



A Field Study to Characterize Water and Energy Use of Commercial Ice Machines and Quantify Saving Potential

DRAFT

Food Service Technology Center
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The FSTC recognizes the commitment of the participating establishments to increasing the energy efficiency of their facilities and eagerness to support conservation initiatives. The enthusiasm of the facility staffs to accommodate our on-site visits and needs was appreciated.

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Background

Ice machines are installed throughout the food service and hospitality industry, from bars, delis, and restaurants, to hotels, hospitals, and other institutional kitchens. The installed base of ice machines represents one of the largest inventories of food service equipment. The Air-Conditioning and Refrigeration Institute (ARI) publishes a directory of ice-making equipment containing energy and water usage data. Interrogating this database quickly reveals large differences in water and energy consumption per 100 pounds of ice produced by different manufacturers and models of both air-cooled and water-cooled ice machines. This directory has the potential to be utilized by utilities to help customers select water/energy efficient models or as a basis for financial incentives to promote equipment that is more efficient.

A general sizing guideline for ice machines is to choose the unit for a duty cycle of 75% based on the ARI capacity data and the assumed daily ice requirement. However, real-world duty cycles and load profiles of ice machines are not well documented. From site survey experience, it is known that ice machine usage can vary dramatically from one installation to another. Some ice machines may be undersized and seldom turn off in order to meet the demand, and others may seldom turn on because they have high production capacity or low demand. In order to determine the potential for shifting ice production from peak utility periods to non-peak periods, more data on the characteristic usage in the different types of facilities is needed.

ARI standards establish rating criteria and procedures for measuring and certifying product performance. The ARI Directory of Certified Automatic Commercial Ice-Cube Machines and Ice Storage Bins provides Standard Ratings that are determined in accordance with ARI Standard 810 using the following test conditions: an ambient air temperature of 90°F, a water inlet temperature of 70°F, and a water inlet pressure of 30 ± 3 psig. Since these conditions vary in the field, there is limited confidence to project annual water, sewer and energy usage and/or cost savings to utilities and to food service operators based on the data published in the ARI directory.

Key variables that affect the ice machine water usage rate are the system water pressure and also the purge water timer setting, which can be adjusted to deviate the factory standard setting to compensate for varying water quality and is sometimes indiscriminately set to the maximum by field service personnel. Energy consumption rate is affected ambient air and inlet water temperatures.

Objectives

- 1) To measure actual water and energy usage in representative commercial installations and compare these results to ARI and/or manufacturer supplied (lab) testing data.
- 2) Determine for each ice machine the annual water, wastewater, and energy consumptions and savings that could be achieved by retrofitting with models that are more water/energy-efficient.
- 3) Capture field data to quantify the energy savings potential for reductions in regional water distribution (pumping) and wastewater treatment.

Scope

The project involves field testing of eight ice machines, consisting of two water-cooled and six air-cooled units, in selected food service facilities to verify ARI published data and to investigate the variability in water usage rate due to water pressure and machine settings. Embedded energy in water and wastewater can be calculated based on measured use.

Evaluation Method

Sites were selected based on convenience of locating, ease of measurement, and cooperation of the owners. Water and electrical energy usage data was collected from each ice machine for a period of approximately one month. Water consumption was measured with a water meter installed at the inlet line of each machine and used in tandem with an electronic data logger that recorded time-stamped pulses from each meter. An energy data logger was installed in the circuit breaker panel feeding each machine to record power and energy consumption.

Ice production was directly weighed for three consecutive harvest cycles and then averaged. The cumulative number of completed harvest cycles was compiled from the electrical data profiles. The quantity of water that was made into ice was calculated by multiplying the number of cycles by the ice harvest weight per cycle.

Cumulative daily water and energy consumption and duty cycles were calculated from 12 am to 12 am. The difference between the total measured inlet water quantity and water used for harvested ice was the amount of wastewater that was purged (and used for condenser cooling for the water-cooled units). Recorded water and energy consumption rate values were compared to those found in the ARI directory. Potential savings were calculated based on typical performance specifications for new, efficient machines in the 500-1000 lb/day ice harvest rate range. Values of 20 gal/100 lb. and 5.8 kWh/100 lb. were used as comparative references for the tested machines if they were to be replaced (or adjusted to use less water).

The measured average and maximum duty cycle is used to determine the potential for off-peak load shifting. A 75% or lower duty cycle would be required if the machine were to be turned off for six hours per day during peak hours.

Results

The following results tables include the ARI Standard Ratings for each machine, measured water and energy consumption, and the difference between the measured and ARI standard values of water and energy usage rates. The average daily water and energy consumption and duty cycle values also include averaged data from facility off-days (for sites that were not open seven days a week). The daily averages were multiplied by 360 days per year to calculate annual consumption totals. Duty cycles averaged between 34.5 % and 86.6 % with single-day maximums ranging between 47.6 % and 100 %.

Typical day profiles show the electrical power through the harvest cycles and cumulative water consumption over the course of the day. Data sets for the typical day profiles were chosen from days with total water and energy consumption values that best matched the averages, with the exception of Machines #6 and #8 since those sites were open less than seven days a week and had higher typical-day consumption as compared to the average.

The eight machines exhibited a wide range of deviation from ARI performance data figures. Water use rate ranged from 19% under (26.1 vs. 32.1 gal/100 lb) to an outlier example of 142 % over (61.9 vs. 25.6 gal/100 lb), and the electrical consumption rate ranged from 28 % under (3.6 vs. 5.0 kWh/100 lb) to 37 % over (7.1 vs. 5.2 kWh/100 lb). Considerable savings potential was evident for the less efficient machines. While for the more efficient machines, the potential savings calculations would not yield any water or energy savings (when compared to 20 gal/100 lb and 5.8 kWh/100 lb respectively, i.e., they already used less, probably due to cooler operating conditions) and were denoted N/A in the results tables.

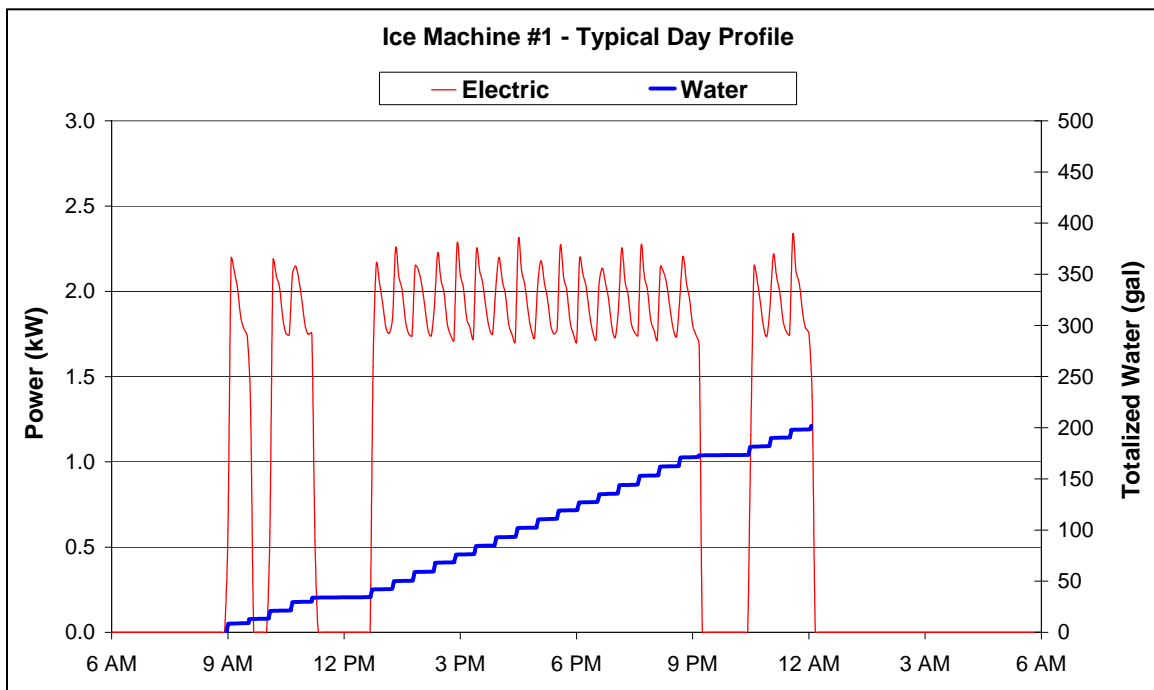
A specific utility rate cost can readily be applied to the quantified water and energy consumption and potential reduction values to calculate operating cost and cost savings potential values.

Ice Machine #1: This air-cooled ice machine was located in quick-service restaurant that opened for lunch and dinner seven days a week. The average water consumption was 212 gal/day, and the average electrical consumption was 24.6 kWh/day. Operating with an average duty cycle of 47.6 % and a maximum of 60.8 %, load shifting to off-peak can effectively be applied to this machine.

Manufacturer	Hoshizaki
Model	KM-1300MAH
Type	Air-cooled
<u>ARI Performance Data</u>	
Ice Harvest Rate (lb/24 hr)	1059
Potable Water Use Rate (gal/100 lb ice)	32.3
Condenser Water Use Rate (gal/100 lb ice)	N/A
Energy Consumption Rate (kWh/100 lb ice)	6.0
Average Harvest Weight (lb/cycle)	23.4
Average Harvest Cycles Per Day	23.2
Average Ice Production (lb/day)	544
Average Daily Duty Cycle (%)	47.6 %
Maximum Daily Duty Cycle (%)	60.8 %
Average Water Consumption (gal/day)	212
Average Energy Consumption (kWh/day)	24.6
Water to Ice (gal/day)	65.2
Wastewater (gal/day)	146.7
Water-to-ice / Water-to-waste ratio	2.25
Annual Ice Production (lb/yr)	195,800
Annual Water Consumption (gal/yr)	76,300
Annual Electrical Energy Consumption (kWh/yr)	8860
Measured Water Use Rate (gal/100 lb)	39.0
Difference from ARI Data (gal/100 lb)	+ 6.7
Percentage Difference from ARI	+ 21%
gal/day Difference from ARI	+ 36.3
Measured Energy Consumption Rate (kWh/100 lb)	4.52
kWh/100lb Difference from ARI	- 1.48
Percentage Difference from ARI	- 25%
kWh/day Difference from ARI	- 8.0
Potential Annual Water Savings Using a 20 gal/100 lb Machine (gal/yr)	37,200
Potential Annual Water Cost Savings Using \$5.00/CCF	\$ 248
Potential Annual Energy Savings Using a 5.8 kWh/100 lb Machine (kWh/yr)	N/A
Potential Annual Energy Cost Savings Using \$0.15/kWh	N/A



Machine #1

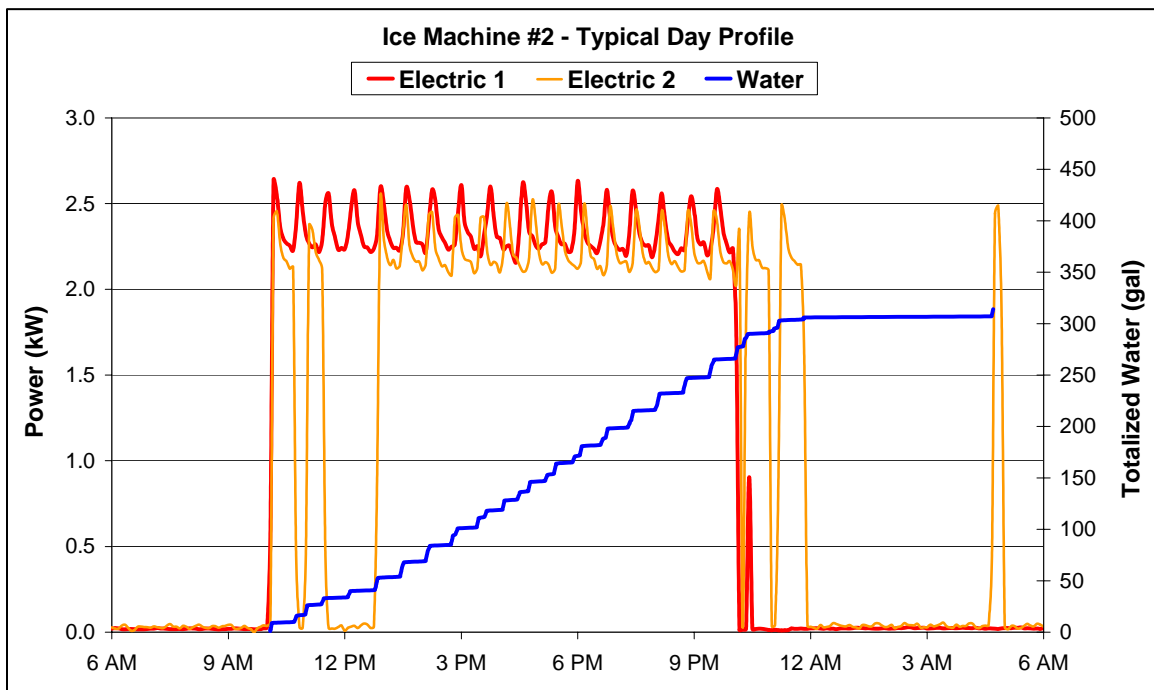


Ice Machine #2: Located a in full-service restaurant that opened for lunch and dinner seven days a week, this machine configuration utilized one bin with two stacked air-cooled ice machine heads with remote condensers. The average water consumption was 321 gal/day, and the average electrical consumption was 55.4 kWh/day. The average duty cycle was 49.7 %, with a maximum of 64.9 %, which allows for load shifting to off-peak operation.

Manufacturer	Hoshizaki
Model	KM-1200SRE (x 2)
Type	Air-cooled Remote
<u>ARI Performance Data</u>	
Ice Harvest Rate (lb/24 hr)	1130 (x 2)
Potable Water Use Rate (gal/100 lb ice)	29.5
Condenser Water Use Rate (gal/100 lb ice)	N/A
Energy Consumption Rate (kWh/100 lb ice)	4.6
Average Harvest Weight (lb/cycle)	30.8
Average Harvest Cycles Per Day	37.3
Average Ice Production (lb/day)	1147
Average Daily Duty Cycle (%)	49.7 %
Maximum Daily Duty Cycle (%)	64.9 %
Average Water Consumption (gal/day)	321
Average Energy Consumption (kWh/day)	55.4
Water to Ice (gal/day)	137.6
Wastewater (gal/day)	183.8
Water-to-ice / Water-to-waste ratio	1.34
Annual Ice Production (lb/yr)	413,980
Annual Water Consumption (gal/yr)	115,690
Annual Electrical Energy Consumption (kWh/yr)	19,950
Measured Water Use Rate (gal/100 lb)	28.0
Difference from ARI Data (gal/100 lb)	- 1.5
Percentage Difference from ARI	- 5 %
gal/day Difference from ARI	- 17.1
Measured Energy Consumption Rate (kWh/100 lb)	4.83
kWh/100lb Difference from ARI	+ 0.23
Percentage Difference from ARI	+ 5%
kWh/day Difference from ARI	+ 2.6
Potential Annual Water Savings Using a 20 gal/100 lb Machine (gal/yr)	33,200
Potential Annual Water Cost Savings Using \$5.00/CCF	\$ 221
Potential Annual Energy Savings Using a 5.8 kWh/100 lb Machine (kWh/yr)	N/A
Potential Annual Energy Cost Savings Using \$0.15/kWh	N/A



Machine #2

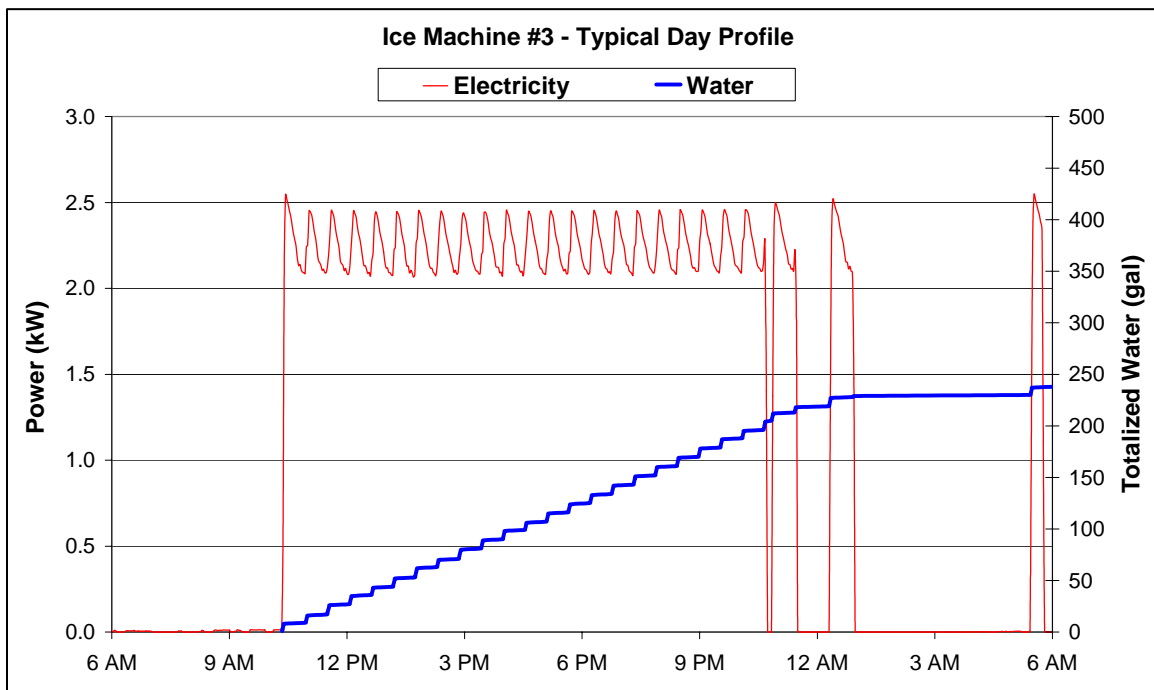


Ice Machine #3: This air-cooled ice machine was located a in a fine-dining restaurant which operated seven days a week. (The restaurant employed a second ice machine during busy days.) The average water consumption was 224 gal/day, and the average electrical consumption was 31.0 kWh/day. The average duty cycle was 59.5 %, with a maximum of 90.8 %. Load shifting for this machine is possible during average days, but would likely need to be overridden during heavy use, high duty cycle days.

Manufacturer	Hoshizaki
Model	KM-1300SRF
Type	Air-cooled Remote
<u>ARI Performance Data</u>	
Ice Harvest Rate (lb/24 hr)	1133
Potable Water Use Rate (gal/100 lb ice)	32.1
Condenser Water Use Rate (gal/100 lb ice)	N/A
Energy Consumption Rate (kWh/100 lb ice)	5.0
Average Harvest Weight (lb/cycle)	28.8
Average Harvest Cycles Per Day	29.8
Average Ice Production (lb/day)	858
Average Daily Duty Cycle (%)	59.5 %
Maximum Daily Duty Cycle (%)	90.8 %
Average Water Consumption (gal/day)	224
Average Energy Consumption (kWh/day)	31.0
Water to Ice (gal/day)	102.9
Wastewater (gal/day)	121.3
Water-to-ice / Water-to-waste ratio	1.18
Annual Ice Production (lb/yr)	308,830
Annual Water Consumption (gal/yr)	80,710
Annual Electrical Energy Consumption (kWh/yr)	11,150
Measured Water Use Rate (gal/100 lb)	26.1
Difference from ARI Data (gal/100 lb)	-6.0
Percentage Difference from ARI	-19 %
gal/day Difference from ARI	-51.2
Measured Energy Consumption Rate (kWh/100 lb)	3.61
kWh/100lb Difference from ARI	-1.39
Percentage Difference from ARI	-28 %
kWh/day Difference from ARI	-11.9
Potential Annual Water Savings Using a 20 gal/100 lb Machine (gal/yr)	18,950
Potential Annual Water Cost Savings Using \$5.00/CCF	\$ 127
Potential Annual Energy Savings Using a 5.8 kWh/100 lb Machine (kWh/yr)	N/A
Potential Annual Energy Cost Savings Using \$0.15/kWh	N/A



Machine #3

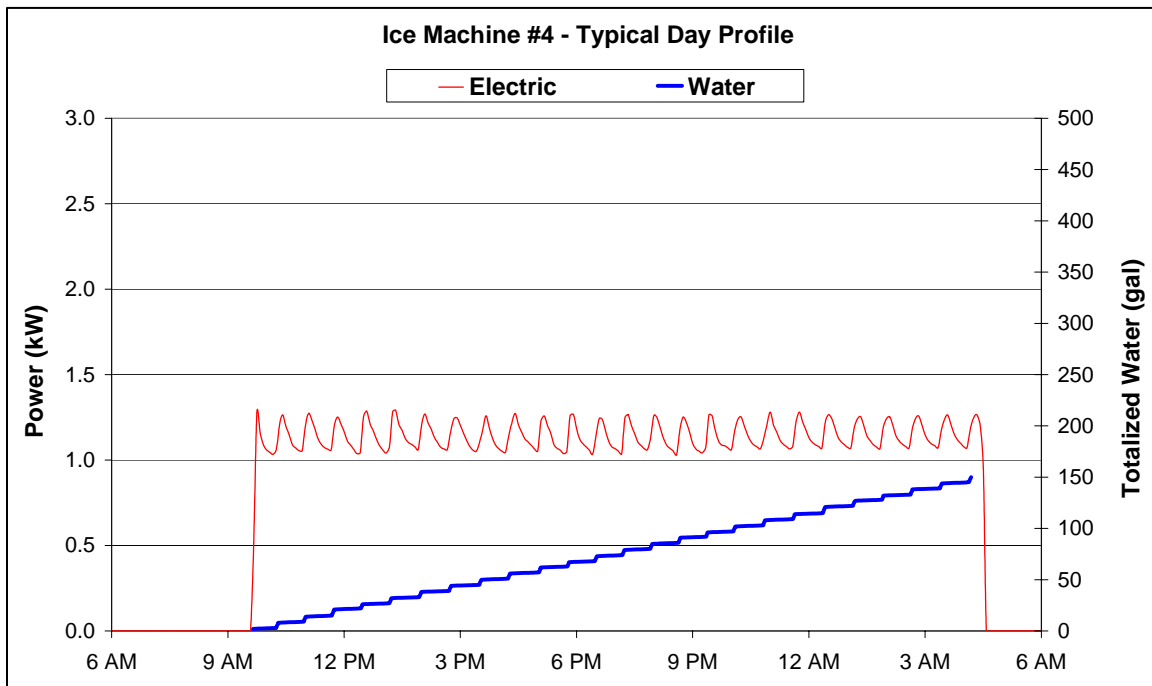


Ice Machine #4: This air-cooled ice machine was located in a diner that served breakfast and lunch seven days a week. The average water consumption was 110 gal/day, and the average electrical consumption was 16.1 kWh/day. The average duty cycle was 58.5 %, with a maximum of 84.7 %. The amount of usage indicates that the machine cannot always be switched off during peak periods. Although a more efficient replacement machine would also decrease the duty cycle in addition to providing water and energy savings.

Manufacturer	Hoshizaki
Model	KM-451-DU
Type	Air-cooled
<u>ARI Performance Data</u>	
Ice Harvest Rate (lb/24 hr)	340
Potable Water Use Rate (gal/100 lb ice)	25.6
Condenser Water Use Rate (gal/100 lb ice)	N/A
Energy Consumption Rate (kWh/100 lb ice)	8.8
Average Harvest Weight (lb/cycle)	9.2
Average Harvest Cycles Per Day	19.9
Average Ice Production (lb/day)	178
Average Daily Duty Cycle (%)	58.5 %
Maximum Daily Duty Cycle (%)	84.7 %
Average Water Consumption (gal/day)	110
Average Energy Consumption (kWh/day)	16.1
Water to Ice (gal/day)	21.4
Wastewater (gal/day)	89.0
Water-to-ice / Water-to-waste ratio	4.16
Annual Ice Production (lb/yr)	64,260
Annual Water Consumption (gal/yr)	39,760
Annual Electrical Energy Consumption (kWh/yr)	5,800
Measured Water Use Rate (gal/100 lb)	61.9
Difference from ARI Data (gal/100 lb)	+ 36.3
Percentage Difference from ARI	+ 142 %
gal/day Difference from ARI	+ 64.7
Measured Energy Consumption Rate (kWh/100 lb)	9.02
kWh/100lb Difference from ARI	+ 0.22
Percentage Difference from ARI	+ 2 %
kWh/day Difference from ARI	+ 0.4
Potential Annual Water Savings Using a 20 gal/100 lb Machine (gal/yr)	26,910
Potential Annual Water Cost Savings Using \$5.00/CCF	\$ 180
Potential Annual Energy Savings Using a 5.8 kWh/100 lb Machine (kWh/yr)	2,070
Potential Annual Energy Cost Savings Using \$0.15/kWh	\$ 310



Machine #4

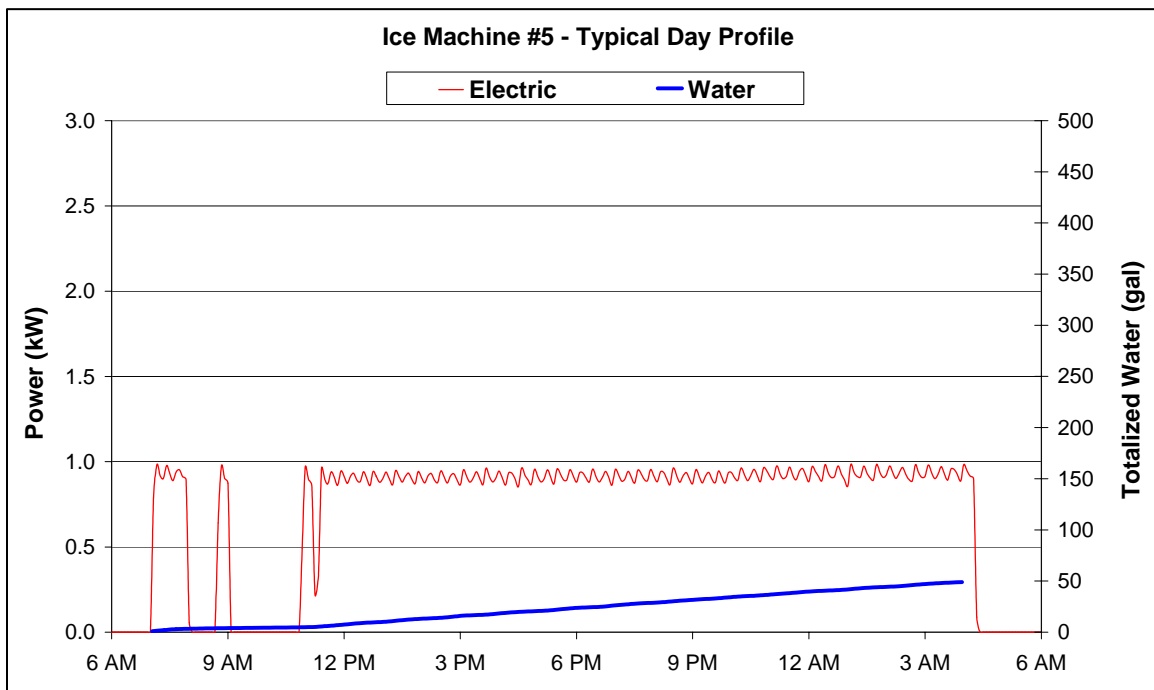


Ice Machine #5: This air-cooled ice machine was located a in restaurant and bar that opened seven days a week. The average water consumption was 53 gal/day, and the average electrical consumption was 18.0 kWh/day. The average duty cycle was 82.8 %, with a maximum of 100 %, which indicative of the machine working very long to meet the demand and that a larger (and more efficient) machine needs to be selected to apply load shifting.

Manufacturer	Manitowoc
Model	QY0374A
Type	Air-cooled
<u>ARI Performance Data</u>	
Ice Harvest Rate (lb/24 hr)	275
Potable Water Use Rate (gal/100 lb ice)	26
Condenser Water Use Rate (gal/100 lb ice)	N/A
Energy Consumption Rate (kWh/100 lb ice)	8.3
Average Harvest Weight (lb/cycle)	3.3
Average Harvest Cycles Per Day	66.1
Average Ice Production (lb/day)	215
Average Daily Duty Cycle (%)	82.8 %
Maximum Daily Duty Cycle (%)	100 %
Average Water Consumption (gal/day)	53
Average Energy Consumption (kWh/day)	18.0
Water to Ice (gal/day)	25.8
Wastewater (gal/day)	26.9
Water-to-ice / Water-to-waste ratio	1.04
Annual Ice Production (lb/yr)	77,340
Annual Water Consumption (gal/yr)	18,960
Annual Electrical Energy Consumption (kWh/yr)	6,500
Measured Water Use Rate (gal/100 lb)	24.5
Difference from ARI Data (gal/100 lb)	- 1.5
Percentage Difference from ARI	- 6 %
gal/day Difference from ARI	- 3.2
Measured Energy Consumption Rate (kWh/100 lb)	8.39
kWh/100lb Difference from ARI	+ 0.09
Percentage Difference from ARI	+ 1 %
kWh/day Difference from ARI	+ 0.2
Potential Annual Water Savings Using a 20 gal/100 lb Machine (gal/yr)	3,490
Potential Annual Water Cost Savings Using \$5.00/CCF	\$ 23
Potential Annual Energy Savings Using a 5.8 kWh/100 lb Machine (kWh/yr)	2,000
Potential Annual Energy Cost Savings Using \$0.15/kWh	\$ 300



Machine #5

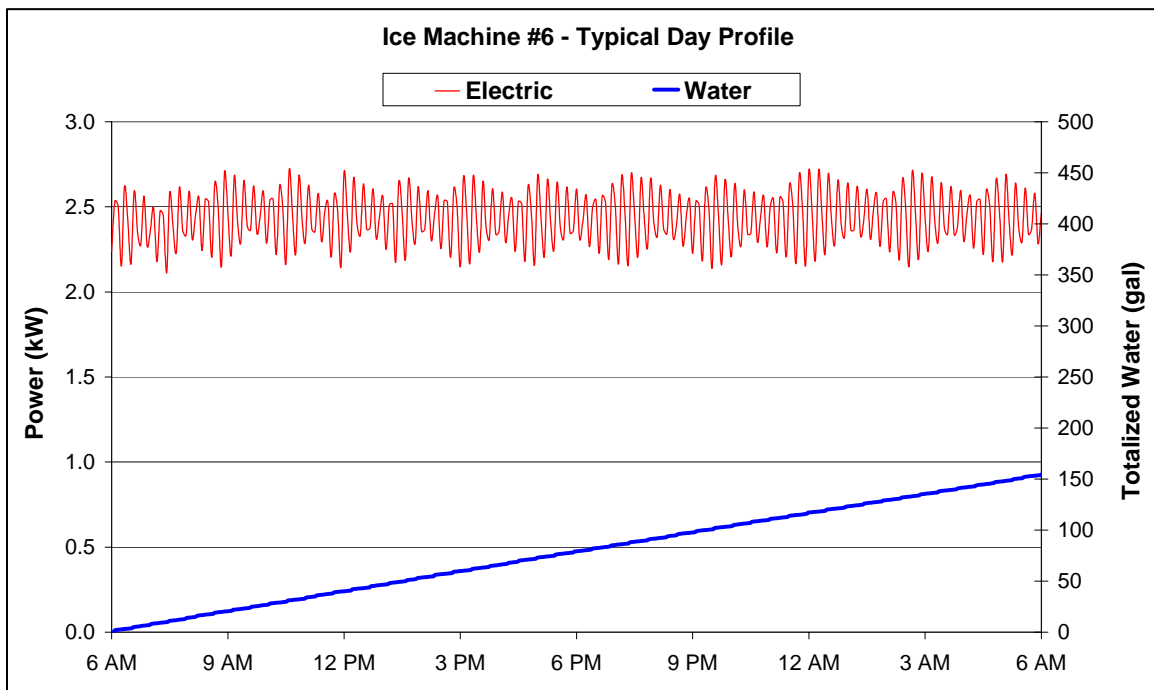


Ice Machine #6: This air-cooled ice machine was located in a corporate cafeteria that was open five days a week. The average water consumption was 130 gal/day, and the average electrical consumption was 50.7 kWh/day. The average duty cycle was 86.6 %, with a maximum of 100 %. During the week, the typical-day duty cycle for the machine was usually 100%. The facility uses the machine to full or near-full capacity and uses a flaker ice machine for cold buffet table service.

Manufacturer	Manitowoc
Model	QY10004A
Type	Air-cooled
<u>ARI Performance Data</u>	
Ice Harvest Rate (lb/24 hr)	830
Potable Water Use Rate (gal/100 lb ice)	20.4
Condenser Water Use Rate (gal/100 lb ice)	N/A
Energy Consumption Rate (kWh/100 lb ice)	6.9
Average Harvest Weight (lb/cycle)	8.1
Average Harvest Cycles Per Day	85.4
Average Ice Production (lb/day)	694
Average Daily Duty Cycle (%)	86.6 %
Maximum Daily Duty Cycle (%)	100.0 %
Average Water Consumption (gal/day)	130
Average Energy Consumption (kWh/day)	50.7
Water to Ice (gal/day)	83.2
Wastewater (gal/day)	46.6
Water-to-ice / Water-to-waste ratio	0.56
Annual Ice Production (lb/yr)	249,920
Annual Water Consumption (gal/yr)	46,740
Annual Electrical Energy Consumption (kWh/yr)	18,260
Measured Water Use Rate (gal/100 lb)	18.7
Difference from ARI Data (gal/100 lb)	- 1.7
Percentage Difference from ARI	- 8 %
gal/day Difference from ARI	- 11.8
Measured Energy Consumption Rate (kWh/100 lb)	7.31
kWh/100lb Difference from ARI	+ 0.41
Percentage Difference from ARI	+ 6 %
kWh/day Difference from ARI	+ 2.8
Potential Annual Water Savings Using a 20 gal/100 lb Machine (gal/yr)	N/A
Potential Annual Water Cost Savings Using \$5.00/CCF	N/A
Potential Annual Energy Savings Using a 5.8 kWh/100 lb Machine (kWh/yr)	3,760
Potential Annual Energy Cost Savings Using \$0.15/kWh	\$ 564



Machine #6

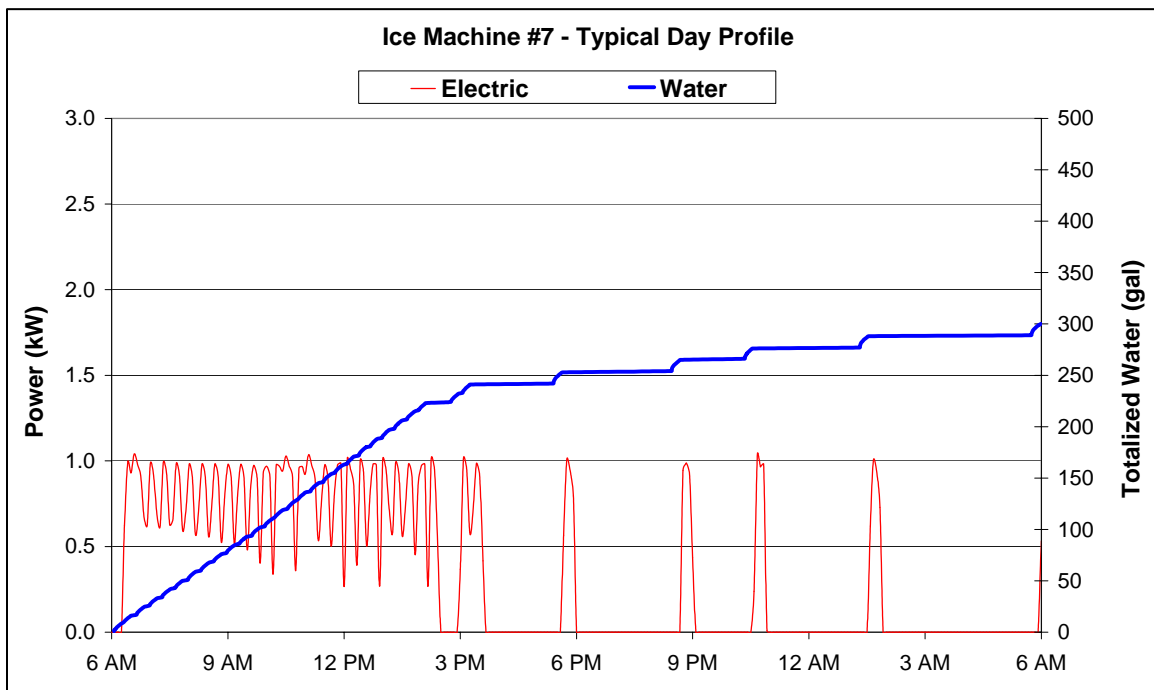


Ice Machine #7: This water-cooled ice machine was located in a casual dining restaurant operating twelve hours per day during breakfast and lunch, seven days a week. The average water consumption was 295 gal/day, and the average electrical consumption was 8.6 kWh/day. The 34.5 % average and 47.6 % maximum duty cycles are low enough to easily allow for timed peak-load shifting.

Manufacturer	Manitowoc
Model	QY0425W
Type	Water-cooled
<u>ARI Performance Data</u>	
Ice Harvest Rate (lb/24 hr)	440
Potable Water Use Rate (gal/100 lb ice)	26.4
Condenser Water Use Rate (gal/100 lb ice)	177
Energy Consumption Rate (kWh/100 lb ice)	5.5
Average Harvest Weight (lb/cycle)	4.6
Average Harvest Cycles Per Day	34.3
Average Ice Production (lb/day)	158
Average Daily Duty Cycle (%)	34.5 %
Maximum Daily Duty Cycle (%)	47.6 %
Average Water Consumption (gal/day)	295
Average Energy Consumption (kWh/day)	8.6
Water to Ice (gal/day)	18.9
Wastewater (gal/day)	276.0
Water-to-ice / Water-to-waste ratio	14.6
Annual Ice Production (lb/yr)	56,870
Annual Water Consumption (gal/yr)	106,173
Annual Electrical Energy Consumption (kWh/yr)	3,100
Measured Water Use Rate (gal/100 lb)	186.7
Difference from ARI Data (gal/100 lb)	- 16.7
Percentage Difference from ARI	- 8 %
gal/day Difference from ARI	- 26.4
Measured Energy Consumption Rate (kWh/100 lb)	5.44
kWh/100lb Difference from ARI	- 0.06
Percentage Difference from ARI	- 1 %
kWh/day Difference from ARI	- 0.1
Potential Annual Water Savings Using a 20 gal/100 lb Machine (gal/yr)	94,800
Potential Annual Water Cost Savings Using \$5.00/CCF	\$ 634
Potential Annual Energy Savings Using a 5.8 kWh/100 lb Machine (kWh/yr)	N/A
Potential Annual Energy Cost Savings Using \$0.15/kWh	N/A



Machine #7

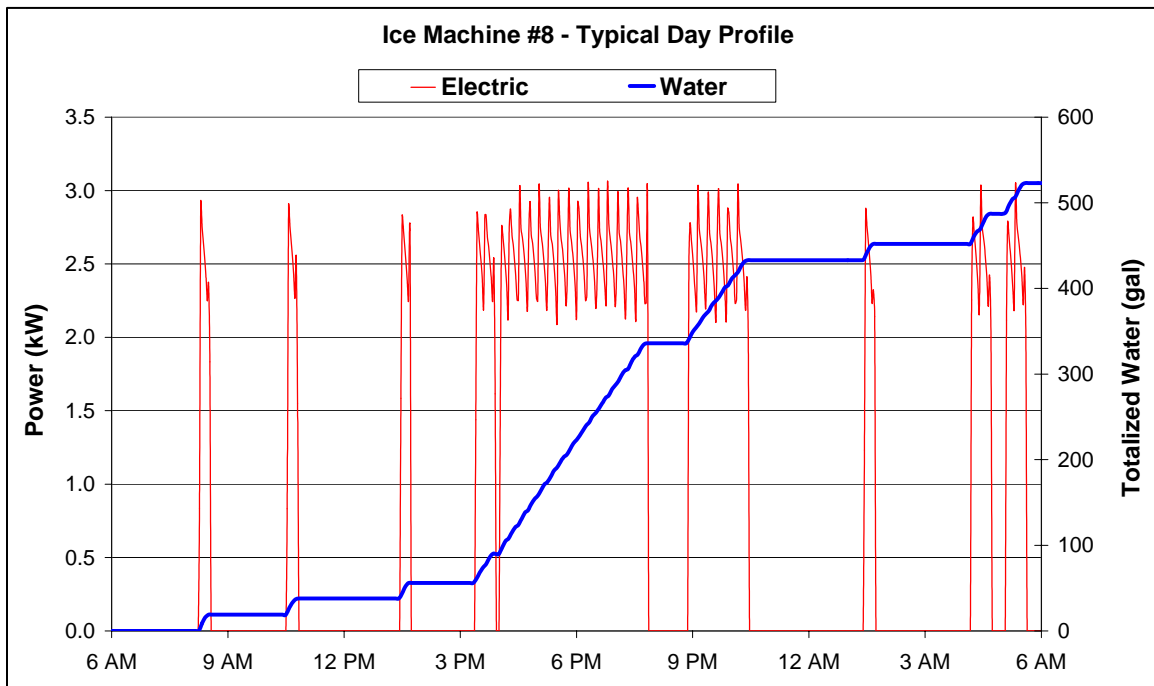


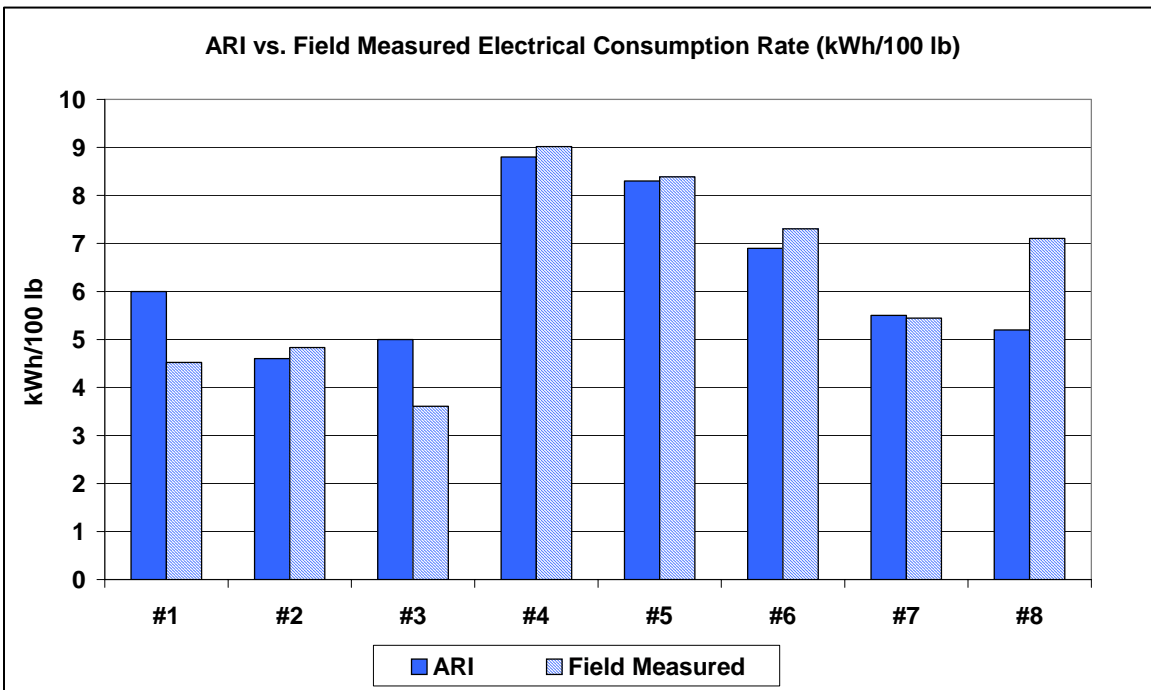
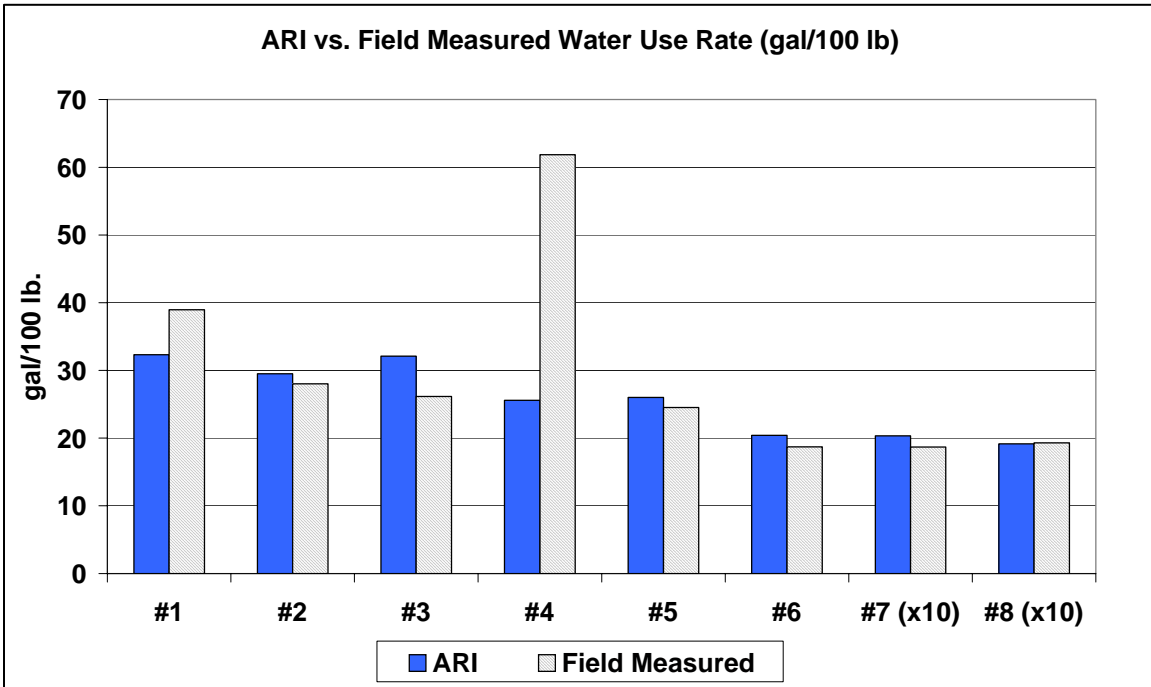
Ice Machine #8: This water-cooled ice machine was located a in a golf club restaurant which was open for dinner six days a week. The average water consumption was 592 gal/day, and the average electrical consumption was 21.8 kWh/day. The average duty cycle was 35.3 %, with a maximum of 78.5 %. Effective peak load shifting with a timer is achievable with this machine.

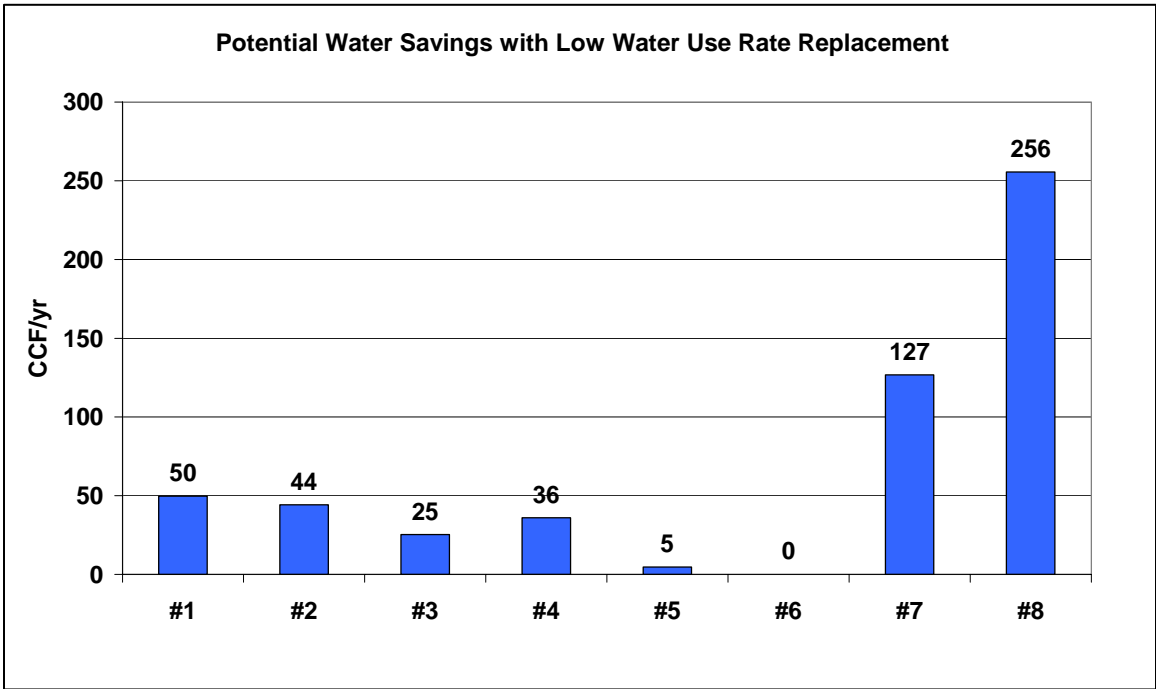
Manufacturer	Manitowoc
Model	GY1205W
Type	Water-cooled
<u>ARI Performance Data</u>	
Ice Harvest Rate (lb/24 hr)	1130
Potable Water Use Rate (gal/100 lb ice)	19.6
Condenser Water Use Rate (gal/100 lb ice)	172
Energy Consumption Rate (kWh/100 lb ice)	5.2
Average Harvest Weight (lb/cycle)	9.1
Average Harvest Cycles Per Day	33.8
Average Ice Production (lb/day)	307
Average Daily Duty Cycle (%)	35.3 %
Maximum Daily Duty Cycle (%)	78.5 %
Average Water Consumption (gal/day)	592
Average Energy Consumption (kWh/day)	21.8
Water to Ice (gal/day)	36.8
Wastewater (gal/day)	555.6
Water-to-ice / Water-to-waste ratio	15.1
Annual Ice Production (lb/yr)	110,450
Annual Water Consumption (gal/yr)	213,260
Annual Electrical Energy Consumption (kWh/yr)	7,850
Measured Water Use Rate (gal/100 lb)	193.1
Difference from ARI Data (gal/100 lb)	+ 1.5
Percentage Difference from ARI	+ 1%
gal/day Difference from ARI	+ 4.6
Measured Energy Consumption Rate (kWh/100 lb)	7.11
kWh/100lb Difference from ARI	+ 1.91
Percentage Difference from ARI	+ 37 %
kWh/day Difference from ARI	+ 5.8
Potential Annual Water Savings Using a 20 gal/100 lb Machine (gal/yr)	191,200
Potential Annual Water Cost Savings Using \$5.00/CCF	\$ 1,280
Potential Annual Energy Savings Using a 5.8 kWh/100 lb Machine (kWh/yr)	1,440
Potential Annual Energy Cost Savings Using \$0.15/kWh	\$ 216



Machine #8







Conclusions and Recommendations

This field study successfully characterized the water and energy use of eight individual ice machines operating in commercial food service operations. The data document the water and energy saving potential that would be realized by replacing a given unit with a more water/energy efficient model. The measured average and peak duty cycles, combined with the actual electric load profile, provide insight into the potential for off-peak operation of each ice machine.

The test results showed that water use and energy consumption rates varied significantly from the standard ratings. Maintenance points potentially affecting performance include scale removal and appropriate purge-timer settings.

As expected, replacement of water-cooled machines with air-cooled models will yield the most savings. Furthermore, when replacing them with remote condenser unit air-cooled units, there will be no extra heat introduced into the ice machine area. Remote condenser or split-system ice machine can be specified to reject heat outdoors and away from areas that are normally air-conditioned. Quiet operation is an added benefit.

Most of the machines monitored in the field study operated during the day through peak utility rate periods and were off at night (aside from occasional cycles initiated to top off the bin) long enough to build-up enough ice to supply peak periods when shut down. Five of the eight machines monitored slowed potential for off-peak operation. Three of these machines are straightforward candidates (i.e., peak duty cycles below 70%) for time clock based control.

When specifying new or replacement machines, it is recommended that models with the highest practical harvest rate capacity and inherently higher energy efficiency be selected. Peak load shifting through use of a timer should be employed when possible. The storage bin must have sufficient holding capacity for the daily ice demand at least through the peak period during which the machine would be switched off.