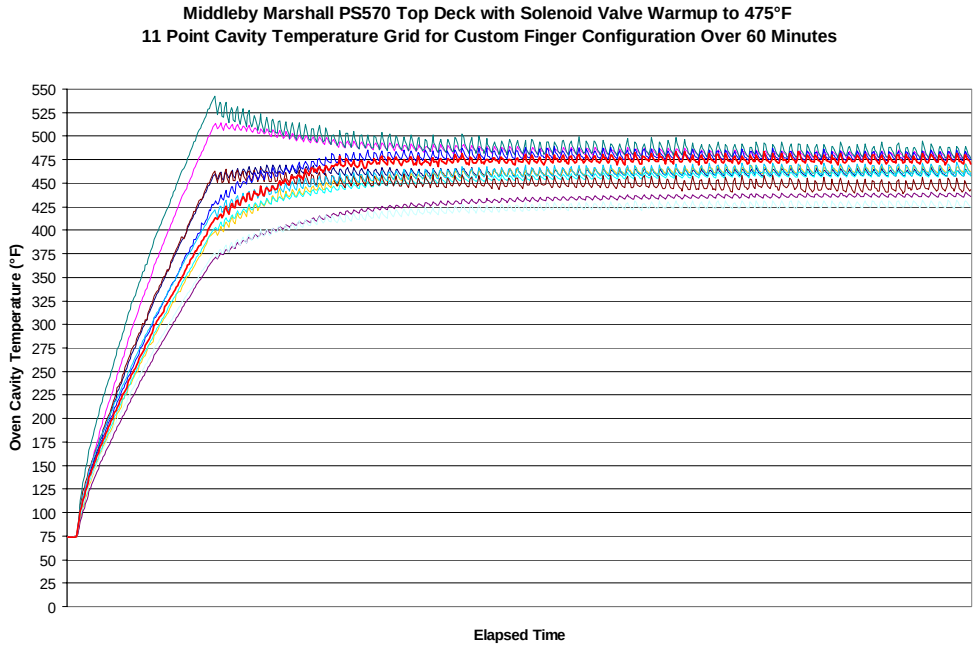

Figure 3-3.

Oven warmup with solenoid valve temperature grid measurement.

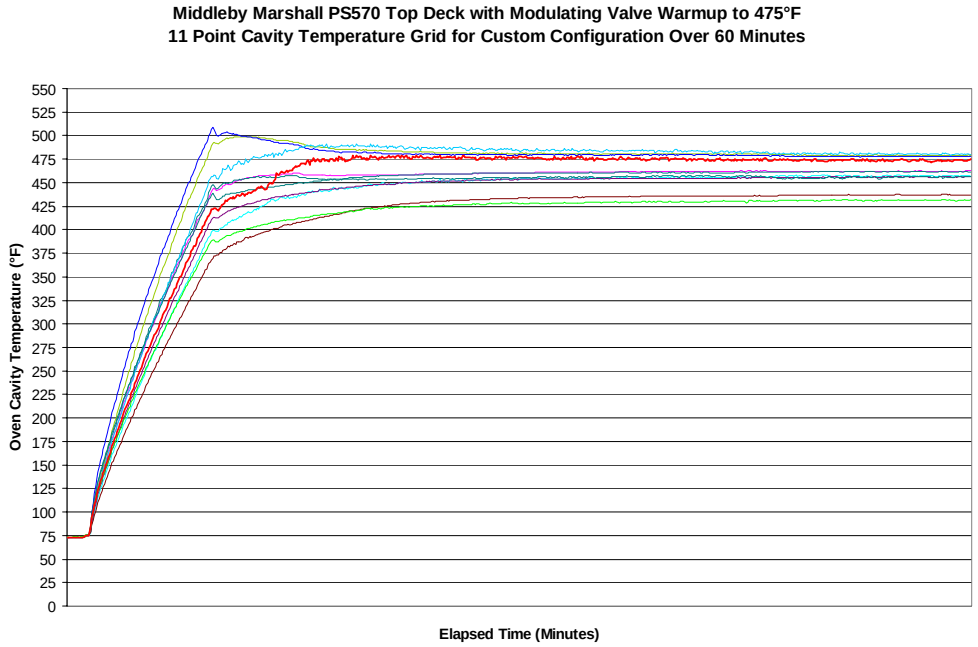

Figure 3-4.

Oven warmup with modulating valve temperature grid measurement.

Results

Cooking Tests

The oven was tested under light and heavy load cooking scenarios. The gas consumption, electric energy consumption, elapsed cook time, oven cavity temperature, and ambient temperature were monitored during each test. Final pizza temperatures were recorded at five-second intervals. Minor variations in loading had a slight impact in the cook times and production rates.

Light-Load Efficiency Tests

The light-load tests were used to determine the oven's performance under partial loading conditions, typical of what may occur during a slow period. With four pizzas, the standard oven completed the test in 7.96 minutes, while demonstrating a cooking-energy efficiency of 11.2% at a production rate of 30 pizzas/hour.

Heavy-Load Efficiency and Production Capacity Tests

The heavy-load cooking tests were designed to reflect an oven's maximum performance. With 20 pizzas, the standard oven completed the heavy load test in 5.48 minutes, while exhibiting a cooking-energy efficiency of 47.4% at a production rate of 219 pizzas/hour.

Test Results

Cooking-energy efficiency is defined as the quantity of energy consumed by the pizzas expressed as a percentage of energy consumed by the oven during the cooking test:

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

Results

The energy transferred to the food was calculated using the measured values of initial and final pizza temperature, initial and final pizza weight, the specific heat of the pizza (based on the specified pizza composition), and the heat of vaporization of water. Energy consumed by the oven is the sum of the gas and electric energy consumed during the test. Table 3-2 summarizes the PS570 oven's performance under the ASTM test method. Appendix D contains a synopsis of test data for each replicate of the cooking tests.

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

	Light Load	Heavy Load
Number of pizzas	4	20
ASTM Measured Cook Time (mm:ss)	4:02	4:02
Test Time (minutes)	7.96	5.48
Total Cooking Energy Rate (Btu/h)	49,990	84,140
Electric Cooking Energy Rate (kW)	1.03	1.01
Energy Efficiency (%)	11.2 ± 1.1	47.4 ± 3.4
Production Rate (pizzas/h)	30	219 ± 4.3

Heat Gain Tests

For the heat gain tests, the upper deck was operated at 475°F with the other two decks turned off. Test results show that when proper capture and containment of the effluent was attained, the single deck operating at the calibrated 475°F setpoint generated a radiant load of 1,800 Btu/h to the kitchen. When the airflow rate was lowered to 50 cfm/linear foot of hood, which was well below where the hood should operate for this appliance, the heat gain to space increased to 11,100 Btu/h. This heat gain increase was a result of the spillage of the flue products into the space, thereby increasing the room temperature and diminishing the air quality in the kitchen. This operating condi-

tion can contribute to a hot and humid kitchen environment. The results of the heat gain testing are graphically shown in Figure 3-5.

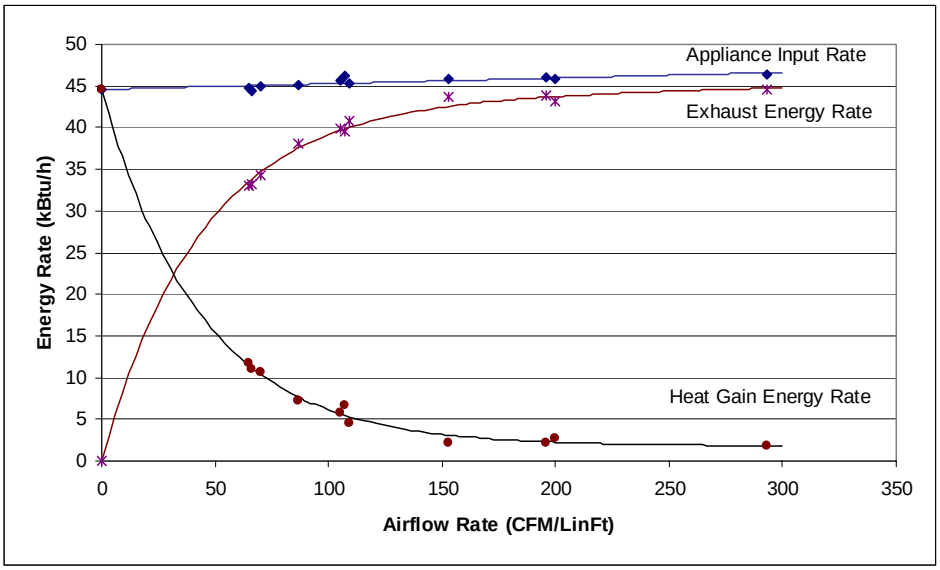

Figure 3-5.
Energy curves at various flow rates.

4 Conclusions

The Middleby Marshall gas conveyor oven, model PS570, performed under the rigorous conditions of the ASTM test methods. The pizzas were consistently and evenly cooked in approximately 4 minutes. The controls were simple to operate and the equipment was relatively easy to clean. Critical internal components were easy to access, troubleshoot, and modify.

The warmup energy rate of 162,000 Btu/h for the standard oven configuration was within 5% of the rated gas energy consumption rate. The oven's duty cycle - that is the percentage of actual energy compared to the 162,000 Btu/h measured energy input rate—was 25% during idle conditions and 54% during heavy load cooking operations. The low duty cycles calculated for idle and cooking conditions imply the oven's burner has much more capacity than is being used during normal operations.

Thermal mapping demonstrated the advantage of using a modulating control valve in this oven design. With the modulating valve's ability to incrementally increase and decrease the fuel supplied to the burner, the temperature swing was reduced, resulting in more consistent oven temperatures.

The PS570 was able to cook 219 pizzas per hour on a single deck, in its standard configuration. The single deck tested demonstrated a heavy-load cooking-energy efficiency of 47.4%, while consuming energy at a rate of 87,600 Btu/h (including electric motor energy). During the test at the FSTC in 1998, the Middleby Marshall PS 360WB demonstrated a heavy-load energy efficiency of 45.0%, while producing 282 pizzas/hour per deck.[3] In both cases, with each deck being completely separate from the others, it is simply a matter of switching off unnecessary decks to save appliance energy based on customer demand for pizzas.

Conclusions

The heat gain to space from the single top deck PS 570 was very low, considering the rate of energy consumption by the appliance. The use of insulation and the forced air-cooling of the oven's front resulted in surfaces that were mostly cool to the touch, and directly reduced the heat gain to space.

With its quick and efficient air impingement cook system, the Middleby Marshall PS570 gas conveyor oven is well suited for heavy use that demands high cooking volume with consistently high product quality.

5 References / Bibliography

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Appendixes

A Glossary

Conveyor Oven

An appliance that carries the food product on a moving conveyor into and through a heated chamber. The chamber may be heated by gas or electric forced convection, radiants, or quartz tubes. Top and bottom heat may be independently controlled.

Conveyor Speed (min)

Time required for a single point on the conveyor belt to travel through the oven cavity.

Cook Time (min)

Time required for an entire pizza to travel through the oven cavity, measured from the time when the leading edge of the pizza enters the oven cavity, to the time when the trailing edge of the pizza exits the oven cavity.

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.

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.

Glossary

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 at a specified control setting.

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.

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

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).

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 cook zone heats during a preheat.

Preheat Time (minute)
Preheat Period

The time required for an appliance to "preheat" 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.

Glossary

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.

Recovery Time (minute, second)

The average time from the removal of the cooked food product from the appliance until the cooking cavity is within 10°F of the thermostat set point and the appliance is ready to be reloaded.

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.

B Appliance Specifications

Appendix B includes the product literature for the Middleby Marshall, Model PS570 Conveyor Oven

Middleby Marshall®
CONVEYORS OF EXCELLENCE

A/A File No.: _____

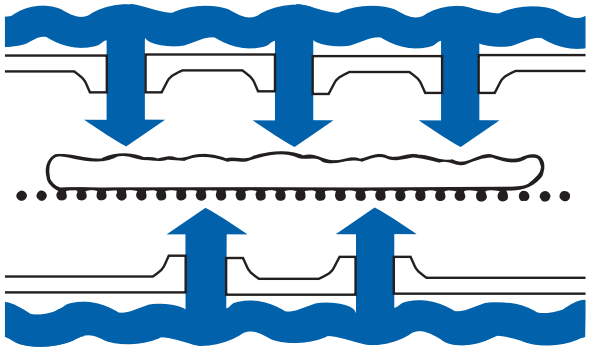
Item No.: _____

PS570

Direct Gas Fired Conveyor Oven

Principle

Middleby Marshall PS Series Conveyor ovens bake both faster and at a lower temperature than other ovens. Patented vertical columns of hot air move heat aerodynamically instead of using high temperatures. The streams of hot air remove the boundary layers of cool heavy air which tend to insulate the product. This gives very rapid baking without burning. All Middleby ovens are designed to cook a multitude of products including pizza, seafood, bagels, ethnic foods and more.



General Information

PS570 conveyor oven features a 70" long cooking chamber, a 32" wide conveyor belt, and a patented “Jet Sweep” impingement process that delivers constant heat to the chamber. All ovens feature microprocessor controlled bake time/conveyor speed. Customer-specific adjustable jet fingers and front-loading window are standard. Jet fingers are independently adjustable. Ovens have stainless steel front, sides and top. The conveyor drive is reversible. Conveyor belt provides automatic delivery when product is finished. Front loading window with cool handle design allows products with different bake times to be cooked consistently regardless of loading.

Special Features

PS570 units are stackable up to four high. Split belt option also available upon request.

Conserves Energy

Middleby ovens provide very efficient heat transfer to product. Energy is conserved as air is recycled from heater to product, with minimum flue or vent loss.

Cleanability

PS570 ovens are designed for easy cleaning. Removable parts include: crumb pans, end panels, air fingers, and a folding conveyor belt assembly.

Easily Serviced

Control compartment is designed for quick and easy access. All electrical controls are door-mounted.

Warranty

All PS570 models have a one year parts and labor warranty. Oven start-up and demonstration are included at no additional charge (USA only).

Ventilation

For installation under a ventilation hood only.

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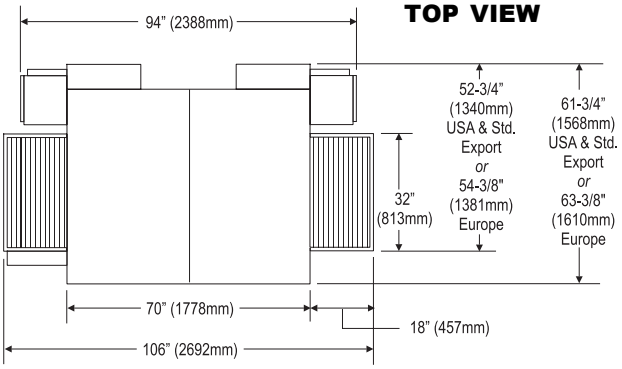
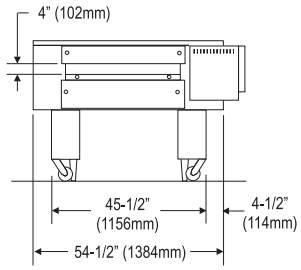
Middleby Marshall
CONVEYORS OF EXCELLENCE

PS570 Series
Direct Gas Fired Conveyor Oven

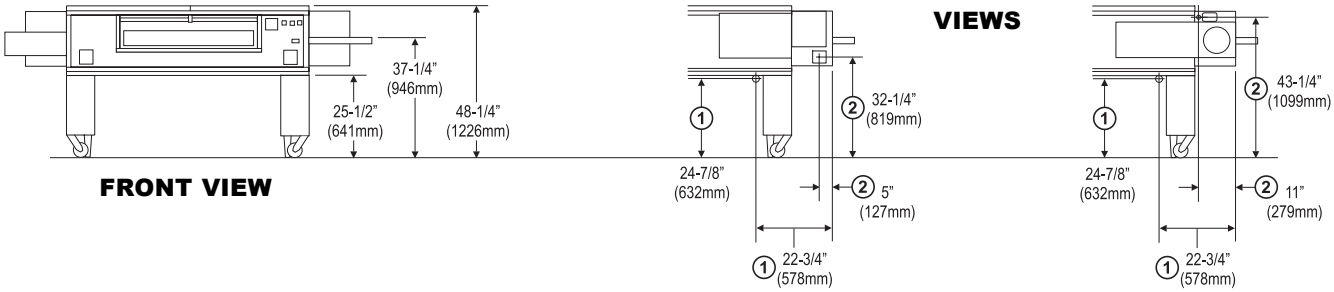




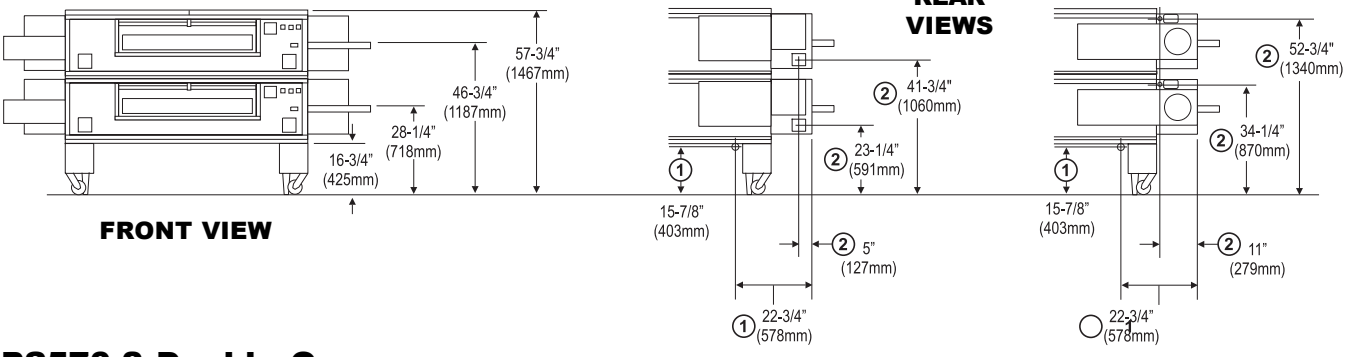
① Gas Utility Connection

② Electrical Utility Connection

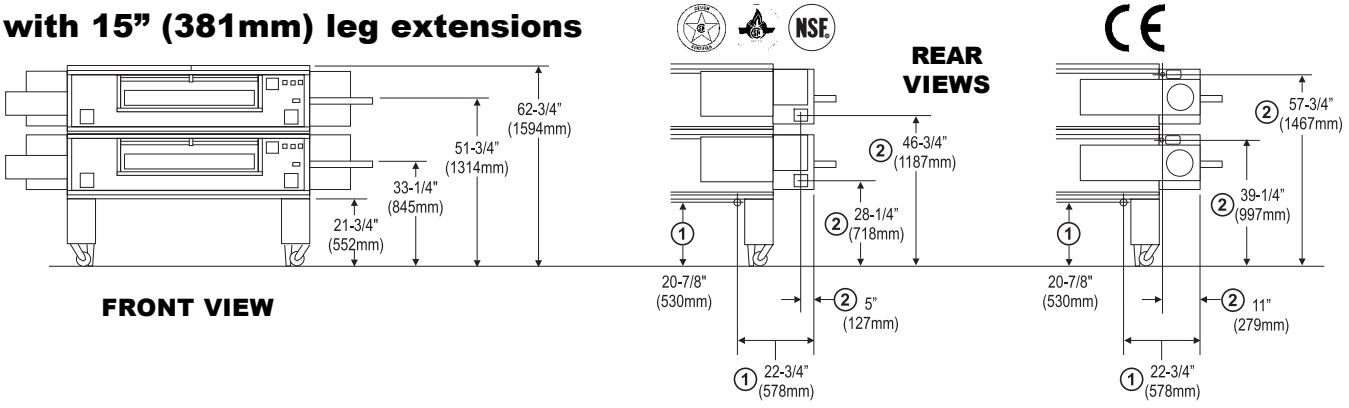
PS570-1 Single Oven with 19" (483mm) leg extensions



PS570-2 Double Oven with 10" (254mm) leg extensions



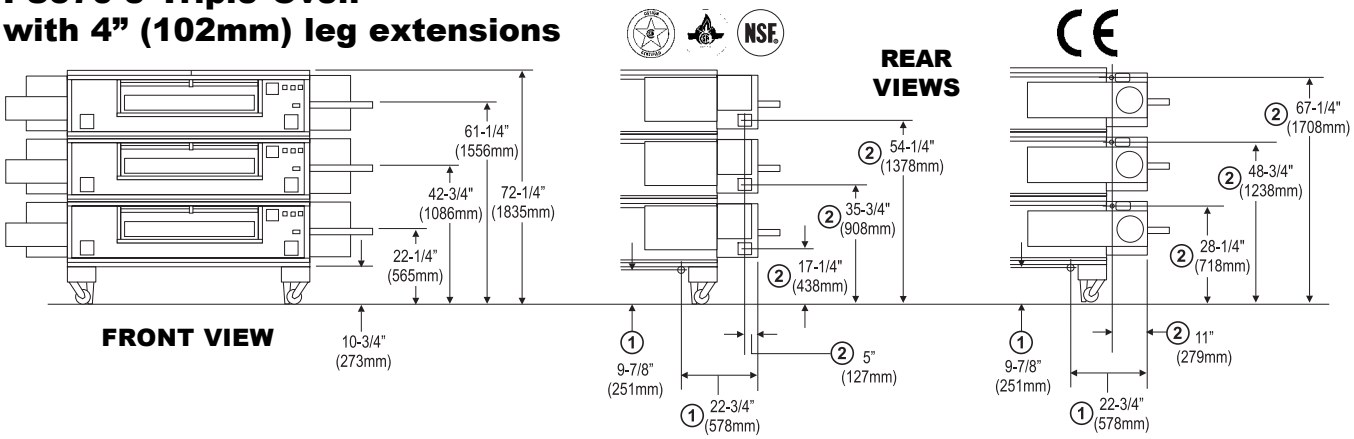
PS570-2 Double Oven with 15" (381mm) leg extensions



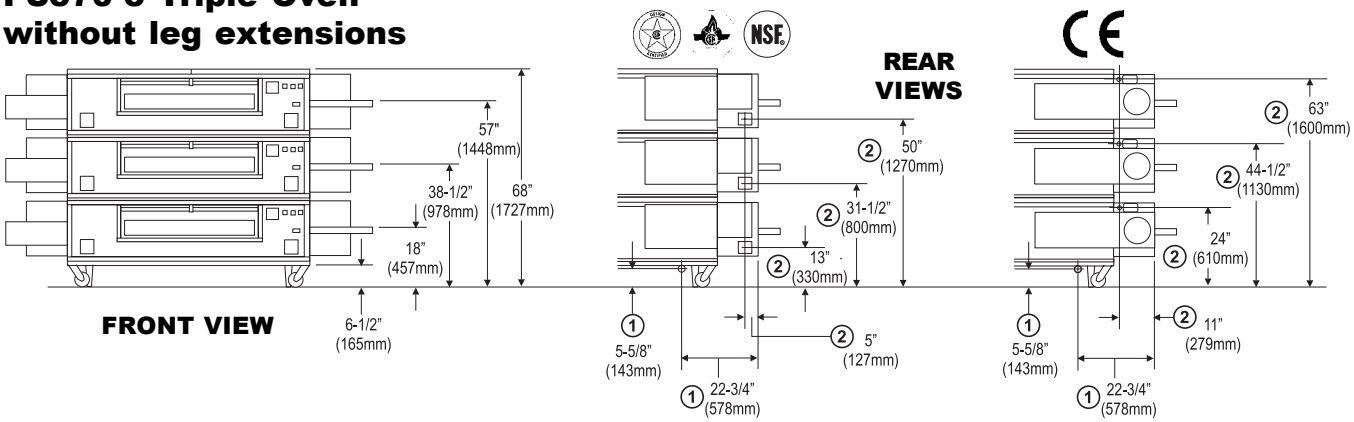
Middleby Marshall®
CONVEYORS OF EXCELLENCE

PS570 Series
Direct Gas Fired Conveyor Oven

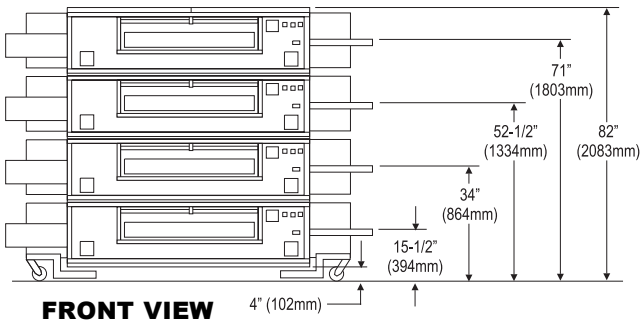
PS570-3 Triple Oven with 4” (102mm) leg extensions

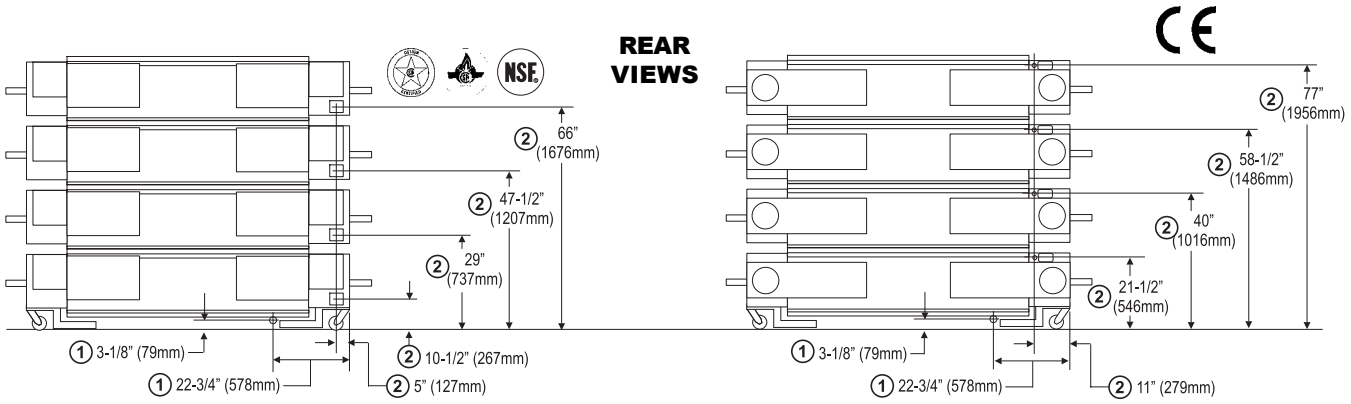


PS570-3 Triple Oven without leg extensions



PS570-4 Quad Oven with outriggers





Middleby® Marshall
CONVEYORS OF EXCELLENCE

PS570 Series
Direct Gas Fired Conveyor Oven

RECOMMENDED MINIMUM CLEARANCES

Rear of oven to wall	Control end of oven to wall	Non-control end of oven to wall
6" (152mm)	0" (0mm)	0" (0mm)

GENERAL INFORMATION

Model	Heating Zone	Baking Area	Belt Length	Belt Width	Depth	Depth CE	Height	Max. Operating Temp.	Bake Time Range	Ship Wt.	Ship Cube
PS570-1 with 19" (483mm) leg extensions	70" 1778mm	15.5 sq. ft. 1.44m²	106" 2692mm	32" 813mm	61-3/4" 1568mm	63-3/8" 1610mm	48-1/4" 1226mm	550°F 288°C	2:40-29:50	1750 lbs. 795kg	160 ft.³ 4.5m³
PS570-2 with 10" (254mm) leg extensions	140" 3556mm	31 sq. ft. 2.88m²	106" 2692mm	32" 813mm	61-3/4" 1568mm	63-3/8" 1610mm	57-3/4" 1467mm	550°F 288°C	2:40-29:50	3500 lbs. 1589kg	320 ft.³ 9.0m³
PS570-2 with 15" (381mm) leg extensions	140" 3556mm	31 sq. ft. 2.88m²	106" 2692mm	32" 813mm	61-3/4" 1568mm	63-3/8" 1610mm	62-3/4" 1594mm	550°F 288°C	2:40-29:50	3500 lbs. 1589kg	320 ft.³ 9.0m³
PS570-3 with 4" (102mm) leg extensions	210" 5334mm	46.5 sq. ft. 4.32m²	106" 2692mm	32" 813mm	61-3/4" 1568mm	63-3/8" 1610mm	72-1/4" 1835mm	550°F 288°C	2:40-29:50	5250 lbs. 2384kg	480 ft.³ 13.5m³
PS570-3 without leg extensions	210" 5334mm	46.5 sq. ft. 4.32m²	106" 2692mm	32" 813mm	61-3/4" 1568mm	63-3/8" 1610mm	68" 1727mm	550°F 288°C	2:40-29:50	5250 lbs. 2384kg	480 ft.³ 13.5m³
PS570-4 with outriggers	280" 7112mm	62 sq. ft. 5.76m²	106" 2692mm	32" 813mm	61-3/4" 1568mm	63-3/8" 1610mm	82" 2083mm	550°F 288°C	2:40-29:50	7000 lbs. 3178kg	640 ft.³ 18.0m³

ELECTRICAL SPECIFICATIONS

Model	Version	Voltage	Phase	Freq.	Current Draw	Supply	Breakers
PS570		208-240V	1	60 Hz	12A	3 pole, 4 wire (2 hot, 1 neut., 1 gnd)	As per local codes
PS570	CE	230V	1	50 Hz	10A	2 pole, 3 wire (2 hot, 1 gnd)	As per local codes

GAS SUPPLY SPECIFICATIONS

	Min. Gas Pipe Size	Supply Gas Pressure	Rated Heat Input
Natural Gas	2-1/2" (63.5mm) main One 1-1/4" (12.7mm) NPT branch to lower oven cavity with individual full-flow shutoff valve	6-12" W.C. (14.9-29.9 mbar)	170,000 BTU (42,840 kcal, 50 kW/hr.) per oven cavity
Propane Gas	2" (50.8mm) main One 1-1/4" (12.7mm) NPT branch to lower oven cavity with individual full-flow shutoff valve	11-14" W.C. (27.4-34.9 mbar)	170,000 BTU (42,840 kcal, 50 kW/hr.) per oven cavity

* *The gas supply pressures shown are for ovens installed in North America. The required gas supply pressures of other locations are dependent on the local gas type and on all applicable local codes.*

ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

Middleby® Marshall
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THE MIDDLEBY CORPORATION
THE BRAND BEHIND THE BRANDS

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www.middleby.com

Printed in U.S.A 1/01 Form 4501

C Results Reporting Sheets

Manufacturer	Middleby Marshall, Inc.
Model	PS570
Date:	December 2000

Section 11.1 Test Oven

Description of operational characteristics: The oven draws heated air through a fan which forces it into the oven cavity through air distribution fingers above and below the conveyor, which carries food into and through the oven. The oven has front mounted controls for all operating functions.

Section 11.2 Apparatus

The oven was installed in accordance with the manufacturer's instruction on a tiled floor 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 300 cfm per linear foot of hood.

The oven was instrumented using a positive displacement gas meter, a watt/watt-hour transducer, and a 24 gauge, type K fiberglass insulated thermocouple wire (for oven cavity temperature measurement). A voltage regulator maintained a constant voltage for all tests and data was recorded at five-second intervals by a computerized data acquisition unit. All test apparatus were installed in accordance with Section 9 of the ASTM test method.

Results Reporting Sheets

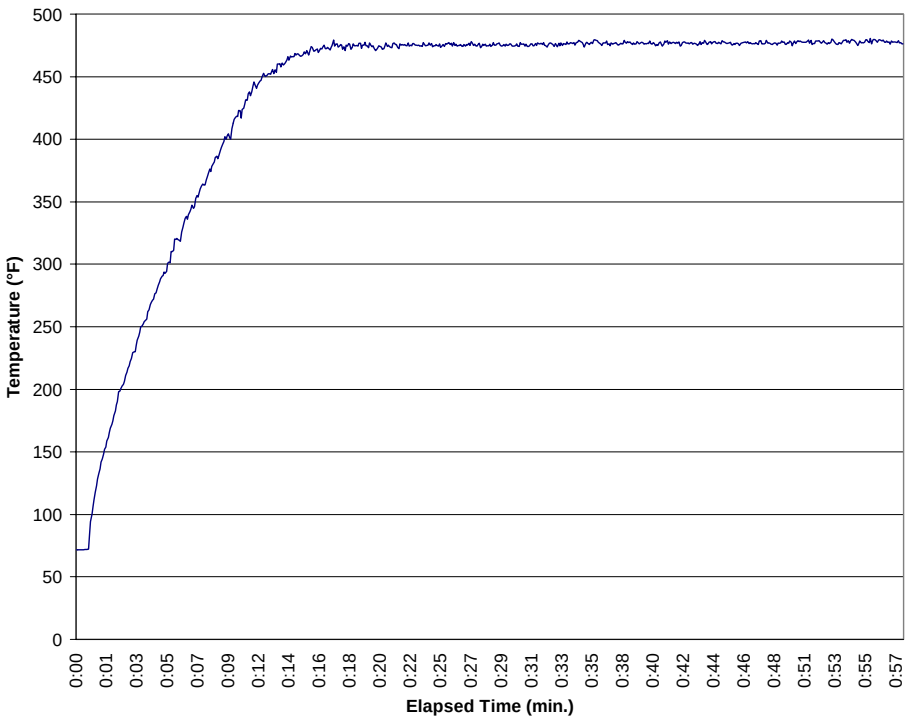
Section 11.4 Energy Input Rate

Test Voltage	208 V
Gas Heating Value	989 Btu/ft^3
Rated	170,000 Btu/h
Measured	162,000 Btu/h
Percent Difference between Measured and Rated	4.7 %
Fan/Control Energy Rate (Gas Ovens Only)	1.12 kW

Section 11.5 Preheat Energy and Time

Test Voltage	208 V
Gas Heating Value	989 Btu/ft^3
Energy Consumption	36,900 Btu
Time from 75°F to 465°F	15.1 min

Preheat Characteristics



Results Reporting Sheets

Section 11.6 Idle Energy Rate

Test Voltage	208 V
Gas Heating Value	989 Btu/ft^3
Idle Energy Rate	40,600 Btu/h

Section 11.7 Pilot Energy Rate

Gas Heating Value	N/A
Pilot Energy Rate	N/A

Section 11.8 Cooking Energy Efficiency and Cooking Energy Rate

Cook Time Determination:

Cook Time	4.03 min
Conveyor Speed	3.5 min

Light Load:

Test Voltage	208 V
Gas Heating Value	986 Btu/ft^3
Cooking Energy Efficiency	11.2 ± 1.1%
Gas Cooking Energy Rate	49,990 Btu/h
Electric Cooking Energy Rate	1.03 kW

Heavy Load:

Test Voltage	208 V
Gas Heating Value	990 Btu/ft^3
Cooking Energy Efficiency	47.4 ± 3.4%
Gas Cooking Energy Rate	84,140 Btu/h
Electric Cooking Energy Rate	1.01 kW
Production Capacity	219 ± 4.3 Pizzas/h
Production Capacity	311 ± 11.3 lb/h

D Cooking-Energy Efficiency Data

Table D-1. Physical Properties.

Specific Heat (Btu/lb °F)	
Pizza	0.593
Latent Heat (Btu/lb)	
Vaporization, Water	970

Table D-2. Light Load Pizza Efficiency Test Data.

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Number of Pizzas	4	4	4
Conveyor Speed (min)	3.5	3.5	3.5
Initial Pizza Temperature (°F)	40.0	40.0	40.0
Final Average Pizza Temperature (°F)	194.0	197.7	193.9
Total Initial Pizza Weight (lb)	5.69	5.66	5.82
Total Final Pizza Weight (lb)	5.40	5.38	5.56
Test Time (min)	8.0	7.8	8.0
Gas Volume (ft^3)	6.6	6.8	6.8
Electric Energy (Wh)	140	140	140
Calculated Values			
Energy Consumed by Pizzas (Btu)	820	790	780
Gas Energy Consumed by Oven (Btu)	6,510	6,690	6,690
Electric Energy Consumed by Oven (Btu)	470	470	470
Total Energy Consumed by Oven (Btu)	6,980	7,160	7,160
Cooking Energy Efficiency (%)	**11.7**	**11.0**	**10.9**
Gas Cooking Energy Rate (Btu/h)	**48,620**	**51,270**	**50,090**
Electric Cooking Energy Rate (kW)	**1.02**	**1.04**	**1.02**

Cooking-Energy Efficiency Data

Table D-3. Heavy Load Pizza Efficiency Test Data.

	Repetition #1	Repetition #2	Repetition #3
Measured Values			
Number of Pizzas	20	20	20
Conveyor Speed (min)	3.5	3.5	3.5
Initial Pizza Temperature (°F)	40.0	40.0	40.0
Final Average Pizza Temperature (°F)	198.8	192.0	193.1
Total Initial Pizza Weight (lb)	28.19	28.46	28.36
Total Final Pizza Weight (lb)	26.91	27.23	27.16
Test Time (min)	5.5	5.4	5.5
Gas Volume (ft^3)	7.8	7.6	8.0
Electric Energy (Wh)	90	90	90
Calculated Values			
Energy Consumed by Pizzas (Btu)	3,830	3,780	3,750
Gas Energy Consumed by Oven (Btu)	7,680	7,490	7,870
Electric Energy Consumed by Oven (Btu)	320	307	320
Total Energy Consumed by Oven (Btu)	8,000	7,800	8,190
Cooking Energy Efficiency (%)	**47.9**	**48.4**	**45.8**
Gas Cooking Energy Rate (Btu/h)	**83,820**	**82.750**	**85,840**
Electric Cooking Energy Rate (kW)	**1.02**	**1.0**	**1.02**
Production Capacity (Pizzas/h)	**218**	**221**	**218**
Production Capacity (lb/h)	**307.5**	**316.2**	**309.4**

Cooking-Energy Efficiency Data

Table D-4. Cooking-Energy Efficiency and Production Capacity Statistics.

	Cooking-Energy Efficiency		Production Capacity
	Heavy Load	**Light Load**	**(pizzas/h)**
Replicate #1	47.9	11.7	218
Replicate #2	48.4	11.0	221
Replicate #3	45.8	10.9	218
Average	**47.4**	**11.2**	**219**
Standard Deviation	1.38	0.44	1.73
Absolute Uncertainty	3.42	1.09	4.29
Percent Uncertainty	7.22	9.73	1.96