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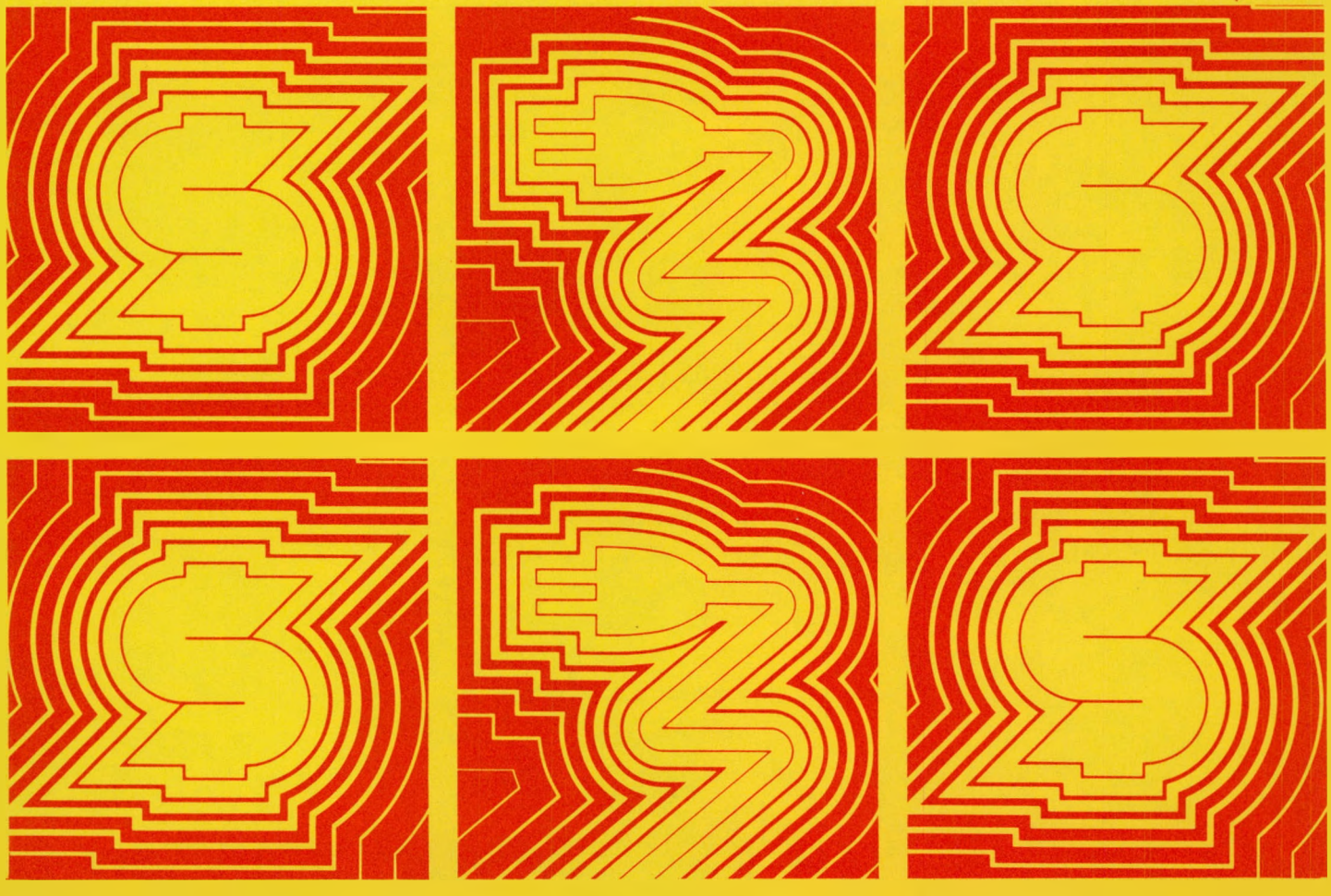
U.S. Department of Energy

Assistant Secretary for
Conservation and Solar Applications
State Energy Conservation Programs Division

July 1979

Saving Money with Energy Conservation

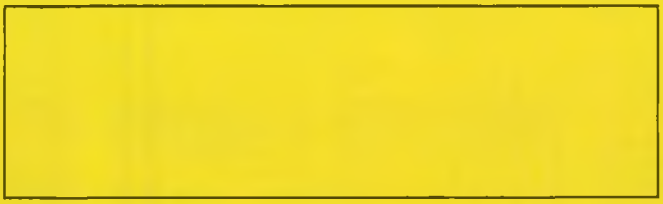
An Energy Audit Workbook for Retail Stores



While the recommendations and examples contained in this workbook have been reviewed for technical accuracy, the U.S. Department of Energy, its contractor and the State Energy Office are not liable if potential cost savings identified as a result of using this workbook are not actually achieved.

For a more detailed presentation of the topics covered in this booklet, the reader is directed to the Energy Audit Workbook for Retail Stores, U.S. Government Printing Office stock number 061-000-00164-6, from which portions of this material have been excerpted. Your State Energy Office may also be able to provide other more detailed material.

For additional assistance contact your State Energy Office.



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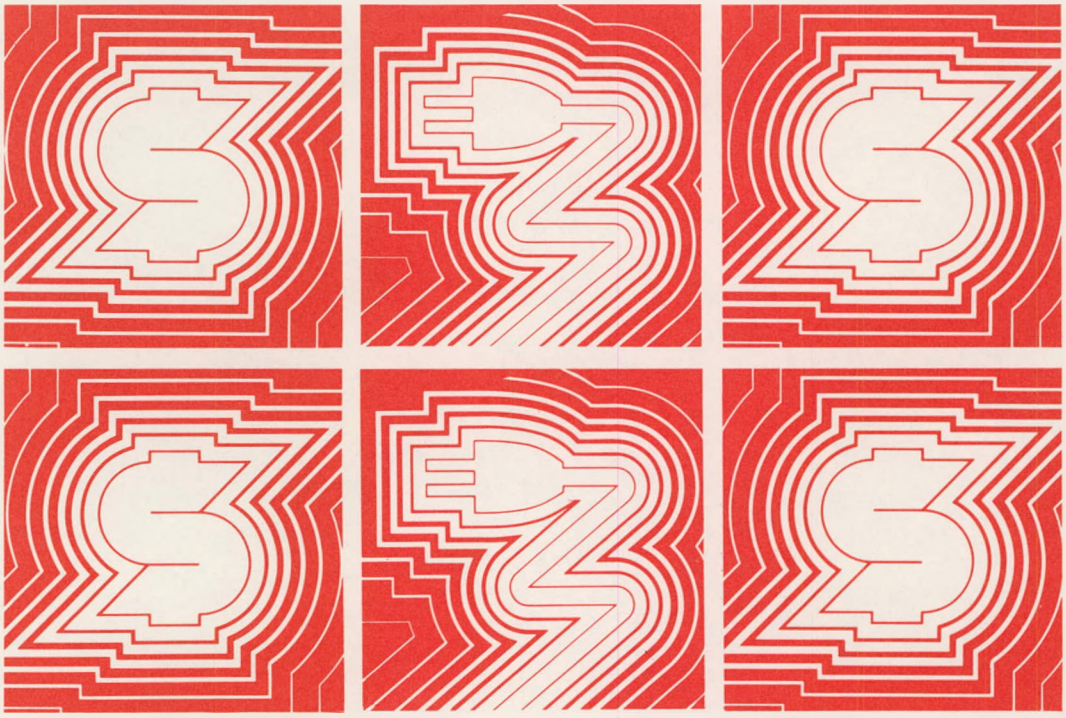
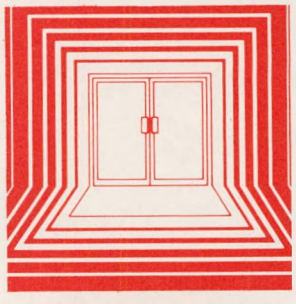
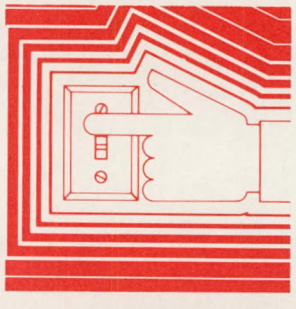


CONTENTS





SAVING MONEY WITH ENERGY CONSERVATION

Energy conservation means reducing waste today so we can afford to do business tomorrow. Profit minded managers everywhere are looking for ways to cut their utility bills. It's just good business.

Would you like to save twenty percent of your annual utility bills? This booklet is filled with hints to help reduce energy waste and inefficiencies. Many of the suggestions are easy to do and involve no expense. Where else can you get hundreds or even thousands of dollars for a few hours work?

Saving this money is a matter of correcting many small problems. It requires a greater awareness and responsibility by everyone.

Part 1 of this booklet lists 15 ideas with high potential for savings. If you haven't already implemented these ideas, give them a try. When you finish these, read on, Part 2 contains more ideas which require no initial capitol investment and offer significant savings. Part 3 has even more ways to save but with some small capitol investment. Following these idea sections, Part 4 contains three forms to help you manage your energy conservation program. Part 4 also has two examples to show how you can estimate the dollar savings potential of the various ideas. Read the introduction to Part 4 before going too far with your conservation program.

Equipment in top working order will work more efficiently and utilize less energy. Equipment in need of repair should be brought to a high standard of operational efficiency. Then establish a preventative maintenance schedule based on the manufacturers' specifications and standards.

This workbook provides a do-it-yourself, fill-in-the-blanks approach to an energy conservation program for retail stores without full-time engineering personnel. Of necessity, it is a generalized approach which cannot be as detailed as an energy audit conducted by an engineering team. If a particular suggestion does not apply to your store, read on; the next one probably will.

A good way to start the energy conservation effort in your store is by assembling utility bills for the last 12 months. If you haven't already summarized your store's energy consumption needs, you may wish to use the form in Part 4 for this purpose. Record both price and actual consumption. You can tell a lot about your building(s) by examining the monthly records.

Then after implementing several of the conservation measures suggested in this book, record several more months of utility bill information. You should see a reduction in the total Btu's consumed. The percentage reduction in Btu's is a good estimate of the percentage reduction in utility costs. Although rising utility rates and complex billing formulas may cause actual savings to be less.

Shortages of fuel cause an increase in price, that is a proven fact. Shortages may also result in imposed limitations. You must weigh this possibility and then base your future energy conservations on such possibilities.

PART 1

15 EASY WAYS TO BIG SAVINGS

1 Lower thermostat settings during heating season and raise them during cooling season. Change settings gradually until it becomes uncomfortable. You can save 8% on your heating bill with just a five degree reduction.

2 Examine all doors, windows, walls and roofs for air leaks. Sealing even small leaks can save amazing amounts of energy.

3 Remove all unnecessary lights. Have someone add up your total lighting wattage (ceiling and display). Divide the total by sales floor area. If this figure is more than 3 watts per square foot, your store is not competitive. Every 4 foot, 40 watt tube costs about $7.50 per year to operate. Every 8 foot, 75 watt tube costs $14.00 a year. Replacing a 150 watt flood with the new 75 watt ER type flood will save $15.00 per year with no loss of lighting. Replacing old flourescent tubes with newer high efficiency tubes can also save money with no loss in lighting.

4 Prepare a month by month energy consumption budget. Use kwh for electricity and the appropriate units for gas and fuel oil. Set a goal for percent reduction from similar months before conservation. Ten to twenty percent reduction should be easy for most stores. Give this goal and the budget to your manager. Get a monthly report. (What's 20 percent of your annual utility bills?)

5 Involve employees in the energy savings program. Have a campaign to turn off unnecessary lights and keep doors closed during heating and cooling seasons. Ask for suggestions on how to reduce energy. Employee involvement will save energy and reduce any problems that changes may bring.

6 Shut off or set back all heating and cooling in areas where its not needed like storage, corridors, and entrance ways.

7 In grocery stores, save on coolers and freezers. Increase temperature settings to the highest possible relative to food storage needs. Make sure doors close tightly. If you can double up and turn off or remove coolers, you'll save!

8 Turn off parking or outdoor lights late at night using a photocell or timer. If you do, you'll save money.

9 Use a timer to turn heating and cooling off just before closing and leave it off until you open. You'll be surprised how little the temperature will change while the system is off eight or ten hours.

10 Instruct the cleaning and restock crew to turn off all but necessary lights while they work. Light only that part of store that they are actively cleaning or restocking. The savings will amaze you.

11 Replace old, inefficient burners in your heating system with new, efficient ones.

12 If you have a boiler, have a technician check its efficiency on a regular basis. A percent loss of boiler efficiency is a percent loss of energy and cost. It is generally worth any cost incurred to optimize the boiler operation.

13 Insulate hot, bare heating pipes. Economic thicknesses can be supplied by contractors using guidelines established for FEA Conservation Paper 46, "Economic Thickness for Industrial Insulation".

14 Develop a "Night Close Up Checklist". Insure the list covers turning off all unnecessary equipment, adjusting thermostats, closing air circuits, closing doors and windows, and reducing the lighting level to acceptable security levels.

15 If you are being penalized by the electric company for a low power factor, it may be cost effective to correct it. Contact your utility to find out how.

PART 2

MORE IDEAS ON WAYS TO SAVE

The following is a valuable list of energy conservation ideas. To conduct a continuing energy conservation/ maintenance program, a checklist of operations and maintenance measures should be set down and followed faithfully. The measures listed here have been categorized under general building, heating, cooling, etc. There is an "Action Plan" form in Part 4 of this book which you can use to help make your list.

Read through this section, making notes as you go along. Examine the suggested maintenance and operational changes that pertain to your facility. Accomplish the items that can be done immediately, then explore the possibility of doing the other steps which may require more information or advice. Start incorporating the applicable preventive maintenance items into a regular program immediately.

GENERAL BUILDING

1. OFFER INCENTIVES TO MANAGERS for their efforts in controlling power costs.
2. REDUCE DISPLAY APPLIANCES from running all the time to run only during selling periods.
3. SHUT OFF HEATING AND COOLING SYSTEMS during the last half hour of store hours.
4. REVISE CLEANING SCHEDULES for sales floor to minimize lighting other than during productive selling hours. Light only areas being cleaned.
5. KEEP WINDOWS AND DOORS SHUT while heaters or air conditioners are running.
6. MAKE MONTHLY ENERGY CONSUMPTION AND COST DATA AVAILABLE to the manager so that the data can be evaluated and compared against similar months in previous years and against an energy budget.
7. INVOLVE EMPLOYEES with energy conservation measures so that each individual has a sense of responsibility.

298-796 O - 79 - 2

8. CONDUCT A SPACE BY SPACE BUILDING SURVEY to determine the actual lighting and heating/cooling needs.

9. CHANGE DAY-NIGHT TIMECLOCK SETTINGS for the spring, fall and winter, to operate heating, ventilation, and cooling equipment as few hours as possible.

10. DISCONNECT REFRIGERATION ON ALL WATER FOUNTAINS.

11. INSURE WORKING ORDER OF SEALING GASKETS AND CAM LATCHES for all windows.

12. DIRECT ALL PERSONNEL to keep doors closed whenever possible.

13. CAULK AND WEATHERSTRIP DOORS AND WINDOWS and their frames. Don't forget delivery doors.

14. CAULK CRACKS IN WALLS.

15. REDUCE OPERATING TIME OF ESCALATORS; run only one bank between floors when store is not open.

16. HAVE REGISTERS READ AND MAXIMUM AMOUNT OF CLEANING DONE WHEN SALES FLOORS ARE LIT FOR SELLING ACTIVITY.

17. ENCOURAGE EMPLOYEES TO DRESS WARMER in winter.

18. RESCHEDULE STOCKING AND CLEANING PERSONNEL TO WORK WHEN STORE IS OPEN.

19. REDUCE HOURS WAREHOUSE IS OPEN, including Saturdays.

20. SHUT OFF HEATING AND COOLING SYSTEMS in spaces which are used infrequently or only for short periods of time.

21. INVESTIGATE WAYS TO CONTROL THE BUILDING ELECTRIC LOAD DEMAND so that excessive peaks will not occur.

22. CLOSE OFF UNUSED AREAS AND ROOMS. Where possible, be certain that blinds or other shading devices are drawn, registers closed, etc.

23. SEAL DUCTS AND ACCESS DOORS in heating equipment rooms to minimize loss of hot and cold air.

24. SCHEDULE OPERATING MAINTENANCE AND CLEANING TO OVERLAP MORE WITH NORMAL WORKING HOURS or when daylight is available and sufficient for the task.

25. PROVIDE ADEQUATE PREVENTIVE MAINTENANCE on power distribution equipment to assure minimum power loss from loose connections and/or contacts.

HEATING

1. KEEP SURFACES OF RADIATORS, CONVECTORS, BASE-BOARDS, AND FINNED-TUBE HEATERS CLEAN for efficient operation.
2. REDUCE SPACE HEATING HOT WATER TEMPERATURE, if you use hot water for heating, to a level that will just satisfy heating needs.
3. TURN OFF UNNECESSARY RADIATORS.
4. DO NOT HEAT PARKING GARAGES.
5. DO NOT HEAT STORAGE ROOMS unless it is necessary for protection of stored contents.
6. CHECK REFLECTORS OF INFRARED HEATERS to see if they are beamed in the right direction, and the surface is clean.
7. CHECK AUTOMATIC TEMPERATURE-CONTROL SYSTEMS and related control valves and accessory equipment to ensure that they are regulating the system properly.
8. HAVE HEATING SYSTEM INSPECTED for proper operation and minimum fuel usage on a yearly or as needed basis.
9. KEEP HEAT TRANSFER SURFACES OF ALL ELECTRIC HEATING UNITS CLEAN AND UNOBSTRUCTED.
10. KEEP AIR MOVEMENT IN AND OUT OF ELECTRIC UNITS UNOBSTRUCTED.
11. INSPECT ELECTRIC HEATING ELEMENTS, controls and, as applicable, fans, on a periodic basis to ensure proper functioning.

COOLING

1. CHANGE ROOM TEMPERATURES SEASONALLY by steps up and down to match the changes in outside temperatures.
2. SHADE WINDOWS from direct sun from April through October.
3. SET 78°F in the summer if your central air conditioning system does not have a hot deck or reheat coil.
4. HAVE AIR CONDITIONING TECHNICIAN ADJUST SYSTEM yearly or as needed, to maintain optimum operating conditions.

5. REDUCE HOT DECK TEMPERATURES, and increase cold deck temperatures as far as humidity requirements will allow.

6. DO NOT COOL BUILDING WHEN IT IS UNOCCUPIED.

7. OPERATE ONLY THOSE WATER PUMPS NEEDED to maintain flow volume where multiple pumps are installed in parallel. This would apply to chilled water pumps and condenser water pumps.

8. SHUT OFF SECONDARY HOT WATER PUMPS located in the airhandling units during the spring, fall, and summer when heating is not required.

9. USE VENETIAN BLINDS OR DRAPERIES AS INTERIOR SHADING DEVICES during cooling season.

10. REDUCE OR ELIMINATE AIR LEAKAGE FROM DUCT WORK AND AROUND COILS.

11. CLEAN FANS ANNUALLY to maintain an efficient system.

12. ELEVATE CHILLED WATER TEMPERATURES when humidity conditions permit.

13. CHANGE OR CLEAN air filters often.

14. TURN ON SELF-CONTAINED UNITS, such as window and through-the-wall units, only when needed. Turn them off when the space is to be unoccupied for several hours.

15. SET THE DEMAND LIMITER ON THE CHILLER AT LOWEST SETTING THAT WILL MAINTAIN THE BUILDING TEMPERATURE.

16. INSPECT EQUIPMENT for any visual changes such as oil spots on connections or on the floor under equipment.

17. CONSULT WITH MANUFACTURER to determine if cooling equipment can be shut down when outside temperatures are below certain levels.

18. ESTABLISH WHAT THE NORMAL OPERATING PRESSURES AND TEMPERATURES FOR THE SYSTEMS SHOULD BE. Check all instrumentation frequently to ensure that the design conditions are being met. Increased system pressure may be due to dirty condensers, which will decrease system's efficiency. High discharge temperatures are often caused by defective or broken compressor valves.

19. OPERATE ONE OF MULTIPLE COMPRESSORS AND CHILLERS AT FULL LOAD, rather than two or more at part load.

20. INSPECT THE LIQUID LINE LEAVING THE STRAINER. If it feels cooler than the liquid line entering the strainer, the strainer is clogged. If it is very clogged, sweat or frost may be visible at the strainer outlet. Clean as required.

21. INSPECT TENSION AND ALIGNMENT OF ALL BELTS AND ADJUST AS NECESSARY.

22. OBSERVE THE NOISE MADE BY THE COMPRESSOR. If it seems to be excessively noisy, it may be a sign of a loose drive coupling or excessive vibration. Tighten compressor and motor on the base. If noise persists, call a mechanic.

23. LUBRICATE MOTOR BEARINGS AND ALL MOVING PARTS, where applicable, according to the manufacturer's recommendations.

24. KEEP CONDENSER COIL FACE CLEAN TO PERMIT PROPER AIR FLOW.

25. INSPECT AIR INLET SCREEN, SPRAY NOZZLE OR WATER DISTRIBUTION HOLES, AND PUMP SCREEN. Clean as necessary.

26. FOLLOW MANUFACTURER'S GUIDELINES FOR FAN AND PUMP MAINTENANCE.

27. CLEAN CONDENSER SHELL AND TUBES by swabbing with a suitable brush and flushing out with clean water. Chemical cleaning also is possible, although it is suggested that a water treatment company be consulted first.

28. KEEP THE COOLING TOWER CLEAN to minimize both air and water pressure drop.

29. INSPECT SPRAY-FILLED TOWERS OR DISTRIBUTED TOWERS for proper nozzle performance. Clean nozzles as necessary.

30. INSPECT GRAVITY DISTRIBUTED TOWER for even water depth in distribution basins.

31. CLEAN EVAPORATOR AND CONDENSER COILS IN WINDOW UNITS.

LIGHTING

1. ACQUIRE ENERGY CONSERVATION REMINDERS such as posters and individual decals that can be located next to the light switches and on bulletin boards to alert staff that turning off lights is their responsibility.

2. SHUT OFF LIGHTS IN UNOCCUPIED ROOMS during after hours cleaning periods, light only areas being cleaned.

3. MOVE DESKS AND OTHER WORK SURFACES to a position and orientation that will use installed lighting fixtures to their greatest advantage (instead of moving light fixtures).

4. GROUP TOGETHER TASKS WHICH REQUIRE APPROXIMATELY THE SAME LEVELS OF LIGHTING (to the extent permitted by productivity requirements and related concerns). This may reduce the number of areas requiring higher illumination levels and provide an opportunity to reduce the total amount of lighting needed.

5. LIGHT LEVELS CAN BE REDUCED UP TO 50% IN OVERLIGHTED AREAS. In rooms or areas fitted with 2-bulb fluorescent fixtures, remove one bulb from each fixture if they are not wired in series. Have electrician disconnect ballast if possible. Consider dual bulb removal from alternate fixtures if they are wired in series. This will save energy and produce a uniform lighting level.

6. REMOVE LIGHTS OVER STORAGE STACKS OR IN OTHER "USELESS" AREAS.

7. SET A TIME LIMIT OF TEN MINUTES AFTER CLOSING FOR THE MAJORITY OF THE FLOOR LIGHTS TO BE ON, then switch to full night light schedule to be in effect within thirty minutes.

8. LOCATE WORK STATIONS REQUIRING THE HIGHEST LIGHTING LEVELS NEAREST THE WINDOWS. Note: Use of natural lighting will have an impact on heat gain, therefore requiring that the heat gain/light gain trade-off be given careful consideration; in many cases, glazing can be modified to limit heat gain while still permitting entry of a significant amount of light. To reduce glare, rearrange work surfaces so that sidewall daylighting crosses the task perpendicular to the line of vision.

Kicking the habit of wasting energy is well worth the effort.

9. ELIMINATE EXTERIOR LIGHTING except where lighting is to be used for the purpose of identifying the building entrances and/or for security.

10. LAMPS SHOULD BE WIPED CLEAN AT REGULAR INTERVALS TO ASSURE MAXIMUM EFFICIENCY. Lamps which are exposed to substantial amounts of dirt, dust, grease, or other contaminants should be cleaned more frequently than lamps in a relatively clean atmosphere.

11. CLEAN CEILINGS, WALLS, AND FLOORS FREQUENTLY to improve reflective qualities. In rooms or areas where natural daylight is used to maintain light levels, wash the windows frequently.

HOT WATER

1. REMOVE OR TURN OFF DOMESTIC HOT WATER TO BOILER ROOMS AND OTHER SPACES THAT COULD FUNCTION WITHOUT HOT WATER.

2. OPERATE ONLY ONE DOMESTIC HOT WATER HEATER. If one unit can carry the load, leave others off for standby.

3. REDUCE TEMPERATURE OF HOT WATER TO THE MINIMUM. This may be achieved by turning it down 5°F at a time until the optimum temperature is reached. About 110°F is usually adequate. Expected savings of about 400 Btu per gallon of hot water demand per year are reasonable.

4. CONSIDER LIMITING THE DUTY CYCLE if you have an electric domestic water heater, to avoid adding water heating load to the building during periods of peak electrical demand.

5. TURN OFF THE PUMP SUPPLYING AREAS WHEN THEY ARE UNOCCUPIED if hot water is distributed through forced circulation.

6. INSULATE HOT WATER PIPES. Adding one inch of insulation to pipes of a gas fired hot water system set at 150°F would save $1.60 per year per foot of insulation. For an electric hot water system, the savings would be $11.68 per foot.

VENTILATION

1. POST A SMALL SIGN NEXT TO EACH WINDOW instructing employees not to open window while the building is being heated or cooled.

2. INSPECT ALL AUTOMATIC DOOR CLOSERS to ensure that they are functioning properly. Consider adjustment to enable faster closing.

3. PLACE A SMALL SIGN NEXT TO EACH DOOR LEADING TO THE EXTERIOR OR UNCONDITIONED SPACES advising employees to keep door closed at all times when not in use.

4. USE FULL OUTDOOR AIR VENTILATION TO REMOVE EXCESS HEAT AND PRE-COOL THE STRUCTURE to reduce airconditioning load in the summer when the outdoor temperature at night is lower than indoor temperature.

5. READJUST FRESH AIR LIMIT CONTROLLERS during heating season to significantly reduce make up air. Make sure outdoor dampers close tightly.

6. REDUCE OUTDOOR AIR to the minimum acceptable level required to balance the exhaust requirements and maintain a slight positive pressure to retard infiltration of outside air.

7. CONSIDER TURNING OFF ELECTRIC REHEAT COILS DURING THE SUMMER. With increased supply air temperature, reheat may not be necessary.

8. CLEAN DEBRIS FROM UNIT VENTILATORS to permit more efficient operation.

9. INSPECT FILTERS CAREFULLY. If necessary, create a filter replacement or cleaning schedule. Utilize high-efficiency, low-cost filters.

10. CONSIDER CLOSING OUTSIDE AIR DAMPERS during the first and last hours of occupancy and during peak loads.

11. TURN OFF HUMIDIFIERS whenever a building is closed for extended periods of time, except when process and equipment requirements take precedence.

12. LOWER THE COOLING EFFECT BY RUNNING ROOM COOLING FANS AT LOWER SPEEDS IN MILD WEATHER.

13. INSPECT DAMPER BLADES AND LINKAGES. Clean, oil, and adjust them on a regular basis. Make sure dampers close tightly.

14. CHECK SIZE AND SPEED OF EXHAUST FAN AND LIMIT TO ACTUAL NEEDS.

15. ADJUST OUTSIDE AIR, RETURN AIR, AND MIXED AIR DAMPER CONTROLS IN WINTER to raise supply air temperature to a level between 64°F and 70°F, depending on the conditions in the area served by the system.

16. ESTABLISH A VENTILATION OPERATION SCHEDULE so exhaust system operates only when it is needed.

17. OPERATE THE VENTILATION UNITS WITH NO OUTSIDE AIR, if practical, whenever the outside temperature is below 25°F or above 95°F. There may be sufficient fresh air leakage through the dampers to provide adequate ventilation.

18. DISCONTINUE OUTSIDE AIR PREHEATING WHERE PRACTICAL.

Not managing your heating and air conditioning systems is like blowing money out the door.

PART 3
MORE WAYS TO SAVE

This part of the manual contains a list of energy measures that require an initial capital investment. More often than not, they will yield greater return in energy and cost savings than the no-cost operational and maintenance changes listed in Part 2. However, before investing any money make sure you have implemented as many of the no-cost items as practical.

Read through the list, making notes as you go along. Choose measures that are appropriate for your store. Some measures obviously require a greater investment than others; therefore, estimating the payback period of those measures which apply to your store is a convenient method of establishing priorities. In some cases, it might be wise to contact a consulting energy auditor/engineer to help analyze the saving potential. Your state energy office can help you identify such people. In other cases, the cost is minimal and a detailed analysis is not necessary. To find the simple payback period, merely divide the installation cost by the estimated annual savings.

GENERAL BUILDING

1. WEATHERSTRIP ALL OF THE WINDOWS AND OUTSIDE DOORS to reduce air infiltration. If this is done, the building may be maintained at a positive pressure with the addition of very little outside air.

2. ADD CONTROLS TO ENABLE UP TO 100% SHUT-DOWN OF AIR AND WATER SUPPLIED TO UNOCCUPIED SPACE.

3. SEAL DUCTS AND ACCESS DOORS IN EQUIPMENT ROOMS to minimize by-pass of hot and cold air.

4. REPAIR OR REPLACE ALL FAULTY TIME CLOCKS.

5. UTILIZE SOLID-STATE MOTOR DRIVES INSTEAD OF MOTOR GENERATOR SETS FOR ELEVATORS. Solid-state drives typically provide energy savings of 25%.

298-796 0 - 79 - 3

6. INSULATE ALL ROOFS, WALLS, AND FLOORS THAT HAVE AN EXTERIOR EXPOSURE.

7. INSTALL RIGID INSULATION BETWEEN METAL PANELS BELOW WINDOWS.

8. INSTALL TIMERS TO CUT OFF LIGHTS AND EQUIPMENT AUTOMATICALLY.

9. BE SURE USEABLE WINDOWS HAVE SEALING GASKETS and tight latches.

10. INSULATE METAL WALLS OF PENTHOUSE ROOMS to reduce heat loss and heat gain.

11. INSTALL LOADING DOCK DOOR SEALS. While it may not be possible to completely seal off such an opening, the effort to do so is rewarding in energy savings.

12. PROVIDE VESTIBULES WITH SELF-CLOSING WEATHERSTRIPPED DOORS.

13. USE WATER COOLED REFRIGERATION UNITS rather than air cooled ones, since the former are up to 20% more efficient.

14. CONSIDER REPLACING FREE-RUNNING DRINKING FOUNTAINS WITH SPIGOT TYPES which utilize a paper cup. Up to half the water drawn by free-running fountains is wasted.

HEATING

1. CONSIDER COMPUTER CONTROL OF THE HEATING AND COOLING SYSTEMS IN LARGE APPLICATIONS.

2. ADD INSULATION to existing pipes, ducts, tanks, etc. Economic thicknesses can be supplied by contractors using guidelines established for FEA Conservation Paper 46, "Economic Thickness for Industrial Insulation."

3. INSPECT LOCATIONS OF THERMOSTATS. Relocate if they are positioned near outside walls or in areas that are seldom used, or if they are subject to outside drafts.

4. INSTALL THERMOSTATS for control of all heating equipment where none currently exist.

5. INSTALL KEY-LOCK COVERS OVER THERMOSTATS to prevent unnecessary adjustment in offices, lobbies, and display areas.

6. INSTALL NIGHT SET-BACK AND MORNING START-UP CONTROLS which enable you to schedule heating and cooling operations for each zone on the basis of occupancy patterns. Such controls can easily save from 10% to 30% on fuel consumption.

7. TEST THE ACCURACY OF ALL INSTRUMENTS (thermometers, pressure gauges, thermostats, etc.) once a year. Any definciencies noticed by operators should be corrected immediately.

8. USE SPOT HEATERS and/or coolers in spaces having a large volume but low occupancy.

9. HAVE A COMBUSTION ENGINEER MAKE A FLUE GAS ANALYSIS annually to properly adjust the fuel input and to check combustion.

10. PREHEAT OIL TO INCREASE EFFICIENCY. Preheating oil can increase efficiency by as much as 3%, depending on the particular constituents of the oil involved. Heating oil to above 135°F for #4 oil, 185°F for #5, or 210°F for #6 will increase efficiency even more. However, care must be taken not to overheat oil, as this could cause vapor locking and flame-out.

11. BUILD PENTHOUSE TYPE ENCLOSURES AROUND ROOF-TOP UNITS to reduce radiation and wind losses from exposed ducts.

12. CHECK HEATER ELEMENTS FOR CLEANLINESS. Replace as necessary.

13. HEATING EQUIPMENT SHOULD BE CLUSTERED together and located away from cooling equipment.

14. REPLACING WORN-OUT BOILER CONTROL SYSTEM could increase the efficiency of the boiler system and conserve energy. If the boiler is large enough to require a licensed operator, then the boiler control system is complex enough to greatly affect the efficient operation of the boiler. As the boiler control system approaches 10 years of age, the potential for defective operation from worn-out controls increases.

15. HAVE A REGISTERED MECHANICAL SYSTEMS CONTRACTOR or engineer thoroughly check your system for operating efficiency and ways to save energy. If you are in a fairly cold climate this could mean dramatic savings in your heating bills.

COOLING

1. REPLACE INEFFICIENT AIR CONDITIONERS. Newer units may save as much as 25% or more on the energy consumed for the same cooling.

2. CONSIDER INSTALLING INTERLOCKS between the heating and cooling systems of each unit to prevent simultaneous heating and cooling.

3. REDUCE AIR FLOW TO ALL AREAS TO MINIMALLY ACCEPTABLE LEVEL.

4. INVESTIGATE CLOSING OFF COLD DUCTS AND SHUT DOWN THE COOLING SYSTEM when no cooling loads are present. Reset hot deck according to heating loads and operate as a single-duct system. When no heating loads are present, follow the same procedure for heating ducts and hot deck. It should be noted that operating a dual-duct system as a single-duct system reduces air flow, resulting in increased energy savings through lowered fan speed requirements.

5. LOOK FOR UNUSUAL COMPRESSOR OPERATION such as continuous running or frequent stopping and starting, either of which may indicate inefficient operation. Determine the cause and, if necessary, correct.

6. CHECK ALL COMPRESSOR JOINTS FOR LEAKAGE. Seal as necessary.

7. INSTALL INSULATION ON ALL HOT AND CHILLED WATER PIPES, fittings, and valves passing through unconditioned spaces to minimize heat losses and heat gains.

8. USE WATER TREATMENT TECHNIQUES if the local water supply leaves surface deposits on the coil.

9. CAULK OPENINGS BETWEEN COOLING UNIT AND WINDOWS OR WALL FRAMES.

LIGHTING

1. USE ENERGY-CONSERVING FLUORESCENT LAMPS. When relamping, replace 40-watt fluorescent lamps with 35-watt lamps to achieve a reduction in electrical energy consumption. These lamps save about 15% of the fixture's electrical energy.

2. LIGHT OUTPUT SHOULD BE CHECKED REGULARLY by maintenance personnel with a calibrated light meter because lamp efficiency deteriorates over the life of a lamp. When the light output of a group of lamps has fallen to approximately 70% of the original light output, relamp all fixtures in the group at the same time. This is also a good time to check whether a more efficient or lower-wattage lamp is suitable.

3. CLEAN REFLECTING SURFACES AND SHIELDING MEDIA to maintain fixture efficiency. Replace lens shielding that has yellowed or become hazy with a clear acrylic lens with good nonyellowing properties. For some applications, a clear glass lens can be considered if it is compatible with the fixture and does not present a safety hazard. (Caution should be used to assure that an existing fixture will safely support and hold the glass lens.)

4. REPLACE OUTDATED OR DAMAGED fixtures with modern ones that have good cleaning capabilities and that use lamps with good lumen maintenance characteristics.

5. CONSIDER REPLACING PRESENT LAMPS WITH THOSE OF LOWER WATTAGE that provide the same amount of illumination or a lower level of illumination. (Changing the lens or lowering the fixture may be practical.)

6. SELECT LAMPS THAT ARE THE MOST EFFICIENT, as measured in lumens per watt, and that are compatible with the application. Compatibility with the fixture, of course, is also essential. If some replacement is to be undertaken, determination of the lamp type involved should also be considered. In general, efficiencies of lamp types rank as follows, in descending order:

	LUMENS PER WATT (INCLUDING BALLAST)		
	Smaller sizes	Middle sizes	Larger sizes
High-pressure sodium	84	105	126
Metal halide	67	75	92
Fluorescent	66	74	70
Mercury	44	51	57
Incandescent	17	22	24

7. CONSIDER USING A SINGLE, LARGER INCANDESCENT LAMP, where possible, rather than two or more smaller lamps. Higher-wattage general service incandescent lamps are more efficient than lower-wattage lamps.

8. REVISE SWITCH CIRCUITS TO PERMIT MORE LOCAL CONTROL OF LIGHTING.

9. AVOID MULTILEVEL LAMPS. The efficiency of a single-wattage lamp is higher per watt than a multilevel lamp.

10. USE EXTENDED SERVICE LAMPS in special cases where short lamp life is a problem, such as recessed directional lights.

11. CONSIDER USING HIGHER POWER FACTOR BALLASTS WHEN REFITTING.

12. CONSIDER ADDING SOLID-STATE DIMMING CONTROLS for incandescent fixtures in multiple-purpose spaces which require more than one level of illumination.

13. CONSIDER INSTALLING LENSES WHICH PROVIDE SPECIAL LIGHT DISTRIBUTION PATTERNS, where appropriate, to increase lighting effectiveness. As examples, linear batwing, radial batwing, parabolic louvers, or polarizing lenses may provide better visibility with the same or even reduced wattage. It is suggested that competent technical advice be obtained to evaluate where such lenses can be used most effectively.

14. RELOCATE FIXTURES to provide light on task areas at an angle outside the zone which causes veiling reflections if relocation of work station is impractical.

15. CONSIDER LOWERING FIXTURES so they will provide recommended illumination levels on the task area at a reduced wattage.

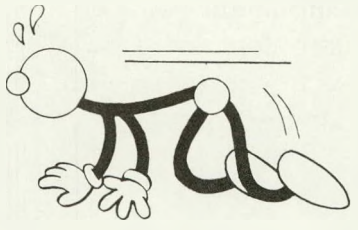
16. CONSIDER DEVELOPING A DESK LAMP ISSUANCE PROGRAM. When existing circuitry makes it impossible to selectively utilize less than 25% of the light in a given large space whenever light is needed, consider developing a desk lamp issuance program to enable persons to use a simple desk lamp or two instead of a large bank of fixtures. Desk lamps should also be used when people work during normally unoccupied periods.

17. REPLACE ALL INCANDESCENT PARKING LIGHTING WITH H.I.D. LAMPS. For example, Low Pressure Sodium, High Pressure Sodium or Mercury Vapor lamps.

18. CONSIDER THE USE OF PHOTOCELL SWITCHING. When natural light is available in a building, consider the use of photocell switching to turn off banks of lighting in areas where the natural light is sufficient for the task.

19. USE PHOTOCELLS FOR TURNING ON EXTERIOR LIGHTS: USE TIME CLOCKS FOR TURNING OFF THE EXTERIOR LIGHTS.

20. PROVIDE TIMERS TO AUTOMATICALLY TURN OFF LIGHTS IN REMOTE OR SELDOM-USED AREAS.



Look High *and* low—there *are* ways to save money on energy

21. PROVIDE SELECTIVE SWITCHING. Initial cost economics and lack of knowledge about final space subdivision often lead to the use of central panelboards as the only means of controlling large blocks of lighting. This design approach precludes the potential for turning on only the amount of lighting that is actually needed after the space has been subdivided.

22. CONSIDER NEON INDICATOR LIGHTS. Lighting use in remote areas can be monitored by providing neon indicator lights at central stations. Personnel will be alerted to investigate and turn off lights not being used.

23. USE LIGHT-COLORED REFLECTIVE PAINT WHEN REDECORATING.

HOT WATER

1. MEET HOT WATER HEATING NEEDS FROM:

   a. waste heat from incinerators or furnaces
   b. rejected heat of compression from refrigeration units
   c. waste condensate return from steam operated systems
   d. solar collectors

2. INSPECT WATER SUPPLY SYSTEM AND REPAIR ALL LEAKS, including those at the faucets.

3. CONSIDER INSTALLING A PRESSURE REDUCING VALVE. If water pressure exceeds 40 to 50 pounds, consider having a plumber install a pressure reducing valve on the main service to restrict amount of hot water that flows from the tap.

4. INSPECT AND TEST HOT WATER CONTROLS to determine if they are working properly. If not, regulate, repair or replace.

5. INCREASE AMOUNT OF INSULATION INSTALLED ON HOT WATER PIPES AND STORAGE TANKS or replace existing insulation with a type having better thermal properties ("R" value).

6. CONSIDER REPLACING EXISTING HOT WATER FAUCETS with spray type faucets with flow restrictors wherever practical. Consult with the appropriate government health agency before making modification.

7. USE A SINGLE SYSTEM TO MEET HANDWASHING NEEDS.

8. INSTALL A SMALL DOMESTIC HOT WATER HEATER to maintain the desired temperature in the water storage tank if you are using space heater boilers for this purpose now.

9. CONSIDER ARRANGING CIRCULATING PIPEWORK TO MINIMIZE THE LENGTH OF DEAD LEGS CONNECTING TO FAUCETS.

VENTILATION

1. REDUCE AMOUNT OF OUTDOOR AIR INTAKE to the required minimum, considering the task it is performing, room volume, and periods of occupancy.

2. ADJUST OUTSIDE AIR INTAKE including return air and mixed air damper controls in winter to raise supply air temperature to a level between 65°F and 70°F, depending on the conditions in the area served by the system.

3. ADD WARM-UP CYCLE TO AIR HANDLING UNITS WITH OUTDOOR AIR INTAKE. Keep outdoor air dampers closed during the morning building warm-up or cool-down so only air already in the building is conditioned. A cycle can be incorporated using a two-circuit time clock to control air damper and fan operation.

4. INSPECT DUCTWORK FOR AIR LEAKAGE. Seal all leaks by taping or caulking.

5. REPLACE BROKEN OR CRACKED WINDOW PANES.

6. INSPECT DUCTWORK INSULATION. Condensation on air handling surface is a sign of inadequate or loose insulation. Repair or replace insulation as necessary.

7. CAULK, GASKET, OR OTHERWISE WEATHERSTRIP ALL EXTERIOR JOINTS, such as those between wall and foundation or wall and roof, and between wall panels.

8. CAULK, GASKET OR OTHERWISE WEATHERSTRIP ALL OPENINGS, such as those provided for entrance of electrical conduits, piping, through-the-wall cooling and other units, outside air louvers, etc.

9. COVER ALL WINDOW AND THROUGH-THE-WALL COOLING UNITS when not in use and where practical. Specially designed covers can be obtained at relatively low cost.

10. ADJUST OVERSIZED EXHAUST HOOD so no more air than necessary is exhausted. This can be done easily by blocking off a portion of the hood, or lowering the hood, or reducing fan speed, or utilizing a combination of these techniques in compliance with applicable health regulations.

11. CONSIDER INSTALLING NEW FRESH AIR DAMPERS. Many older ventilation systems are designed with fresh air dampers which do not provide for accurate intake control. These dampers can be replaced with high-quality, opposed blade dampers with the proper seals at the blade edges and ends. This will minimize air leaks as well as provide better fresh air intake settings.

12. INSTALL BAFFLES to prevent wind from blowing directly into an outdoor air intake.

13. CONSIDER INSTALLING ECONOMIZER/ENTHALPY CONTROLS ON AIR HANDLING UNITS to minimize cooling energy requirements by using proper amounts of outdoor and return air from "free cooling" when possible. Economizer controls generally are used to provide "free cooling": Whenever the outdoor air temperature is lower than the indoor temperature, outdoor air is brought directly into conditioned spaces instead of being treated by the mechanical cooling system.

    Enthalpy controls have a similar purpose, but are more sophisticated and effective. They measure the total heat content of outdoor air and return air and utilize proper amounts of each to provide maximum energy benefits.

14. CONSIDER INSTALLING AUTOMATIC DOOR CLOSERS on all doors leading to the exterior or unconditioned spaces.

15. CONSIDER INSTALLING A VESTIBULE FOR THE FRONT ENTRANCE OF THE BUILDING, where practical. It should be fitted with self-closing weatherstripped doors. It is critical that sufficient distance between doors be provided.

16. CONSIDER UTILIZING REVOLVING DOORS FOR MAIN ACCESS, in addition to swinging doors needed by those in wheelchairs or on crutches. Studies have shown that revolving doors allow far less air to infiltrate with each entrance or exit. If high peak traffic is involved, swinging doors can be used to supplement revolving doors.

17. INSULATE ALL DUCTWORK CARRYING CONDITIONED AIR THROUGH UNOCCUPIED SPACES with at least 1-1/2" of fibrous insulation or its thermal equivalent.

18. INSPECT AIR HEATING, COOLING, AND DEHUMIDIFICATION COILS FOR CLEANLINESS. Coils can be kept clean by using a mixture of detergent and water in a high-pressure portable cleaning unit.

19. UTILIZE DUCTWORK ACCESS OPENINGS TO CHECK FOR ANY OBSTRUCTIONS such as loosely hanging insulation (in lined ducts), loosely turning vanes and accessories, and closed fire dampers. Adjust, repair or replace as necessary.

20. INSPECT GASKETING ON GARAGE AND OTHER OVERHEAD DOORS. Repair, replace, or install as necessary.

21. ADD CONTROLS TO SHUT DOWN THE VENTILATION SYSTEM whenever a building is closed for an extended period of time, as during the evening, weekends, etc.

22. FRESH AIR MAKE-UP UNITS SHOULD BE DESIGNED SO THAT THE DAMPER IS CLOSED WHEN THE UNIT IS SHUT DOWN.

23. WIRE ALL REMOTE CONTROL PANELS INTO ONE CENTRAL PANEL.

Time and effort on energy management "grow" savings dollars

PART 4 MANAGING YOUR ENERGY CONSERVATION PROGRAM

Being aware of the possibilities for saving money and energy is only the beginning step toward an energy management program. This book has presented many possible areas in retail stores where savings may be achieved. Now it is up to you, the owner or manager, to get the wheels in motion and implement the applicable conservation measures. An organized system of priorities should be established to decide where to focus your efforts. The action plan worksheets enclosed in this section are designed to help you organize your list of priorities.

The first step is to review the no-cost changes which you intend to implement. Use the first worksheet to list the applicable ones, schedule their implementation, and assign responsibility for accomplishing them. Once these no-cost items have been implemented, a monthly review and update of the Energy Management Form in this section can be made to determine whether energy and money is, in fact, being saved.

In order to be cost effective, an energy conservation measure should return its initial cost by the savings it creates. To calculate the simple payback period, the initial cost of the measure in dollars is divided by the annual savings using today's prices. By ranking the measures in order of shortest to longest payback period, one can develop a priority system.

The example problems in this section are designed to illustrate the method for calculating the energy savings period for two conservation measures.

ACTION PLAN

CHANGES FROM PART-2

CHANGE #	RESPONSIBILITY NAME & DEPT.	COMPLETION DATE & INITIAL	REMARKS

ACTION PLAN

CHANGES FROM PART-3

PROJECT	COST	PAYBACK PERIOD	RESPONSIBILITY	COMPLETION	REMARKS

ENERGY MANAGEMENT FORM

An Energy Management Form is shown on the following page. The data from the form can be used to budget and account for energy usage. In addition, it can be used to calculate the payback period for several of the recommended energy conservation measures illustrated.

To make it easy to use, you may wish to remove it from the book. The form is intended to be an aid for establishing a continuing energy bookkeeping procedure for your store. If it is filled out each month, the manager or owner of the retail store can get a sense of monthly and yearly energy consumption and cost. It can also be used as a base to evaluate energy savings that result from energy conservation measures.

You should remember that the billing period for electricity may vary from 25 to 40 days. If so, you will have to adjust it to be consistent with the other types of energy on the form. Calculate the kwh per day and multiply by the number of days in the month or period you are using for oil and gas.

Continue to update the Energy Management Form at regular, frequent intervals during the implementation of your energy conservation program. That way, the reduced consumption of fuel and/or electricity will become real and you will be able to demonstrate and verify the savings with your consumption measurements.

Diligent effort on energy conservation helps rake in savings

ENERGY MANAGEMENT FORM

BUILDING _____ _____ YEAR

MONTH*	ELECTRICITY			OIL			NATURAL GAS			COAL ☐ WOOD ☐ PURCHASED STEAM ☐ other _____			TOTAL ENERGY COST
	QUANTITY KWH	COST (DOLLARS)		QUANTITY GALLONS	COST (DOLLARS)		QUANTITY MCF. CCF. OR THERMS	COST (DOLLARS)		QUANTITY UNIT	COST (DOLLARS)		
		TOTAL $	$/KWH		$/GAL	TOTAL $		TOTAL $	$/MCF		TOTAL $	$/UNIT	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
JANUARY													
FEBRUARY													
MARCH													
APRIL													
MAY													
JUNE													
JULY													
AUGUST													
SEPTEMBER													
OCTOBER													
NOVEMBER													
DECEMBER													
ANNUAL TOTALS													
ANNUAL AVERAGES													

*Or comparable time period

CALCULATING SAVINGS

The following pages contain two examples of how to calculate energy costs and savings for typical ideas presented in this booklet. The examples are printed in such a way that you can work out your own problem step by step beside the example.

The section for you to fill out is on the left-hand side of the page as the example numbers are shown to the right.

The following abbreviations are used in the problems:

MMBTU	= One Million Btu	°F	= degrees Fahrenheit
MCF	= 1,000 Cubic Feet	CFM	= cubic feet per minute
CCF	= 100 Cubic Feet	Btu/hr·10 ft	= Btu per hour per 10 feet of pipe
kwh	= Kilo Watt Hours		

CONVERT YOUR ENERGY USAGE FROM $'S TO BTU'S.

The British Thermal Unit or Btu, is a common unit for the measurement of all forms of energy. With the projected dollar increase for utilities it will be impossible to measure energy usage and savings as the basis of dollar amount of the utility bills. Conversion to Btu's eliminates the differences in units used to measure various types of fuel, as well as variations in price for fuels in different geographic regions and future price increases. A Btu is a very small unit of energy. Large quantities of energy are often expressed in terms of a million Btu's or in some cases therms. Converting dollar energy usage to Btu's is a simple process, and will allow additional analysis of the figures on page 26. As you develop your energy management program consider incorporating Btu figures on a form similar to the chart on page 26.

BTU CONVERSIONS

SOURCE	MEASURE	HEAT
electricity	kwh =	3410 Btu's
natural gas	cubic foot =	1000 Btu's
natural gas	1,000 cubic feet =	1 MCF
natural gas	1 MCF	10 Therms
oil	gallon	140,000 Btu's
steam	1 lb.	1000 Btu's

PROBLEM NUMBER 1 - Saving on lighting expense.

Remove unnecessary lamps or fixtures. However, do not remove fluorescent lamps without disconnecting the ballast. WARNING: Ballasts use high voltages and should only be removed by an electrician.

Data Needed for Calculations:

1. Count the number of lights that you feel can be removed in the store front or stock rooms (Note: 4 foot tubes are generally 40 watts and 8 foot tubes 75 watts. Add 10 percent of total if ballasts are also removed.):

   _____ bulbs or tubes removed

   _____ watts/bulb

2. From the Energy Management Form obtain the average cost of electricity ($/kwh) (Average of column 4)

   _____ $/kwh

3. Estimate the number of hours per day the lights are on:

   _____ hr/day

4. The number of days per year the store is open:

   _____ days/yr

EXAMPLE PROBLEM

50 bulbs or tubes

75 watts/bulbs

.04 $/kwh

10 hr/day

260 days/yr

Calculations:

1. The energy saved with lights removed:

   _____ bulbs × _____ watts/bulb
   × _____ hr/day = _____ watt-hr/day

2. Energy saved per year:

   _____ watt-hr/day × _____ days/yr
   ÷ 1000 watt-hr/kwh = _____ kwh/yr savings

3. Cost saved per year:

   _____ kwh/yr savings × _____ $/kwh
   = _____ $/yr savings

EXAMPLE PROBLEM

50 bulbs × *75* watts/bulb
× *10* hr/day = *37,500* watt-hr/day

37,500 watt-hr/day × *260* days/yr
÷ 1000 watt-hr/kwh = *9750* kwh/yr savings

9750 kwh/yr savings × *.04* $/kwh
= *390* $/yr savings

PROBLEM NUMBER 2 - Saving on new lighting

Use energy efficient fluorescent bulbs. There are bulbs on the market now that put out the same light levels but use less energy. (This problem uses 4 foot bulbs as an example.)

Data Needed for the Calculations:

1. Count the number of four foot fluorescent bulbs in the store:

   _____ bulbs at 40 watts each

2. The total watts are:

   _____ bulbs × 40 watts/bulb
   = _____ watts

3. Energy conserving bulbs use:

   (35 watts/bulb)

4. Average time per day the bulbs are turned on:

   _____ hr/day

5. Extra cost of energy efficient bulbs as opposed to regular tubes (Get a price quote from a contractor):

   _____ $/bulb

6. Electricity cost per kwh average:
   (from Energy Management Form column 4)

   _____ $/kwh

EXAMPLE PROBLEM

320 bulbs

320 bulbs × (40 watts/bulb)
= *12,800* watts

(35 watts/bulb)

10 hr/day

.42 $/bulb

.6 $/kwh

Calculations:

EXAMPLE PROBLEM

1. Energy saved per bulb:

   (40 watts) − (35 watts)
   = 5 watts/bulb

2. Total energy saved with efficient bulbs:

   5 watts/bulb × _____ bulbs
   = _____ watts saved

3. Total energy saved per year:

   _____ watts saved × _____ hrs/day
   × (365 day/yr) ÷ (1000)
   = _____ kwh/yr saved

4. Cost saved per year:

   _____ $/kwh × _____ kwh/yr saved
   = _____ $/yr saved

(40 watts) − (35 watts)
= 5 watts/bulb

5 watts/bulb × *320* bulbs
= *1600* watts saved

1600 watts saved × *10* hr/day
× (365 day/yr) ÷ (1000)
= *5840* kwh/yr saved

.06 $/kwh × *5840* kwh/yr saved
= *350* $/yr saved

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