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U.S. Department of Energy
Assistant Secretary for Conservation
and Solar Applications
Office of State and Local Programs
Office of State Grant Programs

September 1978

MASTER

Energy Audit Workbook for Hotels and Motels

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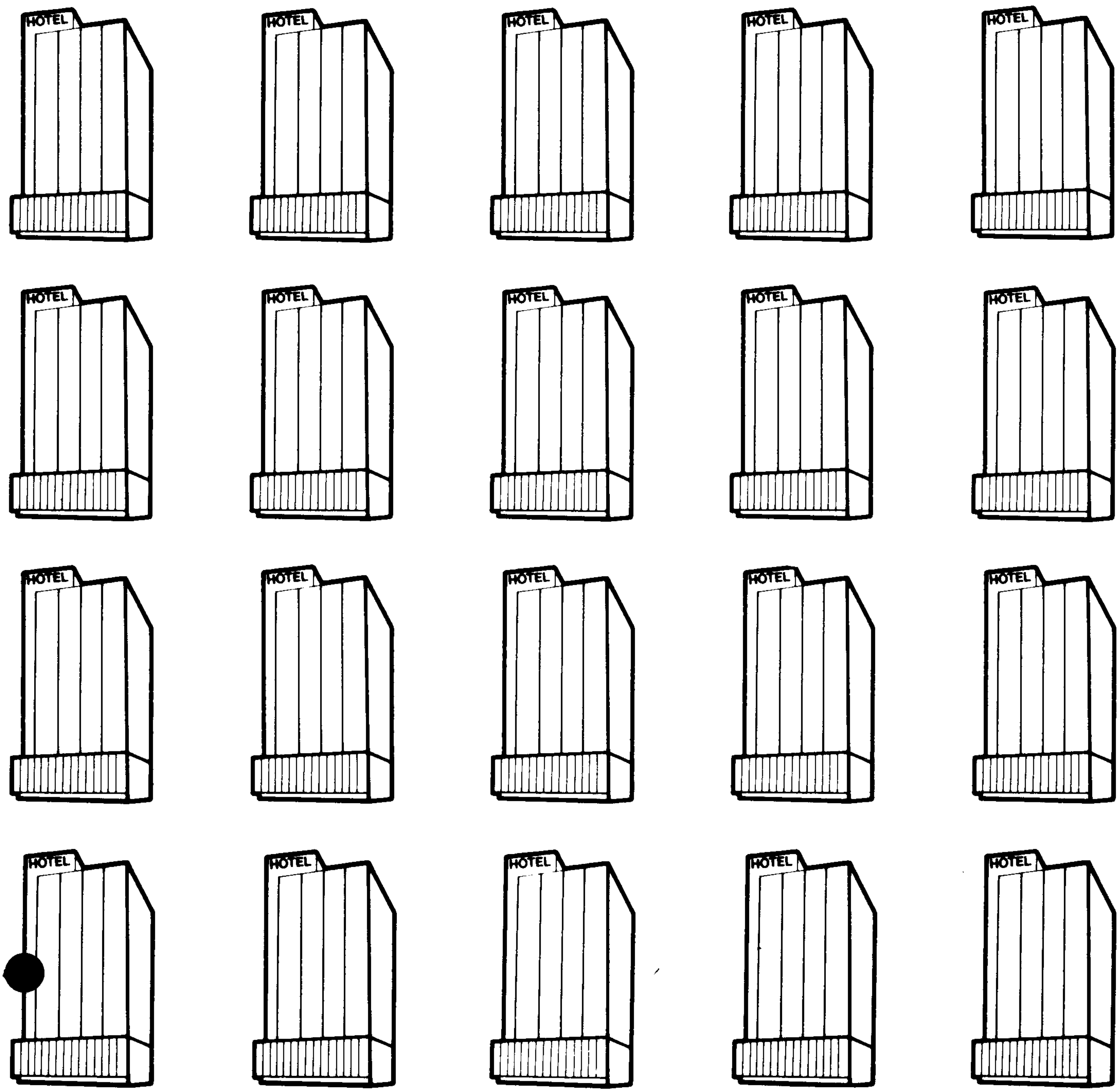

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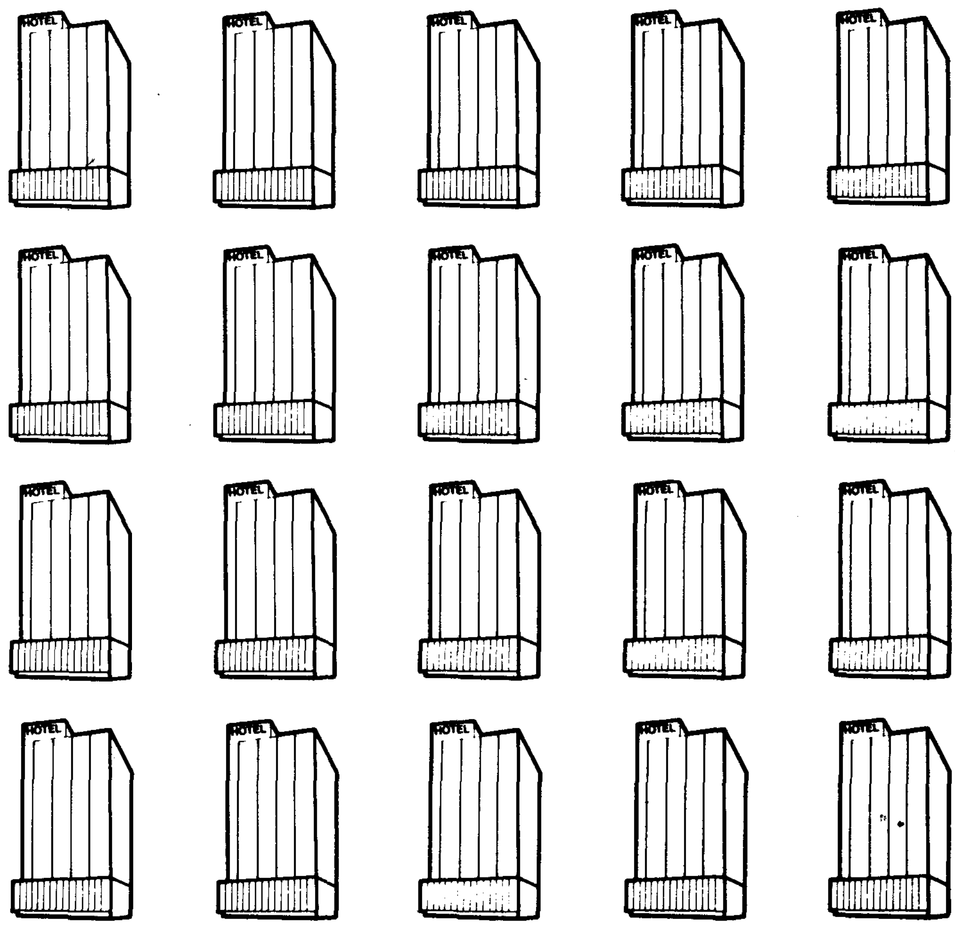

FOREWORD

This workbook has been prepared for use by State Energy Offices as a tool in assisting hotel or motel owners and managers in performing Class C information energy audits to identify energy conservation measures.

This workbook is one of a series of eleven (11) workbooks for different types of buildings; one each for apartments, bakeries, die-cast plants, educational institutions, hospitals, hotels and motels, offices, restaurants, retail stores, transportation terminals, and warehouses and storage facilities. In addition, a two-volume instruction manual has been prepared to assist energy auditors in performing Class A energy audits.

Fuel and Energy Consultants assisted in the preparation of the workbooks and the States of New Mexico, New York, Michigan, Minnesota, and Texas participated in a field test of the workbooks. Their participation and invaluable comments and suggestions are deeply appreciated.

PREFACE

While all owners and managers of hotels and motels wish to do their part by conserving energy, they often overlook the positive impact that energy conservation can have on their operating budgets.

In a typical hotel or motel, it is possible to save as much as 15% of utility costs through common sense actions without any appreciable capital expenditure. (A building is considered typical if the original facility was built 20 to 50 years ago, with wings and other additions added over intervals up to the present.) Even if a building was built after 1976, it is still possible to find many opportunities to conserve energy.

As the owner or manager, you do not have to be an engineer to identify those areas where energy and real dollar savings can be realized. Just keep in mind that, up until about 1975 or 1976, energy conservation was not a major factor in the design of the facilities. Look for the obvious -- and that is the purpose of this workbook: finding the obvious savings through an energy audit.

The first obvious thing to look at is the lighting. Are the hallways, convention halls, meeting rooms, lobbies, laundry rooms, mechanical rooms, and nonessential areas overlighted? Common sense will tell you which areas are and good guesswork can enable you to reduce the number of lamps in the excessively bright areas. Since fluorescent lamps use much less energy than incandescent lamps, it is feasible to replace incandescent lamps with fluorescent fixtures, where possible. If a mechanical room has only incandescent lamps, good economic sense tells you not to replace the lamps if the room is used only one or two hours a week. Just make sure that the lamps are turned off when the room is not occupied. For that matter, turning off lights when not needed is an obvious goal.

Consider another obvious thing which will be brought out in the workbook -- "domestic hot water." The hot water used by the guests and staff should not be over 105 to 110^{O}F. Do you have to mix cold water with hot water at the taps and shower heads to adjust the hot water temperature? Or, (ask your maintenance personnel) is your domestic hot water cooled through an automatic hot-cold water mixing system prior to delivery to the points of use? If so, and your facility is typical, your hot water system is set for 160 to 180^{O}F, perhaps less but considerably more than 110^{O}F. By lowering the temperature control to 110 to 120^{O}F, a significant energy and dollar savings can be realized.

If your heating, ventilating and air conditioning system (HVAC) is typical, did you know that you probably have your chiller (air conditioner) operating when the outside temperature is only 50 to 55^{O}F? Why? Because that is the way that most HVAC control systems were designed before the 1974 Arab oil embargo. The systems are designed to mix fresh outside air with hot returned inside air in a mixing chamber and adjust the mixed air's temperature by cooling to the desired thermostat control setting. There is no law that says the chiller must operate when the outside air is 55°F. Change the controls so that the chiller will turn on at say, 63°F instead. More fresh air will be brought in and more inside hot air will be rejected to arrive at the proper mix. Your maintenance people or your HVAC contractor can do this for you. What do you save? The usual 150 to 250-room hotel or motel will have 300 to 500-ton chillers. When the chillers operate over the 50 degree to 63 degree outside temperature range, they may operate at 1/3 to 1/2 of their designed ratings. When the chiller is operating under these conditions, the hourly energy cost is about $3.50 - $7.50 plus demand charges plus fuel adjustment charges plus tax. The savings are obvious.

The purpose of the workbook is to bring "the obvious" to your attention. This can be readily accomplished by you through filling out the form and following the examples given in the workbook. You will be surprised at how many items you will find that will offer you savings.

Some of the sections of the book will not apply to you. For example, if your facility burns only gas, ignore sections of the form which are directed towards oil or coal. If your hotel or motel does not have a boiler, skip that section -- and so on. Make every effort to thoroughly understand your utility billings. When in doubt, do not hesitate to call the utility sales representative and ask for a full explanation. They will be glad to cooperate.

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INTRODUCTION

This workbook describes some simple methods by which the owner, manager, or operator of a hotel or motel can analyze energy uses, determine areas in which energy savings can be made, and estimate the magnitude of cost savings in accordance with U.S. Department of Energy procedures described as Class C Information Audits.

The workbook provides a do-it-yourself, fill-in-the-blanks approach to an energy conservation program for hotels and motels which do not have 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.

Although this workbook emphasizes the energy-intensive processes and some of the recognized areas of energy waste in hotels and motels, it should be used selectively because each building has its unique energy-use patterns. If a particular suggestion does not apply to your building(s), read on; the next one probably will.

Start the energy audit of your hotel or motel by assembling energy consumption data for the last 12 months. Your gas, oil and/or electric bills are a good place to start. If you haven't already summarized your building's energy consumption needs, you may wish to use the form in Chapter 2 for this purpose. Record both price and actual consumption. You can tell a lot about your building(s) by examining the monthly records. For example, if electric usage is lowest during some months, it may well be that usage is a basic minimum including lights and hot water. If oil consumption goes to zero during July and August, you can be sure that the oil is being used only for heating.

Next, make yourself aware of your building's geographic location and site conditions. Obtain from your library, utility, weather station, or State Energy Office the average monthly degree days and the past 12 months of degree days for both heating (winter) and cooling (summer). These climate conditions will be useful in many ways, including identifying the magnitudes of oil consumption for heating and electricity consumption for cooling that your hotel or motel may need. You will need this information to fill out the Energy Management Form in Chapter 2 and, subsequently, to work out the problems in that section.

The next step in your energy audit is to have your building or buildings' description at hand -- the building size, floor plan, general condition, insulation, type and size of windows, wall materials, roofing material and roof size, doorways, garage, and any other aspect of your building that may lead to an understanding of its basic construction. Obviously, a set of building plans would answer this need very well.

Next, list the heating plant, air-conditioning equipment, electrical equipment and lighting fixtures that are controlled by you, the hotel or motel owner or manager, rather than by guests. These systems are the biggest energy users in hotel or motel, and you will want to understand them to help identify means of making them more efficient with the aid of this workbook.

This completes the information gathering required for your energy audit. The information will provide a base for implementing the Maintenance and Operational Changes and Energy Conservation Measures that will make your hotel and motel as energy efficient as your time, budget, and enthusiasm will permit.

Chapter 1 will provide suggestions that will enable you, without cost, to increase your building's present energy efficiency by Maintenance and Operational Changes.

CHAPTER 1

MAINTENANCE AND OPERATIONAL CHANGES

By diligently following a maintenance program, a hotel or motel owner or manager can conserve a substantial quantity of energy by maintaining the building at its optimum designed conditions. Energy saved as a result of such a program is obviously dollars saved, since little or no capital investment is required.

To conduct a continuing energy conservation/maintenance program, a checklist of items to be done on a regular basis should be set down and followed faithfully. This section of the workbook is in the form of a checklist that will aid in identifying maintenance and operational changes that will result in energy conservation.

The general energy users in a hotel or motel have been categorized into headings such as housekeeping, food preparation, air conditioning, ventilation, etc. Under these broad categories the pertinent maintenance and operational changes have been listed.

Several of the items listed have been shown to be particularly applicable to most hotels and motels since they result in the quickest energy and dollar savings. For reference they are as follows (they will also appear in their respective functional headings in this chapter):

1. Lower the thermostats during the heating season and raise them during the cooling season. You can save about 8% of your heating fuel bill by lowering the thermostats a mere five degrees.

2. Examine the entire building for air leaks around windows, doors and any place that they might occur. Seal up the leaks.

3. Lower the domestic hot water to 110°F.

4. Make the monthly energy consumption and cost data available to the manager and chief operating engineer so that they can evaluate and compare against previous months and normal budget.

5. Involve the staff in the goals of energy conservation.

6. Reduce the preheat time of ovens and stoves in the kitchen to the minimum.

7. In overlighted areas remove lights to produce a uniform lower light level.

8. Lower the laundry room hot water to the minimum acceptable by law.

After reading through the check list pick up a pencil, put on your walking shoes, and start walking through the building. Examine the suggested maintenance and operational changes that pertain to your facility. Make notes as you go along. 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 preventative maintenance items into a regular program immediately.

LIST OF MAINTENANCE AND OPERATIONAL CHANGES

A. HOUSEKEEPING DEPARTMENT

1. Reset thermostats. In a particular case, when the outdoor temperature is 40°F, a room heated to 68°F uses 20% less energy than a room heated to 75°F.

2. Instruct bellmen to turn on heating or cooling system when showing guests to rooms, and to adjust thermostats to setting recommended by management.

3. Remove obstructions which restrict free flow of air through heating and cooling units. Furniture placed within a foot of the air inlets of units, and books, or magazines placed on top of units, could cause fan coil or self-contained units to operate longer than necessary and waste energy.

4. Keep radiator units free of dirt, lint, and dust. The free flow of air over radiator surfaces improves the effectiveness of installed heating units, and saves energy by reducing the need for supplementary heating or cooling which otherwise may be required.

5. Turn off motor operated fans and compressors in unoccupied guest rooms.

6. Consider permanently turning off heating and cooling systems in closets and in storage rooms which are entered only occasionally. (But take care not to cause freeze damage by turning off heat.)

7. Keep windows and outside doors closed. The entry (infiltration) of unheated air in the winter and uncooled air in the summer can be a large waste of energy. Example: A three foot wide window raised just one inch will result in a heat loss of 18,014,000 Btu per year in an Indianapolis winter (5000 degree days). On a cold day, for a room heated with electricity (0°F outside, 68°F inside), the wasted energy would cost 16-1/2 cents per hour at an electric rate of 5 cents per kilowatt hour. Multiply by 150 rooms and the hourly cost becomes $24.75. On a warm, humid day (95°), the same window raised just one inch could allow air to enter the room which would require 881 watts per hour to cool. At an electric rate of 5 cents per kilowatt hour, the wasted energy would cost more than 4 cents per hour. In a 150-room property, this would mean $6.60 per hour.

8. Consider use of air fresheners instead of opening doors and windows to "air" rooms.

9. Make use of natural window light when possible.

10. Review lighting levels and prepare new standard lamping plans for guest rooms, corridors, storage areas, and other assigned spaces so as to use the minimum necessary number of lamps and the minimum necessary size lamp to light each area consistent with safety standards.

11. Clean walls, windows, and floors regularly. A clean surface reflects light better, so that less artificial lighting is needed.

12. Follow routine cleaning schedules for lighting fixtures. All fixtures become dirty with use, and produce more light when cleaned. Energy will be saved if fewer lights are required, or smaller lamps can be used to provide satisfactory lighting.

13. Open draperies and raise shades during cleaning or other temporary occupancy of spaces where adequate natural light from windows is available. Close draperies and shades when cleaning is completed or space is vacated. (However, keep draperies and shades closed even when cleaning during extremely hot or cold weather, to avoid heating and cooling losses greater than lighting losses.)

14. Reduce use of lights during night cleaning by turning on only those in areas actually being cleaned. Example: One 100-watt lamp burning for 10 hours uses 1 kilowatt hour of electricity. If the lamp burned 12 hours a day for a year, 438 kilowatt hours of electricity would be used. The cost of energy wasted would be $21.90 at the rate of 5 cents per kilowatt hour, or $3,285 if one such lamp burned in each room of a 150-room property.

15. Turn off lights in linen room, maid's closet, and storage room when they are unoccupied.

16. Mark or color code individual switches in multiple switch installations to identify lights controlled.

17. Instruct bellhops to check lights as designated when showing guests to rooms, then leave on only lights requested by guests.

18. Instruct maids and housemen to observe the following:

    a. Turn off dripping faucets, showers, and toilets which run continuously. Report problems promptly for the engineer to repair.

    b. Be sure that heating or cooling systems are turned off in physically unoccupied or unused guest rooms when make-up and cleaning are completed.

    c. Turn off TV sets in guest rooms when rooms are physically unoccupied and when they are being made up. Example: A 350 watt color TV left on 12 hours a day for a year would use 1533 kilowatt hours of electricity. The cost of energy wasted would be $76.65 at the rate of 5 cents per kilowatt hour. In a 150-room property, this would amount to $11,497.50.

    d. Keep draperies and shades closed in unoccupied guest rooms at all times. Energy will be saved through insulating effects both in reducing heat gain in summer and heat loss in winter. In the winter, it is possible that rooms could gain some heat from the sun if the draperies and shades were kept open when the sun is shining on windows. (However, since the sun would be effective only for a few hours on any side of the building, the heat losses for the balance of the day would quickly offset any gain.)

19. Place cards and decals in guest rooms to encourage guests to cooperate in saving energy.

B. MEETINGS AND CONVENTIONS DEPARTMENT

1. Assign an individual to be responsible for turning lights on and off.

2. Turn off function room lights when rooms are vacant or unoccupied. Turn on lights a short time before functions start, and then reduce them to a minimum immediately after guests depart.

3. Reduce use of lights during night cleaning by turning on only those in areas actually being cleaned and turn lights off even when leaving room for a short time.

4. Open draperies and raise shades during set-up and tear-down of rooms where adequate natural light from windows is available. Close draperies and shades when tear-down is completed or rooms are vacated.

5. Review lighting levels and prepare new standard lamping plans for meeting, convention, and other function rooms which use the minimum number of lamps and the minimum size lamp to light each area consistent with safety standards.

6. Assign an individual to be responsible for turning the heating and cooling systems on and off.

7. Reset thermostats. 68°F (heating), 78°F (cooling).

8. Shut off air conditioning, ventilating, and exhaust systems when space is not in use. (But conform to local codes.)

9. Use outside air for cooling when conditions allow. Use economizer cycle, where installed.

10. Turn on heating and cooling systems as close to the start of a function as practicable (determine by trial and error). Turn off systems immediately after function.

11. Minimize the fresh air supply according to the use of the room. Low occupancy and no smoking requires much less outdoor air than high occupancy and smoking. The recommended outdoor air supply for rooms with smoking is 40 cubic feet per minute (cfm) per person compared to 7-1/2 cfm where there is no smoking.

12. Keep windows and outside doors closed.

13. Keep draperies and shades closed in unoccupied function rooms.

14. Assign an individual to be responsible for closing draperies and shades in function rooms after tearing down and cleaning have been completed.

C. <u>FOOD SERVICE - DINING ROOMS</u>

1. Turn off lights when they are not needed.

2. Review lighting levels and prepare new standard lamping plan for food service areas which use the minimum size lamp to light each area.

3. Mark or color code individual switches in multiple switch installations to identify lights each one controls.

4. Reposition lamps to light only those areas where people are working or eating.

5. Adjust draperies and shades to reduce energy consumption.

6. Schedule cleaning of areas during daylight hours whenever practicable.

7. Set duct registers to provide efficient air flow within the food service area, and a balanced air distribution between it and the kitchen.

8. Reduce peak electric demand by staggering the times individual heating, ventilating, and cooling units are started.

9. In areas where nights are much cooler than days, try using the cool outside air to flush out the food service areas before the ventilating system is turned off at night.

10. Keep windows and outside doors closed.

D. FOOD PREPARATION - KITCHENS - GENERAL

1. Ask the utility company to check regularly that adequate gas pressure is being supplied.

2. Check for short cycling and loss of temperature control periodically.

3. Carefully follow instructions in the user's guide for all equipment.

4. Keep records of breakdowns, parts replacements, and regular maintenance checks on all equipment.

5. Turn on equipment only as needed. Do not let them operate when not in use, and make certain they are turned off at night.

6. Keep equipment and door seals free of debris to prevent steam leakage and energy waste.

7. Reduce "peak loading." Your electric bill is determined by two factors: (a) a demand charge, the highest (or peak) kilowatt use for any short time period during the month (usually a 15- or 30-minute period); and (2) an energy charge based on your total consumption in kilowatt hours. Some rules to follow in reducing peak use and demand charges are:

   a. Schedule energy-intensive cooking, such as baking and roasting, during non-peak demand hours (periods in which the least amount of electric energy is being used in the kitchen and in other departments.

   b. Set a limit on the number of electric appliances which may be used at the same time.

8. Set up a schedule of preheating times for kitchen appliances and stick to it. Equipment should be turned on at a specific time to a specific temperature, and turned off at times when it is not needed. A 10- to 15-minute preheat period is sufficient for solid-top gas ranges. A deep fat fryer requires only 7 to 15 minutes for preheating. Consult manufacturer's instructions for individual appliances.

9. Ensure that thermostatic controls are operating properly. Maintenance of higher than necessary temperatures wastes energy.

10. Set thermostats to the lowest temperature that still gives satisfactory results. Dialing higher does not reduce preheating time, while a low temperature results in lower energy consumption because less energy will be lost to the surrounding air.

11. Keep thermometers properly calibrated to ensure that desired temperature is maintained.

12. Regularly use a reliable commercial thermometer to check surface temperature against the control dial reading. If the readings do not match, your thermostat may need recalibrating. Many utilities and commercial maintenance companies offer this service.

13. Plan menus to minimize energy usage. Meals which require less cooking time to prepare will use less energy, and can still be appealing.

14. Cook foods in the largest volume possible. Most food service operators find they can cook some items partially or completely in advance, thus making more efficient use of energy.

15. Keep all cooking surfaces clean. Build-up of grease and other encrusted matter reduces cooking efficiency.

16. Check cooking oil level frequently. Food must be covered with oil to cook correctly. Add fresh oil if level drops below marker. Cooking without sufficient covering oil wastes energy.

17. Check the temperature of cooking oil often to be certain heating elements and thermostat controls are working correctly.

18. Clean heating elements at least weekly. This should be done daily if you do high-volume frying. Remove all traces of burned food, grease, or carbon.

19. Have gas burners checked semi-annually by an experienced service representative.

20. Regularly check all gas units for uneven or yellow flames. To correct the condition, clean the burners, pilot lights, and orifices with a stiff wire brush. If the flame is still yellow or uneven, have your serviceman correct the gas-to-air mixture by adjusting the air shutters.

21. Correct faulty operation of burners. A blue flame with a distinct inner cone is best. Flames should never float or strike directly on refractor elements but should just wipe the surface.

22. Regulate gas burners for optimum heating and energy efficiency. Adjust the flame until it is entirely blue and has a firm center cone. The tips of the flame should just touch the utensil bottom.

23. If you must keep electric burners on for short periods when they are not actually in use, reduce the temperature until you are ready to cook. This will not only conserve energy, but it will also prolong the life of the burners. Only a few minutes are required to bring the surface of a solid top range up to cooking temperature.

24. Do not turn gas burners on until you are ready to cook.

25. Fill cooking vessels according to manufacturer's recommendations, and to capacity, if possible.

26. Use flat bottom pots and pans to maximize heat transfer.

27. Cover pots and pans with lids. They will keep the heated air in and decrease cooking time.

28. Burners should always be smaller than the kettle or pot placed on them. The diameter of the pot should be about 1" larger than the diameter of the electric coils or plates.

29. Group kettles and pots on close-top ranges. By using as little surface area as possible, and adjusting heating elements to desired levels, heat loss will be decreased.

30. Turn down heat as soon as food begins to boil, and maintain liquids at a simmer. Keeping the heat higher than the boiling temperature does not cook food any faster, and it uses more energy.

31. Turn the burners down during slack periods. Use thermostatic control when possible to avoid continuously high or excessive heat.

32. Place foil under range and griddle burners. The operating efficiency will improve, and the equipment will be easier to clean. (But don't block air inlet openings for gas burners.)

33. Remove boil-overs and spill-overs promptly to avoid buildup of carbon deposits which can adversely affect efficiency of the unit.

34. Clean burners and be sure openings as well as air shutters are clear. (Handle ceramic refractor units carefully.)

35. Where possible, begin cooking food in a steamer. Then finish it as necessary in the desired manner.

36. When practical, consider using steam cookers for such items as vegetables, rice and pasta to speed up cooking time. Only small amounts of energy are required to maintain the cooking temperature once it has been reached.

37. Maintain the temperature control on steam tables at a level that will keep food warm without allowing clouds of steam to escape. Clouds of steam indicate unnecessarily high temperatures, which waste enery.

38. Regularly inspect and clean interiors of fixed-well fryers for grease or carbon deposits.

39. Do not load beyond manufacturer's stated capacity. Normally, baskets are loaded to one-half to two-thirds capacity. Crowded food takes longer to cook and wastes energy.

40. Clean fryers regularly.

41. Drain fryers daily.

42. Turn thermostat up only as high as required to reach frying temperatures (310-360°F). Preheat time from room temperature to 350°F is only about 5 minutes.

43. Use a low or medium flame for light griddling.

44. Place food being cooked close together and heat only that portion of the griddle being cooked on.

45. Place weight on bacon and sausage to quicken cooking time. (But note that this may alter the characteristics of the product.)

46. When practical, load heated broilers to capacity to utilize the entire surface area.

47. Use infrared broilers to advantage. These can be turned off when not in use and quickly reheated.

48. Turn char-broiler heat to medium after briquets are hot.

49. Keep briquets clean.

50. Plan baking and roasting to use ovens to capacity. This eliminates bringing the oven to full heat more than once or twice a day. Energy is wasted when all of the available cooking heat is not used. In standard ovens, allow at least a 2-inch clearance for air to circulate around pans.

51. In roasting, save energy by using lowest practical temperature.

52. Use warm-up time to begin cooking food (except for food which will dry out or overcook). Start the day's baking with foods that require the lowest oven temperature. Use other electrical appliances sparingly while preheating electric ovens to avoid excessive demand charges.

53. Load and unload oven quickly to avoid unnecessary heat loss, and avoid opening doors to look at food. For every second an oven is open, the interior temperature can drop as much 10°F.

54. Wipe up spills frequently, and keep interior surfaces of oven clean.

55. Clean and wipe out the grease troughs and remove any stuck-on food at least once a day.

56. Repair broken door hinges and cracks that allow heat to escape from oven.

57. Once or twice a year check the level of ovens.

58. Have the oven timer professionally checked at least once a year.

59. Turn off rotary toaster when not in use.

60. Clean rotary toaster regularly. Clean equipment performs more efficiently and uses less energy.

61. Consolidate foods stored in refrigeration and freezer space where possible.

62. Check to be sure that refrigeration units are not left running with little or no food in them. Consolidate minor leftovers, and turn off those units which are not needed.

63. Set up procedures to reduce the frequency and length of time refrigerator and freezer doors are opened. Frequent and lengthy openings are extremely wasteful of energy.

    a. Plan ahead to take out or replace several items at one time.

    b. Clearly label stored items.

    c. Prepare schedules for use of walk-ins.

64. Be sure that items do not jam against closing doors.

65. Do not store anything within four feet of the compressor.

66. Do not store products in front of coils in a manner that restricts air flow.

67. Keep blower coil free of ice build-up and dust.

68. Allow hot food a few minutes to cool before placing it in refrigerator or freezer. Air cooling reduces the amount of work the refrigerator or freezer must do.

69. Thaw frozen food in the refrigerator.

70. Equip walk-ins with pilot lights on light switches.

71. Turn off lights in walk-ins when leaving.

72. Feel the outside walls for cold spots. Do this frequently for a new unit.

73. Maintain defroster.

74. Keep all door gaskets and seals in good condition.

75. Maintain proper tension on refrigerator compressor belts and replace those that are worn or damaged.

76. Schedule food deliveries, where possible, to avoid overloading refrigeration facilities, or undercapacity utilization.

77. Close ice-maker storage bins after each use.

78. Use hot tap water for cooking whenever possible. A water heater uses less energy than a range-top to heat the same amount of water.

79. Semi-annually, drain and flush hot water tanks. Accumulations of water impurities act as insulation and prevent the efficient transfer of heat to the water. Where water contains heavy amounts of lime or other sediment, drain and flush tanks more frequently. In areas with heavy lime deposits, consider installing a water conditioner to reduce the lime build-up. The heating coil should be removed and cleaned every year on storage type tanks heated by a steam coil.

80. Make sure the power rinse on the dishwasher is turning off automatically when the tray has gone through the machine.

81. Do not wash dishes until you have a sufficient load.

82. When a power dryer is used, adjust it so that heated air is delivered just long enough to barely dry the dishes. Drying will continue after the machine is shut off.

83. Consider using a wetting agent which will eliminate the need for power drying.

84. Be sure that the dishwasher is shut off after use.

85. Regularly check the flow controls to be sure you use the proper amount of water in the rinse.

86. Regularly check the rinse water temperature.

87. Regularly remove hardwater lime deposits from spray nozzles and tanks.

88. Regularly check the speed reducer on conveyor-type washers for proper lubrication.

89. Keep pressure reducing valves in full order. If you do not have one, check to see if it is needed. While dishes will not rinse thoroughly if the pressure is too low, higher than necessary water pressure will waste heated water.

90. Inspect the feed drain valves weekly for water leakage.

91. Inspect pumps monthly for water leakage.

92. Check to see that the hot water lines in a recirculation loop are insulated.

E. SPACE HEATING - GENERAL

1. Lower the thermostats during the heating season and raise them during the cooling season. If your building is like most, you can save about 8% of your heating fuel bill by lowering the thermostat(s) a mere five degrees.

2. Surfaces of radiators, convectors, baseboard, and finned-tube heaters must be kept clean for efficient operation.

3. Reduce the space heating hot water temperature to a level that will just satisfy heating needs.

4. Determine if all installed radiation is really necessary.

5. Shut off (or remove) heating units from vestibules, lobbies, and corridors.

6. Do not heat parking garages, docks, and platform areas.

7. Do not heat storage rooms unless it is necessary for protection of stored contents.

8. Inspect oil heaters to ensure that oil temperatures are being maintained according to manufacturer's or oil supplier's recommendations.

9. If you have infrared heaters, check to see if the reflectors are beamed in the right direction and the surface is clean.

10. When the sun is not shining during the heating season, close interior shading devices to reduce radiation from body to cold window surfaces.

11. If you have a coal-fired system, check stoker(s), grate(s), and controls for efficient operation.

12. Adjust heating and cooling controls in rooms so that both systems cannot be on at the same time.

13. Check temperature controls to ensure they are working properly.

14. Use an outdoor thermostat to check calibration and operation of heating controls. See that the thermostat is in a location not affected by sun, exhaust air, or heat from lights or other sources.

15. Check locations of room thermostats. They should not be on cold walls, or so close to lighting fixtures that they are heated by lights, or be in a draft from an air conditioner outlet.

F. HOTELS AND MOTELS THAT USE BOILERS FOR SPACE HEATING

1. If you use steam only for space heating, shut off boilers in the spring and fall when the air conditioning system is on and temperature control is not needed.

2. If two boilers are used, leave one off during most of the winter heating season and perhaps during the entire season if one boiler is capable of carrying the entire load under design conditions. A single boiler carrying the building space heating load will operate at a higher annual efficiency than two boilers dividing the load.

3. If the boiler has a natural gas standing pilot, turn it off during the summer months when the boiler is off.

4. Keep a daily log of pressure, temperature, and other data obtained from instrumentation. This is the best method available to determine the need for tube and nozzle cleaning, pressure or linkage adjustments, and related measures. Variations from normal can be spotted quickly, enabling immediate action to avoid serious trouble. On an oil-fired unit, indications of problems include an oil pressure drop, which may indicate a

plugged strainer, faulty regulator valve, or an air leak in the suction line. An oil temperature drop can indicate temperature control malfunction or a fouled heating element. On a gas-fired unit, a drop in gas pressure can indicate a drop in the gas supply pressure or malfunctioning regulator.

5. Inspect exhaust stacks (units containing a number of smoke ducts grouped together). They should not be giving off smoke. If they are smoky it probably indicates that a burner adjustment is necessary.

6. Consider eliminating a hot standby boiler since, in many cases, a boiler failure will not cause serious hardships.

7. Operate only the heating water pumps necessary for required heating.

8. Examine operating procedures when more than one boiler is involved. It is far better to operate one boiler at 90% capacity than two at 45% capacity each. The more boilers used, the greater the heat loss.

9. Check and repair oil leaks at pump glands, valves, or relief valves.

10. Clean mineral or corrosion build-up on gas burners.

11. Measure with the gas meter the fuel consumption of the boiler on manual vs. automatic firing. During moderate temperature periods, the manual low-fire setting should result in the boiler operating longer periods of time at higher efficiency.

12. Adjust the boiler so that during the spring and fall the boiler will come on line at low fire and stay on low fire until the heating requirement is satisfied. The boiler will cycle less often and maintain a higher overall annual efficiency with this procedure.

13. Reduce the amount of resh air admitted to the boiler room in winter. (Do not choke boilers, however.)

14. At the end of the heating season, or when a rise in the stack temperature occurs, inspect the fireside of the furnace and water tubes for deposits of soot, flyash and slag (molten ash). Also, examine the fireside of all boiler insulation, refractory, brickwork, and casing for hot spots and air leaks.

G. HOTELS AND MOTELS THAT ARE ELECTRICALLY HEATED

1. Keep heat transfer surfaces of all electric heating units clean and unobstructed.

2. Keep air movement in and out of the electric units unobstructed.

3. Inspect electric heating elements, controls, and, as applicable, fans on a periodic basis to ensure proper functioning.

4. Where sill-height electric heaters are used, adjust thermostat so heat provided is just sufficient to prevent cold downdrafts from reaching the floor.

5. Turn off portable electric heaters and portable fans when not needed or during unoccupied periods.

H. AIR CONDITIONING CONSERVATION

1. Produce chilled water at the highest temperature that is compatible with the equipment using the chilled water. Less energy is needed to produce chilled water as the temperature setting is raised. Example: An electrically driven centrifugal water chiller will use about 10% less BHP when producing chilled water at 48^{o}F rather than at 42^{o}F.

2. Raise the temperature of water leaving the chiller as the air conditioning load reduces.

3. When multiple chiller installations are operating at low loads for most installations, do not put a second chiller on the line until the first one is up to load. Normally, less energy is used by one chiller operating at 90% of capacity than by two chillers, each at 45% of capacity.

4. When a chiller is out of service, shut down its condenser water pump and chilled water pump.

5. Cycle cooling tower fans on old systems as the load varies, to keep the condenser water at a constant temperature.

6. Make use of lower condenser water temperatures for chillers which are not limited to 85^{o}F condenser water. Newer chillers can take condenser water at 60^{o}F. In such cases, keep fans running and the colder condenser water will save power at the chiller.

7. Check efficiency of chillers, check water temperatures in and out of condensers and chillers against design specifications, check amperage on compressor motor against manufacturer's data.

8. Check purge operation for signs of air or water leakage.

9. Check gauges and thermometer on equipment frequently.

10. Lubricate all bearings and other moving parts.

11. Lubricate drive motors.

12. Examine speed reducing gear boxes for proper lubrication, gear condition, and thrust and main bearing condition.

13. Where belts are used, see that all are equally tensioned.

14. When belts are frayed or need replacing, replace entire set.

15. Clean spray nozzles, remove scale and dirt.

16. Check water level in the cooling tower. If it is overflowing, reset the make-up water control.

17. Keep condenser coil face clear of leaves, dirt and other obstructions to air flow.

18. Lubricate fan and motor bearings.

19. Clean coil surfaces by washing and brushing.

20. Clean spray nozzles or water distribution devices to maintain even water flow.

I. LOCAL AIR CONDITIONING UNITS

1. Clean or replace filters when dirty.

2. Remove dust, lint, and other materials from condenser and evaporator coil surfaces.

3. Clean intake louvers and screens.

4. Follow manufacturer's recommendations for lubrication of motors and compressors.

J. VENTILATION SYSTEM

1. Shut off air conditioning, ventilating, and exhaust systems for function rooms and other similar rooms when they are not occupied.

2. When function rooms are to be put in service, use all recirculated air rather than outdoor air to pre-cool or pre-heat the rooms.

3. Consider turning off electric reheat coils during the summer. With increased supply air temperature, reheat may not be necessary.

4. Review amount of fresh air being used at minimum conditions.

5. Set temperature of air entering reheat coil as high as practical to reduce reheat requirements.

6. On induction systems, check air volume and static pressure against design conditions.

7. Turn off supply and exhaust fans when they are not needed.

8. Keep windows and outside doors closed.

9. Close air supply ducts and exhaust duct dampers when they are not in use. In cold weather the failure to do this will result in the infiltration of cold air and lowering of the temperature to an uncomfortable level.

10. Use outside air when possible to reduce cooling system loads. Let mother nature work for you.

    a. Where night temperatures are cooler, flush out your facility with outside air before shutting off ventilating systems.

    b. Use cold air for cooling when outside temperatures are satisfactory. (Commonly called an Economizer Cycle.)

11. Inspect automatic dampers for proper operation.

12. Insure that all dampers to the outside air intake or exhaust connection are fully closed when equipment is shut off.

13. Check operation of economy cycle if your system has one.

14. Periodically examine electronic air filters for excessive accumulations on the plates.

15. Follow manufacturer's instructions for cleaning fan blades.

16. Determine cause of any excessive vibration or noise and make corrections.

17. Check fan speed against design conditions. Adjust or replace sheaves as required.

18. Insure that hot air discharge is not entering the air inlet.

19. Check alignment of motors and fans.

20. Lubricate fan and motor bearings regularly.

21. Schedule fan and condenser cleaning and compressor check-up as a regular maintenance item.

22. If energy conservation suggestions have been implemented which reduce the amount of air needed for air conditioning, determine new air quantities and reduce fan speed accordingly.

23. Check all control valves to make sure that they close fully.

K. DOMESTIC WATER

1. Repair dripping faucets and shower heads, and continuously running toilets. Example: Dripping faucets and showers, and running toilets could waste at least 5 gallons of water per day, per room. In a 150-room property, this could amount to a waste of 274,000 gallons per year, which would cost $822 at $3 per thousand gallons.

2. Check toilet flushometers and tank-type water flush levels to reduce flushing time and water quantities to the minimum required. Repair or replace as necessary.

3. Wasting water wastes energy required to treat and pump the water, and energy required to sewage disposal systems. In addition, wasting hot water wastes energy necessary to heat the water.

4. Reduce hot water waste.

   a. Use hot water only when cold water will not do the job.

   b. Do not leave faucets running.

   c. In pot washing area, fill sinks for washing utensils instead of using continuously running water.

5. Reduce domestic hot water temperature to 120°F or 110°F at the water heater. Even taking into account heat losses in distribution systems, water will be delivered to guest rooms at about 110°F, which is very satisfactory for guest comfort. Energy will be saved in reduced distribution system heat loss, and in a reduction in cold water used to cool the heated water for use in guest rooms. The average temperature of hot and cold water mixed as it comes from the shower head for guest use is about 105°F. Be aware that when reducing the temperature that the capacity of the tank becomes an important factor.

6. Turn off booster heater until it is needed.

7. Shut down filtration system when swimming pool is closed for extended periods.

L. LAUNDRY DEPARTMENT

1. Run washing machines and dryers at full load whenever possible.

2. Consolidate loads whenever possible. It may be possible to reduce hours of equipment use by beginning operations only after all soiled laundry has been assembled. This also will make it possible to save energy by running full loads.

3. Check timers on dryers and washers to prevent excessive operation.

4. Repair all leaks in water supply systems promptly.

5. Do not leave faucets running.

6. Use cold water detergents where permitted and satisfactory for your purposes. Example: A 50-pound washer uses about 150 gallons of water per load of which about 75% is hot water. Heating that much water consumes large amounts of energy - 28 kWh of electricity ($1.40 per load at 5 cents/kWh) or 94 pounds of steam (47 cents per load at $5 per 1000 pounds), or 1.0 gallons of oil (40 cents per load at 40 cents per gallon). The use of cold water detergents, where permitted, will reduce energy consumption considerably.

7. Heat water only to the temperature needed. Water temperatures higher than those needed for guest rooms generally are not necessary for normally soiled washables.

8. Test hot water heater controls.

9. Check insulation on hot water storage tanks, pipes, and steam lines.

10. Drain and flush hot water heater tanks semi-annually.

11. Repair all steam leaks promptly.

12. Check steam traps for leakage.

13. Turn off main steam valve when laundry is closed.

14. Check control valves to be sure they are working properly and do not leak.

15. Check operation of heat recovery equipment where installed.

16. Consider using no-iron bed linens.

17. Run ironers as little as possible and heat up only when actually needed.

18. Check the level front to rear, of tumbler basket or cylinder. A small difference in level of the basket axis will result in uneven loading of the materials and a substantial waste of heat energy.

19. Verify rotating speed of tumbler at full load. If speed is too low, not enough of the fabric surface will be exposed to the drying air and energy will be wasted.

20. Lubricate bearings as recommended by the manufacturer. Bearings on all rotating equipment should be kept lubricated to reduce friction and the resulting waste of energy.

21. Verify speed of fans in tumblers and dryers.

22. Clean lint, screens, exhaust blowers, and housings.

23. Clean rotating baskets or cylinders in tumblers.

24. Inspect and clean gas burners in dryers.

25. Adjust firing rate of direct-fired equipment. All direct gas fired equipment should be set at the exact firing rate recommended by the manufacturer. Firing at a higher or lower rate will waste energy.

26. Verify proper operation of water extractors. The water that is removed by the extractor does not have to be evaporated by the dryers. Less heat is used and energy is saved.

27. Check efficiency of tumblers by determining the Btu's required to evaporate the water in the fabrics. Example: A tumbler which uses 3800 Btu per pound of water evaporated can be replaced with a modern unit which requires about 2000 Btu per pound of water. The fuel consumption would be cut by 47%.

28. Do not take make-up air from air conditioned spaces. Laundry make-up air should be taken from the outdoors. Stealing air from the conditioned spaces results in infiltration into them of outside air. Such air has to be cooled and dehumidified, a needless waste of energy.

29. Set schedules to reduce peak use and demand charges. Whenever possible, make arrangements to do laundry work during periods when the least amount of energy is being used at the property (non-peak demand hours). If practical, try to limit the amount of equipment being used at the same time.

CHAPTER 2

STEP-BY-STEP EXAMPLES

Now that you have examined and implemented the pertinent no-cost maintenance and operational changes in Chapter 1, you need to work your way through the energy and dollar effects of various energy conservation measures which apply to your hotel or motel. A priority system must be developed to decide which measures to invest in first. Calculating the simple payback period of the suggested measures is an excellent way of establishing such a priority system.

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 problems in this chapter are designed to illustrate the method for calculating the energy savings and payback period for several energy conservation measures.

It is unlikely that your particular circumstances are identical to any of these samples, but it is very likely that the pattern of problem solving will enable you to quantify your Measures in an adequate and satisfying manner.

Before working out the step-by-step examples, you will need to complete the Energy Management Form. The directions for filling out the form are described on the following pages. It may be convenient to have your accounting or billing department fill in the necessary data. But, if all the necessary utility bills are available to you, it shouldn't take more than a few hours to fill out the entire form.

After the form is completed you will have all the energy cost data needed to work out the step-by-step examples. In some problems, a new installation rate must be obtained by calling a contractor for a price quote. Or, you may have to make a few simple measurements pertaining to the general operation of the building.

In each problem, the section for you to fill out is on the left-hand side of the page and a worked out example problem of a typical hotel or motel is on the right. In each case, the boxes coincide with an underlined number in the example problem.

ENERGY MANAGEMENT FORM

Enclosed in this Chapter is a fold-out Energy Management Form. The data from the form will be used in this section of the manual to calculate the payback period for several of the recommended energy conservation measures illustrated. If you already have a similar energy bookkeeping system, you may wish to modify it to be consistent with the enclosed form. The main objective is to arrive at a common unit cost of each type of energy used in dollars per million Btu ($/MMBtu). Use your bills of last year or the last 12 months to fill in the form now.

To make it easy to use you may wish to remove it. The form is intended to be an aid for establishing a continuing energy bookkeeping procedure for your facility. If it is filled out each month, the manager or owner of the hotel or motel 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.

I. NECESSARY DATA FOR FILLING IN THE ENERGY MANAGEMENT FORM

A. ELECTRICITY: The monthly electric bills for one full year.

B. FUEL OIL:

1. To calculate the monthly consumption you will need the amount of fuel oil in the tank in the beginning and the end of the month and the quantity in gallons of each delivery made during that month;
2. The price per gallon of the oil in dollars per gallon;
3. The type of fuel oil you use - #2, #4, #5 or #6 oil.

C. NATURAL GAS:

1. The monthly bills for the same full year;
2. The heat content (the number of Btu per cubic foot) of the gas if available. If it is not available, use 1030 Btu per cubic foot.

D. STEAM: If you purchase steam, you will need the monthly bills for the same full year, the quantity used and the heat content of the steam for each pound or cubic foot purchased.

E. If you use any other type of fuel (coal, wood, etc.), you will need the monthly consumption, the cost per unit, and the heat content of the fuel per unit.

F. From your local utility, weather station, or library, or State Energy Office, obtain the monthly total heating degree days and cooling degree days for your area during the same year. The daily heating degree day figure equals the number of degrees the mean temperature has fallen below 65°F. The daily cooling degree day figure equals the number of degrees the mean temperature has risen above 65°F.

II. FILLING IN THE FORM

A. Enter the monthly heating degree days in column 2 and the monthly cooling degree days in column 3.

B. ELECTRICITY - CONSUMPTION AND COST:

1. For each monthly electric bill or for each month covered by the majority of the billing period:*

   a. enter in column 4 the total number of kWh used during the month;

   b. enter in column 5 the total cost for the month that appears on the bill;

   c. to calculate column 6, the cost per kilowatt hour (kWh), divide column 5 by column 4;

   d. to calculate the cost per million Btu ($/MMBtu) multiply column 6 by 293 and enter this in column 7.

2. After completing each month, calculate the annual totals and averages.

   a. sum column 4 and enter at the bottom of the column;

   b. sum column 5 and enter at the bottom of the column;

   c. divide the sum of column 5 by the sum of column 4 and enter in annual average at the bottom of column 6;

   d. multiply the annual average of column 6 by 293 and enter at the bottom of column 7.

---

* NOTE: The billing period 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.

C. OIL - CONSUMPTION AND COST:

1. Enter in column 8 the oil consumption in gallons for each month.

2. Enter the price per gallon in column 9 in dollars per gallon. For example, if it is 35¢ per gallon, enter .35.

3. Calculate the total per month and enter in column 10. Multiply column 9 by column 8.

4. To calculate the cost per million Btu (column 11), divide column 9 by the conversion factor for your fuel listed as follows:

   No. 2 oil - divide by .139 MMBtu/gal.
   No. 4 oil - divide by .150 MMBtu/gal.
   No. 5 oil - divide by .152 MMBtu/gal.
   No. 6 oil - divide by .153 MMBtu/gal.

5. Calculate the annual total and averages:

   a. sum column 8;

   b. sum column 10;

   c. divide b. by a. and enter at the bottom of column 9;

   d. divide c. by conversion factor above (C4.) and enter at the bottom of column 11.

D. NATURAL GAS - CONSUMPTION AND COST:

1. Enter in column 12 the consumption for each month in 1000 cubic feet (MCF). If your bill is not in MCF, use the following formulas to convert:

   a. if the bill is in CCF (100 cubic feet) divide the total by 10:

   ____CCF ÷ 10 =____MCF;

   b. if the bill is in CF (cubic feet) divide the total by 1000:

   ____CF ÷ 1000 =____MCF;

c. if the bill is in therms, divide the total by 10.30:*

____therms ÷ 10.30 =____MCF.

2. Enter the total cost for each month in column 13.

3. To calculate column 14, the cost per MCF, divide column 13 by column 12.

4. To calculate column 15, the cost per million Btu, divide column 14 by 1.030. Or, if you know the heat content** of your particular gas: column 14 ÷ heat content per cubic foot x 1000 = column 15.

5. Calculate the annual totals and averages:

   a. sum column 12;

   b. sum column 13;

   c. divide b. by a. and enter in the bottom of column 14;

   d. calculate the average of column 15 by using one of the following:

      - divide c. above by 1.030
        or
      - divide c. above by the heat content per cubic foot and multiply by 1000.

E. If you use any other type of fuel or energy, use the same basic reasoning with the goal of arriving at the cost per million Btu (MMBtu). You may need to set up a separate sheet for other types of fuel.

F. Column 20 is the monthly total energy cost. Sum the monthly total cost for each type of energy used. For example, if you used electricity, oil, and gas in February, add the entries in column 5, column 10, and column 13 and enter the sum in column 20.

G. After each month has been completed, sum up column 20 to calculate the energy cost for the year. Enter the total at the bottom of column 20.

---

* This figure is based on the 1977 national average of 1030 Btu per cubic foot. If you know the actual heat content of your gas, such as 1020, adjust accordingly, i.e., 10.20.

** Heat content - the amount of energy supplied by the gas in Btu per cubic foot of gas.

ENERGY MANAGEMENT FORM

BUILDING ____________________   ____________ YEAR

MONTH*	HEATING DEGREE DAYS	COOLING DEGREE DAYS	ELECTRICITY				OIL				NATURAL GAS				COAL ☐ WOOD ☐ PURCHASED STEAM ☐ OTHER ______				TOTAL ENERGY COST
			QUANTITY KWH	COST (DOLLARS)			QUANTITY GALLONS	COST (DOLLARS)			QUANTITY MCF	COST (DOLLARS)			QUANTITY UNIT	COST (DOLLARS)			
				TOTAL $	$/KWH	$/MMBTU		$/GAL.	TOTAL $	$/MMBTU		TOTAL $	$/MCF	$/MMBTU		TOTAL $	$/UNIT	$/MMBTU	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
JANUARY																			
FEBRUARY																			
MARCH																			
APRIL																			
MAY																			
JUNE																			
JULY																			
AUGUST																			
SEPTEMBER																			
OCTOBER																			
NOVEMBER																			
DECEMBER																			
ANNUAL TOTALS																			
ANNUAL AVERAGES																			

* Or comparable time period

ELECTRICITY = 3412 Btu/Kwh
GAS = 1030 Btu/CF

OIL: #2 = .139 MMBTU/gal
#4 = .150 MMBTU/gal
#5 = .152 MMBTU/gal
#6 = .153 MMBTU/gal

MCF = 1000 cubic feet of gas
MMBTU = one million Btu

The following abbreviations are used in the problems:

MMBtu	=	One Million Btu
MCF	=	1,000 Cubic Feet
kWh	=	Kilo Watt Hours
yr	=	years
hr	=	hours
mo	=	months
$	=	dollars
gal	=	gallons
ft	=	feet
in	=	inches
^oF	=	degrees Fahrenheit
CFM	=	cubic feet per minute
Btu/hr•10 ft	=	Btu per hour per 10 feet of pipe

PROBLEM NUMBER 1

Weatherstrip all of the windows to reduce the infiltration. If this is done the hotel may be maintained at a slight positive pressure with the addition of very little outside air.

A) DATA NEEDED FOR THE CALCULATIONS

1) The building has how many windows?

   [ ] windows

2) The size of each window is:

   [ ] in x [ ] in

   = [ ] in^2

3) The area of each window is:

   [ ] in^2 ÷ 144

   = [ ] ft^2 per window

EXAMPLE PROBLEM

100 windows

54 inches x 96 inches

= 5184 in^2

5184 in^2 ÷ 144

= 36 ft^2 per window

4) During the heating season the thermostats for heating are set at: [ ] °F

5) From the Energy Management Form the total heating degree days for the year are: (Annual total column 2)
[ ] degree days

6) The cost of energy is:
(From Energy Management Form, columns 7, 11, 15 or 19, depending on the type of fuel used)
[ ] $/Million Btu

7) From an efficiency test by a technician, the efficiency of the burner is:
[ ]
(use 1.0 if electric heat.)

8) Use chart on following page to obtain the coefficient with no weatherstrip for your type of windows:
NW = [ ]

EXAMPLE PROBLEM

70°F

5000 degree days

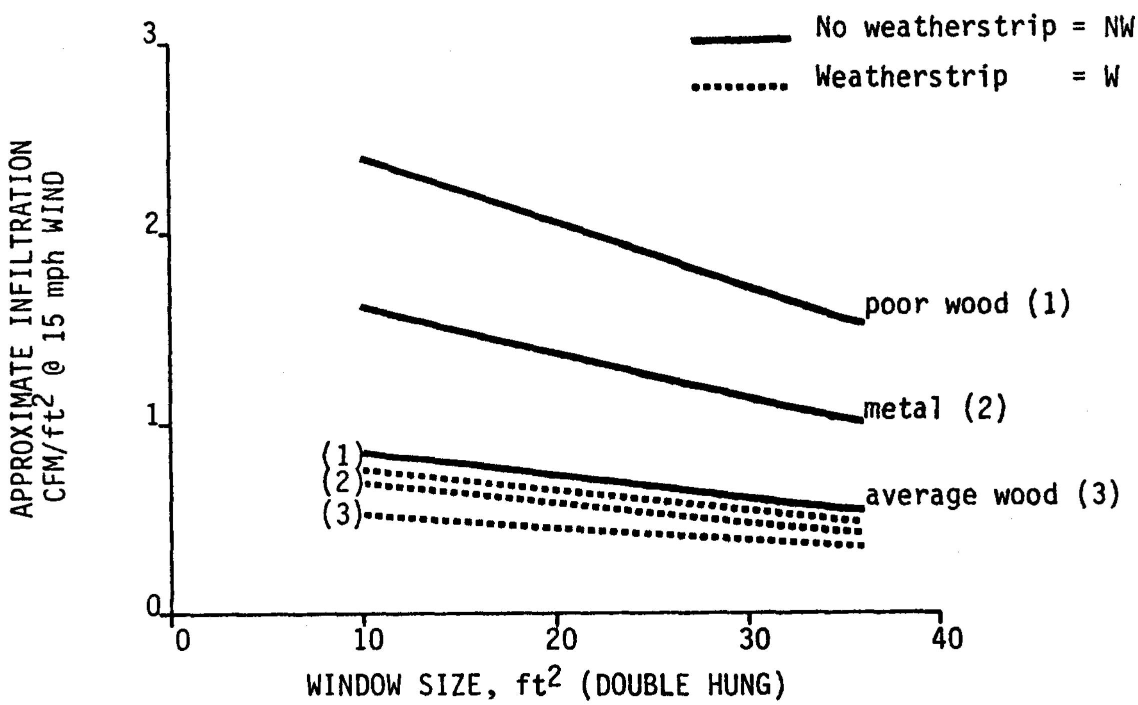
3.25 $/Million Btu

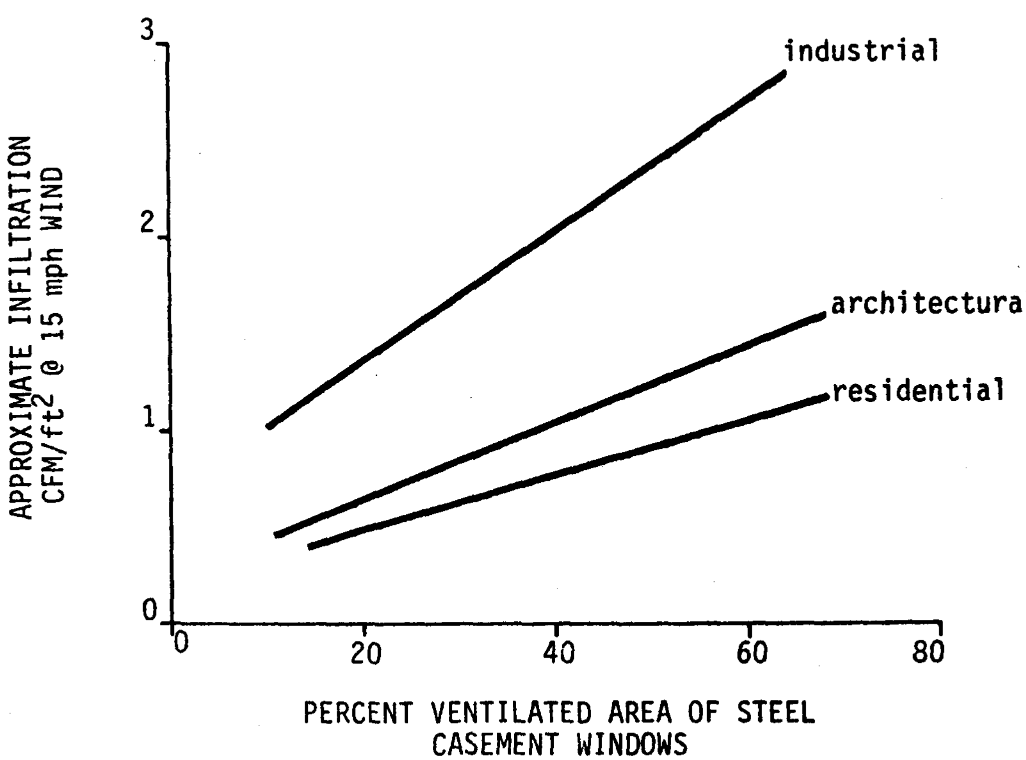
.65

NW = .53

CHART 2-1

INFILTRATION THRU WINDOWS AND DOOR - WINTER





9) Use chart 2-1 to obtain the coefficient with weatherstrip for your type of windows

W = [ ]

10) Get a quote from a contractor for the cost to install weatherstripping:

[ ] $ materials + [ ] $ Labor

= [ ] $ Total Cost Installed

EXAMPLE PROBLEM

W = .33

160 $ + 240 $

= $400 Total Cost

B) CALCULATIONS

1) Calculate the total window area that is subject to infiltration:

[ ] windows x [ ] ft^2/window ÷ 2

= [ ] ft^2

(The 2 assumes that half the windows face the wind at one time)

2) The infiltration with no weatherstripping:

[ ] ft^2 x [ ] NW

= [ ] CFM

3) The infiltration with weatherstripping:

[ ] ft^2 x [ ] W

= [ ] CFM

EXAMPLE PROBLEM

100 windows x 36 ft^2/window ÷ 2

= 1800 ft^2

1800 ft^2 x .53 NW

= 954 CFM

1800 ft^2 x .33 W

= 594 CFM

4) Therefore the reduction in infiltration with weatherstripping equals:

____ CFM - ____ CFM

= ____ CFM

5) Calculate the difference between the inside temperature and the average outdoor temperature in winter:

$$\frac{\text{\_\_\_\_ Total Degree days}}{240}$$

= ____ ° Below 65°F

Outdoor temperature:

65 - ____ °F = ____ °F

difference:

____ °F - ____ °F = ____ °F

EXAMPLE PROBLEM

954 CFM - 594 CFM

=360 CFM

$$\frac{\text{5000 Degree days}}{240}$$

= 20.8 Below 65° F

65°F - 20.8 °F = 44.2°F

70 °F - 44.2°F = 25.8 °F

6) Calculate heat saved:

$\frac{\boxed{\quad} \text{ CFM} \times 240 \text{ days} \times 24 \text{ hr/day}}{1{,}000{,}000}$

$\times\ 1.08\ \frac{\text{Btu}}{\text{hr-CFM-°F}} \times \boxed{\quad}\ \text{°F}$

$= \boxed{\quad}$ Million Btu/year saved

7) Cost saved:

$\boxed{\quad}$ \$/MMBtu energy x $\boxed{\quad}$ Million Btu/yr

÷ $\boxed{\quad}$ efficiency

= $\boxed{\quad}$ \$/yr saved

8) Payback Period

$\frac{\boxed{\quad}\ \text{\$ Total Cost}}{\boxed{\quad}\ \text{\$/yr saved}}$

= $\boxed{\quad}$ yrs

EXAMPLE PROBLEM

$\frac{360 \text{ CFM} \times 240 \times 24}{1{,}000{,}000}$

x 1.08 x 25.8 °F

= 58 Million Btu/year saved

3.25 \$/MMBtu x 58 MMBtu/yr

÷ .65 efficiency

= 289 \$/yr saved

$\frac{400 \text{ \$ Cost}}{289 \text{ \$ saved}}$

= 1.4 yrs

PROBLEM NUMBER 2

Repair or replace leaking steam traps.

Figure 2-2 tells the story concisely.

To use the chart:

1) Determine the diameter of the orifice in inches. Find this diameter in the lower right hand corner of the chart. Go up vertically from this point to the intersection with the diagonal, corresponding to the pressure in the line in psig.

2) From this point, draw a horizontal line to the left until it intersects with the diagonal line, corresponding to the cost of the fuel used for boiler heating in $/MMBtu.

3) From this point, draw a vertical line down and find the equivalent fuel cost of the leak in $/year.

If the replacement trap costs $150, the payback would be:

$$\frac{\text{Cost } \$150}{\text{Saving } \$3600} = 2 \text{ weeks}$$

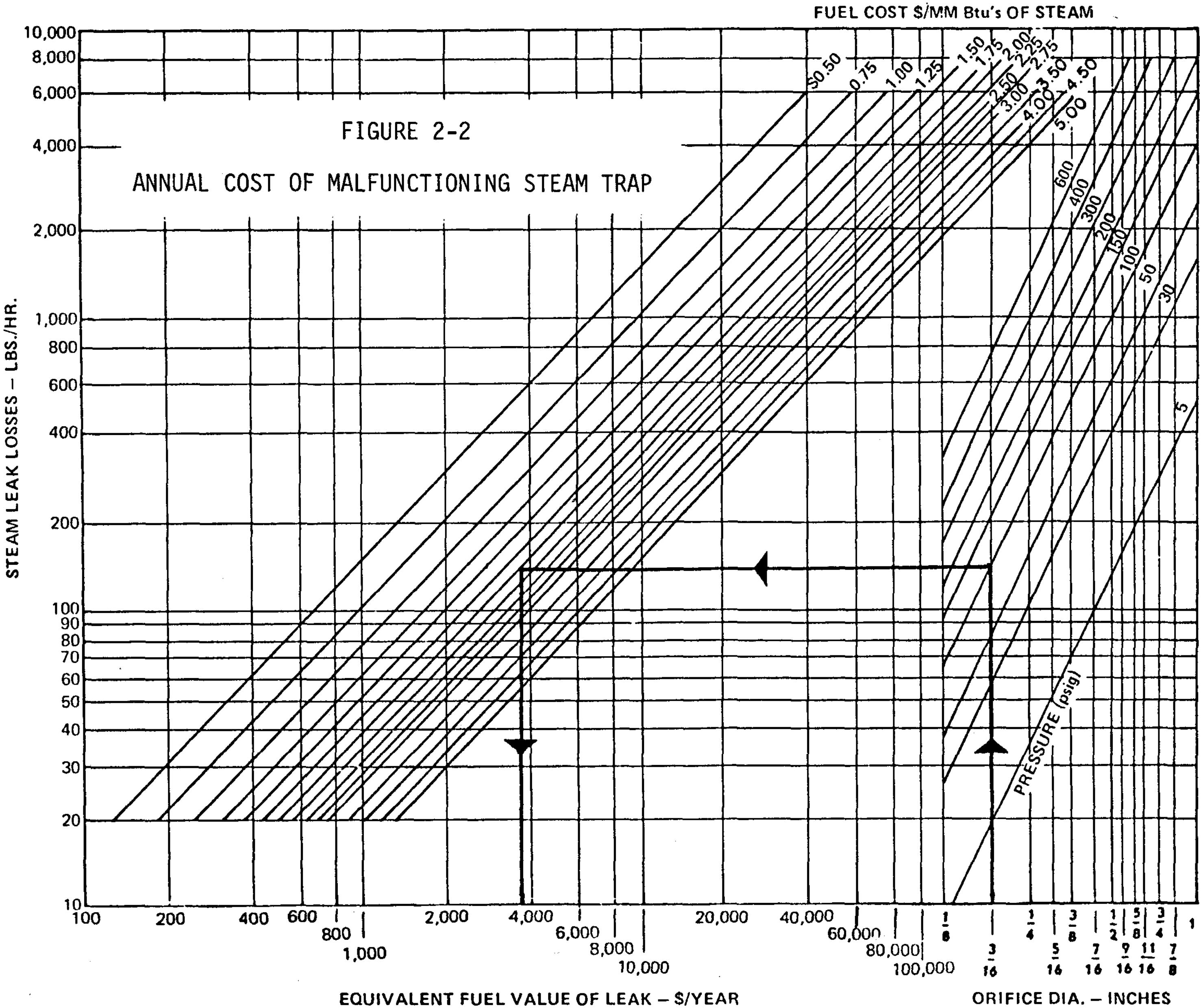


FIGURE 2-2

ANNUAL COST OF MALFUNCTIONING STEAM TRAP

PROBLEM NUMBER 3

Use more efficient individual air conditioners. Replacing window air conditioning units with more efficient units can cut electrical use for cooling by 25 percent or more.

A) DATA NEEDED FOR CALCULATION

1.) Use figure 2-3 - on the following page to obtain the zone your building is in:

[ ] zone

2.) Then from the following estimated hours of operation for window units enter your zone's operation:

Zone 1 - 800 hours/year

Zone 2 - 1100 hours/year

Zone 3 - 1400 hours/year

Zone 4 - 1700 hours/year

Zone 5 - 2200 hours/year

Source FEA /D-76/467

[ ] hours/year

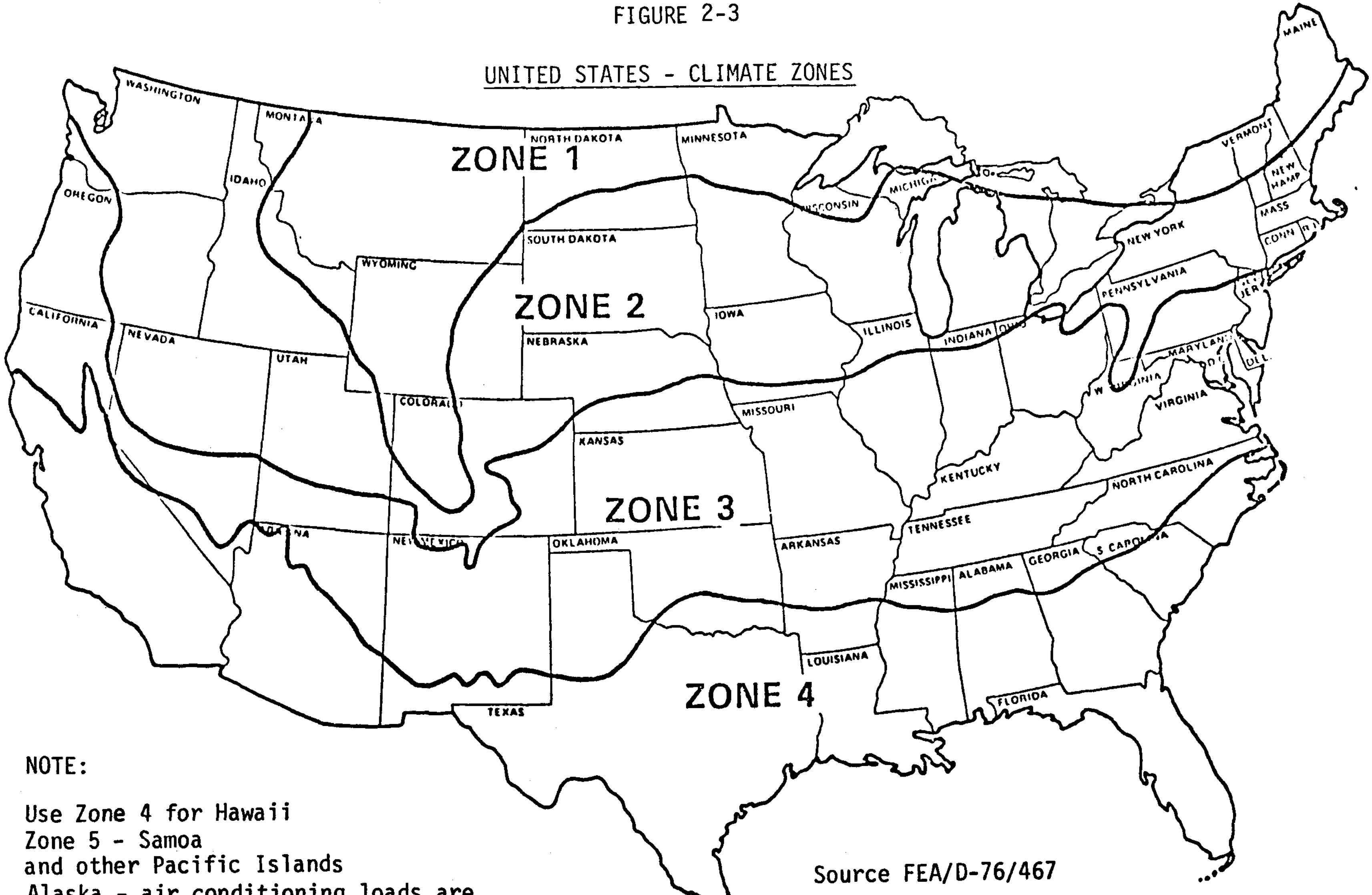
EXAMPLE PROBLEM

2 zone

1100 hours/year

FIGURE 2-3

UNITED STATES - CLIMATE ZONES



Source FEA/D-76/467

NOTE:

Use Zone 4 for Hawaii
Zone 5 - Samoa
and other Pacific Islands
Alaska - air conditioning loads are
considered small. For an estimate
use Zone 1.
Puerto Rico and Virgin Islands - use Zone 4.

3) Count the number of air conditioning units and find the amp and volt rating of each unit. Also, list the phase, 1 or 3 from the nameplate.

Phase of air conditioner:

Volt Rating [ ] volts

Amp Rating [ ] amps [ ] phase

4) Cost of Electricity from Energy Management Form Column 6: [ ] $/kWh

5) Cost of a new efficient air conditioner: (From a supplier's quote)

[ ] $

6) The number of air conditoners with the above ratings: [ ] units

EXAMPLE PROBLEM

220 volts

5 amps 3 phase

.06 $/kWh

150 $

20 units

B) CALCULATIONS:

1) For each air conditioner the power consumed is:

[ ] volts x [ ] amps x K [ ]

= [ ] watts

K = 1 if phase = 1 from nameplate

K = 1.732 if phase = 3 from nameplate

2) Energy required per year:

[ ] watts x [ ] hr/yr ÷ 1000

= [ ] kWh/yr

3) With new unit 25% more efficiency expected.

Therefore, electrical energy saved:

[ ] kWh/yr x .25

= [ ] kWh/yr saved

EXAMPLE PROBLEM

220 volts x 5 amp x 1.732

= 1905.2 watts

(In this example, K = 1.732 since phase = 3)

1905.2 watts x 1100 hr/yr ÷ 1000

= 2095 kWh/yr

2095 kWh/yr x .25

= 523.8 kWh/yr saved

4) Cost saved per year:

____ kWh/yr x ____ $/kWh electricity

= ____ $/yr saved per air conditioner

5) Total savings with new units:

____ units x ____ $/unit

= ____ $/yr saved

6) Cost of Air Conditioners:

____ units x ____ $/unit

= ____ $ Cost

7) Payback Period:

$$\frac{\text{\_\_\_\_ \$ Cost}}{\text{\_\_\_\_ \$/yr saved}}$$

= ____ yr

EXAMPLE PROBLEM

523.8 kWh/yr x .06 $/kWh

= 31.4 $/yr saved

20 units x 31.4 $/unit

= 628 $/yr saved

20 units x 150 $/unit

= 3000 $ cost

$$\frac{\text{3000 \$ cost}}{\text{628 \$/yr saved}}$$

= 4.8 yr

PROBLEM NUMBER 4

Check the efficiency of the boiler(s). A percent loss of boiler efficiency is a percent loss of energy and dollars. It is generally worth any cost incurred to optimize the boiler operation. It is a good first step to reduce the excess air until smoke or emission violations occur. For instance, if the flue gas temperature is 400°F and excess air is changed from 100% to 50% an efficiency of 2.5% is immediately achieved.

The efficiency gain is observed clearly on Figure 2-4. The efficiency at 100 percent excess air is found at point A to be less than 82 percent and at 50 percent excess air to be greater than 84% at point B. Figures 2-4, 2-5, and 2-6 provide easy evaluations of the efficiency changes with changes in other variables.

The savings in fuel is related to the change in efficiency:

$$\frac{\text{New Efficiency} - \text{Old Efficiency}}{\text{New Efficiency}} \times \text{fuel consumption.}$$

In the above example if the oil consumption was 25,000 gallons per year at 82 percent efficiency with the increase in efficiency to 84 percent the fuel savings would be:

$$\frac{(.84 - .82)}{.84} \times 25000 \text{ gal/year} = 595 \text{ gal/year}$$

If oil cost 46 cents per gallon, the cost savings would be:

595 gal/year x .46 $/gal = 273 dollars per year.

FIGURE 2-4 COMBUSTION EFFICIENCY vs PERCENT CO_2 OR EXCESS AIR-FUEL OIL (GRADES 2-6)

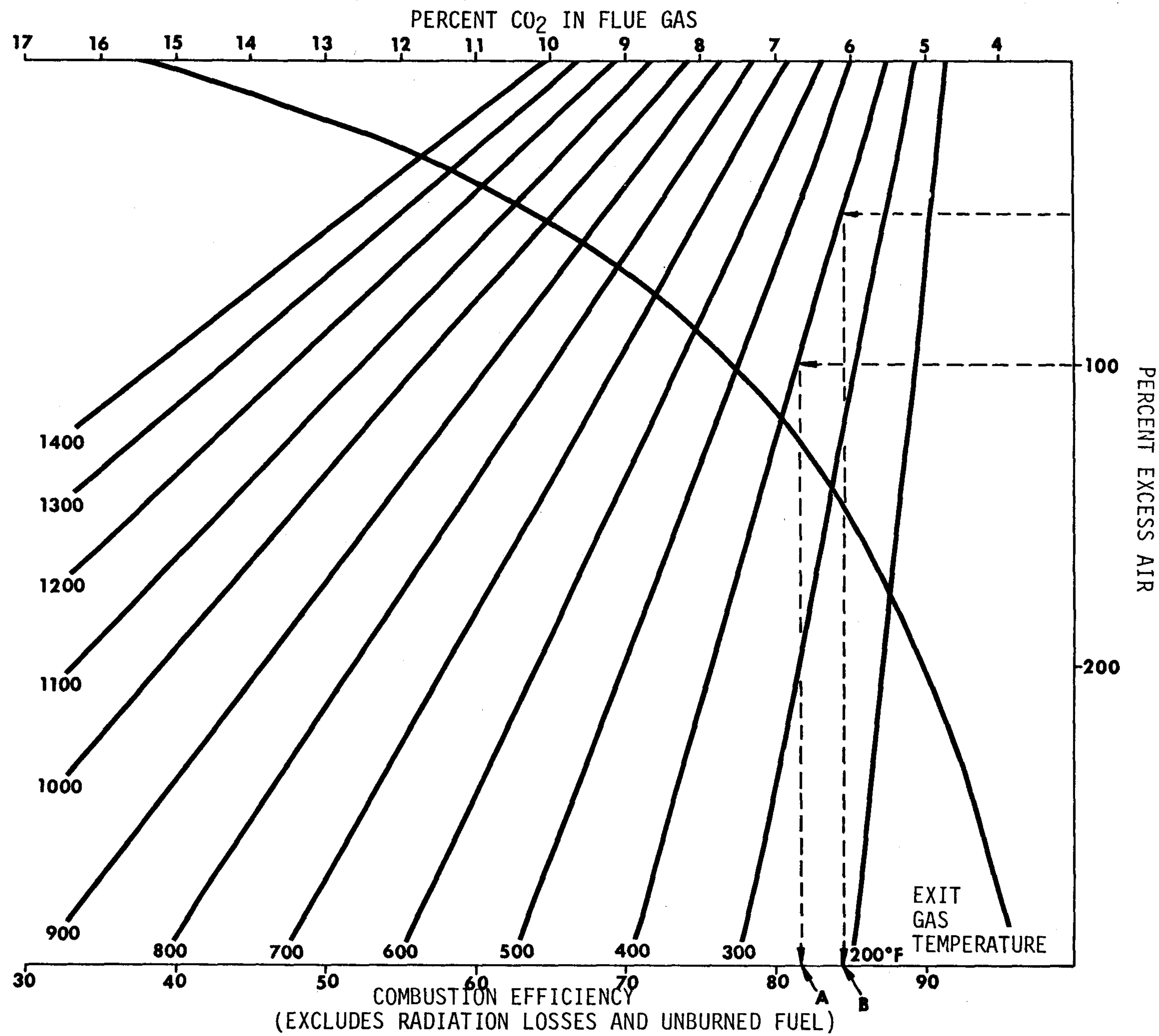


FIGURE 2-5 COMBUSTION EFFICIENCY vs PERCENT CO_2 OR EXCESS AIR-NATURAL GAS

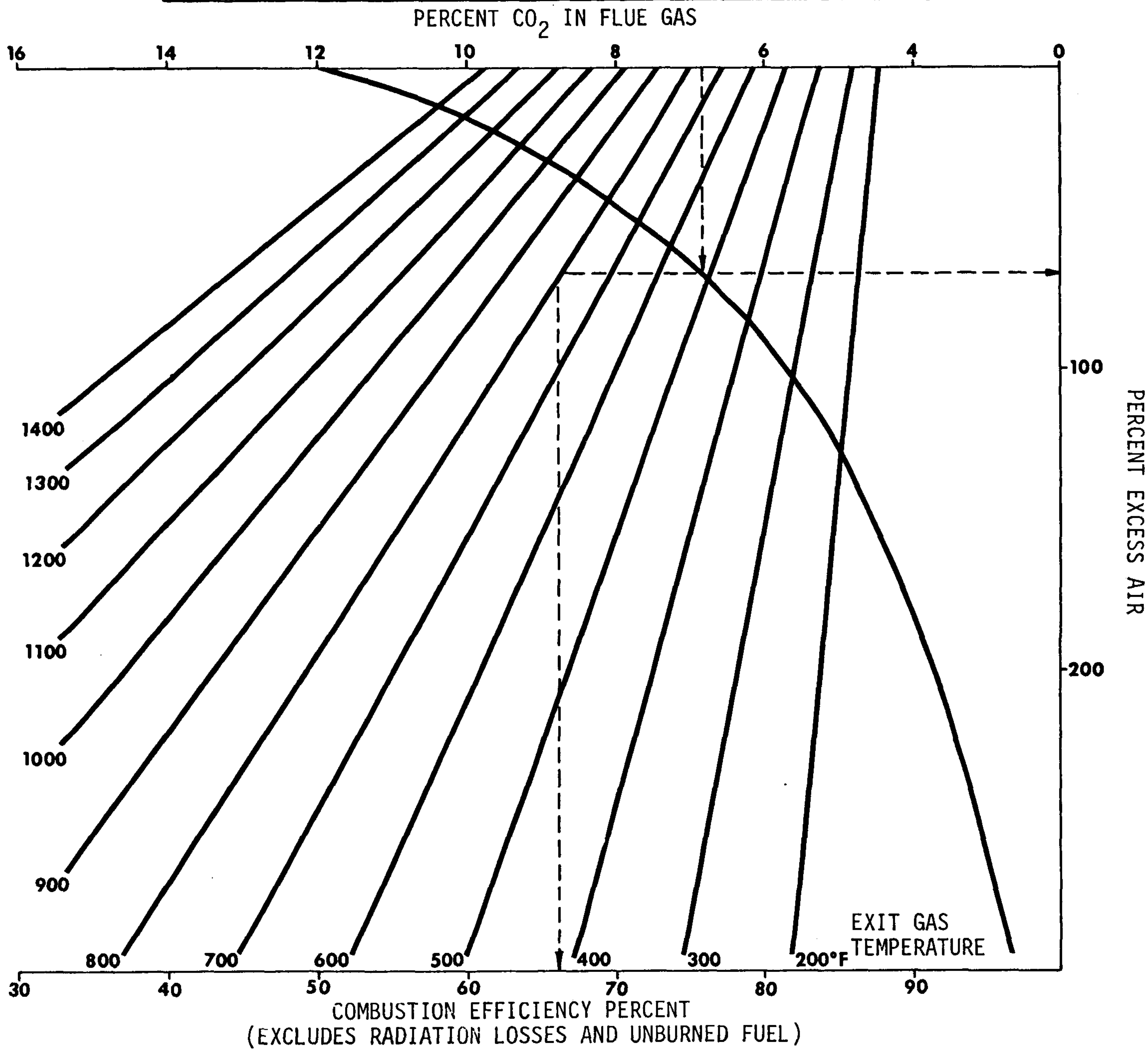
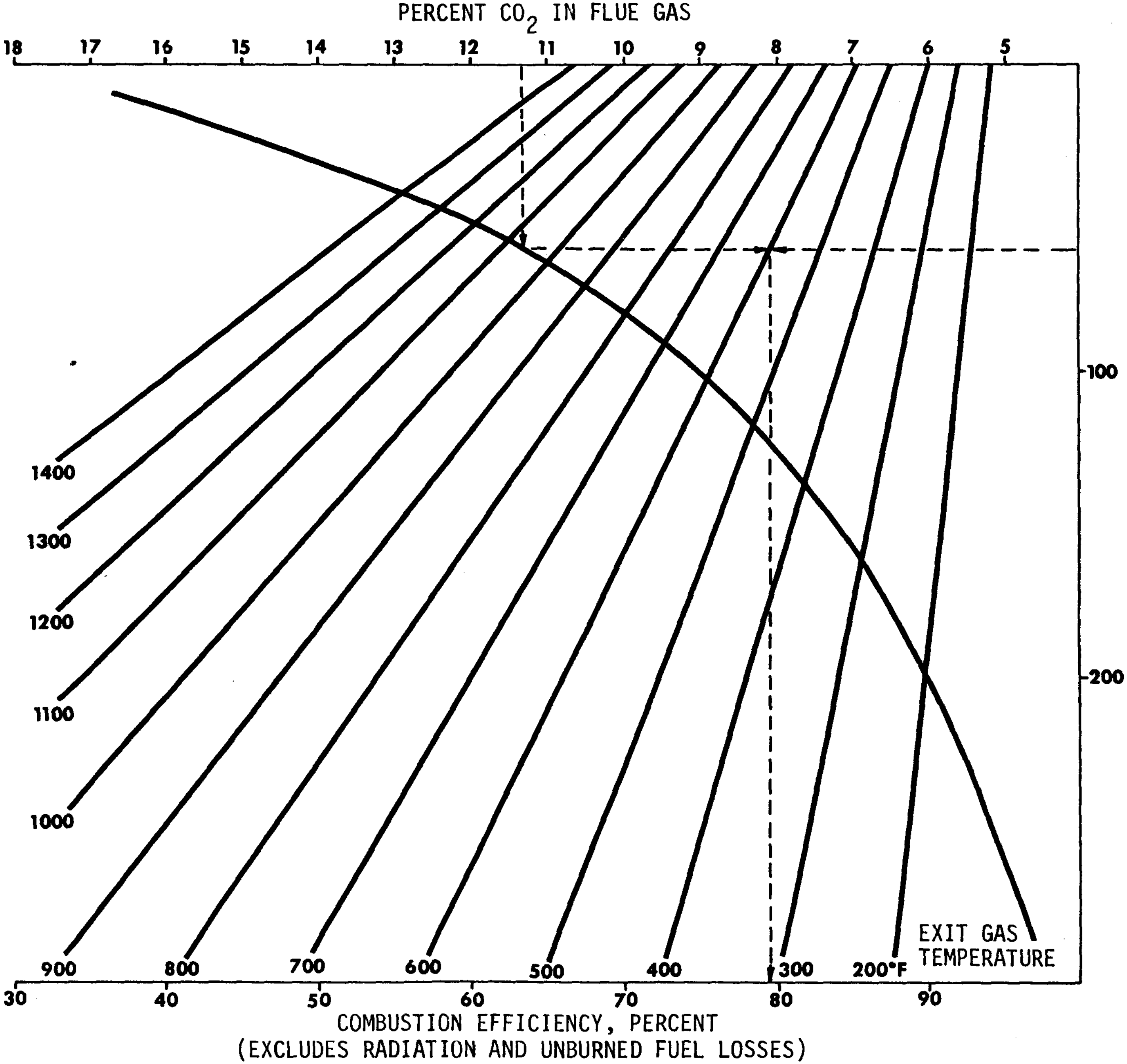


FIGURE 2-6 COMBUSTION EFFICIENCY vs PERCENT CO_2 or EXCESS AIR-BITUMINOUS COAL



PROBLEM NUMBER 5

Install flow restrictors for faucets and showers.

A) DATA REQUIRED FOR THE PROBLEM

1) Faucets

The present water flow is: [ ] gal/minute

The reduced water flow is: [ ] gal/minute

Showers

The present water flow is: [ ] gal/minute

The reduced water flow is: [ ] gal/minute

2) The number of units in the motel is:

[ ] units

3) The average hot water demand is:

(If this figure is not available, use the appropriate value listed in the table below *)

Number of Units	Demand
20 or less	20 gal/unit/day
60	14 gal/unit/day
100 or more	10 gal/unit/day

* Source: ASHRAE Systems Handbook, 1973

EXAMPLE PROBLEM

3 gal/minute

1 gal/minute

6 gal/minute

3 gal/minute

20 units

	EXAMPLE PROBLEM
[ ] gal/unit/day	20 gal/unit/day
4) The temperature of the water entering the heating system is: [ ] °F	60°F
5) The temperature of the water exiting the heating system is: [ ]	110°F
6) The temperature difference is: [ ] °F	50°F
7) The cost of energy is: (From Energy Management Form, columns 7, 11, 15, or 19, depending on type of fuel used)	12.5 $/Million Btu

B) CALCULATIONS

1) The present hot water demand is:

$$\frac{\text{Average hot water demand per unit}}{\text{Present faucet and shower water flow}} =$$

$$\frac{\boxed{}\ \text{gal/unit/day}}{\boxed{}\ \text{gal/minute/day}} =$$

☐ minutes/unit/day

2) The reduced hot water demand is:

Faucets

☐ minutes/unit/day x ☐ gal/min =

☐ gal/unit day

Showers

☐ minutes/unit/day x ☐ gal/min =

☐ gal/unit/day

EXAMPLE PROBLEM

$$\frac{20\ \text{gal/unit/day}}{9\ \text{gal/minute/day}} =$$

2.2 minutes/unit/day

2.2 minutes/unit/day x 1 gal/min =

2.2 gal/unit/day

2.2 minutes/unit/day x 3 gal/min =

6.6 gal/unit/day

Total

____ gal/unit/day + ____ gal/unit/day =

____ gal/unit/day

3) The water savings is:

____ gal/unit/ day (original flow)

____ gal/unit/day (reduced flow) =

____ gal/unit/day

4) The heat savings is:

____ gal/unit/day x 8.34 x ____ units x

365 day/yr x ____ °F x $\frac{1}{1,000,000}$ =

____ Million Btu/yr

5) The cost savings is:

____ Million Btu/yr x

____ $/Million Btu = ____ $/year

EXAMPLE PROBLEM

2.2 gal/unit/day + 6.6 gal/unit/day=

8.8 gal/unit/day

20 gal/unit/day -

8.8 gal/unit/day =

11.2 gal/unit/day

11.2 gal/unit/day x 8.34 x 20 units x

365 day/yr x 50° x $\frac{1}{1,000,000}$ =

34.1 Million Btu/yr

34.1 Million Btu/yr x

12.5 $/Million Btu = 426 $/yr

6) The payback period is:

$$\frac{\text{Cost} \ \boxed{}}{\text{Savings} \ \boxed{}} = \boxed{} \text{ yrs}$$

EXAMPLE PROBLEM

$$\frac{\$40}{\$426} = .1 \text{ yrs (5 weeks)}$$

PROBLEM NUMBER 6

Replace old, inefficient burners with new efficient ones.

A) DATA NEEDED FOR THE CALCULATIONS:

1) From the energy Management Form the burner is now consuming how many gallons of fuel per year?:

[ ] gal/yr

2) The cost of the fuel oil from the Energy Management Form: (column 9)

[ ] $/gal

3) The efficiency of the burner being used now is: (From the results of a test by a technician)

[ ]

4) The efficiency of a new burner would be: (From design conditions quoted by contractor) [ ]

5) The cost of the new efficient burner: [ ] $

EXAMPLE PROBLEM

1) 120,000 gal/yr

2) .46 $/gal

3) .60

4) .75

5) 10,000 $

B) CALCULATIONS:

1) The fuel savings with the more efficient burner:

$$\frac{(\boxed{} - \boxed{}) \times \boxed{}}{\boxed{}} \text{ gal/yr}$$

= ☐ gal /yr savings

2) Cost savings per year:

☐ gal/yr saved x ☐ $/gal

= ☐ $/yr savings

3) Payback Period:

$$\frac{\boxed{}\ \$ \text{ cost of new burner}}{\boxed{}\ \$/\text{yr savings}}$$

= ☐ yr

EXAMPLE PROBLEM

$$\frac{(.75 - .60) \times 120{,}000 \text{ gal/yr}}{.75}$$

= 24,000 gal/ yr savings

24,000 gal/yr x .46 $/gal

= 11,040 $/yr savings

$$\frac{10{,}000\ \$ \text{ cost}}{11{,}040\ \$/\text{yr savings}}$$

= 0.9 yr

PROBLEM NUMBER 7

Insulate hot, bare heating pipes.

A.) DATA NEEDED FOR THE CALCULATIONS:

	EXAMPLE PROBLEM
1) The building now has how many feet of uninsulated hot waterpipes: ______ feet	1000 feet
2) The diameter of the pipe is: ______ inch	1 1/2 inch
3) The temperature of the water in the pipe is: ______ °F	180 °F
4) The efficiency of the boiler or hot water heater is: (this should be tested by a technician or by the in-plant staff. If not available use .65) ______ (use 1.0 if electric heat)	.65

EXAMPLE PROBLEM

5.) The cost of the energy used to heat hot water:

From Energy Management form:

If Electric: use annual average of column 7.

If Oil: use annual average of column 11.

If Natural gas: use annual average of column 15.

If Other: use annual average of column 19.

[ ] $/Million Btu

Example: 3.25 $/Million Btu

(Oil Burner in the example)

6.) Use table 2-7 to obtain cost of the insulation:

[ ] $/ft

Example: 2.26 $/ft

NOTE: An assumption used in this problem is that there are 240 days in the heating season.

TABLE 2-7

INSTALLED COST/LINEAR FOOT OF PIPE INSULATION
(includes material and labor)

Pipe Size (inches)	Insulation Thickness (inches of fibrous material)		
	1/2	1	2
1/2	$1.60	$2.00	$3.37
3/4	1.66	2.06	3.39
1	1.73	2.13	3.46
1-1/4	1.80	2.20	3.53
1-1/2	1.86	2.26	3.59
2	2.00	2.40	3.73
2-1/2	2.13	2.53	3.86
3	2.26	2.66	3.99

Source: Based on Guidelines for Saving Energy in Existing Buildings, ECM-2, FEA, 1975. (Updated in 1978)

(B) CALCULATIONS

	EXAMPLE PROBLEM
1) Heat loss through pipe with no insulation. (Use table 2-8, or figure 2-10 details)	
[ ] Btu/hr · 10 ft	1500 Btu/hr · 10 ft
2) Choose a size of insulation:	
(2, 1 or 1/2 inch) [ ] inch	1 inch
3) The heat lose if the pipe is insulated with the above insulation: (use table 2-9; pick off diameter and thickness of insulation and read off heat loss.)	
[ ] Btu/hr · 10 ft.	200 Btu/hr · 10 ft.
4) The heat saved with insulation:	
[ ] Btu/hr·10 ft − [ ] Btu/hr · 10 ft	1500 Btu/hr·10 ft − 200 Btu/hr·10 ft
= [ ] Btu/hr·10 ft	= 1300 Btu/hr·10 ft

TABLE 2-8

HEAT LOSS WITH UNINSULATED PIPE

(Btu/hr 10·ft of Pipe)

Temperature °F of Water In Pipes

Pipe Size in Inches	100°	120°	140°	150°	180°
1/2	200	330	460	480	710
3/4	250	375	560	690	850
1	310	500	670	850	1060
1 1/2	430	680	935	1190	1500
2	510	800	1125	1400	1700
2 1/2	600	940	1330	1635	2000
3	700	1100	1580	1920	2350

Read pipe size on left and temperature of water on top and follow down and across to the intersection, to get heat loss. For example: If the pipe size is 1 1/2, and the temperature is 180°F the heat loss will then equal 1500 Btu/hr/10·ft.

Source ECM -2 FEA 1975

TABLE 2-9

HEAT LOSS WITH INSULATION
(Btu/hr·10 ft of Pipe)

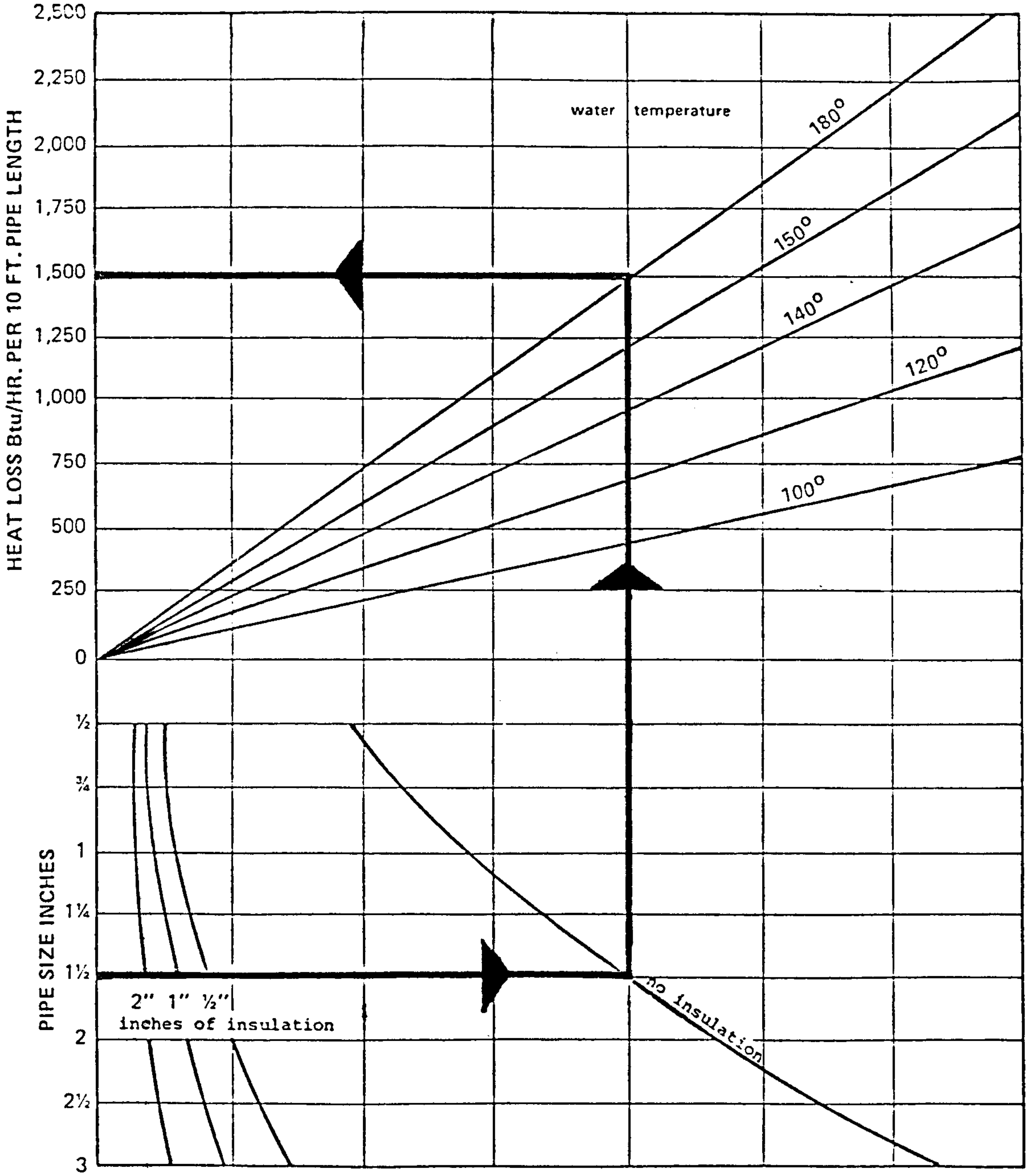
Temperature of water in Pipe

Pipe Size in Inches	100°	120°	140°	150°	180°
	For 2 inches of insulation				
1/2	30	60	90	100	125
3/4	30	65	95	105	130
1	35	65	95	110	140
1 1/4	35	65	95	110	170
1 1/2	35	65	95	120	140
2	35	65	95	125	150
2 1/2	35	65	95	130	170
3	40	70	100	150	200
	For 1 inch of insulation				
1/2	30	65	90	120	130
3/4	30	60	90	125	160
1	35	65	90	125	160
1 1/4	35	65	95	130	170
1 1/2	40	70	100	150	200
2	50	80	115	170	225
2 1/2	70	110	150	225	250
3	100	140	200	260	300
	For 1/2 inch of insulation				
1/2	50	80	125	160	190
3/4	50	80	125	165	195
1	65	85	130	170	195
1 1/4	90	125	175	200	250
1 1/2	120	150	195	250	300
2	130	175	210	290	340
2 1/2	140	200	260	395	460
3	180	250	350	450	550

For other temperatures of water use more detailed chart on following page. For example if water = 130°F.

FIGURE 2-10

HEAT LOSS FROM HOT WATER PIPES



Source: Guidelines for Saving Energy in Existing Buildings, ECM-2, FEA, 1975.

5) The energy saved per year would be:

____ x ____ ft x $\frac{240}{10}$

x $\frac{24}{1,000,000}$

= ____ Million Btu/yr

6) Heat cost saved:

____ x $\frac{\text{____ \$/Million Btu}}{\text{____ Efficiency}}$

= ____ $/yr

7) The cost of insulating the bare pipe:

____ $/ft x ____ ft pipe

= ____ dollars cost

8) Payback Period:

$\frac{\text{____ \$ Cost}}{\text{____ \$/yr savings}}$ = ____ yr

EXAMPLE PROBLEM

1300 x 1000 ft x $\frac{240}{10}$

x $\frac{24}{1,000,000}$

= 748.8 Million Btu/yr

748.8 x $\frac{\text{3.25 \$/Million Btu}}{\text{.65 efficiency}}$

= 3744 $/yr

2.26 $/ft x 1000 ft

= 2260 dollars cost

$\frac{\text{2260 \$ cost}}{\text{3744 \$/yr savings}}$ = .6 yr

PROBLEM NUMBER 8

Lower the domestic hot water to 110°

A) DATA NEEDED FOR THE CALCULATIONS

1) The number of units in the building is

   ______ units

2) The average hot water demand is:

   (If this figure is not available, use the appropriate value listed in the table below*)

Number of Units	Demand
20 or less	20 gal/unit/day
60	14 gal/unit/day
100 or more	10 gal/unit/day

   ______ gal/unit/day

* Source: ASHRAE Systems Handbook, 1973

EXAMPLE PROBLEM

20 units

20 gal/unit/day

3) The present hot water temperature is:

(From the setting on the hot water heater)

[ ] °F

4) The reduced hot water temperature is (110°F)

5) The cost of energy to heat the hot water is:

(From the Energy Management Form, columns 7, 11, 15 or 19 depending on the type of fuel used)

[ ] $/Million Btu

EXAMPLE PROBLEM

160°F

(110°F)

12.5 $/Million Btu

B) CALCULATIONS

1) The total hot water consumption per year is:

[ ] gal/unit/day x [ ] units x

(365) day/yr = [ ] gal/yr

2) The Savings in heat if the temperature is reduced is:

[ ] gal x ([ ] °F - [ ] °F) x

$8.34 \times \frac{1}{1{,}000{,}000}$ = [ ] Million Btu/yr

3) The cost savings per year:

[ ] Million Btu/yr x [ ] $Million/Btu=

[ ] $/yr

4) The Payback Period is immediate since there is no cost for implementation.

EXAMPLE PROBLEM

20 gal/unit/day x 20 units x

365 day/yr = 146,000 gal/yr

146,000 gal/yr x (160°-110°) x

$8.34 \times \frac{1}{1{,}000{,}000}$ =

60.7 Million Btu/yr

60.7 Million Btu/yr x 12.5 $/Million Btu=

759 $/year

PROBLEM NUMBER 9

Use energy efficient fluorescent bulbs. There are bulbs on the market now that put out the same light levels but use less energy.

A.) DATA NEEDED FOR THE CALCULATIONS

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

[ ] bulbs at 40 watts each

2.) The total watts is:

[ ] bulbs x 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.) Energy efficient bulbs cost:

(Get a price quote from a contractor)

[ ] $/bulb

EXAMPLE PROBLEM

320 bulbs

320 bulbs x (40 watts/bulb)

= 12,800 watts

(35 watts/bulb)

10 hr/day

2.50 $/bulb

6.) Electricity cost per kWh average :

(from Energy Management Form annual average of column 6)

[ ] $/kWh

EXAMPLE PROBLEM

.06 $/kWh

B . CALCULATIONS:

1.) Energy saved per bulb:

(40 watts) - (35 watts)

= 5 watts/bulb

2.) Total energy saved with efficient bulbs:

5 watts/bulb x ______ bulbs

= ______ watts saved

3.) Total energy saved per year:

______ watts saved x ______ hrs/day

x (365 day/yr) ÷ (1000)

= ______ kWh/yr saved

4.) Cost saved per year:

______ $/ kWh x ______ kWh /yr saved

= ______ $/yr saved

EXAMPLE PROBLEM

(40 watts) - (35 watts)

= 5 watts/bulb

5 watts/bulb x 320 bulbs

= 1600 watts saved

1600 watts saved x 10 hr/day

x (365 day/yr) ÷ (1000)

= 5840 kWh/yr saved

.06 $/ kWh x 5840 kWh /yr saved

= 350 $/yr saved

5.) Cost of installing new bulbs:

[ ] $/bulb x [ ] bulbs

= [ ] $ to install new bulbs

6.) Payback period:

$$\frac{[\ ]\ \$\ \text{cost to install}}{[\ ]\ \$/\text{yr saved}}$$

= [ ] yr

EXAMPLE PROBLEM

2.50 $/bulb x 320 bulbs

= 800 $ to install new bulbs

$$\frac{800\ \$\ \text{cost to install}}{350\ \$/\text{yr saved}}$$

= 2.3 yr

CHAPTER 3

ENERGY MEASURES

This Chapter 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 maintenance and operational changes listed in Chapter 1. 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 hotel or motel. Some measures obviously require a greater investment than others; therefore, estimating the payback period of those measures which apply to your building(s) is a convenient method of establishing your priorities. Use the basic reasoning and techniques portrayed in the problems of Chapter 2 as a guide for estimating energy savings and payback periods. For example, follow the basic methods of estimating the annual savings for a given measure. Then, obtain an installation price for that measure. To find the simple payback period, divide the installation cost by the estimated annual savings.

The following measures have been shown to produce the most dramatic savings for the least initial investment (they are also listed in their respective functional headings in this chapter):

1. Replace old, inefficient burners with new, efficient ones.
2. If you have a boiler, have a technician check the efficiency of it 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.
3. 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".
4. Repair or replace leaking steam traps.
5. Install shower head restrictors. This may save up to 50% of the hot water consumption.
6. Where practical use waste heat for hot water heating.
7. Control exterior lighting with photo electric cells.

8. Preheat combustion air where practical.

9. Use energy conserving fluorescent lamps.

10. If you are being penalized by the electric company for a low power factor, it may be cost effective to correct it.

11. Use more efficient individual air conditioners.

ENERGY CONSERVATION MEASURES

A. GENERAL BUILDING

1. Weatherstrip all of the windows 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. Weatherstrip the outside doors to reduce air infiltration.

3. Add controls to enable up to 100% shut-down of air and water supplied to unoccupied space.

4. Seal ducts and access doors in equipment rooms to minimize by-pass of hot and cold air.

5. Repair or replace all faulty time clocks.

6. Install heat recovery systems wherever practical.

7. A low power factor on an electrical system within a building will increase the losses in the electric utility system and reduce the system's capacity. Many electric utility companies have a penalty charge for a lower power factor. Correcting the power factor can provide for more efficient use of energy as well as a reduction in the cost of electricity. Electrical devices known as capacitors can be installed to correct low power factor.

8. Utilize solid-state motor drives instead of motor generator sets for elevators. Solid-state drives typically provide energy savings of 25%.

9. Insulate all roofs, walls, and floors that have an exterior exposure.

10. Install rigid insulation between metal panels below windows.

11. Install timers to cut off lights and equipment automatically.

Some of the measures have been selected in part from two copyrighted publication and used by permission:

12. Be sure operable windows have sealing gaskets (packing used for making joints air-tight) and tight latches.

13. Insulate the metal walls of penthouse rooms to reduce heat loss and heat gain.

14. Provide vestibules with self-closing weatherstripped doors.

15. Rehang misaligned doors and windows.

16. Prepare future plans for conversion to alternate fuels in the event of mandatory cutback in the fuel currently being used.

17. Where floors are located over unheated spaces such as a garage, consider suspending a ceiling beneath the open floor beams with batt insulation.

18. Reduce fan power input equipment by reducing air volume. Whenever heating and cooling loads are reduced, fan air volume reductions should be implemented to reduce fan energy consumption. Air volume can be reduced by changing the speed of rotation.

19. Use water cooled refrigeration units rather than air cooled ones, since the former are up to 20% more efficient.

20. 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.

21. Disconnect all refrigerated water fountains if acceptable to building occupants.

22. Re-examine the assumptions that were made regarding occupancy, usage and environmental standards when the building was originally designed.

B. SPACE HEATING - GENERAL

1. Replace old, inefficient burners with new, efficient ones. Changing a 60% unit for a 75% one with a 25,000 gallon per year experience will save 5,000 gallons of oil or more than $2,000 per year. The payback is about one year.

2. Consider computerizing the heating and cooling systems in large applications.

3. 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."

4. 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.

5. Install thermostats for control of all heating equipment where none currently exist.

6. Install key-lock covers over thermostats to prevent building employees from adjusting settings in offices, lobbies, and other areas.

7. Hire an engineering consultant to review and develop heating system standard operating procedures.

8. Once a year, calibrate (test the accuracy of) all instruments (thermometers, pressure gauges, thermostats, etc.). Any deficiencies noticed by operators should be corrected immediately.

9. Connect all of the manual day-night control switches to time clocks so that night setback temperatures can be achieved even if switches are accidentally left on "day."

10. Use spot heaters and/or coolers in spaces having a large volume but low occupancy.

11. Check the fuel-air ratio on all gas burners and adjust to the most efficient mixture.

12. Have a competent combustion engineer make a flue gas analysis annually to properly adjust the fuel input and to check combustion.

13. 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.

14. Remove perimeter radiation from hallways in favor of multi-glazing and additional wall insulation.

15. Install throttling oil burners to eliminate continuous cycling.

16. Provide adjustable vent air valves on radiators to aid in balancing system.

17. Build penthouse type enclosures around roof-top units to reduce radiation and wind losses from exposed ducts.

18. Check heater elements for cleanliness. Replace as necessary.

19. Heating equipment should be clustered together and located away from cooling equipment.

C. HOTELS AND MOTELS THAT USE BOILERS FOR SPACE HEATING OR OTHER PROCESSES

1. 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. Replacing worn-out controls with a new system could increase the efficiency of the boiler system and conserve energy.

2. Consider replacing existing boilers with modular boilers (small, independent boilers). Most boilers achieve maximum efficiency only when running at their rated output. In most cases, however, full boiler capacity is seldom required because heat load is 60% less than full load 90% of the time. As a result, large-capacity boilers in single units operate intermittently for the major part of the heating season. A modular boiler system comprised of two or more small-capacity boiler units will increase seasonal efficiency. Each module is fired at 100% of its capacity only when required. Fluctuations of load are met by firing more or less boilers. Each small-capacity boiler with low-thermal inertia (i.e., providing rapid response and low heat-up and cool-down losses) will either be running at maximum efficiency or be completely turned off. In a typical installation where single-unit, large-capacity boilers are replaced by modular boilers, boiler seasonal efficiency may be improved from 68% to 75%. This represents a 9% savings of present fuel consumption. Use of the modular approach is particularly worthwhile in cases where the present boiler plant is at or near the end of its useful life. Replacement modular boilers should be sized to meet the reduced heating load resulting from use of other measures.

3. Feel the pipe on the downstream side of steam traps. If it is excessively hot, the trap probably is passing steam. This can be caused by dirt in the trap, a valve off the stem, excessive steam pressure, or worn trap parts (especially valves and seats). If the pipe is moderately hot (as hot as a hot water pipe), it probably is passing condensate, which it should do. If it's cold, the trap is not working at all, and should be replaced or repaired.

4. Have a technician check the boiler(s). A percent loss of boiler efficiency is a percent loss of energy and money. It is generally worth any cost incurred to optimize boiler operation. A good first step is to simply reduce the excess air to the point where any further reduction would result in smoke. For instance, if the temperature of the flue gas (the gaseous products of combustion from a boiler furnace that travel to the stack through a passage known as the flue) is 400°F and excess air is changed from 100% to 50%, an efficiency increase of 3% is immediately achieved.

5. Replace inefficient boilers (e.g., single-pass tubed) and other boilers which are at or near the end of useful life. These boilers should be replaced by a modern version which is matched to current and projected needs of the installation involved. In most cases, new boilers on the market can obtain 80% efficiency. Even more efficiency can be gained by specifying multiple boilers. Replacement burners should be selected on the basis of long-term cost rather than initial cost. Increased cost of fuel, labor, and materials should be considered in developing long-term cost projections. Also consider installation of a dual-fuel system to avoid problems in the event of any shortages or curtailments.

6. Convert to a low pressure system to improve the heating system's annual operating efficiency. The installation of small steam electric boilers near the termination of some steam lines may reduce the need for piping modifications.

7. Lower steam pressure to the minimum pressure that will just satisfy needs.

8. Install a flue gas analyzer: Optimum combustion efficiency varies continuously with changing loads and stack draft. Accordingly, maintaining optimum combustion efficiency requires continuous adjustment of fuel/air ratios. This can be achieved through installation of a flue gas analyzer, which provides continuing information on flue gas temperature and CO_2 or O_2 content, thus enabling manual adjustment on a continuing basis. The specific type of flue gas analysis instrumentation required depends on the type of installation involved. Due to the increasingly more widespread need for multifuel burners, however, O_2 analysis is considered to be the single most useful measure for all fuels since the O_2 to total air ratio varies within narrow limits.

9. Most service companies will test burners for a token fee for the following:

   a. Air to fuel ratio: This must be maintained properly. In case of insufficient air, the fire will smoke and deposit soot on the water tubes of the boiler. Soot acts like insulation on the tubes, which causes waste of energy.

   b. Firing period: If it is improper, it could be a sign of faulty control.

   c. Flue gas analysis: The efficient combustion of fuel in a boiler requires burner adjustment to achieve proper stack temperature, CO_2 and excess air settings. Check settings to provide stack temperatures of not more than 150°F above steam or water temperature. There should be no carbon monoxide. For a gas-fired unit, CO_2 should be present at 9 to 10%. For #2 oil, 11.5 to 12.8%; for #6 oil, 13 to 13.8%.

10. Decrease gas or oil input rate of the boilers so that they will operate over longer periods of time. This will decrease losses incurred during the off cycle.

11. Readjust damper control to maintain proper draft under both low and high fire.

12. Install automated damper controls to provide positive draft shut-off when the boiler is not operating.

13. Check boiler stack temperature. If it is too high (more than 150°F above steam or water temperature) clean tubes and adjust fuel burner.

14. Isolate off-line boilers: Light heating loads on a multiple boiler installation are often met by one boiler on line with the remaining boilers idling on stand-by. Idling boilers consume energy to meet stand-by losses. In many cases, these losses are increased by a continuous flow of air drawn in through the idling boilers and up the chimney. Unless a boiler is about to be used to meet an expected increase in load, it should be secured and isolated from the heating system (by closing dampers). A large boiler can be fitted with bypass valves and a regulating orifice (a small opening intended for the passage of a fluid) to allow the minimum flow required to keep the boiler warm and avoid thermal stress when it is brought on line again. If a boiler waterside is isolated, it is important to prevent back-flow of cold air through the stack, which could cause the boiler to freeze.

15. Inspect boilers for scale deposits, accumulation of sediment (the solid substance that is deposited in the bottom of a liquid), or boiler compounds on waterside surfaces. Rear portion of the boiler must be checked because it is the area most susceptible to deposits of scale. Scale reduces the efficiency of the boiler and possibly can lead to overheating of furnace, cracking of tube ends, and other problems. Have scale cleaned regularly.

16. Provide proper chemical treatment of boiler water to reduce scale build-up, protect the boiler, and help protect condensate returns.

17. Inspect insulation of all mains, risers and branches, economizers and condensate (condensed steam that is now water) receiver tanks. Repair or replace as necessary.

18. Preheat the air before it enters the combustion chamber of the boiler by the waste gases from the chimney.

19. Connect the space heating hot water pumps to the time clock so that they will operate only when the boiler is being used.

20. If possible, install a boiler stack economizer.

21. In case of leakage, replace flanged valves with weld-end valves, except at locations where frequent removal of valves is necessary.

22. Reduce blowdown losses: Some of the water is removed from the boiler by blowdown in order to control the amount of solids and salts in solution and thereby maintain the desired concentration. Blowdown results in a steady energy drain because make-up water must be heated. Energy can be saved, however, if blowdown water is not discarded but instead is used to heat make-up water.

23. Listen to steam traps to determine if they are opening and closing when they should be. If they are not, repair or replace the traps.

24. Route vents from steam system flash tanks (where the low-pressure steam is collected after the boiler has been through its blowdown cycle) back into low-pressure steam mains.

25. If practical, install turbulators in boiler tubes to increase the heat transfer from the hot gases to the waterside.

26. Inspect boiler door gaskets. Replace them if they do not provide a tight seal.

D. VENTILATION

1. Reduce the 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. 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.

3. Add a warm-up cycle to air handling units with outdoor air intake. Keep outdoor air dampers closed during 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. Consider adding variable volume valves and eliminating terminal heaters.

5. Reduce system resistance to air flow to a minimum by replacing those duct sections and fittings which impose unnecessary resistance on the system; replacing dirty filters with adequately sized filter media which have a high efficiency and low air flow resistance; removing unnecessary dampers and other obstructions from ductwork, and replacing high-resistance inlets and outlets with modern grilles and diffusers providing low resistance.

6. Inspect ductwork for air leakage. Seal all leaks by taping or caulking.

7. If possible, use permanently sealed windows to reduce infiltration in climate zones where this is a very large energy user.

8. Install storm windows throughout or double glaze windows throughout. A single 36 sq ft window will save 3.5 million Btu per year with storm windows added.

9. Replace broken or cracked window panes.

10. Inspect ductwork insulation. Condensation on air handling surface is a sign of inadequate or loose insulation. Repair or replace insulation as necessary.

11. Caulk, gasket, or otherwise weatherstrip all exterior joints, such as those between wall and foundation or wall and roof, and between wall panels.

12. 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.

13. Where practical, cover all window and through-the-wall cooling units when not in use. Specially designed covers can be obtained at relatively low cost.

14. If an exhaust hood is oversized, adjust it 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.

15. Modify duct system and hoods to introduce unheated outdoor or return air directly to the exhaust hoods.

16. Reduce or eliminate the need for using outdoor air for odor control by installing chemical or activated charcoal-absorbing devices.

17. Install baffles to prevent wind from blowing directly into an outdoor air intake.

18. Supply ventilated air to parking garages to levels indicated by a CO_2 monitoring system.

19. 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.

20. Consider installing automatic door closers on all doors leading to the exterior or unconditioned spaces.

21. If the building has a garage but does not have a garage door, consider installing one, preferably motorized to enable easier opening and closing.

22. 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.

23. 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.

24. In locations where strong winds occur for long durations, consider installing wind screens to protect external doors from the direct blast of prevailing winds. Screens can be opaque, constructed cheaply from concrete block, or can be transparent, constructed of metal framing with armored glass. Careful positioning is necessary for infiltration control.

25. Insulate all ductwork carrying conditioned air through unoccupied spaces with at least 1-1/2" of fibrous insulation or its thermal equivalent.

26. The valves of steam headers in the boiler room that supply steam to unused individual air handling units should be kept in an off position. This will reduce steam piping heat losses.

27. Acquire the services of a temperature control expert to check and adjust all system controls and to recommend modifications.

28. Change fans and pumps from steam to electric motor devices to permit reduction of steam pressure in mild weather.

29. Install a grille on the furnace room door to provide adequate, inside combustion air, not outside air.

30. Use ventilation blinds or drapery as interior shading devices.

31. Inspect air valves in dual-duct mixing boxes (an area in which air of different temperatures and humidities are mixed) to ensure full sealing and minimum air leakage.

32. 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.

33. 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.

34. Inspect insulation on suction and liquid lines. Repair as necessary.

35. Inspect gasketing on garage and other overhead doors. Repair, replace, or install as necessary.

36. Install an automation system to operate the ventilation units so that supply air temperature and return-air/fresh-air dampers can be adjusted to maintain the desired space temperature in the room.

37. Operate exhaust fans only when needed. Consider separate time clocks for these cycles. Some pressurized buildings may not require all of the exhaust fans to operate for proper ventilation.

38. Transfer air from "clean" areas to more contaminated areas (toilet rooms, heavy smoking areas) rather than supplying fresh air to all areas regardless of function.

39. Increase the ventilation unit's summer mixed air temperature to minimize the air conditioning and reheat requirements.

40. Fresh air makeup units should be designed so that the damper is closed when the unit is shut down.

41. Fresh air dampers installed in return air duct could eliminate the operation of the air conditioning (except fan) during off-peak seasons.

42. When more than 10,000 cubic feet per minute are involved, and when building configuration permits, consider installing heat recovery devices such as a rotary heat exchanger. For some climatic conditions an "enthalpy wheel," which permits recovery of some 75% of outdoor heat load during both heating and cooling cycles, will be feasible.

43. Use exhaust hoods only while operations are underway. Add control dampers or gravity dampers to keep the air path in the exhaust duct closed when the fan is not operating.

44. Wire all remote control panels into one central panel.

45. Adjust or replace all supply air temperature gauges so that accurate ventilation temperature can be read and maintained.

46. To minimize infiltration, balance mechanical ventilation and provide building static pressure (the normal pressure which exists inside that building) control so that supply air quantity equals or exceeds exhaust air quantity.

47. In existing systems where throttling is necessary to control flow, revise the fan drive or the pump to required flow with no throttling.

48. For cooling only (or cooling mostly) systems, relocate the fan motor outside of the conditioned air stream, but be careful not to overheat the motor.

E. 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. Increase the supply air temperature on all air handling units during the summer to the point where at least one space served by each unit is warmer than desired.

3. Consider installing interlocks between the heating and cooling systems of each unit to prevent simultaneous heating and cooling.

4. Inspect the moisture-liquid indicator on a regular basis. If the color of the refrigerant indicates "wet," it means there is moisture in the system. This is a particularly critical problem because it can cause improper operation or costly damage. A competent mechanic should be called in to perform necessary adjustments and repairs immediately. Also, if there are bubbles in the refrigerant flow as seen through the moisture-liquid indicator, it may indicate that the system is low in refrigerant. Call in a mechanic to add refrigerant if necessary and to inspect equipment for possible refrigerant leakage.

5. Reduce air flow to all areas to minimally acceptable level.

6. When no cooling loads are present, close off cold ducts and shut down the cooling system. 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.

7. Use a leak detector to check for refrigerant and oil leaks around shaft seals, sight glasses, valve bonnets, flanges, flare connections, and the relief valve on the condenser assembly, and at pipe joints to equipment, valves, and instrumentation.

8. 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.

9. Check all compressor joints for leakage. Seal as necessary.

10. Reduce secondary water flow during maximum heating and cooling periods by pump throttling or, for dual-pump systems, by operating one pump only.

11. If self-contained units are relatively old, consider replacing them with more efficient air-to-air heat pumps or similar units having a higher energy efficiency rating.

12. Install insulation on all hot and chilled water pipes, fittings, and valves passing through unconditioned spaces to minimize heat losses and heat gains.

13. Use water treatment techniques if the local water supply leaves surface deposits on the coil.

14. Perform tests to determine if solid concentrations are being maintained at an acceptable level in the cooling tower.

15. Determine if there is air bypass from the tower outlet back to the inlet. If so, bypass may be reduced through the addition of baffles or higher discharge stacks.

16. Caulk openings between unit and windows or wall frames.

17. Observe the noise made by the system. Any unusual sounds could indicate a problem. Determine the cause and correct it.

18. Chillers with water-cooled condensers should have the condenser heads removed annually and the tubes and waterbox (the tank in which the tubes are immersed) cleaned. The waterside of the evaporator should be opened every three years and cleaned in the same manner as the condenser.

F. 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. Lamp efficiency deteriorates over the life of a lamp. Light output should be checked regularly by maintenance personnel with a calibrated light meter (a meter which has been adjusted for accuracy). 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. Luminaire efficiency can be maintained by properly cleaning the reflecting surfaces and shielding media. 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 luminaire and does not present a safety hazard. (Caution should be used to assure that an existing luminaire will safely support and hold the glass lens.)

4. Replace outdated or damaged luminaires with modern luminaires 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 provides the same amount of illumination or (if acceptable for the tasks involved) a lower level of illumination. (Changing the lens or lowering the luminaire can often help facilitate this option.) This method is particularly applicable where current lighting levels are higher than recommended or where uniform lighting is the most practical due to occupant density.

6. Select lamps that are the most efficient, as measured in lumens (a unit of light output from a source) per watt, and that are compatible with the application. Compatibility with the luminaire, of course, is also essential. If some luminaire 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. Where possible, use a single, larger incandescent lamp (a lamp in which light is produced by heating one substance to a white or red heat) 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 turning off unused or unnecessary light.

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 luminaires in multiple-purpose spaces which require more than one level of illumination.

13. Where appropriate, consider installing lenses which provide special light distribution patterns 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. 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 luminaires. Desk lamps should also be used when persons work during normally unoccupied periods.

15. Replace all incandescent parking lighting with H.I.D. lamps. For example, Low Pressure Sodium, High Pressure Sodium or Mercury Vapor lamps.

16. When natural light is available in a building, consider the use of photocell (a device which controls electricity by measuring the available light) switching to turn off banks of lighting in areas where the natural light is sufficient for the task.

17. Use photocells for turning on exterior lights; use time clocks for turning off the exterior lights.

18. Provide timers to automatically turn off lights in remote or seldom-used areas.

19. Provide selective switching. Initial cost economics and lack of knowledge about final space subdivision often lead to the use of central panel-boards 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.

20. Investigate ways to provide local control of lighting. Localized switches can be provided near doorways. Remotely controlled switches can be located near panelboards to control groups of lights. Low voltage control circuits can provide local control of switches located in remote areas. (These controls usually are relatively inexpensive.) When properly used, localized switching usually will save enough energy to provide a payback on the investment within a short period of time.

21. 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.

22. Use light-colored reflective paint when redecorating.

G. DOMESTIC 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.

2. Install shower head restrictors. This may save up to 50% of the hot water consumed.

3. Inspect water supply system and repair all leaks, including those at the faucets.

4. If water pressure exceeds 40 to 50 pounds, consider having a plumber install a pressure reducing valve on the main service to restrict the amount of hot water that flows from the tap.

5. Inspect and test hot water controls to determine if they are working properly. If not, regulate, repair or replace.

6. Increase the amount of insulation installed on hot water pipes and storage tanks or replace existing insulation with a type having better thermal properties ("R" value).

7. Consider replacing existing hot water faucets with spray type faucets with flow restrictors wherever practical. Consult with a government infection control committee before making modification.

8. Consider installing spring-activated hot water taps.

9. Use a single system to meet handwashing needs in toilets.

10. If boilers are used as the primary heat source for domestic hot water, install a boiler to match the load rather than use an oversized heating boiler all summer.

11. Install a small domestic hot water heater to maintain the desired temperature in the water storage tank. This eliminates the need for running one of the large space heater boilers at a very low efficiency during the summer months.

12. Consider arranging circulating pipework to minimize the length of dead legs connecting to faucets.

CHAPTER 4

THE ACTION PLAN

Being aware of the possibilities for saving energy and money is only the beginning step toward an energy management program. This book has presented many possible areas in hotels and motels 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 Maintenance and Operational changes and Energy Measures. An organized system of priorities should be established to decide where to focus your efforts. The worksheet enclosed in this chapter is designed to help you organize your list of priorities.

The first step is to examine the no-cost Maintenance and Operational Changes which fit your hotel or motel. Make a list of the applicable ones, schedule them, 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 Chapter 2 should be made to determine whether energy is, in fact, being saved as predicted.

Having accomplished the no-cost changes, the next step is to investigate those measures which do require a capital investment. Examine the List of Energy Measures in Chapter 3 and choose those which appear to be most suited to your hotel or motel. Turn to Chapter 2 to get the approach to calculating the energy and cost savings for the measures you have chosen. Calculate these measures and determine their simple payback times. Then, arrange the list in order of shortest payback time first and longest payback time last. Assuming that budgets permit, the list should then be examined item by item to determine if any further conservation of both energy and dollars can be made.

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.

ENERGY CONSERVATION ACTION PLAN

No-Cost Maintenance And Operational Changes

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