Kairak Refrigerated Prep Table Performance Test

Application of ASTM Standard
Test Method F 2143-01

FSTC Report # 5011.03.09

Food Service Technology Center
March 2003

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Acknowledgments

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Specific appreciation is extended Kairak Inc., for supplying the Food Service Technology Center with a 5-foot refrigerated prep table for controlled testing in the appliance laboratory.

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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.

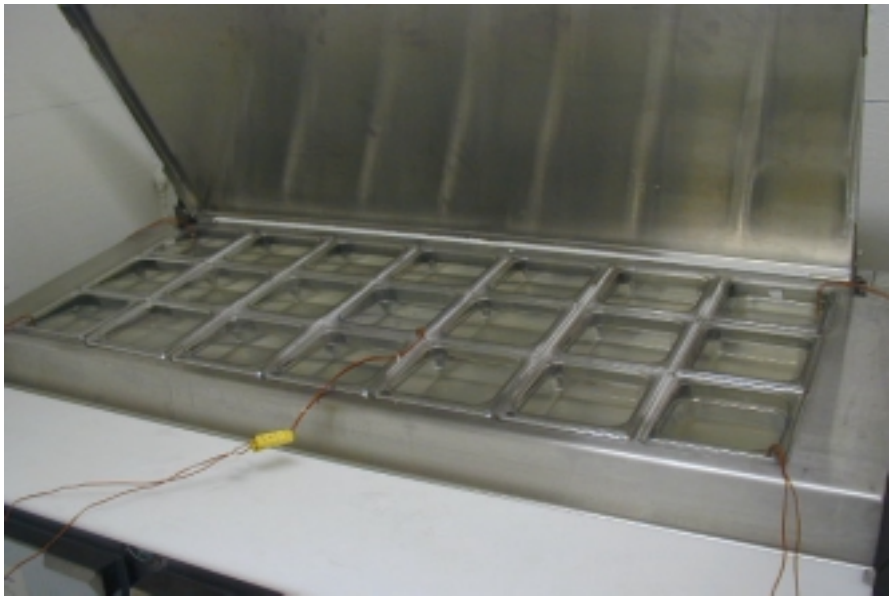


Figure 1.
Refrigerated prep table open display area.

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 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]

Kairak Inc.'s refrigerated prep table line employs a patented Pan Chiller System to maintain the temperature of the food in the display area. This report presents the results of applying the ASTM test method to the Kairak KRP-57S 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 Kairak's 57-inch refrigerated prep table 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 (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

Kairak's KRP-57S, 57-inch refrigerated prep table includes a 3 ½-inch high raised rail that is slightly sloped to the front, for providing easy access to commonly used items. The top is cooled with Kairak's patented Pan Chiller System, which operates separately from the refrigerated base. The top pan chiller, base interior, base front, sides and doors are of stainless steel construction. Nominal 2-inch thick foam insulation surrounds the base to prevent heat gain, while the cabinet doors feature self-closing hinges and snap-in magnetic gaskets. This test model was equipped with two sliding drawers on the right side and a cabinet door on the left side of the base (Figure 2). Figure 3 shows the compressor and controls for the KRP-57S.

Figure 2. Kairak KRP-57S refrigerated prep table.

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

Figure 3.
KRP-57S compressor.

Table 1. Appliance Specifications.

Manufacturer	Kairak, Inc.
Model	KRP-57S
Generic Appliance Type	Refrigerated Preparation and Buffet Table
External Dimensions	57" wide x 32" deep x 40" high (including casters)
Rail Pan Capacity	21 1/6-size pans
Current Rating	12.57 amps @ 115 volts
Refrigerant Type	R404A
Refrigerant Amount	45 oz
Design Pressure	450 psi high; 220 psi low
Construction	Stainless-steel top, front, sides and interior; galvanized steel rear and bottom panels

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 ± 2°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.

Test Food Product

The tests were conducted using the industry standard 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 ½ 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). 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 ± 2°F before loading into the refrigerated rail.

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 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 $^1/_8$-inch above the bottom of the pan as illustrated. Each thermocouple was positioned ½-inch away from the sides of the pan.

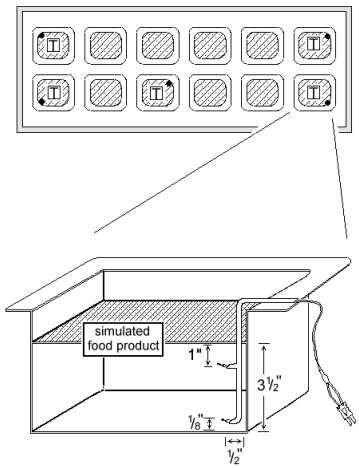


Figure 4. Thermocouple locations and configuration.

Three thermocouples were used to measure the refrigerated cavity (box) temperature 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 ± 2°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 647 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.

The Pan Chiller System is separate from the refrigerated base, minimizing any excess cooling of the cabinet to maintain the temperature of the food wells. In fact, this unit exhibited excellent temperature control in the refrigerated base, with an average swing of only 3.4°F.

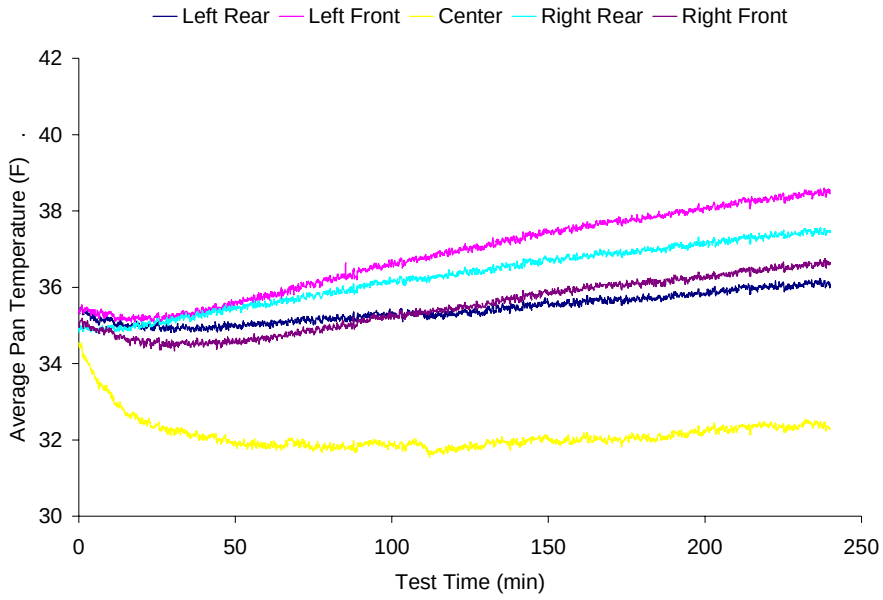


Figure 5.
Well temperatures during the lid-up test.

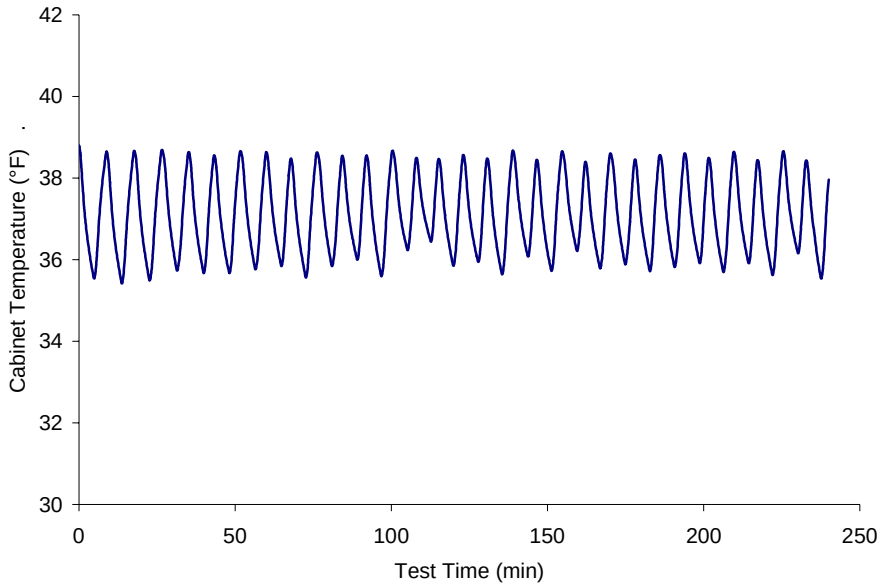


Figure 6. Average cabinet temperature during the lid-up test.

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 631 watts. Well temperature during the lid-down test is presented in Figure 7; Figure 8 shows the average cabinet temperature over the same 8-hour period.

With the lid down, the corner pans cooled to their 35°F starting temperature. The center pan was directly above the Pan Chiller System's evaporator fan and was exposed to more cool air than other pans in the rail. As a result, the temperature in the center pan fell below 30°F during the overnight test.

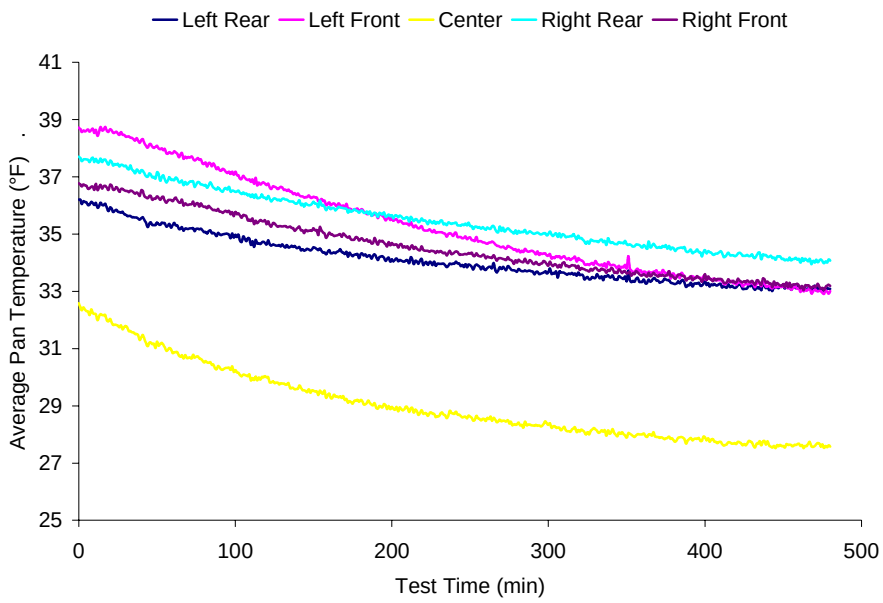


Figure 7.
Well temperatures during the lid-down test.

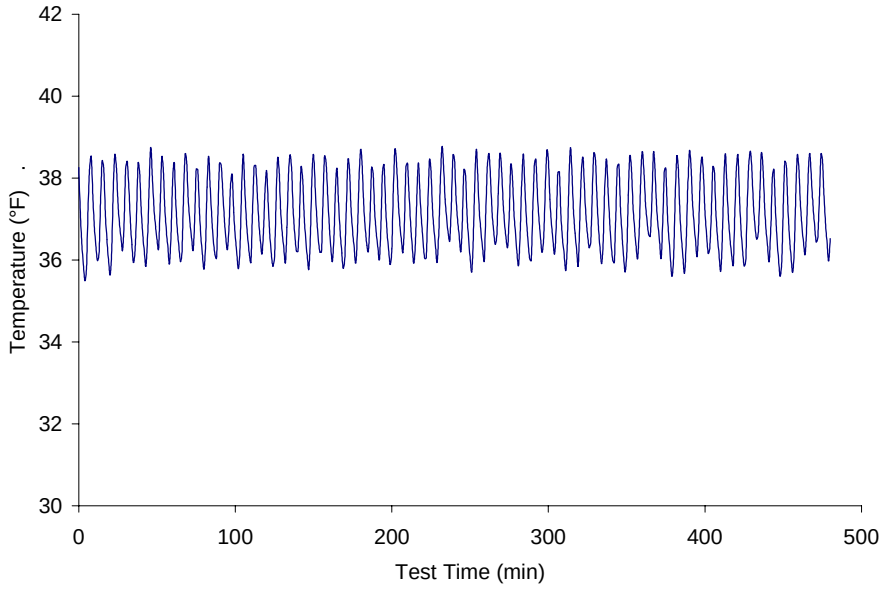


Figure 8.
Average cabinet temperature during the lid-down test.

Since the center pan fell below freezing during the lid-down period, the test was repeated using the manufacturer's recommended overnight defrost cycle. For this second lid-down test, the timer was set to defrost the upper compartment from 12 am to 5 am. In order to characterize the full defrost period, pan temperatures and appliance energy consumption were monitored for a full 12 hours. Figure 9 shows the well temperatures during this extended lid-down period.

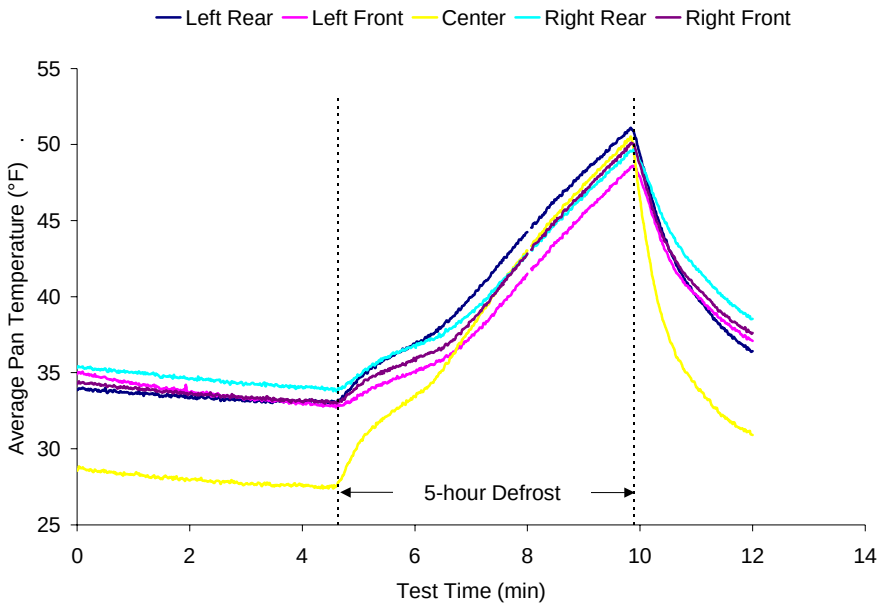


Figure 9. Well temperatures during the extended lid-down test.

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. Due to the operation of the separate cabinets (cabinet and Pan Chiller), the average energy consumption was

virtually the same for both lid-up and lid-down conditions. Table 2 summarizes the test results for the lid-up and lid-down tests.

Table 2. Summary of Test Results.

	Lid-Up	Lid-Down	Lid-Down with Defrost
Test Voltage (V)	120	120	120
Average Energy Rate (W)	647	631	532
Compressor Duty Cycle (%)	61.3	59.6	46.1
Average Pan Temperature (°F)	35.2	34.7	32.7
Pan Temperature Stratification (°F) [a]	5.2	3.8	2.4
Average Cabinet Temperature (°F)	37.2	37.0	37.1
Cabinet Temperature Stratification (°F) [b]	0.9	0.9	0.9

[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 balance of the energy consumption was determined using the average energy rate for the lid-down with defrost cycle. 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	2,834	283
Lid-Down	2,330	233
Total	***5,164***	***516***

Conclusions

Kairak's refrigerated prep table with its patented *Pan Chiller System* performed well during the comprehensive laboratory testing. The unit was capable of maintaining the temperature of the product in the open display area below the FDA-mandated 41°F, while not adversely affecting the performance of the refrigerated cabinet below. In fact, the tight temperature control in the refrigerated base was among the best tested to date at the Food Service Technology Center.

This excellent temperature performance did come with an energy premium, however, as the lid-down energy rate was somewhat higher than for other refrigerated prep tables tested.[1,3] The incorporation of a defrost mode did reduce the lid-down energy consumption somewhat by reducing the compressor cycles for the *Pan Chiller System*.

Kairak's factory thermostat settings proved to maintain acceptable temperatures in both the rail and the cabinet; no further adjustments were necessary. The Kairak KRP-57S refrigerated prep table was a well-designed unit that performed satisfactorily right "out of the box."

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, West Conshohocken, PA.
3. Zabrowski, D., Cowen, D., 2002. *Continental Prep Table Performance Testing.* Food Service Technology Center Report 5011.02.21, October.

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 preheat.

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 number 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 Kairak model KRP-57S refrigerated prep table.

KAIRAK INC. Innovations
UNIQUE FOOD SERVICE EQUIPMENT

KRP Product Line - Self Contained Food Prep Table with Pan Chiller System

U.S. Patents #5,355,687 & #5,927,092

UL Listed UL Sanitation Approved to NSF7 MEA Approved

SPECIFICATIONS

MODELS: Available in lengths from 27-120 inches (see specification sheets for standard lengths).
TOP PAN CHILLER: 16 gauge, #304 stainless steel; 3-1/2" high raised rail, slightly sloped to front with patented Pan Chiller System. Top includes a 1/2" thick white polyethylene cutting board. Made to accommodate 1/3-size pans. All 20 gauge #304 stainless steel construction with hinged night cover.
BODY: Base exterior front, sides, and interior are 20-gauge stainless steel. Back is 20 gauge galvanized metal and bottom is 18 gauge galvanized metal. Interior has

ELECTRICAL: All units 12 amps or less are equipped with 15 amp cord and plug (NEMA 5-15P). Units more than 12 but less than 16 amps are equipped with 20 amp cord and plug (NEMA 5-20P). Units more than 16 amps but less than 24 amps are equipped with 30 amp cord & plug (NEMA 5-30P). Units more than 24 amps must be hard wired by jobsite electrician. All hook-ups at rear.
PLUMBING: Units provided with an electric condensate evaporator.
OPTIONS:
* Drawers
* Removable tray slides

coved corners. 6" casters are provided along with 2" dial thermometer.
INSULATION: Nominal 2" thick foamed-in-place polyurethane.
DOORS: Foam insulated 20 gauge #430 stainless steel with chrome-plated edge mounted, self closing hinges and snap in magnetic gaskets.
SHELVING: Two powder coated (gray), wire shelves are provided for each door section.
REFRIGERATION: R404a or R134a hermetic condensing unit is provided for both the pan chiller and the refrigerated base. Pan Chiller defrost time clock included. Recessed evaporator coils (outfitted with expansion valves, solenoids and thermostats) are provided inside the base liner. Coils have 20 gauge #304 stainless steel covers.

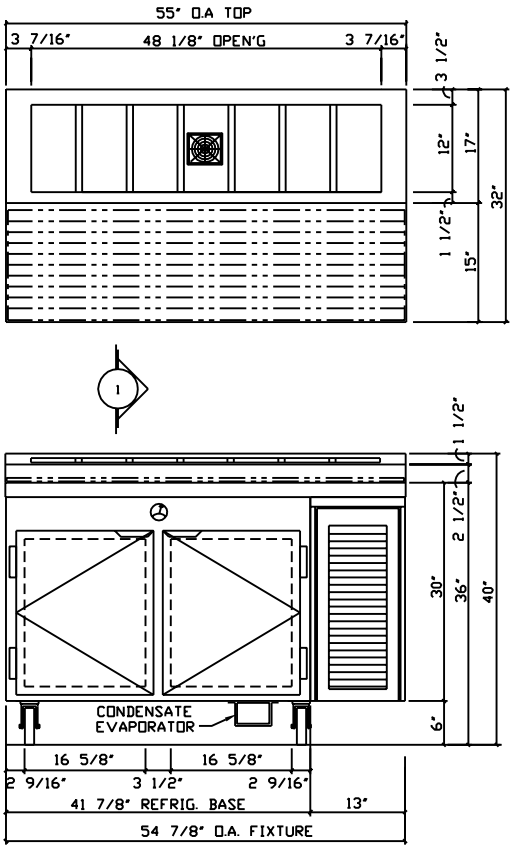
* Door Locks
* Optional Door Hinging
* Freezer Base
* SST Back Panel
* 6" Adjustable legs or 4" casters

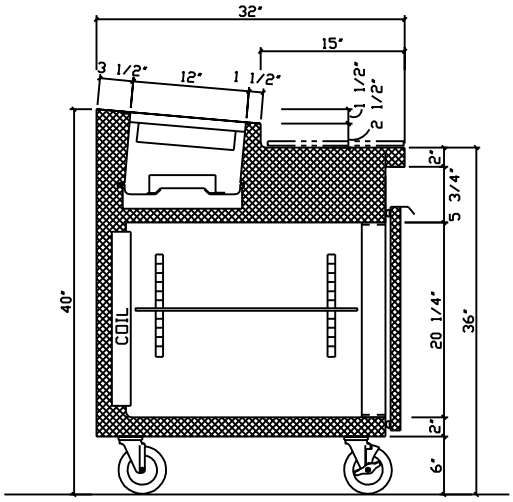
FEATURES:
* Temperatures in insert pans guaranteed to satisfy Health Department requirements. * Food stays fresh longer...decreases waste. * Utility and maintenance savings. * Increased storage capacity. * One-year parts warranty. * Life-time coil core warranty. * 90-days labor warranty. * R404a and R134a refrigerant (environmentally friendly).

Blueprints of available models

Kairak Inc., 23955 President Ave., Harbor City, CA 90710, 310-530-1766 Fax 310-530-3306

MODELS KRP/KRPF-55S





SECTION VIEW 1

STANDARD FEATURES

- HINGED NIGHT COVER
- 1/3 SIZE PAN OPENINGS
- TWO WIRE SHELVES PER DOOR
- 6" CASTERS
- WHITE POLY CUTTING BOARD
- DOORS HINGED LEFT, RIGHT
- EXTERIOR DIAL THERMOMETER
- INTERIOR LIGHT
- CORD AND PLUG

STANDARD OPTIONS

- DOUBLE DEPTH PAN OPENINGS: 1/3, 1/6 OR 1/3, 1/3
- 1/2 SIZE PAN OPENINGS
- 6" LEGS
- 4" CASTERS
- RICHLITE CUTTING BOARD
- S/S BACK PANEL
- DOORS HINGED AS REQUESTED
- DOOR LOCKS
- COMPRESSOR LEFT

JOB NAME: _____

ITEM NUMBER: _____

APPROVED BY: _____

DATE: _____

ELECTRICAL/REFRIGERATION REQUIREMENTS					
MODEL	ELECTRICAL				REFRIGERANT
KRP-55S	1/3 HP	115V	1Ø	11.44A	R134a
KRPF-55S	1/3 HP	115V	1Ø	15.38A	R134a

- U.L. LISTED
- U.L. SANITATION APPROVED NSF 7
- MEA APPROVED
- US PATENTS #5,355,687 #5,927,092

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