Most locations where large numbers of people assemble have food-service facilities. Restaurants and pastry/doughnut shops are obvious members of this category. Most schools, hospitals, hotels, service stations with stores, and convenience stores have food-service operations. Larger office buildings, factories, and institutional facilities provide food service of some type to their employees. Because food-service facilities are characterized by many kinds of water uses and high energy and water consumption, they are prime targets for incentives or requirements for water-efficient equipment, both for new construction and for retrofit of existing facilities. This report focuses on efficient equipment that should be required or at least considered for new construction.

Water-using technologies that have specific potential for water conservation include:

**Refrigeration Equipment**
- Refrigerators and freezers
- Ice-making machines

**Cooking and Food-Service Equipment**
- Steam tables
- Steam kettles
- Pasta cookers
- Steamers
- Combination ovens (a new product in development)
- Dipper wells
- Woks

**Scullery Operations**
- Garbage disposers
- Pre-rinse spray valves
- Dishwashers

**Washing and Sanitation**
- Floor washing
- Hood washing

**Refrigeration Equipment**

**Refrigerators and Freezers**

Refrigeration includes both coolers and freezers used to preserve food. Three major considerations for minimizing water use in refrigeration operations are:
• having adequate refrigeration equipment to minimize the need for thawing food under flowing water
• eliminating once-through cooling
• encouraging air-cooling, especially with remote (outside) compressors that exhaust waste heat outside the building

Description of End Use
Potential water savings from refrigeration equipment fall into three categories:
• sizing refrigerators to provide adequate capacity for thawing frozen food. The California Uniform Retail Food Facilities Law requires that food be defrosted in a refrigerator or be thawed under constantly flowing water that remains below 75°F. Thawing under flowing water is always wasteful and should be avoided whenever possible by designing for adequate refrigeration equipment to be installed in food-service facilities.
• eliminating once-through or pass-through water-cooling by installing air-cooled equipment.
Reach-in refrigeration equipment (smaller display cases, glass- and solid-door coolers, etc.) is almost exclusively air-cooled, but large walk-in units and large display cases can be either air- or water-cooled. Some facilities use recirculating cooling water from either a chilled-water loop or a cooling tower. Although more efficient than once-through cooling, it is usually less economical than air-cooling.
• air-cooling, especially with remote (outside) compressors that exhaust waste heat outside the building, not into the working space. Energy use for air-cooled equipment is primarily a function of the size and capacity of the refrigerator or freezer, combined with the energy efficiency of the equipment.

Water-Savings Potential
Water savings from installing adequate refrigeration varies greatly. Some restaurants can use thousands of gallons a day thawing food under running water in a sink. The typical kitchen faucet turned on half way has a flow rate of about 3.0 gpm and may be left on for an hour or more a day for thawing. Using equipment with once-through cooling saves approximately 145 gallons per ton hour. A three-ton refrigerator uses 5,000 gallons of water a day for once-through cooling.

Cost-Effectiveness Analysis
Example: Thawing under water in a sink versus extra refrigeration space.
• Equipment capital costs: $27 per cubic foot.
• Estimated equipment life: 8 years (Nadel, 2002).
• Water and energy savings: Compare the cost of water and wastewater used to thaw in a sink with the cost of purchasing and maintaining extra refrigeration space. Three faucets flowing at 3.0 gpm, used one hour each day, consume 200,000 gallons a year. The combined water and sewer cost savings equals $1,400 a year.
• Incremental cost per AF of efficient equipment: The average operating cost of refrigeration is approximately $7.50 per cubic foot (for solid doors, Energy Star). The PV of the operating savings and amortized capital costs justify purchasing an additional 121 cubic feet of refrigeration. This change would save 0.6 AF of water per year at no additional cost.

Example: Once-through water-cooled vs. air-cooled.
• Equipment capital costs: The incremental cost for a water-cooled unit versus a remote-head unit is $2,000 for even the largest units.
• Estimated equipment life: 10 years (Energy Star).
• Water and energy savings: An air-cooled unit uses 145 gallons of water per ton-hour, at a cost of $1.00 per ton-hour. A water-cooled three-ton refrigeration unit working 4,000 hours a year would use 1.74 million gallons a year (5.4 AF), for an annual water and wastewater cost of $12,400. The additional energy cost for an air-cooled unit would be $300 a year.
• Incremental cost per AF of efficient equipment: The simple payback for the additional capital costs of a remote-head unit would be two months. The positive benefit per AF is $1,900.

Recommendations

Proven Practices for Superior Performance
• Provide adequate refrigerator space for thawing food.
• Choose energy-efficient equipment.
• Prohibit once-through cooling with potable water.

Additional Practices That Achieve Significant Savings
• Choose air-cooling rather than recirculating cooling-water systems.
• Follow requirements in the cooling tower section of this report.

Ice-Making Machines

Description of End Use
Ice makers are an extension of the refrigeration-equipment category, but unique in many ways. As with refrigeration, both water-cooled and air-cooled equipment are available, with air-cooled being much more water-efficient. There are two basic types of commercial ice equipment: flake-ice and cube-ice machines. Ice-making machines are rated by the hundreds of pounds of ice the machine can make per day. One hundred pounds of ice is equal to 12 gallons of water, but actual water use depends upon the efficiency of the particular machine. Many local utilities in California provide rebates for efficient ice machines.

Flake-ice machines, including the new nugget machines, are the most energy- and water-efficient equipment available. Nugget machines press flake ice into a small cylindrical shape. Flake ice is crunchy and tends to melt quickly in drinks; it is often used to ice down food in serving lines. Nugget ice melts more slowly, can be used in most drink applications, and is increasingly being used instead of cube ice. Nugget ice is appealing in soda-fountain drinks, since the whole nugget becomes flavored with the soda and is easy to chew.

Cube-ice machines produce clear cubes of ice by washing the cubes as they freeze, so any minerals that may precipitate on the forming cubes are washed away. Cube-ice machines are the most common commercial ice-making equipment.

According to the Consortium for Energy Efficiency (CEE), hospitals account for 39.4 percent of all commercial ice-maker purchases, followed by hotels (22.3 percent), restaurants (13.8 percent), retail outlets (8.5 percent), schools (8.5 percent), offices (4.3 percent), and grocery stores (3.2 percent).

Water-Savings Potential
Flake/nugget machines purge the cylindrical tubes with water two or three times a day to flush out any precipitated minerals, using 10 to 30 gallons each time. It takes 20 gallons of water to make 100 pounds of flake/nugget ice. Cube machines use water to wash the cubes so they are crystal clear, increasing water use to 30 or more gallons per 100 pounds of ice in some cases. Water-cooled units use from 72 to 240 gallons of water for every hundred pounds of ice produced. Once-through systems simply dump this water into the sanitary sewer.
The USEPA's Energy Star program has published standards for cube-making ice machine equipment. These standards do not yet include flake and nugget machines. Once separate flake and nugget ice machine standards are developed, they should be followed also. In the interim, the Food Service Technology Center has published a list of qualifying ice machines that include both cube-making and flake and nugget ice machines.

When cube-making ice machines are installed, the installer will set the purge rate, the rate at which water flows over the ice plate surface to remove precipitating minerals. Having the installer set this rate to the lowest level possible will also save water.

Cost-Effectiveness Analysis

Example: 700-pound air-cooled vs. water-cooled ice machines:

- Equipment capital costs: $1,000 additional for an air-cooled unit.
- Estimated equipment life: 7 years, depending on usage.
- Water and energy savings: An air-cooled machine producing 700 pounds of ice per day will save 1,350 gallons per day versus a water-cooled machine. The net annual operating cost savings is $1,600 to $2,300 for an air-cooled versus a water-cooled machine, depending upon the air-cooled configuration. Simple payback for selecting an air-cooled machine is 12 months.
- Incremental cost per AF of efficient equipment: The savings is 10.2 to 10.7 AF over the life of the machine. The net PV of the operating savings is $12,100 for an air-cooled unit in air-conditioned space and $9,200 for a remote-head. The positive benefit ranges from $880 to $1,180 per AF.

Example: 700-pound nugget/flake-ice versus a cube-ice machine:

- Equipment capital costs: Flake- and nugget-ice machines cost from $500 to $1,200 more, depending upon size, due to the cost of a mechanical auger, which removes the flakes of ice from the tubes surrounded by liquid refrigerant.
- Estimated equipment life: 6 years.
- Water and energy savings: Compared with cube machines, air-cooled flake-ice machines reduce water use by about 15 gallons and electricity use by a kilowatt hour for every 100 pounds of ice made. An air-cooled flake machine that makes 700 pounds of ice daily will use 105 gallons and 7.0 kilowatt hours (kWh) a day fewer than a cube machine. In a year, this equals 38,000 gallons and 2,555 kilowatt hours, resulting in an annual operating savings of $475 per year. The simple payback is five months.
- Incremental cost per AF of efficient equipment: The savings will be 0.7 AF over the life of the equipment. There is a positive PV benefit of $1,800 per AF.

Recommendations

Proven Practices for Superior Performance

- Prohibit once-through water-cooled ice makers.
- Nugget- and flake-making ice machines should be selected from the Food Service Technology Center list of qualifying ice machines.

Additional Practices That Achieve Significant Savings

- Ensure that installers set the amount of purge water to the lowest level possible for the quality of water being used.
• Choose energy-efficient flake or nugget machines rather than cube machines. Nugget machines should be adequate for most restaurant and food-service operations, as well as for drinks in convenience stores.
• Mount compressor units outside so rejected heat is not dumped into work or living spaces. “Remote-head” is the term used to describe these outside units.
• Prefer air-cooled units to those using a cooling-tower loop, which increases water use by evaporating 7 to 9 gallons of water per 100 pounds of ice made.

Cooking and Food-Service Equipment

Steam Tables

Description of End Use
Steam tables, used to keep food hot while serving, are filled with water and heated to keep the food at 140° F or higher (California Uniform Retail Service Law). At the end of the day, they are drained. The major consideration regarding water efficiency is whether a steam table is actually needed. Though indispensable in large cafeterias and many institutional settings, they are not needed in every food-service operation. Some tables have both wet and dry options, and others use direct-heating equipment, such as electrically heated serving wells, which use no water at all;

Water-Savings Potential
Steam tables require 20 to 100 gallons of water or more per day, depending upon their design and size.

Cost-Effectiveness Analysis
Steam table prices range from a few hundred to $4,000, depending upon size and capacity. The decision, in terms of water use, is whether a steam table is needed.

Recommendations

Proven Practices for Superior Performance
• None

Additional Practices That Achieve Significant Savings
• For smaller applications, choose dry heating tables that use no water.
• Prefer non-water-using equipment to steam tables, if feasible.
• Use hot water from the steam table for end-of-day mopping.

Steam Kettles

Description of End Use
Steam kettles are often selected for use in large facilities because, as with steam tables, temperatures can be more easily controlled, thereby preventing scorching the food. They should be installed only where large-volume food preparation justifies this water and energy use. Some steam kettles have their own heat source, but where a central boiler is used to supply the steam, the condensate should be returned to the boiler for reuse. Stand-alone steam kettles, which can use either electricity or gas as a heat source and do not require a separate boiler, are the most common type found in restaurants. Large steam kettles are more commonly found in institutional settings.
Water-Savings Potential
The major water-savings potential for steam kettles is for the condensate to be retained and returned to the boiler, if such a system is used.

Cost-Effectiveness Analysis
- Equipment capital costs: Steam traps and condensate return are the only water-saving features available. Condensate return systems cost about $3,000. There is a one-time cost for piping.
- Estimated equipment life: Assume 10 years.
- Water and energy savings: The type of steamer used depends upon the availability of a commercial boiler to produce steam. For example, a 40-gallon kettle using steam at 30 pounds per square inch of pressure will use 214 pounds (25.7 gallons of water) an hour. Operating 12 hours a day, it would dump 308 gallons of water at 212°F. In a year it would consume 133 Mcf (thousand cubic feet) of gas and 113,000 gallons of water, which could cost as much as $2,000 a year (Bowser). Assuming a 20 percent blowdown rate and 30 percent energy savings from recirculating heated water, the annual water and energy cost savings is $1,000. The net PV of the incremental cost and water and energy saving is $4,800.
- Incremental cost per AF of efficient equipment: The recirculating system will save 0.35 AF per year at a net PV positive cost of $1400 per AF.

Recommendations
Proven Practices for Superior Performance
- Return condensate for all boiler-type kettles.

Additional Practices That Achieve Significant Savings
- Size steam traps to operate properly and not inadvertently dump condensate.
- Insulate condensate-return lines.

Pasta Cookers
Pasta cookers look much like fryers, but are used to heat and boil water instead of oil. Strainer baskets, similar to those used in fryers, hold the pasta. Pasta cookers have an overflow to skim off foam and either a manual or automatic fill valve. While in full operation, the fill valve is opened slightly to add fresh water. This helps reduce evaporation that occurs during a rolling boil. Many pasta cookers can be put into a standby or simmer mode when not in active use. Steam kettles and pots on the stove are the alternatives to this equipment.

Water-Savings Potential
Pasta cookers can be made more water-efficient by using automatic control valves to minimize overflow during the cooking process. The valves should shut off when the cooker is in simmer mode. Pasta cookers need not be completely refilled with water regularly, like a pot on a stove, so they can save some water, so long as the overflow is properly controlled.

Cost-Effectiveness Analysis
- Equipment capital costs: N/A
- Estimated equipment life: N/A
- Water and energy savings: Costs for all of the above are similar Water and energy savings depend more upon how they are operated than on the types of controls installed. Having auto-
matic overflow controls provides the opportunity to use the equipment more efficiently.

- Incremental cost per AF of efficient equipment: N/A

### Recommendations

**Proven Practices for Superior Performance**

- Require pasta cookers to have a simmer mode.
- Require automatic overflow controls.

**Additional Practices That Achieve Significant Savings**

- Minimize overflow by restricting flow to one-half gpm.

### Steamers

#### Description of End Use

Steamers are used to cook food with steam. There are two basic types. The first uses a boiler. Water is turned into steam and the left-over steam is vented. These systems require both water and wastewater connections. Water is continuously flushed through the boiler to prevent scale buildup. The boiler must be de-limed on a regular basis.

The second type is the connectionless steamer. It heats water in a reservoir at the bottom of the steamer, and the steam produced is recondensed and returned to that reservoir. These systems do not require water and wastewater connections. Boiler de-liming is not needed since there is no boiler. At the end of the day the reservoir is simply wiped out with a cloth soaked in vinegar.

Other boilerless systems do have water connections. One refills the reservoir as needed and does not dump water; its water efficiency is similar to the connectionless steamer. Another, just like the boiler type, dumps water, requires both water and sewer connections, and has similar water and energy use characteristics.

#### Water-Savings Potential

Both water and energy consumption vary significantly by steamer type. In a recent study, boiler steamers averaged over 450 gallons of water and 89 kWh a day, while comparable boilerless steamers used only 14 gallons and 17 kWh a day. Connectionless steamers use approximately 3 gallons of water per hour of operation, while boiler types use 40 gph or more (Fisher-Nickle).

#### Cost-Effectiveness Analysis

- Equipment capital costs: The costs of connectionless and boiler steamers vary little. However, boiler steamers must have both water and sewer hookups and a reduced-pressure zone (RPZ) backflow preventer, which can add several thousand dollars to the total cost. In addition, the backflow preventer must be tested annually.
- Estimated equipment life:
- Water and energy savings: The cost of operating a boiler steamer is substantially higher for both water and energy. Water consumption is about 175,000 gallons per year, compared with 13,000 for a connectionless steamer (Fisher Nickle). Water savings is 0.5 AF per year. Energy usage is almost four times that of a boiler steamer. Annual savings in operating cost is $1,800 for the water and energy, after deducting the annual testing cost for an RPZ.
• Incremental cost per AF of efficient equipment: After deducting the cost of the RPZ, the savings is $2,600 per AF.

**Recommendations**

**Proven Practices for Superior Performance**

• Combination ovens must be either connectionless or boilerless and consume no more than three gph.

**Combination Ovens**

**Description of End Use**

Combination ovens help keep food from drying out while baking or roasting. Both gas and electric models are available in several configurations. One has a boiler that produces steam which is injected into the oven chamber. Others achieve high humidity with sprays, and some models have closed systems that recondense steam to achieve higher energy and water savings (Alto–Shaam). The cooking capacity of a typical oven is significant. One six-pan model can cook as many as 32 chickens at a time (Sorensen).

**Water-Savings Potential**

A heavily used ten-pan boiler combination oven can consume 30 to 40 gallons of water per hour, while a boilerless misting oven uses only 10 to 15, resulting in an annual savings greater than 110,000 gallons (Reed).

Gas and electric combination ovens vary widely in energy efficiency. Some models are 40 to 60 percent more energy efficient than their conventional counterparts. Inefficient models consume 360 to 480 gpd, while efficient models use only 120 to 180 gpd.

**Cost-Effectiveness Analysis**

• Equipment capital costs: Combination ovens are expensive; small units start in the $10,000 range, while larger units can cost as much as $50,000. Energy Star examples show prices for larger, more-efficient equipment to be approximately $8,400 higher than for conventional models.
• Estimated equipment life: 10 years.
• Water and energy savings: The energy savings is 12,450 kWh per year in this example. Combine this with an estimated savings of 130,000 gallons of water per year, and the annual operating savings is $1,700. Over the life of the equipment, this saves $17,000 in energy costs and 4 AF of water (Energy Star).
• Incremental cost per AF of efficient equipment: When both energy and water savings are considered, the net benefit to the customer is $1,360 per AF or a total of $5,500.

**Recommendations**

**Proven Practices for Superior Performance**

• Combination ovens must use no more than 15 gph.

**Additional Practices That Achieve Significant Savings**

• All combination ovens should comply with the rebate list prepared by Fisher Nickel for energy rebates in California ([www.fishnick.com/saveenergy/rebates/combis/combis.pdf](http://www.fishnick.com/saveenergy/rebates/combis/combis.pdf)).

**Dipper Wells**

Dipper wells are used for applications such as rinsing ice-cream scoops on the serving line. Most have a single faucet or spigot and can be supplied with either hot or cold water.
Water-Savings Potential
The faucet or valve can be adjusted by the server. Typical flow rates are 0.5 to 1.0 gpm. For smaller dipper wells, a flow rate of 0.25 gpm should be adequate. In-line flow restrictors can be installed on the supply line to the dipper well. These can be set at the minimum adequate flow and locked so that employees cannot increase flow.

Cost-Effectiveness Analysis
- Equipment capital costs: N/A
- Estimated equipment life: N/A
- Water and energy savings: As many as several hundred gpd.
- Incremental cost per AF of efficient equipment: N/A

Recommendations
Proven Practices for Superior Performance
- In-line restrictors that reduce flow to under 0.3 gpm.

Woks
Wok stoves commonly used in oriental restaurants rely on a constant flow of water over the surface of the stove to keep it cool for the comfort of the cook. Efforts are underway in Australia to develop a “waterless wok” which employs better insulation and air cooling. For new construction, the waterless wok should be used as soon as it becomes available (Sydney, 2005). As of 2007, waterless woks can be ordered from Australia, but most American kitchen appliance dealers were unaware of them when called in a November 2007 survey.

Cost-Effectiveness Analysis
- Equipment capital costs: N/A
- Estimated equipment life: N/A
- Water and energy savings: N/A
- Incremental cost per AF of efficient equipment: N/A

Scullery Operations

Garbage Disposers
The process of scraping dishes and disposing of waste prior to dishwashing can use from zero to very large quantities of water and energy, depending upon the design of the equipment selected. Commonly found equipment includes garbage disposers, sluice troughs, and pulpers.

Garbage disposers grind food and other items that enter the grinder and send them down the sewer. This waste material adds to the solids and grease entering the sewer and the grease trap. If a grinder is used, it should be equipped with a solenoid to shut off the flow of water when not needed.

Sluice troughs are usually built into the stainless-steel table systems. Water flows continuously into the top end of the trough at 5 to 15 gpm and flushes food waste from pots, pans, dishes, etc. into a garbage disposer. Large flows of water are required. A variation of this is the recirculating system that passes the waste through a grinder, strains out the solids for flushing down the drain, and returns the water to the
sluice trough to flush down more waste. These systems use only two to three gallons of make-up water a minute, but are expensive.

Pulpers strain the solids from the grinder waste stream and compact them to make disposal more convenient. These systems have the advantage of removing solid waste, fats, oils, greases, and other components from the wastewater. According to manufacturers’ literature, they can also recirculate up to 75 percent of the water to the head of a sluice-trough system, as described above.

The main consideration with any of this equipment is whether it is needed in the first place. Many restaurants and food-service establishments are eliminating garbage disposers from their design, in favor of more thorough scraping into garbage cans and the use of strainers or “scraper baskets” to collect food solids for solid-waste disposal. In a typical operation, upwards of 80 percent of solids are already collected in the solid-waste disposal system. Some restaurants, however, may still prefer to have a garbage disposer. In these cases, disposers should be linked to pulpers, recirculating trough-collection systems, and related systems that use no more than 2 gpm of fresh water, or systems with a load-sensing device that regulates the water use to 1 gpm in a no-load situation and 8 gpm in a full-load situation. Only cold water should be supplied to the disposer, and a 15-minute shutoff timer should be installed.

**Water-Savings Potential**

Strainer (scraper) baskets can eliminate the energy and water associated with grinders, pulpers, and related systems, saving as many as 1,000 gpd, depending upon the grinder’s size and hours of use. A typical grinder in a restaurant or food-service setting has a 2- to 8-horsepower (hp) motor and a water-flow rate of 5 to 10 gpm. Some food-service operations report using their grinders 2 to 3 hours a day. Water-saver kits can cut grinder water-use in half. The Aqua Saver grinder reports to tailor energy and water use to the load. It costs several thousand dollars, but can reportedly cut water use by up to 70 percent. Another major savings realized by installing a scraper or strainer system is that grease traps do not need to be pumped as often, and greases, solids, and biochemical oxygen demand (BOD) loadings are reduced at wastewater treatment plants.

Where a food-service or restaurant operation may deem it necessary to install a garbage-grinder-type system, the following guidelines should be followed:

- Use cold water — common code requirement.
- Equip the system with a load-sensing device that regulates the water use to 1 gpm in a no-load situation and 8 gpm in a full-load situation, **or** use a pulper or trough system with a make-up rate of no more than 2 gpm of fresh water.
- Employ a time shutoff — after 15 minutes (option: after 15 minutes of idle use or no-load) the operator must push a button to reactivate.

**Cost-Effectiveness Analysis**

Example: Strainer system **versus** a scrap basket

Grinders cost from a few hundred to over $3,000. Huge savings are possible if a strainer system is used. Strainer-basket systems often eliminate pretreatment charges for grease and suspended solids, and grease traps do not have to be pumped as often.

- Equipment capital costs: For this example, the capital cost for a 4 hp grinder is $750. Pulper systems, recirculating sluice troughs, and similar equipment cost over $10,000. Additional equipment can be added to grinders that adjust water flow to the load, but they cost several thousand dollars, while strainer baskets cost about $350 and eliminate energy and water use.
- Estimated equipment life: One scrap basket should have a life equal to two grinders: 10 years for a scrap basket; 5 years for a grinder.
• Water and energy savings: Estimating 3 hours of operation a day, 365 days a year, with water running at 6 gpm, daily use would be 1,080 gallons and 9 kWh. Potential annual water savings are 395,000 gallons or 1.2 AF and 3,300 kWh. Personnel costs of approximately $1,600 per year for emptying the scrap basket into a dumpster may be absorbed by existing personnel.
• Incremental cost per AF of efficient equipment: The benefit over the life of the scrap basket is $1,600 per AF.

For savings related to the use of pulpers or trough-recirculation systems using no more than 2 gpm, information and calculators are available on manufacturers’ web sites such as www.salvajor.com/troughCollector.aspx or www.insinkerator.com/foodservice/aquasaver.php and related systems.

**Recommendations**

**Proven Practices for Superior Performance**

• Use strainer (scraper) baskets in place of grinders.

**Additional Practices That Achieve Significant Savings**

• If a water-using grinder is selected, install a water-saver kit or choose a grinder that tailors the water use to the load.
• Use a trough or pulper system that uses no more than 2 gpm of fresh water.
• Supply only cold water to such systems and install a timer to shut the system down after 15 minutes of operation or no-load, so that it requires the user to reactivate the system.

**Pre-Rinse Spray Valves**

**Description of End Use**

Pre-rinse spray valves are used to spray dishes and cooking ware prior to placement in a dish washer. The spray knocks off solid food and rinses soluble residues down the drain or into the garbage grinder, usually after the items have been placed in a holding rack that can be inserted into the dish washer. Prior to 2006, there were no restrictions on spray-valve flow rates. The Federal Energy Policy Act of 2005 now restricts flow rates to 1.6 gpm, however, unlike the California Energy Commission standard, the Federal standard does not include cleanability criteria. The spray-valve replacement program in California used valves that met ASTM test standards F2324-03 for flow and cleanability.

Spray valves now becoming available could reduce flow rates to as low as 1.3 gpm and achieve cleanability standards. Since 1.6 gpm is now the standard, new facilities will benefit from these savings. Additional information on spray valves, including the new 1.3 gpm models, can be found at both www.fishnick.com and www.EnergyStar.gov.

As a word of caution, some restaurants have been observed using equipment other than pre-rinse spray valves for spray cleaning, for example, garden hoses and garden-hose sprayers, which may use in excess of 7 gpm. To avoid this, pre-rinse spray valves should be required.

**Water-Savings Potential**

Since the national standard is now 1.6 gpm, all new facilities will have the more efficient spray valve. New spray valves are now on the market that reduce water use to as low as 1.3 gpm and still pass the ASTM standards F2324-03. The new lower-flow spray valves should be field tested before they are mandated. Since hot water is used, the new valve consumes both energy and water. In a very-large restaurant serving breakfast, lunch, and dinner, such a valve may have as many as four hours of continuous use. Studies done by the California Urban Water Conservation Council show that average savings in a
Cost-Effectiveness Analysis

- Equipment capital costs: N/A.
- Estimated equipment life: 5 years.
- Water and energy savings: Both water and energy savings accrue. When compared with older devices no longer allowed, the savings is approximately 137 gpd. The 1.3 gpm valves would reduce water use by another 15 to 20 percent.
- Incremental cost per AF of efficient equipment: N/A.

Recommendations

Proven Practices for Superior Performance
- Use pre-rinse spray valves for dish rinsing.
- Require pre-rinse spray valves that use less than 1.6 gallons per minute.

Additional Practices That Achieve Significant Savings
- Conduct a test program of the 1.3 gpm pre-rinse spray valves to determine their acceptability and performance.
- If test results are acceptable, offer incentives for installation of the 1.3 gpm spray valves.

Dishwashers

Description of End Use
Commercial dishwashers are very different from those found in homes. Residential dishwashers use 3 to 10 gallons per load, and the wash cycle lasts for half an hour or more. Commercial dishwasher run times are typically 1 to 3 minutes, and one machine may wash hundreds of loads per day. The majority of smaller commercial machines are leased by the companies that supply chemicals and detergent to the market; these machines tend to be less efficient. Three technical variations make a significant difference:

- The first variation is whether the machine saves water from the last wash to use in the next load or is a fill-and-dump machine that dumps all of its water after each load. Fill and dump machines are inherently inefficient.
- The second variation is how dishes are sanitized. One of the types most commonly found in small restaurants is the chemical machine, which typically uses a chlorine-based disinfectant. The other is the high-temperature machine, which uses 180°F water for sanitation and uses a booster heater to achieve these high temperatures. Chemical machines tend to use more water. Based upon information from the National Sanitation Foundation (NSF) and studies by the Food Service Technology Center and the CEE, hot-water sanitation machines use less water than chemical-sanitation equipment of the same capacity and type. This is borne out by the new set of commercial dishwasher standards set by the USEPA's Energy Star program, which lists both energy and water-use standards for all but flight-type dishwashers. An independent study of flight-type machines found in the NSF data base, done for this publication, indicates that maximum water use should not exceed 185 gph.
- The third variation has to do with the basic design of the washer.
  » Under-the-counter dishwashers are commonly found in bars, where only glassware is washed, or in small restaurants serving fewer than 60 people a day. They cost $3,500 to $4,000 each.
  » With the door-type machine, a rack of dishes is hand-loaded into the machine, and the cycle is started by hand. These are primarily found in restaurants that serve fewer than 150 customers a day. The cost can range from $4,000 to $10,000.
The C-Line or conveyor pulls the rack of dishes through the washer and pushes the clean rack out the other side. Larger restaurants serving between 150 and 300 people a day commonly use these, which cost from $12,000 to $50,000 per machine.

Flight machines are designed for service to many hundreds or even thousands of people per day and are typically found in large institutional facilities, hospitals, and large hotels with banquet facilities. Their costs range from $50,000 to well over $100,000.

CEE Commercial Kitchens preliminary annual sales data show about 65 percent of machines are door-type, 12 percent under-the-counter, 18 percent C-Line (conveyor), and 5 percent flight machines. Many door and C-Line machines are rented from companies that also supply the chemicals needed for the dishwashers. Rental costs depend upon how the chemicals are sold in the contract, but for a typical door machine, rents range from $80-$100 per month, while C-Line machine rents are $200 a month. The food-service-facility owner who rents has less opportunity to choose higher-efficiency equipment.

Dishwashing machines have variable lifespans. Door and C-Line machines typically function 7 to 10 years, while flight machines can last 15 or more. However, the rebuild and refurbish market for this equipment is enormous, with many new restaurants purchasing older, less-efficient rebuilt equipment.

C-Line conveyor and flight dishwashers can be equipped with electronic sensors and door switches to stop water flow when the machine is not washing dishes. Steam doors can reduce evaporation by up to 40 percent.

**Water-Savings Potential**

It is not uncommon for a C-line machine to wash 500 loads a day. Therefore, even a small increase in efficiency can make a big difference. NSF International data show water-use rates ranging from 72 to 852 gph, with the median use for all makes and models being about 280 gph. For other machines, the difference in water use is about 2 gallons per rack. Savings are based upon the number of racks washed per day. Savings realized by choosing an efficient door or conveyor model may range from hundreds to thousands of gpd, depending upon size and usage. Median use for door machines is about 1.5 gallons per rack and, for conveyors, about 1.2 gallons per rack.

The restaurant industry makes extensive use of refurbished dishwashers. Many of these older refurbished models are far from water-efficient. When purchasing or leasing any ware-washing equipment, ensure that it meets both energy- and water-saving standards.

**Cost-Effectiveness Analysis**

Example: C-Line conveyor high-temperature machine which can wash 900 racks of dishes a day.

- Equipment capital costs: 0.
- Estimated equipment life: 10 years.
- Water and energy savings: The average C-Line conveyor machine uses 1.2 gallons per rack. An efficient machine uses 0.9 gallons per rack or less. Annual operating savings for water, sewer, and avoided water heating are $1,800.
- Incremental cost per AF of efficient equipment: The benefit is $4,500 per AF saved.

Example: Flight machine

- Equipment capital costs: 0.
- Estimated equipment life: 10 years.
- Water and energy savings: Operating continuously eight hours a day, an inefficient machine uses 500 gph, while an efficient machine uses 214 gph. The savings is 835,000 gallons per year or 2.6 AF, for an annual operating cost savings of $15,000.
- Incremental cost per AF of efficient equipment: The benefit is $4,500 per AF saved.

Example: Door machine
- Equipment capital costs: $2,500 incremental cost for a machine with a recycle system.
- Estimated equipment life: 10 years.
- Water and energy savings: The machine washes 300 racks a day. A fill-and-dump machine uses 1.5 gallons a rack, while a machine with a water-recycle system uses 0.9 gallons per rack. Annual water savings is 66,000 gallons or 0.2 AF. Annual operating-cost savings of $1,200, including water, wastewater, and avoided gas water-heating.
- Incremental Cost per AF of Efficient Equipment: The benefit is $4,000 per AF saved.

## Recommendations

**Proven Practices for Superior Performance**
- Ban the use of fill-and-dump machines.
- Equipment must meet efficiency standards for dishwashing equipment set by the U.S. Environmental Protection Agency Energy Star program.
- For flight-type dishwashing equipment, require a flow-rate not greater than 185 gph.

### Washing and Sanitation

#### Floor Washing

**Description of End Use**
Washing floors in food-service establishments can use large quantities of water. The common practice has been to mop the kitchen floor with soapy water, then use a high-pressure hose with hot water to rinse the soapy water into the floor drain. This process uses large amounts of water, as well as energy to heat the water, and has a tendency to splash dirty water onto clean equipment. Some literature reports that water use for floor cleaning in a large commercial kitchen can be in the range of 1,000 to 1,500 gpd.

Four approaches can help reduce the amount of water use.
- First is to perform the conventional floor practice more efficiently, including:
  - Use a broom and dust-pan to clean up solid wastes before mopping.
  - Install a self-closing nozzle on the wash-down hose, so the water runs only when needed.
  - Use a new enzyme product that helps break down grease on the floor and require less water for rinsing.
  - Use a squeegee to push water to the floor drain prior to the final rinse.
- Second is to use the mop and squeegee method only, followed by a rinse with fresh mop water. While sometimes more time consuming, it does eliminate the use of the wash-down hose.
- Third is to use a pressure washer. Especially useful in cleaning floor mats and exhaust-hood filters, they can also be used in place of the standard hose for floor cleaning. Care should be taken not to splash water onto cooking surfaces. A pressure washer is much more water-efficient than a hose hooked to the hot-water faucet, as well as for the occasional need to clean outside areas. In all cases, regulations related to watershed protection and pollution control should be followed.
- Fourth involves the purchase and use of a wet-dry vacuum system or mechanical floor-cleaning system, which can often be used to clean the dining area also. It minimizes water and chemical use. These systems often look like carpet-cleaning equipment, but are designed to
handle heavily soiled solid surfaces. These cost from about $1,000 to more than $6,000, depending upon the size and type of equipment purchased.

Water-Savings Potential
When examining ways to reduce water use at a new facility, the choice of floor-cleaning processes must be part of the facility design.

- Any conventional floor cleaning system with a hot-water hose should, at a minimum, have a self-closing valve.
- Choose pressure-washing equipment for floor, exhaust-hood-filter, and floor-mat washing.
- Arrange equipment so squeegeeing can be done easily.
- Use floor-cleaning machines that have a water tank.
- Consider a floor washer or other systems.

Traditional floor-washing systems can use 1,250 gpd. A water-broom and mop system will cut this to under 500 gpd, and a floor-washing system or machine can reduce this to under 250 gallons, for a savings of 750 to 1,000 gpd of hot water. It is difficult to estimate water savings exactly, since it depends upon many parameters and must be done on a case-by-case basis.

Cost-Effectiveness Analysis

- Equipment capital costs: N/A
- Estimated equipment life: N/A
- Water and energy savings: The cost effectiveness of these systems is strongly dependent upon the individual situation. A range for savings would be $2,000 to $3,500 per year.
- Incremental cost per AF of efficient equipment: N/A

Recommendations

**Proven Practices for Superior Performance**

- Require all hoses used for washdown to have self-closing nozzles and limit flow to no more than five gpm.

**Additional Practices That Achieve Significant Savings**

- Use water brooms that are limited to 3.0 gpm where feasible.
- Use a floor-cleaning machine.
- Use an enzyme cleaning processes.
- Choose pressure-washing equipment for floor, exhaust-hood-filter, and floor-mat washing.
- Arrange equipment so squeegeeing can be done easily.

**Hood Washing**

Hood-washer systems offer a convenient way to clean slot and extractor hoods. The hood washer sprays soapy hot water over the grease-extractor systems after the hood is turned off for the day. Timing can be pre-set depending upon the amount of grease that collects. Hood-washer systems use from 0.5 to 1.0 gpm of water per linear foot. Hood washers may or may not use less water than conventional manual cleaning methods, depending upon the frequency of washing and how the water use with the hood system compares with the water use of manual cleaning, usually done with a pressure washer. Hood systems have a significant cost, although when properly operated, they may save water.

**References**


_________ [www.fishnick.com](http://www.fishnick.com).


Sydney Water Australia. September 1, 2005. **Wok Stove and Steamer Water Efficiency Report.**