

Continental Refrigerated Prep Table Performance Testing

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Prepared by:
David Zabrowski
David Cowen
Fisher-Nickel, Inc.

Contributor:
Scott Miner
Fisher-Nickel, Inc.

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Specific appreciation is extended to Continental Inc., for supplying the Food Service Technology Center with a 4-foot refrigerated prep table for controlled testing in the appliance laboratory.

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Contents

| | Page |
|--------------------------------------|-------------|
| Background | 1 |
| Objectives | 2 |
| Appliance Description | 3 |
| Setup and Instrumentation | 4 |
| Test Procedure and Results | 6 |
| Conclusions | 11 |
| References | 12 |
| Appendix A: Glossary | |
| Appendix B: Appliance Specifications | |

List of Figures and Tables

Figures

| | Page |
|---|-------------|
| 1 Refrigerated prep table open display area..... | 1 |
| 2 Continental SW48-12 refrigerated prep table | 3 |
| 3 Well with METHOCEL [®] K4M slurry and thermocouple | 5 |
| 4 Thermocouple locations and configuration | 6 |
| 5 Well temperature during the lid-up test..... | 7 |
| 6 Average cabinet temperature during the lid-up test | 7 |
| 7 Well temperature during the lid-down test..... | 8 |
| 8 Average cabinet temperature during the lid-down test..... | 9 |

Tables

| | Page |
|-------------------------------------|-------------|
| 1 Appliance Specifications | 4 |
| 2 Summary of Test Results | 10 |
| 3 Energy Consumption and Cost. | 10 |

Continental SW48-12 Performance Testing

Background

Many establishments rely on refrigerated prep tables to provide quick and easy access to commonly used refrigerated items. Changes to the FDA model food code in 1999 required refrigerated prep tables to maintain food in the open display area below 41°F (Figure 1). In response, manufacturers have employed a variety of stratagem for meeting this stricter requirement without freezing the food in the cabinet.



*Figure 1.
Refrigerated prep table
open display area.*

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

Continental SW48-12 Performance Testing

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 such that users can make meaningful 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.

FSTC engineers previously conducted a bench-test to compare the performance of five different 48-inch refrigerated prep tables.¹ These test results showed a wide range in the energy consumption between different designs, leading the FSTC Advisory Board to recommend developing a comprehensive test method for quantifying the energy consumption and performance of these appliances. The draft test method was subsequently approved and ratified by ASTM as the *Standard Test Method for the Performance of Refrigerated Preparation and Buffet Tables* (Designation F2143-01).²

Continental's refrigerated prep table line employs a unique non-recessed pan system that does not require an air curtain to maintain the temperature of the food in the display area. This report presents the results of applying the ASTM test method to the Continental SW48-12 refrigerated prep table. 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 Continental's 48-inch refrigerated prep table under the controlled conditions of the ASTM standard test method. The scope of this testing is as follows:

Continental SW48-12 Performance Testing

1. Verify that the appliance is operating at the manufacturer's rated energy input (current draw).
2. Document pan temperatures and appliance energy consumption with the lid in a raised (operating) position (ASTM test).
3. Characterize the idle energy use with the rail filled with product and the lid closed.
4. Estimate the operating cost based on a standardized cost model.

Appliance Description

Continental's SW48-12, 48-inch refrigerated prep table includes a non-recessed rail, which sits on top of the prep table allowing for easy removal and replacement of pans and access to commonly used items. The top is cooled by the cavity below. The top and front are stainless steel with aluminum comprising the case, interior and end panels (Figure 2).



Figure 2.
Continental SW48-12
refrigerated prep table.

Continental SW48-12 Performance Testing

Nominal 2-inch Non-CFC polyurethane foam insulation prevents heat gain, while the two cabinet doors feature self-closing hinges and snap-in magnetic gaskets.

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

Table 1. Appliance Specifications.

| | |
|------------------------|--|
| Manufacturer | Continental Refrigerator |
| Model | SW48-12 |
| Generic Appliance Type | Refrigerated Preparation and Buffet Table |
| External Dimensions | 48" wide x 30" deep x 43" high (including 6" adjustable legs) |
| Rail Pan Capacity | 12 standard 1/6-size (1½-quart capacity) pans |
| Current Rating | 4.4 amps @ 115 volts |
| Refrigerant Type | R-134A |
| Refrigerant Amount | 11 oz |
| Design Pressure | 324 psi high; 140 psi low |
| Construction | Stainless-steel top and front with aluminum sides, interior and rear panel |

Setup and Instrumentation

Laboratory Set-Up

The refrigerated preparation table was installed in an insulated room in accordance with the provision of the ASTM test method. During testing, the room was held at $86 \pm 2^\circ\text{F}$ with a maximum relative humidity of 50%. Vertical temperature stratification was less than 1.5°F per foot and the air velocity across the surface of the test pans was kept to below 50 ft/min.

Continental SW48-12 Performance Testing

Test Food Product

The tests were conducted using the industry standard $\frac{1}{6}$ -size (1.6 liter or 1.5 quart capacity) plastic food pans, which were approximately 4 inches deep. Each pan was filled with a simulated food product (as specified by the ASTM test method) to $\frac{1}{2}$ inch below the rim of the pan. The test food was a slurry of de-ionized water, salt, and hydroxypropyl methylcellulose (supplied by Dow Chemical under the trade name METHOCEL[®] K4M), as shown in Figure 3. The ingredients were thoroughly mixed to create a smooth and homogeneous mixture. The filled pans were covered and preconditioned in a refrigerator to a stable temperature of $35 \pm 2^{\circ}\text{F}$ before loading into the refrigerated rail.



*Figure 3.
Well with METHOCEL[®] K4M
slurry and thermocouple.*

Instrumentation

A total of ten thermocouples were used to measure the temperature of the simulated food product in the five pans. The four corner pans and one pan in

Continental SW48-12 Performance Testing

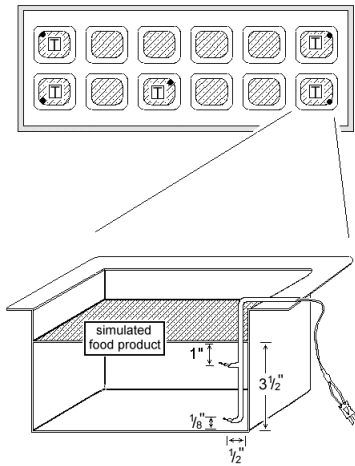


Figure 4.
*Thermocouple locations
and configuration*

the center of the food rail were instrumented as illustrated in Figure 4. Two thermocouples were placed in each pan that was being used to monitor simulated food temperatures. The first thermocouple in each pan was placed 1 inch below the food surface and the second thermocouple was placed $\frac{1}{8}$ -inch above the bottom of the pan as illustrated. Each thermocouple was positioned $\frac{1}{2}$ -inch away from the sides of the pan.

Three thermocouples were used to measure the refrigerated cavity (box) temperatures below the refrigerated rail. No food load was placed in the refrigerated box. One thermocouple was placed on each side of the cavity (left and right side), five inches from the sides, two inches above the bottom surface and centered front to back of the cavity. The third thermocouple was placed in the geometric center of the cavity.

Electrical energy consumption was measured with a Watt-hour transducer that generated a pulse for every 0.00001 watt-hours. The transducer and thermocouples were connected to an automated data acquisition unit that recorded data every 5 seconds. Energy consumption and input rates were calculated and temperature profiles were generated from this information.

Test Procedure and Results

Lid-Up Test

The pans of simulated food were stabilized to $35 \pm 2^\circ\text{F}$ in a separate refrigerator overnight prior to testing. Additional pans filled with 35°F water were used to precondition the refrigerated prep table for a minimum of four compressor cycles prior to loading the top with the simulated food product.

Researchers conducted a 4-hour test with the simulated product in each well. The lid was in the open position and the cabinet doors remained closed during the test. This lid-up test was designed to emulate normal operation during the day.

The unit consumed an average of 402 watts during the lid-up test, while holding the pans comfortably below 41°F . Figures 5 and 6 show the well and cabinet temperatures during the 4-hour test.

Continental SW48-12 Performance Testing

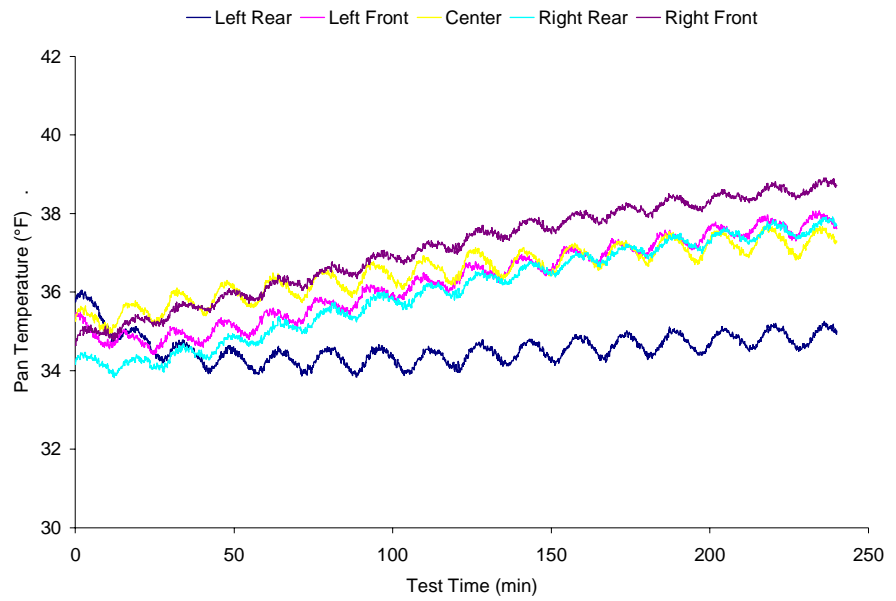


Figure 5.
Well temperature during the lid-up test.

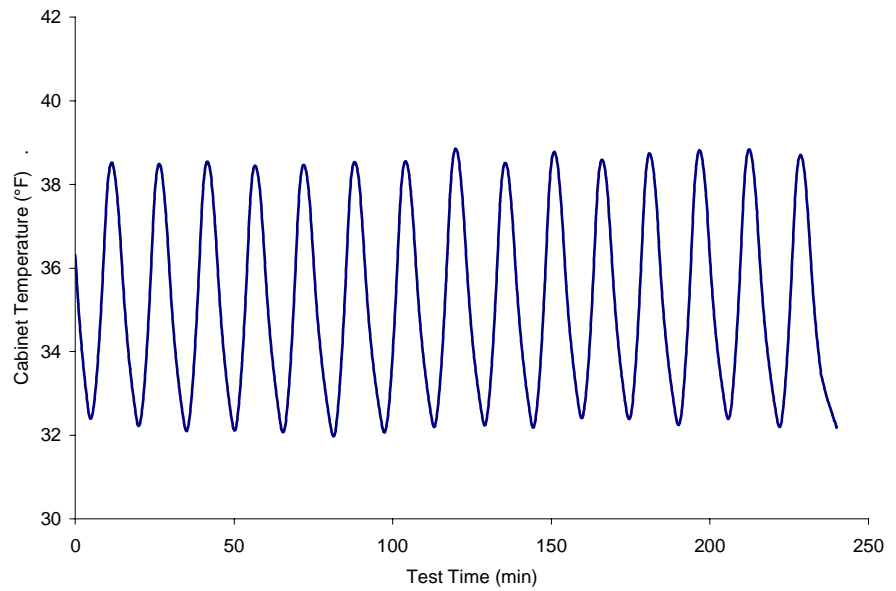


Figure 6.
Average cabinet temperature during the lid-up test.

Continental SW48-12 Performance Testing

Lid-Down Test

To further characterize the performance of the refrigerated prep table during non-usage periods, a separate lid-down test was conducted over an 8-hour period immediately following a 4-hour lid-up test. The lid and cabinet doors remained closed to simulate nighttime operating conditions.

During the lid-down test, the unit consumed an average of 390 watts. Well temperatures during the lid-down test are presented in Figure 7; Figure 8 shows the average cabinet temperature over the same 8-hour period.

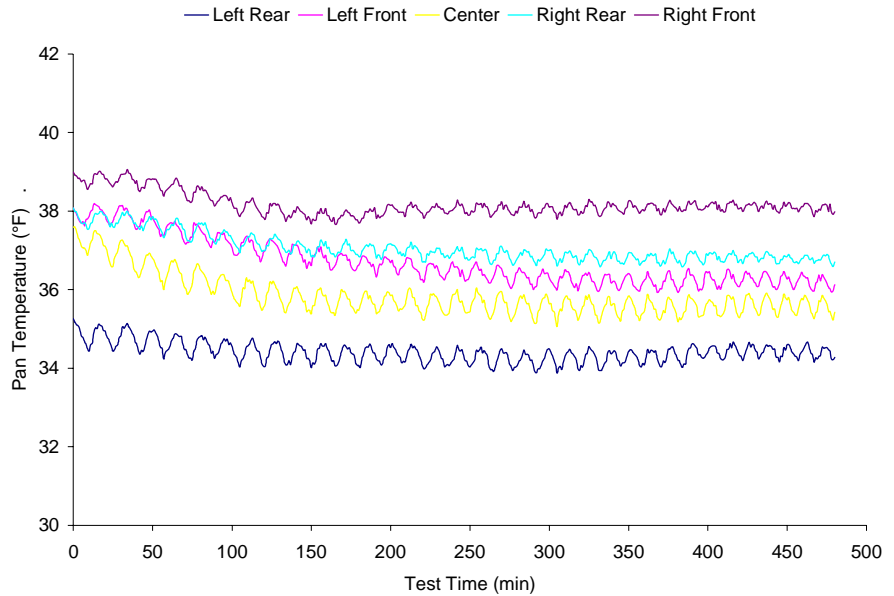
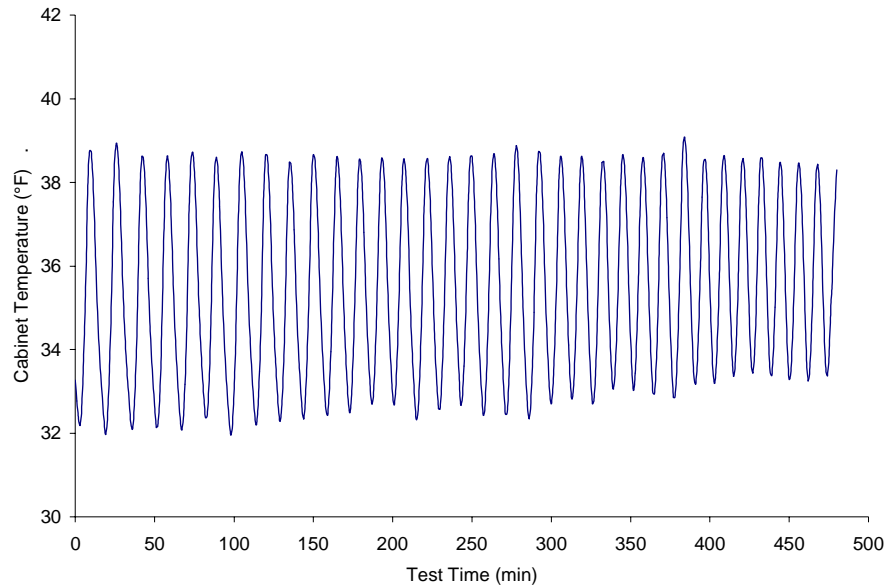


Figure 7.
Well temperature during the lid-down test.

Continental SW48-12 Performance Testing



*Figure 8.
Average cabinet temperature during the lid-down test.*

Test Results

Compressor percentage run time, or duty cycle, was calculated for the two different operating tests. During both the lid-up and lid-down tests, the compressor exhibited frequent, short on-cycles. The average energy consumption was virtually the same for both lid-up and lid-down conditions. As there is no air curtain cooling the pans from the surface the unit used equivalent amounts of energy to maintain the mandated temperatures below 41°F during both the lid-up and lid-down tests. Cooling the pans from below proved to be very effective with average pan and cabinet temperatures of 36.1°F and 35.3°F, respectively, for lid-up tests and 36.6°F and 35.3°F, respectively, during lid-down tests. With average energy rates of approximately 400 Watts during both tests conditions the unit performed on par with other refrigerated prep tables tested at the Food Service Technology Center. Table 2 summarizes the test results for the lid-up and lid-down tests.

Continental SW48-12 Performance Testing

Table 2. Summary of Test Results.

| | Lid-Up | Lid-Down |
|--|--------|----------|
| Test Voltage (V) | 120 | 120 |
| Average Energy Rate (W) | 402 | 390 |
| Compressor Duty Cycle (%) | 65.9 | 63.9 |
| Average Pan Temperature (°F) | 36.1 | 36.6 |
| Pan Temperature Stratification (°F) ^a | 3.7 | 3.3 |
| Average Cabinet Temperature (°F) | 35.3 | 35.3 |
| Cabinet Temperature Stratification (°F) ^b | 2.4 | 2.5 |

^a Pan temperature stratification represents the average temperature difference from the bottom of the pan to within one inch of the top.

^b Cabinet temperature stratification represents the average temperature difference from the left side to the right side of the cabinet with no food load.

Energy Model

Researchers developed an energy usage/cost model to estimate annual user costs. The model is based on operational energy use from both the lid-up and lid-down tests. The lid-down test was used to estimate nighttime energy use of the unit, while the lid up test was used to estimate typical operational use during the day. The model assumed 12 operating (lid-up) hours per day, 365 days per year. The energy cost was based on \$0.10/kWh, a typical average energy rate for the United States. Energy consumption and operating cost are summarized in Table 3.

Table 3. Energy Consumption and Cost.

| | Energy Consumption (kWh/yr) | Annual Operating Cost (\$/yr) |
|--------------|-----------------------------|-------------------------------|
| Lid-Up | 1,763 | 176 |
| Lid-Down | 1,709 | 171 |
| Total | 3,472 | 347 |

Continental SW48-12 Performance Testing

Conclusions

Continental's refrigerated prep table performed well during the comprehensive laboratory testing. The unit was capable of maintaining the temperature of the pans in the open display area below the FDA-mandated 41°F without using the commonly employed air curtain. The cabinet was solely responsible for maintaining the temperature of the pans in the rail by cooling from below. The SW48-12 exhibited impressive temperature performance, especially considering that the unit maintained the pan temperatures without allowing the cabinet temperature to fall below freezing.

The temperature performance did come with an energy premium, however, as the lid-down energy rate did not drop considerably when compared to the lid-up test. It is important to note that the well temperatures did not approach freezing during the lid-down test, a condition we have seen from other prep tables tested at the FSTC Lab.

Continental's SW48-12 refrigerated prep table proved to be easy to operate out of the box with the factory thermostat settings requiring only a minor adjustment to maintain acceptable temperatures in both the rail and the cabinet; no further adjustments were necessary.

Continental SW48-12 Performance Testing

References

1. Gil Ashton Publishing, LLC. *Probing New NSF 7 Prep Tables*, Foodservice Equipment Reports, November 1998.
2. American Society for Testing and Materials. 2001. *Standard Test Method for the Performance of Refrigerated Preparation and Buffet Tables*. ASTM Designation F2143-01, in *Annual Book of ASTM Standards*, Philadelphia.

A Glossary

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 pre-heat.

Idle Energy Rate (kW or Btu/h)

Idle Energy Input Rate

Idle Rate

The rate of appliance energy consumption while it is “idling” or “holding” at a stabilized operating condition or temperature.

Idle Temperature (°F, Setting)

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

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 the initial appliance draw-down or cool-

down period (i.e., the period of operation when the compressor(s) are “on”).

Capacity

The amount of pans that can be held in the open display area of the refrigerated prep table.

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.

Relative Humidity

RH

A measurement of the degree of saturation of air, with 100% indicating completely saturated air and 0% indicating completely dry air.

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.

B Manufacturer Specifications

Appendix B includes the product literature for the Continental model SW48-12 refrigerated prep table.

Continental



Utilizing Environmentally Safe, CFC-free R-134a Refrigerant

Refrigerator

SANDWICH UNIT REFRIGERATORS



MODEL SW72-18

Models Available

- SW27-8
- SW48-8
- SW48-10
- SW48-12
- SW60-8
- SW60-12
- SW60-16
- SW72-12
- SW72-18

Standard Features

- Unique Air Flow Distribution Allows Pan Product to Maintain 33°-41°F Being in Compliance with and Certified Under the New '98 NSF Standard For Preparation Units.
- Modern, State-of-the-Art Styling
- Performance Rated Refrigeration System Utilizing Environmentally Safe R-134a Refrigerant
- Easily Serviceable Back Mounted Compressor
- 2" Non-CFC Polyurethane Foam Insulation
- Spring Loaded, Self Closing Door
- Magnetic Snap-In Gasket
- Adjustable 6" Legs
- Heavy-Duty, Epoxy-Coated Steel Shelves
- Interior Hanging Thermometer
- 12" Deep Full Length Nylon Cutting Board
- Cabinet Construction Consisting of Stainless Steel Front and Top, Aluminum End Panels, Case Back and Interior
- Non-Corrosive, Plasticized Fin Evaporator Coil
- Completely Enclosed, Vented and Removable Case Back
- Automatic, Energy Saving, Non-Electric Condensate Disposal
- 1/6 Size Pans, 4" Deep
- 10 ft Cord and Plug Attached

Optional Features & Accessories

- | | |
|--|------------------------|
| • Casters | • Electric Condensate |
| • Remote Models R | • Pan Opening Sizes |
| • Stainless Steel End Panels- SA Models | • Stainless Steel Legs |
| • Stainless Steel Interior & Exterior-SS Models | • Additional Shelves |
| • Stainless Steel Finished Back in Lieu of Aluminum | • Door Locks |
| • Stainless Steel Roll Out Drawers in Lieu of Doors-D Models | • Single Overshelf |
| | • Double Overself |

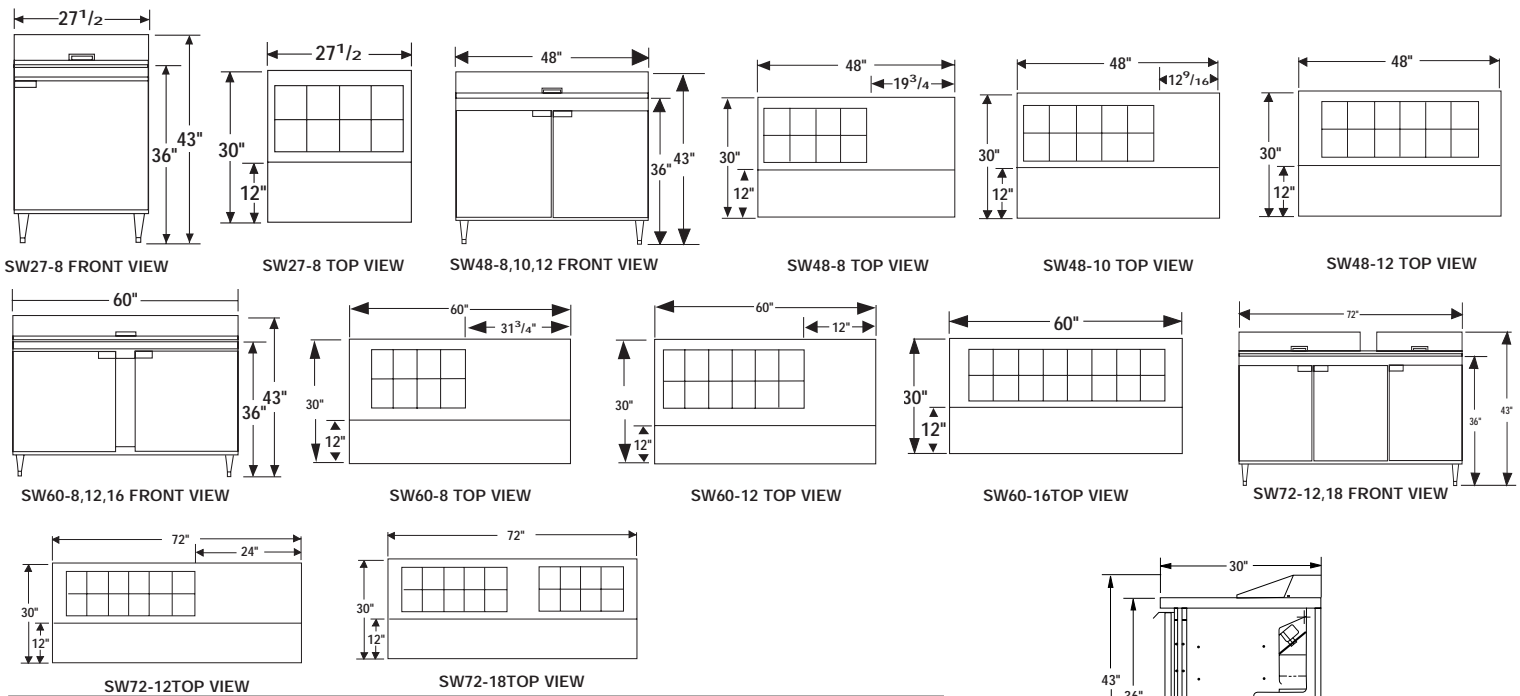




SANDWICH UNIT REFRIGERATORS

SPECIFICATIONS

| | MODEL SW27-8 | MODEL SW48-8 | MODEL SW48-10 | MODEL SW48-12 | MODEL SW60-8 | MODEL SW60-12 | MODEL SW60-16 | MODEL SW72-12 | MODEL SW72-18 |
|---------------------------------------|--------------|--------------|---------------|---------------|--------------|---------------|---------------|---------------|---------------|
| DIMENSIONAL DATA | | | | | | | | | |
| Net Capacity (cu. ft.) | 7.4 | 13.4 | 13.4 | 13.4 | 17.0 | 17.0 | 17.0 | 20.6 | 20.6 |
| 1/6 Size Pans | 8 | 8 | 10 | 12 | 8 | 12 | 16 | 12 | 18 |
| Width, Overall (in.) | 27 1/2 | 48 | 48 | 48 | 60 | 60 | 60 | 72 | 72 |
| Depth, (incl. Hdls. & Bumpers) (in.) | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| Depth, Body Only (Less Door(s))(in.) | 27 1/2 | 27 1/2 | 27 1/2 | 27 1/2 | 27 1/2 | 27 1/2 | 27 1/2 | 27 1/2 | 27 1/2 |
| Depth, Cutting Board (Std. Top) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Height, Overall (incl. 6" Legs) (in.) | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| Shelf Area (sq. ft.) | 3.5 | 6.8 | 6.8 | 6.8 | 8.1 | 8.1 | 8.1 | 10.2 | 10.2 |
| No. of Shelves | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 |
| No. of Doors | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 |
| Condensing Unit Size (H.P.) | 1/5 | 1/5 | 1/5 | 1/5 | 1/4 | 1/4 | 1/4 | 1/4 | 1/4 |
| Refrigerant | R134a | R134a | R134a | R134a | R134a | R134a | R134a | R134a | R134a |
| Cabinet Electrical | 115/60/1 | 115/60/1 | 115/60/1 | 115/60/1 | 115/60/1 | 115/60/1 | 115/60/1 | 115/60/1 | 115/60/1 |
| Amps | 6.2 | 7.1 | 7.1 | 7.1 | 8.2 | 8.2 | 8.2 | 9.0 | 9.0 |
| Fans | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | 4 |
| Interior Depth (in.) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Interior Height (in.) | 26 1/4 | 26 1/4 | 26 1/4 | 26 1/4 | 26 1/4 | 26 1/4 | 26 1/4 | 26 1/4 | 26 1/4 |
| Interior Width (in.) | 24 1/4 | 44 | 44 | 44 | 56 | 56 | 56 | 68 | 69 |
| Shipping Weight (lbs.) | 180 | 267 | 268 | 270 | 309 | 311 | 315 | 385 | 389 |
| Shipping Height (in.) | 43 1/4 | 43 1/4 | 43 1/4 | 43 1/4 | 43 1/4 | 43 1/4 | 43 1/4 | 43 1/4 | 43 1/4 |
| Shipping Length (in.) | 35 3/4 | 64 | 64 | 64 | 68 1/4 | 68 1/4 | 68 1/4 | 80 1/4 | 80 1/4 |
| Shipping Depth (in.) | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 | 46 |



Continental Refrigerator

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