Chef Bases for Foodservice Applications

ET15SCE1010 Report

Prepared by:

Emerging Products
Customer Service
Southern California Edison

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EXECUTIVE SUMMARY

Chef bases are found in almost all commercial kitchens. These devices are equipment stands with refrigerated or freezer compartments underneath for quick and easy access to various refrigerated or frozen products. The tabletops are designed to support heavy and/or hot cooking equipment while still maintaining safe food temperatures in the compartments. While chef bases are common place, little is known about their energy performance. The purpose of this laboratory evaluation is to test numerous commercially available chef bases per ASHRAE 72 Method of Testing Open and Closed Refrigerators and Freezers to collect comparable energy performance data.

The objective of this project is to test six different chef bases to understand the energy performance of this category of commercial refrigeration equipment. Testing was conducted in a standardized manner according to ASHRAE 72 Method of Testing Open and Closed Refrigerators and Freezers.

Table-ES 1 shows the annual energy consumption from two different models of chef bases that represent the most efficient and least efficient models tested.

TABLE-ES 1. SUMMARY OF ENERGY SAVINGS AND DEMAND REDUCTION

	ANNUAL ENERGY CONSUMPTION (KWH/YR)	ANNUAL ENERGY SAVINGS (KWH/YR)	PEAK DEMAND (KW)	PEAK DEMAND REDUCTION (KW)
Least Efficient Model	3,026	-	0.61	-
Most Efficient Model	628	2,398	0.28	0.33

Results indicate energy efficiency marketing collateral and incentives can help educate and drive the commercial kitchen market to adopt more efficient chef bases.

ABBREVIATIONS AND ACRONYMS

ASHRAE	American Society of Heating, Refrigerating, and Air-conditioning Engineers
Ft^3	Cubic feet
kWh	kilowatt-hours
NIST	National Institute of Standards and Technology

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INTRODUCTION

Chef bases are found in almost all commercial kitchens. These devices are equipment stands with refrigerated or freezer compartments underneath for quick and easy access to various refrigerated or frozen products. The tabletops are designed to support heavy and/or hot cooking equipment while still maintaining safe food temperatures in the compartments. While chef bases are common place, little is known about their energy performance. The purpose of this laboratory evaluation is to test numerous commercially available chef bases per American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) 72 Method of Testing Open and Closed Refrigerators and Freezers to collect comparable energy performance data.

ASSESSMENT OBJECTIVES

The objective of this project is to test six different chef bases to understand the energy performance of this category of commercial refrigeration equipment in order to identify if energy efficiency incentives can help drive the commercial kitchen market to adopt more efficient chef bases.

TECHNOLOGY/PRODUCT EVALUATION

Chef bases are refrigerated equipment stands used to store refrigerated and/or frozen food product in a location convenient for cooking staff. Chef bases range from approximately three feet in length to over eight feet in length. The refrigerated compartment can be equipped with drawers or doors depending on a customer's desired specifications. Typical chef bases operate using a conventional vapor compression refrigeration cycle charged with R-404a. However, one unit tested is designed to operate with and was charged with R-290 propane.

Energy performance of chef bases is not well known. As restaurant owners and kitchen operators move from upright refrigerated compartments to chef bases, they do so without information or knowledge on the full life cycle equipment cost.

The project team tested a total six different models of chef bases from six different manufacturers. The chef base models tested are shown in Table 1 along with the measure refrigerated volume of the units in cubic feet (ft^3).

TABLE 1. CHEF BASE MODELS TESTED IN LABORATORY EVALUATION

MANUFACTURER	MODEL	REFRIGERANT	POWER NAMEPLATE RATING (WATTS)
Traulsen	TE072H7	R-404a	770
Beverage Air®	WTRCS84-1	R-134a	518
Delfield®	F2962C	R-404a	920
Turbo Coil	RB-72-SC	R-404a	1070
True®	TRCB-72	R-134a	1139
Hoshizaki	CRES72	R-134a	494

TECHNICAL APPROACH/TEST METHODOLOGY

This study evaluated refrigerated chef bases for commercial kitchens in a laboratory environment. ASHRAE Standard 72-2014 Method of Testing Open and Closed Commercial Refrigerators and Freezers (ASHRAE 72) was used to evaluate the performance of the chef bases. The project team initially began testing using a modified version of ASHRAE 72 by placing an electric griddle on top of the chef base to emulate the heat load this class of refrigerators are exposed to in a commercial kitchen. However, the use of an electric griddle modified version of ASHRAE 72 was scrapped after testing showed insignificant variation in test results.

All instruments were calibrated before the test.

DATA ACQUISITION

National Instruments™' SCXI data acquisition system was used to log test data. The data acquisition system was set up to scan and log 124 data channels in 20-second intervals.

Screening of collected data ensured the key control parameters were within the acceptable ranges. When any of the control parameters fell outside the acceptable limits, a series of diagnostic inspections was carried out. Corrections were then made and tests were repeated, as necessary.

After the data passed the initial screening process, data was imported to customized refrigeration analysis model where detailed calculations were performed. Appendix A. Instrumentation and Test Setup Diagram provides list of sensor specifications for the instruments used in this project along with schematic diagrams of test set-up.

RESULTS

Table 2 summarizes key laboratory test results. Results were normalized per cubic foot of refrigerated volume for comparison purposes. Energy is reported in kilowatt-hours (kWh).

TABLE 2. SUMMARY OF ENERGY PERFORMANCE LABORATORY TEST RESULTS PER UNIT VOLUME

MANUFACTURER	REFRIGERANT	TOTAL ENERGY PER DAY [KWH/DAY]	ENERGY PER DAY PER VOLUME [KWH/DAY/FT^3]	AVERAGE PEAK POWER PER VOLUME [W/FT^3]
A	R-134a	1.72	0.11	18
B	R-404a	2.14	0.22	34
C	R-134a	4.12	0.26	21
D	R-404a	4.42	0.32	38
E	R-404a	7.28	0.48	50
F	R-134a	8.29	0.60	48

Figure 1 graphs the energy per day per refrigerated volume for each chef base tested.

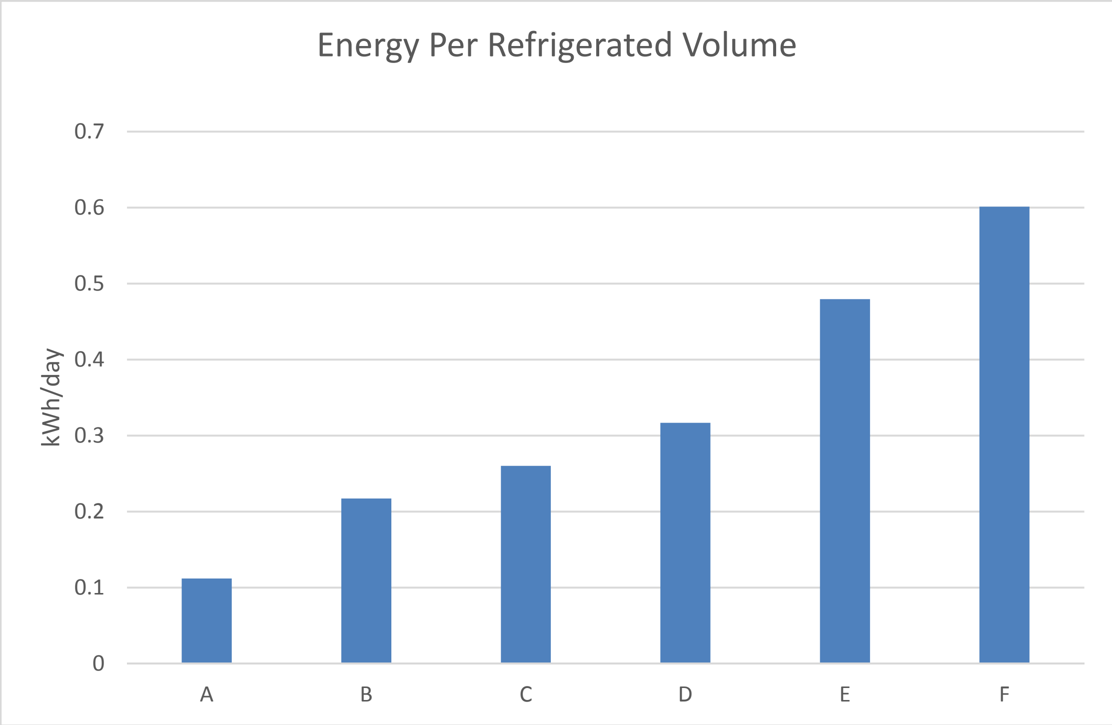

FIGURE 1. LABORATORY TEST RESULTS ENERGY PER UNIT REFRIGERATE VOLUME

Figure 2 shows the same data as Figure 1, but charts the maximum federal code requirement for self-contained commercial refrigerators with solid doors[1]. While chef bases are exempt from current regulations, this graph provides a barometer for this class of refrigerated equipment.

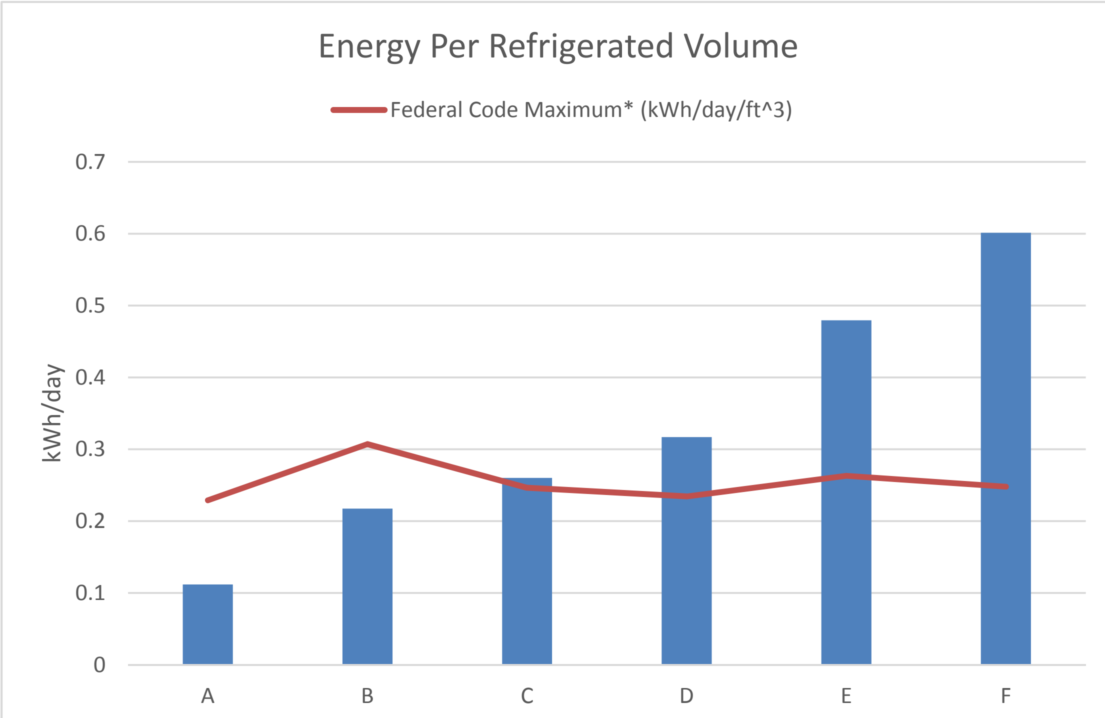

FIGURE 2. ENERGY PER REFRIGERATED VOLUME WITH FEDERAL CODE MAXIMUM (*CHEF BASES EXEMPT FROM CURRENT REGULATIONS)

Table 3 shows detailed test results for each chef base. Off-cycle power refers to the power consumed by the chef base when the compressor was not running. Note, Manufacturer A had virtually no off-cycle power draw, whereas two manufacturers had off-cycle power draws of approximately 120 and 147 Watts.

[1] Federal code maximum daily energy consumption for self-contained commercial refrigerators with solid doors is 0.10V + 2.4 kWh/day. The term "V" means the chilled or frozen compartment volume (ft^3) (as defined in the Association of Home Appliance Manufacturers Standard HRF1-1979).

Table 3. Energy Performance Laboratory Results

Manufacturer	Refrigerated Volume [ft³]	Total Energy Per Day [kWh/Day/ft³]	Compressor Energy Per Day [kWh/Day/ft³]	Compressor Run Time [Hours/Day]	Off Cycle Power [Watts]	Off Cycle Energy Per Year [kWh/Year]
A	15.31	1.72	1.72	6.30	0	0
B	9.84	2.14	1.83	5.43	25.50	1,760
C	15.81	4.12	3.61	10.81	38.32	2,822
D	13.95	4.42	3.18	6.01	69.16	6,957
E	15.18	7.28	4.65	6.14	147.14	14,697
F	13.78	8.29	6.58	9.87	120.54	9,555

As shown in Table 1, a customer who needs a six-foot chef base can select A, D, E, or F. Should a customer choose Manufacturer F, their annual energy consumption will be 3,026 kWh according to lab testing. A customer purchasing Manufacturer A will have an annual energy consumption of approximately 628 kWh. This is nearly 2,400 kWh difference in energy consumption annually. This equates to a difference in energy cost of approximately $360 if using a blended electricity rate of $0.15/kWh.

DISCUSSION

Laboratory test results show a wide range of energy performance across the six manufacturers' units tested. This is likely due to the fact that this product category has not been subjected to federal regulations and therefore no energy performance testing has been conducted in the past for chef bases. Manufacturers themselves know little about the energy performance of their equipment. The focus for this product category is on maintaining safe temperatures for the food product stored inside the refrigerated cabinet. As a result, equipment may be oversized to ensure the chef base can withstand the rigor of a demanding heat load resting on top of the cabinet 365 days per year. Despite the project team's laboratory testing showing little evidence of a heat load affecting the temperatures and energy performance of the chef base over the course of an abbreviated lab test, manufacturers have noted it is not uncommon for customers to report stainless steel warping and insulation melting under the harsh kitchen environments. This makes product categories like chef bases more suitable for voluntary programs, such as utility rebate programs, rathern than mandatory regulations.

CONCLUSIONS

Laboratory testing of chef bases revealed a wide range of energy performance across the market. Results from this study can be used to help educate customers and manufacturers alike regarding the energy performance of chef bases. Incentive programs should be designed to steer the market toward lower energy consuming models. Manufacturers of high energy usage models will then be more inclined to perform design improvements to increase the energy efficiency of their units.

RECOMMENDATIONS

This study produced laboratory testing results needed to build a foundation of knowledge about the energy performance of chef bases. This alone is enough to begin production of a qualified product list. However, more information is needed to fully develop an energy efficiency rebate program for chef bases. This includes collecting market information on existing equipment in operation in the field in order to accurately characterize the baseline energy performance of chef bases. This can be accomplished through customer and distributor surveys, restaurant equipment field audits, and spot measurements.

APPENDIX A. INSTRUMENTATION AND TEST SETUP DIAGRAM

Table 4 lists the specifications for the instruments used in this project. As shown, accuracy relied on National Institute of Standards and Technology (NIST) standards. All the sensors were calibrated in-house prior to installing them on the test equipment and conducting any testing.

TABLE 4. LIST OF SPECIFICATIONS USED FOR INSTRUMENTATION

MEASUREMENT	MAKE/MODEL	ACCURACY (NIST TRACEABLE)
Product & Air Temps.	Masy Systems (type-T thermocouples)	± 1.8°F
Dry-bulb	Vaisala HMP 247	± 0.18°F
Relative Humidity	Vaisala HMP 247	±(0.5+2.5% of the reading)%Rh
Power	Hioki 3169-21	± 0.2% of reading ± 0.1% of full scale + current sensor accuracy
Voltage	Hioki 3169-21	± 0.2% of reading ± 0.1% of full scale
Current	Hioki 3169-21	± 0.2% of reading ± 0.1% of full scale + current sensor accuracy
Current	Hioki 9660	± 0.3% of reading ± 0.1% of full scale
THD	Hioki 3169-21	± 0.2% of reading ± 0.1% of full scale

Figure 3 shows a schematic diagram of sensors for measuring evaporator discharge or supply air dry-bulb and dew-point temperatures. Figure 4 shows a photograph of the filler product and simulated food product in the chef base drawers. Figure 5 shows the drawer opening mechanism developed for the test to implement the test procedure's required systematic drawer openings.

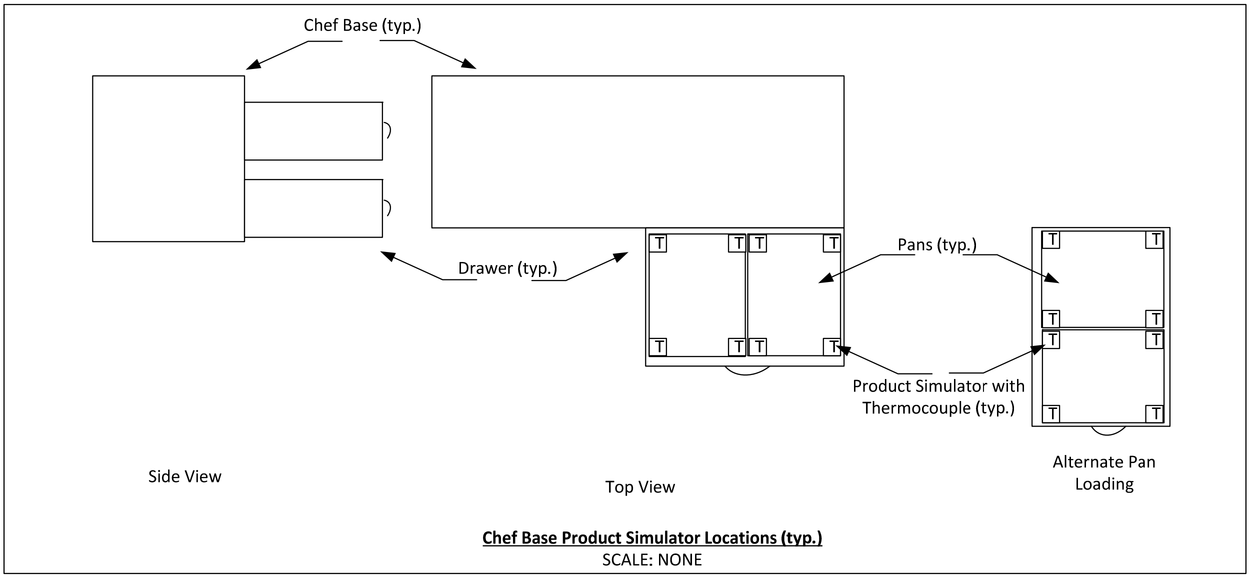

FIGURE 3. SCHEMATIC DIAGRAM OF SENSORS FOR MEASURING EVAPORATOR DISCHARGE OR SUPPLY AIR DRY-BULB AND DEW-POINT TEMPERATURES

FIGURE 4. PHOTOGRAPH OF OPEN CHEF BASE DRAWER WITH FILLER PRODUCT AND SIMULATED FOOD PRODUCT

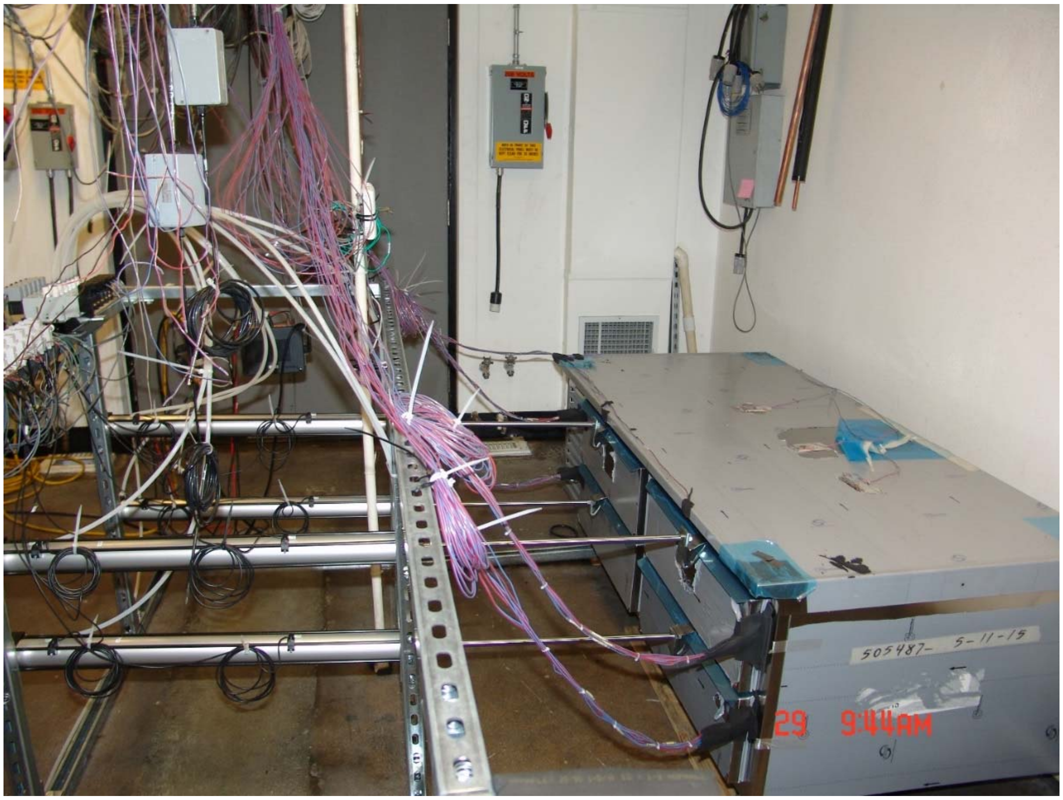

FIGURE 5. PHOTOGRAPH OF DOOR OPENING MECHANISM