Building Operator *Electrical* Information Guide

January 2006

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Electrical Equipment

Introduction

This document is intended to supplement the Electrical Equipment Efficiency section of the training workshop. It contains all the material covered in the workshop as well as additional detail. Those who attended the workshop are encouraged to read this manual afterwards to reinforce the principles that were learned.

Goals

The goals of this section of the Building Operator Awareness Training Program are to:

- elaborate on why conservation, recycling, and energy efficiency are beneficial and important.
- provide a basic understanding of the most common.
- efficiency issues related to electrical equipment.
- address relevant maintenance issues.

Consequences of
Electrical Equipment Efficiency

- Electricity savings.
- Improved quality.
- Decreased maintenance requirements.
- Positive impact on climate change issues.

Personal Computers

Facts About Computer Switching

Many people are reluctant to turn desktop computers off because of the belief that their computers will be harmed by normal switching. There is no evidence to support this.

- A study done by the Swiss Federal Institute of Technology demonstrated that monitors can be switched on and off five times per day with no noticeable impact on typical equipment lifetime.

- It was found that the emission of the cathode (the device which discharges against the monitor screen) will not start to weaken until 20,000 switching cycles, or 17 to 20 years of service. They recommend shutting off monitors if not used for 15 minutes or more.

- Computer companies are not overly worried about thermal cycling or deterioration of internal components from turning equipment on and off.

Computer Operating Life versus Hours of Operation

Computer product life is a direct function of the number of hours of operation. A computer operating continuously will probably fail sooner than one that is shut off overnight and on weekends.

Computer Energy Load

Depending on the model, the average computer, including the monitor and central processing unit (CPU), requires from 80 to 110 watts of electricity. Fifteen-inch monitors consume about 60 watts while the CPU requires about 40 watts. The trend is towards larger LCD monitors. However, LCD monitors are more efficient than the old cathode ray-tube model. A nineteen-inch LCD monitor consumes about 50 watts.

Switching Off Results in Significant Energy Savings

Switching off computers results in substantial energy savings. Figure 1 illustrates the magnitude of energy savings by simply shutting off a computer after the building day. Based on 5 cents per kWh electricity cost and 100 watts of load, a computer running 24 hours per day will cost about $44 per year. Simply shutting it off at the end of the workday will result in a much lower cost of $16 per year, net savings of $28 per year or 64 per cent. A facility with 40 computers could save as much as $1,120 per year on electricity alone!

Most computers are actually only used for an average of two to four hours per day. Hence, additional savings of 40 per cent or more can be achieved by fully utilizing the available energy savings software that is available. It may simply be a matter of activating the existing software or loading it onto your computer or network. This would reduce the cost in the example from $16 per year to $10 per year.

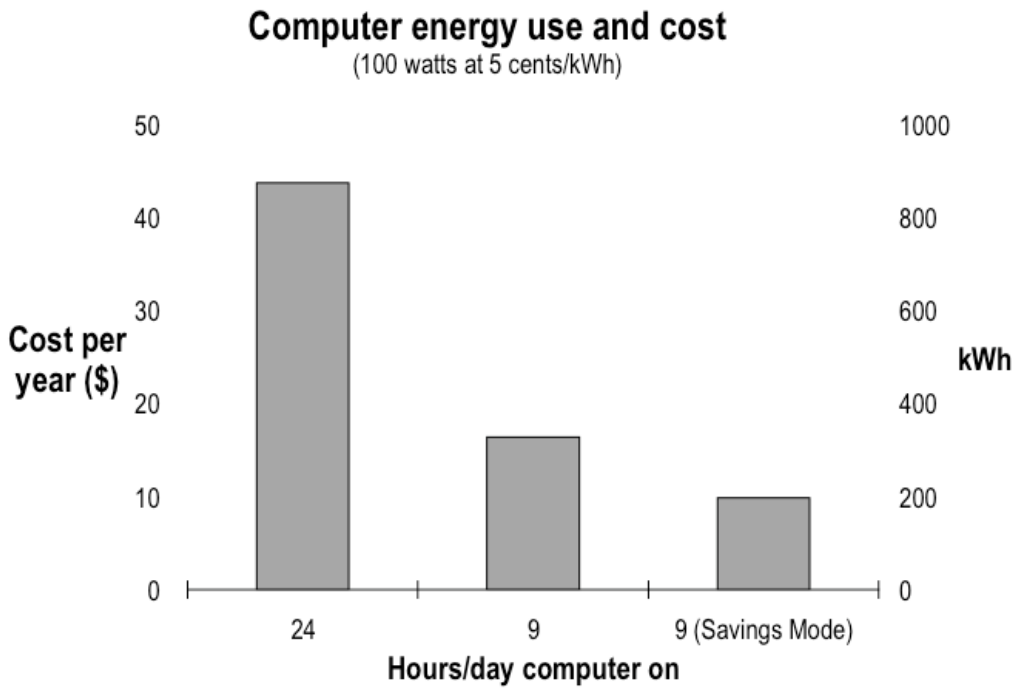

Figure 1

Optimize Existing Energy Savings Options on Computers

It is suggested that any new computers purchased should be specified to meet or exceed Energy Star™ guidelines. This software, if loaded, automatically places the monitor into a low energy use mode when the keyboard has not been used for a specified period of time. Again, this saves energy, preserves the monitor screen, and prolongs life of the equipment.

Since the inception of the Energy Star™ program, most computers have been designed with built-in energy saving capability. For example, Macintosh™ computers typically have sleep and standby modes on the menu. Standby mode reduces power consumption from 100 W to about 40 W. Sleep mode reduces consumption to about 2 W.
On IBM™ type computers, power management options are normally located in Windows™ Control Panel with options like the following:

- Shut off monitor
- Standby mode – shut off monitor and hard drive
- Shut off hard drive,
- Hibernation – save existing data and screen configuration in memory and shut off computer.
- Each of these modes can be preset to activate after a period of inactivity from between one minute to five hours.

Energy savings modes and options are very effective but they must be used and optimized.

Check with manufacturer's instructions for specific information.

Screensaver
The purpose of a screensaver is to prevent the monitor from having common symbols permanently burned into the screen. Only about 10 watts is saved during screensaver mode. It would be better to use the auto monitor shut off mode, which saves up to 60 watts while at the same time saving the screen.

Other Benefits of Shutting Off

Reduced Radiation
Cathode ray-tube monitors emit radiation when operating. Due to health concerns, low radiation designs have been introduced. An additional benefit of these monitors that are off, is that they don't emit radiation.

Reduced Heat Load
As stated earlier, the average personal computer (CPU and monitor) consumes between 80 and 110 watts of electricity. Ultimately, this electricity converts into waste heat, meaning that each computer also functions as an electric heater. This is beneficial during the heating season but not in cooling season. A facility with 30 computers could generate a cooling load of up to 3 kW.

It is common knowledge that excess heat is the enemy of any electronic device. Personal computers have a maximum operating temperature of 90 °F. An enclosed room with many computers left on during vacant periods can easily overheat, resulting in premature failure of electronic components.

If the HVAC system is off, there is no provision for usual cooling and ventilation. Separately or in combination, sunshine, outside air temperature, and computer heat gain can cause the room temperature to rise to a level that is harmful to the electronic components.

A Caution About File Servers

Where several computers are part of a network, one computer will function as the file server. The file server is the brain center for all the other computers and may need to be left on continuously for various reasons. Check with the network administrator before shutting off. It may also be a good idea to clearly mark the file server to avoid inadvertent shut down.

Computer Accessories and Peripheral Devices

Most plug-in electronic devices and computer peripherals consume standby power of 2 to 10 watts even when shut-off. Some newer printers and scanners don't have a shut-off switch but still consume up to 10 watts standby power. Other devices include modems, Ethernet hubs, computer speakers, monitors, and external drives. Daily unplugging all these items would not be practical. However, if they are plugged into a power bar, then the power bar can be easily shut off at night. While 2 to 15 watts is not much for an individual device, 5 or more of these devices would be equivalent to a 40 or 60 watt bulb. At 5 cents per kWh, this could cost $26 per year.

Printers

Inkjet Printers

Inkjet printers typically operate at 15 to 20 watts during printing and 7 to 9 watts on standby. Advantages over laser printers include low capital cost, minimal energy use, and low cost color printing.

Laser Printers

Laser printers can vary from 250 to 800 watts during printing, depending on size and capacity. After a preset time of inactivity, most laser printers will go into a standby or sleep mode of 5 to 10 watts. Laser printers may require a few minutes to warm up after they have been in standby or sleep mode.

Laser printers consume 10 to 40 times as much energy as inkjet printers. However, they offer significant advantages over inkjet printers including speed, quieter operation, lower cost per page, and higher quality print.

Energy Savings Tips for Printer Use	
1	Where the printer is close to computer(s), and infrequently used, the printer should be turned on only when needed.
2	Where a printer is networked to many distant users, it should normally be left on during business hours. However, these printers are easily forgotten about and left on continuously after hours.
3	Consider using an automatic time clock
4	Most laser printers are supplied with energy savings options and software. Are these option effectively used?
5	Manually shut off printers overnight and on weekends as required. Use a power bar if the printer does not have an off switch.
6	Purchase the appropriate size of laser printer, not larger than needed.

Photocopiers

Photocopiers range widely in size, capability, and energy use. Wattage can range from 350 for a desktop copier to 1,200 or more for large units.

Energy Savings Tips for Photocopier Use	
1	Most copiers have an energy savings mode button. This mode saves some energy while keeping the copier in a standby condition for quick warm-up. Post a sign encouraging staff to use this feature.
2	Ask staff to shut off the copier during vacant periods.
3	Read the photocopier manual to learn how to optimize its operation and become aware of specific energy savings features.
4	A time clock, which automatically shuts off the copier after regular hours, should be considered.
5	An easy-to-use bypass system should also be incorporated for any after-hours copying.
6	Avoid purchasing a photocopier that is larger, faster, and more complex than necessary.
7	Generally, a smaller unit with fewer options will take less energy, cost less to operate, and be easier to use.

Freezers

Energy Savings Tips for Freezer Use	
1	Keeping freezers colder than 0 °F (-17.8 °C) is a waste of energy. This is easily checked with a thermometer. Adjust thermostat as necessary.
2	Locate freezers away from direct sunlight, stoves, and dishwashers. Also avoid locating in rooms that are typically hot.
3	Ice build-up reduces efficiency and acts as an insulator. Defrost when ice is more than 3/16" (5 mm) thick.
4	Open the door only as long as necessary. Each time the door is opened, warm and humid air enters the freezer, increasing the cooling load and contributing to frost build-up.
5	Leave plenty of space around the freezer – as much as four inches – so that air can circulate and effectively remove waste heat from the condenser coils.
6	Keep one freezer at least 2/3rds full rather than two freezers half empty. This prevents cold air from being displaced and avoids running one or more freezers unnecessarily.
7	Use refrigerator freezer compartments to store small volumes of food.
8	Dirt and dust will accumulate on exposed condenser coils reducing heat transfer efficiency (those freezers with exposed coils only). Vacuum and clean regularly.
9	In facilities avoid the need to store food over summer holidays so that the freezer can be unplugged when the school is the hottest.
10	Many freezers are located in small enclosed rooms, which become overheated in summer when ventilation fans are off. If the freezer must be left on, then improve air circulation by leaving a door open.
11	Avoid purchasing freezers that are larger than necessary. Compare EnergyGuide™ ratings and buy most efficient unit.

Above photo: Freezer that requires defrosting.

Refrigerators

Refrigerator technology has vastly improved. As a result, refrigerator electricity use was decreased by 50 per cent -- from 120 kWh per month to about 60 kWh per month -- a consideration if you are thinking of purchasing an older used refrigerator.

Energy Savings Tips for Refrigerator Use	
1	Leave plenty of space between the wall and condenser coils at the back of the refrigerator; don't push the refrigerator against the wall. Air circulation around the condenser coils allows waste heat to dissipate. The harder the refrigerator has to work to remove waste heat, the more energy it takes.
2	Locate away from heat sources and hot rooms. As room temperature increases, the refrigerator has to work harder.
3	Vacuum condenser coils regularly. Dirt and dust insulate the coils, decreasing the efficiency of heat transfer to the room.
4	The power saving control shuts off electric heaters, which heat the refrigerator exterior to reduce condensation during humid conditions. Take advantage of the power saving control when humidity is low, as is often the case in during winter in northern latitudes and in dry climates.
5	In facilites such as schools, empty and unplug refrigerators during summer vacation. Consolidate food into one refrigerator from two or more partially empty refrigerators.
6	Avoid overfilling refrigerator and blocking air circulation grilles. This can result in freezing food and uneven temperatures.
7	Don't refrigerate items that don't need it.

Removed the picture above. It is not correct.

Refrigerator Temperature

The ideal temperature for a refrigerator depends on what type of product is being stored. For short-term storage, it can range from 35 to 40 °F (1.7 to 4.4 °C for fresh meat and 35 to 45 °F (1.7 to 7.2 °C) for most fruits and vegetables. Pickled, dried, and cured foods will keep better at slightly higher temperatures, usually in the door compartments. Frozen food is an indication that the temperature is too low. Spoiled food, on the other hand, is a sign of temperatures that are too high.

Chlorofluorocarbons (CFCs) are refrigerants which are known to cause depletion of the ozone layer…. Laws have been passed with stiff penalties for improper handling as well as smuggling of CFCs.

New Refrigerants and Appliances

When acquiring new or used appliances, consider the type of refrigerant that is included with these appliances. Chlorofluorocarbons (CFCs) are refrigerants which are known to cause depletion of the ozone layer. As a result, international agreements have been made to phase out the use of these ubiquitous refrigerants. One of the most common CFCs, referred to as R-12, has been widely used in many types of refrigeration including automobile and residential air conditioning units, refrigerators, and freezers.

Since December 31, 1995 the manufacture of R-12 refrigerant is no longer permitted in any industrial nation. It is also illegal to import or export R-12 to. Laws have been passed with stiff penalties for improper handling as well as smuggling of CFCs. (Non-industrial nations are allowed to produce CFCs until 2010).

It is, however, legal to use and recycle existing stocks. Based on supply and demand of existing stocks, the cost of R-12 will increase, and availability will diminish over time. Many alternative refrigerants are being developed and evaluated. For appliances, R-134A is emerging as the new interim refrigerant in the United States and Canada. An halofluorocarbon (HFC), R-134A has a much lower ozone depletion effect than R-12. As supplies of R-12 dwindle, old refrigerators that need recharging will either be recharged with existing and costly R-12, converted to R-134A or discarded, depending on economics. Fortunately, residential-type refrigerators and freezers are designed with hermetically sealed compressors and rarely experience refrigerant leaks.

Demand and Consumption

What are a kW and a kWh?

In most buildings, excluding residential buildings, utilities charge for both electricity demand and electricity consumption. Both demand and consumption are recorded on the electrical meter in a school.

DEMAND is the total amount of electricity, measured in kilowatts (kW) or kilovoltamps (kVA), required at a single point in time or the total electricity load. Utilities usually charge for the highest peak demand that occurs in each month. Demand meters are the thermal delay type, which means that a peak load must occur for at least 15 minutes for 90 per cent of demand to be recorded on the meter.

CONSUMPTION is the quantity of electricity used over time, measured in kilowatt-hours (kWh), and calculated by the following:

kWh = kW x hours

Demand in a School

Figure 2 is an actual demand profile of a school. Note that load peak occurs around noon hour when the cafeteria is operating at maximum. At night, the load is at a minimum — from heating pumps, emergency lights, outdoor lights. As schools starts, the load increases — lights, appliances, and computers being turned on. HVAC equipment is turned on. At the end of the school day, the load decreases accordingly.

The area under the curve is kWh. The top of the curve is what registers on the demand meter.

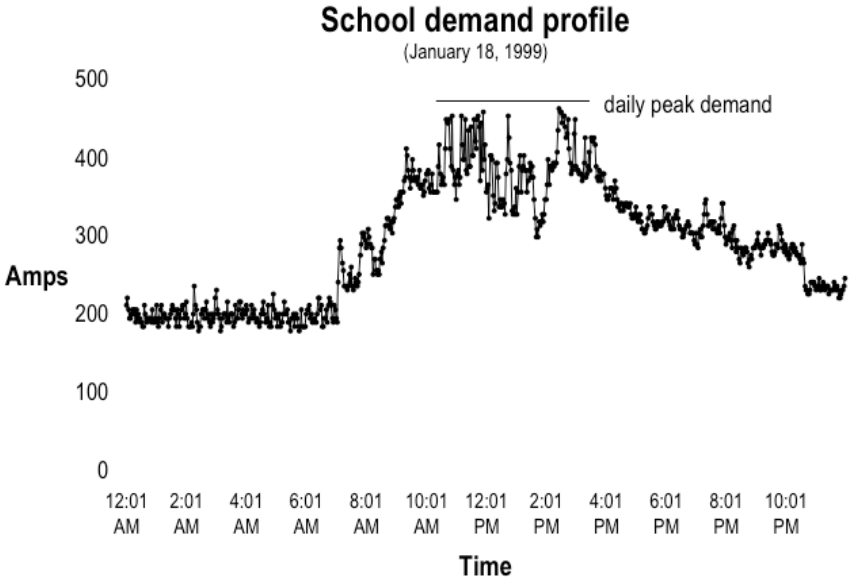

Figure 2

Sample Energy Savings Calculation

Savings by Unplugging a Refrigerator

To illustrate the concepts of electricity consumption and demand, a sample energy savings calculation is shown below.

Existing Conditions…	Typical situation of an older refrigerator in a school: • EnergyGuide rating is 120 kWh/month • Average electricity cost is $0.05 per kWh • Left running empty in July and August
Energy Savings Measure…	Unplug refrigerator during July and August to save on electricity costs.

Calculate Annual Dollar Savings…

Monthly $ savings = kWh/month EnergyGuide rating X average electricity cost

Monthly dollar savings = _____

Annual dollar savings = monthly dollar savings X number of months

Annual dollar savings = _____

Solution…

Monthly dollar savings *$6.00/month = 120 kWh/month X $0.05/kWh*

Annual dollar savings **$12.00/year = $6.00/month X 2 months**

EnergyGuide™ Ratings

EnergyGuide™ is a federal government program that requires manufacturers to provide standardized energy consumption ratings for all major appliances. For example, it provides a simple means for consumers to quickly and easily compare energy consumption of several different refrigerators.

Ratings are usually listed in kWh/year on a conspicuous sticker affixed to the appliance. Assumptions are made about typical and average hours of usage, number of times used etc.

Load Scheduling

Load scheduling can be implemented where high use electrical equipment can be operated during off-peak hours instead of higher cost peak hours. An example of this would be an electric kiln, which employs electric resistance heating to produce fired pottery. Electrical loads can range from 18 kW to 45 kW.

If your electric utility charges more for electricity during peak hours, the cost of operating equipment such as an electric kilns can be dramatically reduced by a simple strategy known as load scheduling. Load scheduling is defined as operating equipment during times of lower electricity costs (off-peak hours) instead of during periods of peak electrical charges. Any electrical load or process that is not essential and can be designated for off-peak operation should be load scheduled.

The magnitude of electrical savings will depend on local electricity rates. Some rates will have an emphasis on kW or demand while other will charge proportionally more for consumption or kWh. With the advent of electricity deregulation and sophisticated metering, the current trend is towards time-of-use rates: higher kWh costs during peak periods and much lower costs during the night and non-peak periods. In any case, significant savings could be achieved.

Operate electric kilns at night or on weekends to avoid excessive electrical costs. This can be achieved either manually or with time clocks. Lockout controls should also be considered to prevent inadvertent use during peak times.

Electrical Equipment and Digital Readouts

Many appliances and electronic devices such as microwave ovens, VCRs, stereos, and televisions are equipped with light-emitting diode (LED) digital clocks and control panels. These LED displays consume 2 to 4 watts of electricity even when not used. A simple energy savings measure is to unplug appliances and electronic devices during vacation and extended vacant periods. Additional benefits of unplugging equipment are the elimination of any potential damage due to lighting or electricity surges, most prevalent during summer. Although equipment fires are rare, this hazard would also be nullified.

Vending Machines

Non-Refrigerated Vending Machines

Most vending machines have internal lights, which, unless electricity is turned off, consume energy 365 days per year and 24 hours per day. Consider unplugging vending machines during vacation periods and unoccupied times. Simple time clocks could also be used to shut off the machines after hours.

The question could also be posed as to whether some or all of the display lights are needed at all. With any energy savings initiatives, changes should be negotiated with the vending machine owner to avoid any misunderstandings or breach of contract. It would probably be best to conduct these negotiations before any vending machines are installed.

Refrigerated Vending Machines

There are many types of refrigerated vending machines, which handle such items as ice cream, sandwiches, soft drinks, and juice. Due to aggressive marketing, soft drink vending machines in particular have been proliferating. They are appearing in schools, recreational facilities, and businesses. At 5 cents to 11 cents per kWh, yearly electricity costs for a typical soft drink machine can range from $100 to $200. Electricity consumption is approximately 1,800 kWh with a demand of 650 watts.

It is important to realize that refrigeration units like these also add waste heat to buildings. In those buildings with mechanical cooling systems, waste heat will incur additional cooling cost.

Yearly, this will result in approximately 540 kWh of waste heat to be rejected for a cost of about $10 (at 5 cents per kWh and cooling system COP of 3). Buildings without mechanical cooling will become warmer and possibly more uncomfortable during the cooling season. When the ventilation fans are off and the building is hot, usually during vacation periods and other unoccupied periods, the vending machine will need to work harder -- consuming additional electricity.

If the building is vacant during vacation, the units should be unplugged. If there are any concerns about product spoilage, then arrange with the vendor to have the machine emptied.

Vending Miser™

Consider use of device such as the Vending Miser™. The Vending Miser™ saves about 40 per cent on energy use by shutting off lights in the vending machine during vacant periods and optimizing compressor operation. It consists of an occupancy sensor and plug-in control. The occupancy sensor is attached with Velcro™ to the wall above the vending machine. The vending machine is plugged into the control unit. The control unit, plugged directly into the outlet, receives an input from the occupancy sensor. When a person approaches the vending machine, the lights turn on. The compressor is not shut off until it is finished the refrigeration cycle, to avoid shutting the vending machine off with a high head pressure. The product is kept satisfactorily chilled to prevent any spoilage.

When negotiating with vending machine companies, ask to have the Vending Miser™ included in the package. If a building is partially in use during summer and has several soft drink machines, unplug those, which are not in use.

If one soft drink machine can adequately serve a certain group then reduce by unplugging others. Signs could be posted to provide explanation.

Outdoor Temperature Control

Temperature controls activate car plugs only when the outside temperature reaches a minimum, typically between +15 °F and -5 °F (-9.4 and -20.6 °C). This prevents unnecessary car engine heating in warm weather. The temperature setting should be checked routinely. Temperature controls are often combined with load scheduling.

Individual Time Clocks

Individual time clocks are handy for home use or in parking lots with low number of stalls. Often, a car is plugged in all day long needlessly even though a maximum of two hours is all that is needed to sufficiently warm the engine block. Where there are no other controls, simple time clocks are a convenient means to save energy.

Power Saver Cords

Power saver cords are similar to regular extension cords except they are equipped with a thermostatic sensor. The power saver cord is connected directly to engine block heat cord and strapped to upper engine coolant hose at the sensor location. The sensor detects engine coolant temperature and shuts off electricity when the coolant temperature is 20 °F (-7 °C) or warmer. Power saver cords are inexpensive and easily installed.

Thermostatic Electrical Receptacles

Thermostatic electrical receptacles have an internal sensor that shuts off electricity at a predetermined outside temperature.

Electric Heaters

Electricity usually costs more than natural gas. In some cases up to five times as much. If this is the case, it is best to avoid and/or minimize the use of electric heating whenever possible.

Portable electric heaters may be a good short-term solution, but in general, avoid the use of portable electric heaters whenever possible.

Portable Electric Heaters

Portable electric heaters are often used for local supplemental heat to improve comfort conditions. These heaters can range from 750 to 1,500 watts. Depending on the specific electrical rate structure, their use can result in a higher than expected energy cost and contribute to a peak demand charge.

Electric heaters may be in use because of problems with the heating system controls. Other buildings may have poor insulation or windows. Minor repairs and maintenance may solve the problem. It could be as simple as replacing a faulty thermostat or radiation heating valve. In some cases, conditions such as an inadequate heating system or poor insulation may require extensive retrofits.

Fixed Electric Heaters

Fixed electric heaters are sometimes installed in remote parts of a building where hot water heating may not be feasible. The two most common types are baseboard heaters and sidewall heaters. Sidewall types often have a circulation fan. Thermostats are adjusted by setting a simple dial to a numerical value like 1 to 5. These heaters can be huge energy wasters if not managed efficiently.

Energy Savings Tips for Fixed Electric Heater Use	
1	Set thermostatic dial to lowest position that will achieve adequate comfort.
2	Check dials regularly and adjust for changing weather conditions or tampering.
3	Shut off the breaker in spring, summer, and fall to prevent inadvertent operation.
4	Ensure they are shut off during vacant periods (if there is no danger of water pipes freezing).
5	Expectations of comfort should be realistic, especially during very cold weather.

Drinking Water Coolers

Drinking water coolers use internal mechanical refrigeration units to chill water. They use between 400 and 1,000 kWh of electricity and cost approximately $20 to $50 per year at 5 cents per kWh.

Energy Savings Tips for Water Cooler Use	
1	Ensure they are shut off during periods of extended vacancy.
2	Install time clocks for automatic shut-off during vacant periods (evenings and weekends).
3	Shut off during summer vacation in facilities such as schools or ice arenas. Local staff should be able to store an adequate supply of drinking water in the staff room refrigerator.
4	If the water is too cold, the thermostat setting for chilled water may be too low. Try increasing the set point and save as much as 28 per cent.
5	Refer to manufacturer's manual for specific operating tips.

Electrical Equipment Notes:
