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ABSTRACT

Presented are materials prepared for the inservice education of school maintenance personnel on the subject of energy conservation in school facilities operations. The course is designed to help maintenance staff understand their schools' energy usage and formulate plans to control that usage. Among the topics covered are building inventory, preventative maintenance, energy audits, boilers, roofs, lighting, and plumbing systems. The manual contains both course guidelines for the instructor and worksheets for course participants to fill out in advance of each lesson. (Author/WB)

Energy Conservation for School Custodial and Maintenance Personnel

Course Outline and Instructional Materials

Program Development
Dept. of Community Colleges
Raleigh, N.C. 27611

ENERGY CONSERVATION

FOR

SCHOOL CUSTODIAL AND MAINTENANCE PERSONNEL

by

Calvin E. Anderson

May, 1979

for

Energy Conservation Curriculum and Short Course Project #8208, Program Development Section, North Carolina Department of Community Colleges

Project Director
Roger G. Worthington

Coordinator
Frank A. Gourley, Jr.

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FOREWORD

One of the purposes of the Department of Community Colleges is to provide learning opportunities for individuals who wish to upgrade and update their occupational skills. This instructional manual was prepared for inservice training of school maintenance personnel on the subject of energy conservation in school facilities operations. By utilizing the principles and information in this text, school maintenance personnel can obtain a clearer idea of energy usage in their schools and an understanding of how to control that usage. The energy situation is a challenge and this manual is addressed to a group of people who can help meet that challenge.

Roger G. Worthington, Director
Program Development Section
Department of Community Colleges

Charles R. Holloman
Senior Vice President in Charge
Department of Community Colleges

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INTRODUCTION

The need for schools to undertake energy conservation programs has been well documented. The need for school personnel to be carefully trained in wise energy management is a vital part of any conservation program. This course has been designed for this latter purpose.

The material for the course, Energy Conservation for School Custodial and Maintenance Personnel has been developed in two sections. The first section is a course outline for the instructor. This sequential approach to the topic of energy is intended as a guide - not a limitation. It does need to be supplemented by the instructor's knowledge and experience.

The second section is a student handbook. It is intended to encourage the student to examine his/her own school as it relates to the weekly topics. The handbook has worksheets which can be filled out in advance of the class.

When the course is completed the student will have a comprehensive statement of how energy is used or misused in his/her school.

Name of School ______ School District ______ City ______

Year Built ______ School Telephone ______ Principal ______ Head Custodian ______

Type of Facility: Elem ☐ Junior/Middle ☐ Senior ☐ Other ☐ ______

Occupancy: Nine-month School ☐ No. of Students ______ Building

Year-round School ☐ No. of Faculty/Staff ______ Hours ______

BUILDING DATA

1. Gross Floor Area ______ GSF X Ceiling Height ______ Ft. = Volume ______ CF, Number of Facilities ______

2. Plan Type:
   Single Loaded Corridor ☐ Double Loaded Corridor ☐ Compact/Open ☐ , Stories or Floors ______

3. Total Glass Area ______ SF Type of Windows: Single ☐ Fixed ☐ Type of Glass: Reflective ☐
   Double ☐ Operable ☐ Clear ☐

4. Exterior Surface Material: Masonry ☐ Wood ☐ Concrete ☐ Stucco ☐ Other ☐
   Area ______ SF Insulation: Type and Thickness ______
   Roof: Built Up ☐ Hip Roof ☐ Composition ☐ Other ☐
   SF Insulation: Type and Thickness ______

5. Operating Conditions: Summer Indoor ______ OF Winter Indoor ______ OF
   Setting; Setback ______ OF Setting; Setback ______ OF

Continued.........

6. Facility Inventory Number of: Classrooms _____, Offices _____, Cafeteria _____, Kitchen _____, Swimming Pools _____
Gymnasium _____, Locker Rooms _____, Art Rooms _____, Shop _____, Science Rooms _____
Auditoriums _____, Restrooms, Home Ec _____, Other _____

Heating System

Fuel Type ______________________________

Rated Input Consumption ____________ Rated Output Capacity ____________

System Type

- ☐ Boiler
- ☐ District Service
- ☐ Unitary Direct Fired
  - ☐ Furnaces
  - ☐ Packaged Equipment

Cooling System

Fuel Type ______________________________

Rated Input Consumption ____________ Rated Output Capacity (tons) ____________

System Type

- ☐ Absorption ☐ Elect Drive
- ☐ Steam Turbine ☐ Water Cooled Package
- ☐ Air Cooled Package Unit
- ☐ Evaporative Coolers ☐ Window Units

Comments ______________________________
____
____

ENERGY CONSUMPTION INFORMATION

Fuel	Gross Yearly[1] Current Year	Quantity[2] Base Year	Conversion BTU Factor	Annual BTU Usage	Base Year	Annual BTU GSF	Base Year	Annual Cost Current Year	Annual Cost Base Year
Electric	______ kwh	______	X 3,413						
Natural Gas	______ ccf	______	X 100,000						
#2 Oil	______ gal	______	X 139,000						
Coal	______ ton	______	X 26,200,000						
Propane	______ gal	______	X 92,000						
Other	______	______	X ______						
			Total						

Degree days ______ Current ______ Base

[1] Current yearly consumption and cost would be previous calendar year.

[2] Base year would be year prior to any energy conservation measurers (1975).

Many of the exercises in this lesson are continuous. The instructor and student will refer back to this lesson frequently during the course and afterwards.

1. The heating system in my building uses ________________ for fuel.
2. There is ( ) is not ( ) a standby fuel supply. The standby system uses __________ for fuel (if applicable).
3. From available records, construct the following chart from the last three years, if possible.

<u>ELECTRICITY</u> (current = current reading) (base = base reading)

	A		B		C		D		E		F		G	
Year	Reading Dates		KWH Used		Measured Demand KWH		$ Cost		(FCA) Fuel Cost Adjstmt. ($)		Total Cost (D + E = F)		$/KWH F ÷ B	
	From	To	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base
1							$	$	$	$	$	$	$	$
2														
3														

NATURAL GAS (if oil use gallons)

	A		B		C		D		E		F		G	
Year	Reading Dates		Gas Used CCF		Gas Cost		Gas Cost Adjstmt.		Total & Cost (C + D = E)		$/CCF (E ÷ B = F)		Degree Days	
	From	To	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base
1					$	$	$	$	$	$	$	$		
2														
3														

Now start a similar chart, beginning with this month's reading. Try each month to read your meter or record your consumption on the same day of the month and as nearly as possible the same time of day.

FUEL CHART

	A		B		C		D		E		F		G	
Month	Reading Date		Gas Used CCF		Gas Cost		Gas Cost Adjstmt.		Total & Cost (C + D = E)		$/CCF (E ÷ B = F)		Degree Days	
	From	To	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base
1					$	$	$	$	$	$	$	$		
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
Total					$	$	$	$	$	$	$	$		
BTU Conversion Factor			x100,000	x100,000										
Total BTU's														

NATURAL GAS ______________________ CCF/Yr.

Notes: This form is intended to be a working document. If it is kept monthly, you will see how effective your Energy Conservation Programs are.

<u>Current</u> means current month
<u>Base</u> means the base month of your base year.

Building ______________________

How does this year's consumption compare with the base year?

If lower, list things you think brought this about.

If higher, list things you think brought this about.

If heating system has been converted from coal to gas, or to oil in the past three years, to establish comparability, it is necessary to convert readings under the old system to equivalents in the new system. Your instructor will be able to help you do this. Examples of heat production in different fuels are:

FUEL OIL

Number 1	137,400 BTU/gal
Number 2	139,000 BTU/gal
Number 3	141,800 BTU/gal
Number 4	145,100 BTU/gal
Number 5	148,800 BTU/gal
Number 6	150,000 BTU/gal

PROPANE

92,000 BTU/gal

NATURAL GAS

950 to 1150 BTU/cu ft
(100,000 BTU's/CCF)

COAL

Bituminous	11,500 to 14,000 BTU/lb
Sub-bituminous	9,500 to 11,000 BTU/lb
Lignite, brown coal	6,300 to 8,300 BTU/lb

Using these figures, suppose that we converted from natural gas to oil, and we are currently using Number 1 fuel oil. The table shows that Number 1 fuel oil furnishes 137,400 BTU/gal. Using 1000 BTU in round numbers as the production of 1 cubic foot of natural gas, we divide all BTU's by gas BTU's:

137,400 ÷ 1000 = 137.4, the number of cubic feet of natural gas needed to furnish the same heat as 1 gallon of Number 1 fuel oil. Suppose the gas readings for the year before we converted to oil were:

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Gas	35,342	30,600	25,750	19,125	9,432	760	125	250	3,400	10,567	22,750	29,854
Oil	257	223	187	139	69	6	1	2	25	77	166	217

ELECTRICITY CONSUMPTION CHART

While we are on the topic of charts, make a chart for electrical consumption similar to the Fuel Chart (p.6).

SAVINGS

Most savings in energy can be accomplished by reducing the length of time fuel or electricity is consumed.

START UP TIME

Research has exploded the fiction that it is economical to maintain overnight temperatures at the same level as the period for building use. It is helpful for a heating plant manager to experiment to see how long at different outside temperatures it takes to bring the building to the temperature desired in the morning and how long the building will "coast" from the heat buildup during the day to determine how soon heat can be cut down after lunch. Devise a chart, using information applicable for your school, to assist in the experiment.

MORNING

TIME WHEN BLDG. SHOULD BE AT 68° FOR TOTAL OCCUPANCY (Make this time when buses arrive)	OUTSIDE TEMPERATURE	LOW SETTING FOR NIGHT	TIME HEATING PLANT TURNED ON FULL
	Below 0°	*55°	______
	0°	55°	______
	10°	55°	______
	20°	55°	______
	30°	55°	______
	40°	55°	______
	50°	55°	______
	60°	55°	______

AFTERNOON

TIME PUPILS LEAVE BUILDING (Hold 68° until buses leave)	OUTSIDE TEMPERATURE	LOW SETTING	TIME HEATING PLANT BEGINS COAST
	Below 0°	*55°	______
	0°	55°	______
	10°	55°	______
	20°	55°	______
	30°	55°	______
	40°	55°	______
	50°	55°	______
	60°	55°	______

*This is not a hard-and-fast figure. It may be found desirable to set the night temperature at 50° or even 45°. On the other hand, it may be possible not to run the plant at all during the night.

AIR CONDITIONING

Make a chart similar to the above to experiment with air conditioning starts and stops. Instead of a "LOW SETTING" you will use a "HIGH SETTING" column.

NIGHT OCCUPANCY

The above charts must be modified when scheduling calls for use of the building after regular school hours.

ZONE CONTROLS

Every building should have Zone Controls. It should be possible to put most of the building on the low settings in winter and high settings in summer and localize heating or cooling applications for only those parts of the building actually to be used. Here again, experimentation on timing for setups and setbacks should be done. It is surprising how much heat the lights and body temperatures of the occupants will give off and how long a well-insulated structure will coast.

HEAT LEAKS

The corollary to the above experimentation is to keep the heat or cool from leaking. Make the rounds frequently to observe:

Are doors closed or are they inadvertently propped open?

Are windows closed?

Outside ventilation flaps closed?

Chimney or stack drafts properly set?

EFFICIENCY

Results of the above described experiments can be aided or defeated if there are inefficiencies in the heating (cooling) plant itself, flaws in the controls, or problems in the distribution systems. LESSON SEVEN, PREVENTATIVE MAINTENANCE, goes hand-in-hand with this lesson.

STEAM BOILERS

In any heating plant, goals are to:

1. Get the most heat out of the fuel used.
2. Get the maximum amount of heat produced into the heating system.
3. Conserve the heat once it is radiated into the building.

BOILER/BURNER (OIL)

Make yourself a check list, breaking it into DAILY, WEEKLY, MONTHLY, SEASONAL points to check. Mark X or put in the date when the check is observed. For example:

Boiler/Burner (Oil) Check List - Daily

	M	T	W	T	F	M	T	W	T	F
1. Signs of oil leaks										
2. Check combustion chamber for soot										
3. Check burner mounting for tightness										
4. Check flame (should be golden orange)										
5. Check stack temperature										
6. Check low water cut-off blow-down										
7. Check draft (use manufacturer's specs)										
8. Listen for unusual noise										

Boiler/Burner (Oil) Check List - Weekly

	Week 1	Week 2	Week 3	Week 4
1. Check boiler and burner for cleanliness				
2. Blow down boiler (if steam)				
3. Test "Pap" valve (if steam)				

Boiler/Burner (Oil) Check List - Monthly

	Month 1	Month 2	Month 3
1. Take CO_2 reading (CO_2 content should be about 12%. A significant drop in CO_2 reading indicates incomplete combustion of fuel)			
2. Check damper operation			

Boiler/Burner (Oil) Check List - Yearly

	Year 1	Year 2	Year 3
1. Thoroughly wash and flush boiler on water side			
2. Vacuum the breaching			
3. Clean all fuel oil passages and chambers in burner			
4. Check lubricating oil in burner			
5. Replace cracked or loose bricks in combustion chamber			
6. Check insulation on all hot water and steam pipes			
7. Check air valves			
8. Check steam traps and thermostatically controlled steam valves at radiators			
9. Check damper operating controls - chains, meters, gears, linkages			
10. Check back draft dampers in exhaust fan ductwork. They should close tightly when fans are not operating			
11. Check fan drive belts			
12. Check thermostats			
13. Clean or replace all filters			
14. Clean grilles, registers, and louvers			

If your system is not steam or if it is not oil fired, using manufacturer's specifications and hints for your [illegible], prepare charts similar to the above for your own system. The instructor will help you develop a suitable plan for operation and maintenance.

Review with the class what experiments you have started in accordance with those outlines in Lesson Two.

Review the check lists in Lesson Two. What discoveries did you make? What changes have you effected since going over the check lists?

What changes would you suggest to improve the check list for your operation?

BOILER MAINTENANCE

Cleanliness is the basis of good boiler maintenance. Accumulations of any kind on the metal hinder transfer of heat from the fire to the water.

FIREBOX

A weekly vacuuming of the boiler tubes was suggested in Lesson Two as a minimum. Actually, a quick look each day at the firebox, not only to check burner and flame condition, but for signs of soot, scale, rust, or ash accumulation is recommended. Some fuels will cause more soot than others. Heavy sooting may be a sign of improper fuel-air mixtures. Improper damper position may contribute to the sooting. Check the cleanliness of the stack, also. Back-drafts, "puff-outs," gassy odors may be an indication of a plugged or partially plugged stack. Old buildings with brick stacks give problems from brick erosion from corrosive exhausts of some fuels. Dislodged bricks in the stack can give trouble.

FLAME

Practice will help you to know what the ideal flame is for your burner.

Trouble Signs:

- -A pale yellow flame
- -A dark sooty flame
- -Sparks in the flame
- -Smoke during combustion

- -Flame should not strike the sides, top, or bottom of the combustion chamber
- -Flame should not strike rear of combustion chamber with any force

BOILER SCALE AND SEDIMENT

Frequency of washing and scaling the boiler will depend upon the quality of the water supply.

Pure soft water gives very little difficulty, but it is still good practice to follow check list schedules in Lesson Two for this kind of supply. Pipe leaks may cause sediment to enter the system in the best of systems. Signs of rusty water will not necessarily mean danger.

Some water may cause a deposit of lime to form on the metal on the water side of the boiler. This scale has amazing qualities of insulation and therefore increases fuel demands. Treating the water should not be attempted unless preceded by a chemical analysis by a reputable testing facility.

PLUMBING

Get the habit of observing pipelines and boilers. Small leaks, undetected and unattended can cause a surprising loss of energy. Check restrooms for dripping faucets; look for oozing valve stems; check shower room fixtures; kitchen fixtures should be checked. Watch radiators for leaks; check insulation for wet spots; make sure that toilet and urinal flush controls operate properly.

FANS AND DUCTWORK

Become familiar with the locations of all fans, dampers, and controls in your system. Be sure you know what each one does and why. Where are the controls? Are they properly set and maintained? Exhaust fans should never run beyond their necessary use. Intake fans should run no longer nor more often than necessary.

IRRIGATION SYSTEMS

It takes energy to pump water and irrigation systems add their share of the load. Check monthly at least for signs of leaks. Also examine valves and cutoffs, couplings, nozzles, hoses to make sure they are free from leaks and malfunctions.

1. In your facility every area has average footcandle readings. This is determined by taking separate readings in four areas of the room and averaging them. In the left column below indicate the average footcandle readings in designated areas. In the right column indicate what they should be according to your school unit's policies:

	WHAT THEY ARE	WHAT THEY SHOULD BE
Gym	______	______
Classrooms	______	______
Kitchen	______	______
Library	______	______
Halls	______	______
Restrooms	______	______

2. Lights add to the heat load in buildings both in summer and winter. Some lights, however, add more than others. Which of the following lights add the most in your facility?

Incandescent ______ Fluorescent ______

How many incandescent bulbs do you have? ______

How many fluorescent? ______

What is the total wattage? ______

3. Lights can add up to 40% of your building's electricity load. What are five approaches you could use to reduce lighting in your building? (Be specific.)

1.

2.

3.

4.

5.

4. Dust and dirt are a form of insulation. This is true in the case of lights as well. When was the last time you cleaned the reflectors and other elements of your lights? ______

What is the cleaning schedule you have established for these fixtures? ______

5. Task lighting is the most effective lighting. List the areas in your school where task lighting is used. ______

______

______

______

6. In every school there are areas that are excessively lighted. What areas in your school do you consider excessively lighted? ______

______

______

______

7. If you were able to reduce the wattage of every light in your school by only five watts, what amount of electricity would you save per hour? ______

8. Contrast is used to prevent glare and rest the eyes. Can you list any areas in your school where you would recommend more contrast? ______

______

______

9. Removing fluorescent tubes is an easy task, but how much energy does it save if you do not disconnect the ballast?

______

10. What are the clues that a fluorescent tube is "burning out" or is giving less than its expected light output?

______

______

______

11. What procedures do you have in your custodial program that encourage the personnel to reduce the lighting load?

____

____

12. Calculate for each individual area in the building the installed wattage per gross square foot. If light meter is available, compare actual lighting levels with recommended levels.

Area	Gross Sq. Footage	Installed Wattage	Watts/sq. ft.	Recommended Lighting Levels (Footcandles)	Actual Lighting Levels
Building no. ______					
Classroom	______	______	______	50-70	______
Hall	______	______	______	20	______
Auditorium	______	______	______	15-30	______
Office	______	______	______	70-100	______
Other	______	______	______	______	______
	______	______	______	______	______
	______	______	______	______	______
Total	______	______			

A quality roof is necessary for an energy-efficient building. It is an area where most of us lack necessary expertise. This is why this worksheet has been developed with a slightly different format.

A PROGRAM OF PLANNED ROOF MAINTENANCE

What causes major roofing problems? In many cases, probably innocent neglect. When roofing trouble starts, who sees it? Probably nobody. And, if anyone did see it, would he know what he was looking at? Would you?

Generally, roofing problems start small and escalate over a period of time into much larger problems requiring expensive solutions. By the time you are conscious of a roof leak, it may be too late.

Unfortunately, many feel a 20-year bonded roof, or a 20-year specification roof, requires little or no maintenance - other than occasionally cleaning drainscreens - for the 20-year period. It is precisely this inattention that permits minor roof problems to develop into more serious ones.

How do you avoid the serious problems? Perform periodic inspections and make necessary repairs.

When should you perform inspections? All built-up roofs should be thoroughly inspected at least twice every twelve months. Ideally, inspections should be made during the summer months on a sunny day when roof is free of all standing water.

WHAT SHOULD YOU LOOK FOR?

Buckles--Wrinkles Look for wrinkles that may appear directly above insulation joints or that may have a random pattern. They may start out narrow and low, remaining unnoticed (on aggregate surfaced roofs) until erosion of aggregate surfacing exposes the bitumen. They can grow to a 2" height. Repeated bending at the ridge, caused by cyclic elongation and contraction accompanying alternate wetting and drying of the felts, ultimately cracks the membrane at the ridges, breaking the roof seal and admitting water.

Blisters Blisters can vary from small, virtually undetectable spongy spots to bloated spaces one foot high and 50 square feet in area. A small blister may result from air or water vapor trapped between the plies. More serious is a large blister which indicates a bond break between the entire membrane and substratum. Normally, blisters will continue to enlarge and unless repaired, will rupture the membranes resulting in a leaking roof.

Exposed Laps Edge of felt exposed (not covered with bitumen) permitting moisture to enter the felt in the exposed areas.

Fishmouth An opening formed by an edge wrinkle in a felt where it overlaps another felt in a built-up roofing membrane.

Alligatoring Alligatoring occurs in asphalt and tar roofs. It occurs on smooth-surfaced roofs and sometimes in bare spots of aggregate surfaced roofs. It consists of deep shrinkage cracks, progressing from the surface down, a result of continued oxidation, aging and embrittling. The alligator cracks can retain water, which threatens eventually to penetrate through to the felts where it can cause damage.

Splits A membrane tear is most serious since it immediately admits water. Built-up roofing membranes generally split parallel to the longitudinal direction of the felts.

Ponding Dead level roofs or improper positioning of drains often result in ponds of water standing on the roofs for extended periods after rain. Ponded water frequently contributes to roof deterioration, leaks and other problems. The ponded areas should be inspected carefully and eliminated whenever possible.

Stack Vents Because of the nature of vents that penetrate the roof and provide possible access for moisture, both hoods and bases should be inspected carefully for possible water and snow entry.

Deteriorated Surface Look for oxidation of coating on smooth surfaced roofs and displacement of aggregate (to the extent of bare bitumen being exposed) on aggregate surfaced roofs.

Bare Areas On aggregate surfaced roofs, bare areas are the result of surface aggregate displacement from wind suction, water flow or drip where conductors from roof above discharge onto a lower roof. Rooftop traffic can also [illegible] re areas.

Bare Areas (cont'd) Surface erosion is less common on smooth-surfaced roofs but can result from excessive foot traffic, weathering, discharge of corrosive or solvent-type fumes or liquids on the roof surface.

Bare areas expose the bitumen and felts to the elements and accelerate deterioration.

Debris and Clogged Drain Screens Miscellaneous pieces of wood, metal, glass, etc., and vegetation will damage roofing. These should not be allowed to accumulate on a roof. Clean drain screens are necessary for the proper drain function.

Flashings Flashing leaks are the most common cause of roofing failure. Whenever leaks of unknown source occur, the flashings should be checked first for tears, holes, open seams, etc.

Flashings seal the joints at gravel stops, curbs, vents, parapets, wall expansion joints, skylights, drains, built-in gutters and other places where the built-up membrane is interrupted or terminated.

Base flashings are essentially a continuation of the built-up roofing membrane, at the upturned edges of the watertight tray. They are normally made of bitumen-impregnated, plastic or other non-metallic materials and applied in an operation separate from the application of the membrane itself. Counterflashing (or cap flashing), normally made of sheet metal, shields the exposed joints of base flashings.

Roof Penetrations and Pitch Pans These areas are very vulnerable areas for moisture admission. Optimally, the flashing detail at roof penetrations follows the general rule of attaching the base flashing to the penetrating element.

To identify a pitch pan, look for a flanged, metal container placed around a column or other roof-penetrating element and filled with bitumen or flashing cement to seal the joint. These should be kept completely filled, and without cracks in the bitumen which fills them.

Curbs and Platforms Top and bottom edges are vulnerable to cracks and splits. Examine carefully for breaks that will allow water to enter.

Expansion Joints Examine base flashing, counter flashing and cover piece for splits, tears, holes and cracks. Also, make sure the cover piece is securely held in place.

Metal Roof Edge Look for open joints or cracks in metal roof edge which permit entry of water into the wall or roof.

IMPORTANT: Whenever you are considering re-roofing in part or in whole, make every effort to include adequate insulation in the package.

A. It is necessary to take an inventory of building usage before energy conservation measures can be taken. Do the following usage inventory for your facility:

1. List the hours the students use your building each week for "regular" school activities.

   Regular classrooms ________ hours per week
   Extra-curricular ________ hours per week

2. Now list the hours of "non-student" activities in your building per week.

   ________ hours per week

3. Put these in a percentage basis and report them to your "boss."

   ________ % of week for classroom activities
   ________ % of week for extra-curricular activities
   ________ % of week for "non-student" activities

4. If you maintained a log of "non-student" activities during a four-week period, would you find:

   a. Activities that could be consolidated to eliminate using the school several times a week?
      _____ yes _____ no (Be specific)

   b. Could you close the building some nights before 10 p.m. _____ ? 9 p.m. _____ ?

   c. Could you consolidate activities in some areas of the buildings?
      _____ yes _____ no (Be specific)

   d. If the heat or air conditioning is turned off when students are dismissed, will the building still be comfortable for community use at night? (See chart on the following page)

What are the hourly temperatures:

Time	Heat	Air Conditioning
4 p.m.	___ °F	___ °F
5 p.m.	___	___
6 p.m.	___	___
7 p.m.	___	___
8 p.m.	___	___
9 p.m.	___	___
10 p.m.	___	___
11 p.m.	___	___

NOTE: Take samples several times a month each month school is in session.

5. A number of school districts have found that turning off security lighting either part of the night or all night does not increase vandalism, but does save energy. Has your school tried this experiment? ___ yes ___ no ___ in process. What do your security lights cost you to operate each month? $_____. In five years? $_____.

6. Night and week-end setbacks are considered the fastest and easiest ways to conserve energy.
   What are the actual times of your school's night set-back? _____p.m. to _____a.m.
   What is the set-back temperature? _____°
   Could you extend the set-back time? If so, to what? _____p.m. to _____a.m.
   Could you have a lower set-back temperature? _____°F

B. A number of schools have reduced energy usage by working closely with an interested teacher and their classes. Does that possibility exist in your school?

B. (cont'd) What activities would you be comfortable in allowing the students to undertake?

____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________

C. Often administrators are not aware of how much or when their building uses energy.

Does your principal see the utility bills? ________.

Does the principal receive any usage comparison reports of one year to the next? (Could you get the information for him?) ________.

Could you read the meters twice a day for a month and analyze time of day usage?

Would you find that you use as much energy during non-school hours as during school hours? (Use the attached form to find out.)

What can you do with the information?

BI-WEEKLY METER READINGS

______________ School

______________ Meter No.

______________ Constant

Date		Meter Reading	Difference of Meter Reading: Day	Night	Weekends
	PM	______			
______	Fri AM	______	______		
	PM	______		______	
______	Thurs AM	______	______		
	PM	______		______	
______	Wed AM	______	______		
	PM	______		______	
______	Tues AM	______	______		
	PM	______		______	
______	Mon AM	______	______		
	PM	______			______
______	Fri AM	______	______		
	PM	______		______	
______	Thurs AM	______	______		
	PM	______		______	
______	Wed AM	______	______		
	PM	______		______	
______	Tues AM	______	______		
	PM	______		______	
______	Mon AM	______	______		
______	Fri PM	______			______

Begin meter readings on bottom line. Subtract last reading from present and enter difference on appropriate line.

	Day	Night	Weekends
Total of differences			
x Meter Constant	x	x	x
= Kilowatt Hours			

D. Take a pad of paper and develop your energy conservation plan for your school as it relates to usage. Be sure to include:

- usage of doors for entrance and exiting
- light reduction
- people usage
- lowering/raising temperature
- using time clocks
- reducing fresh air intake
- utilizing "free-cooling"
- other personnel
- time schedules
- cleaning schedules
- up-dating principal

The following items of maintenance are intended to give you an easy-to-complete check list of items usually in need of service. You may wish to add to it.

	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Heating, Ventilating, Air Conditioning (HVAC) Thermostats, Controls Proper Location - Poorly located thermostats can cause false indications and excessive energy usage. Recommended Action:					
Setpoint Spread (68^0 Htg., 78^0 Clg.) - A 10^0 spread can save one-fourth to one-third energy. Recommended Action:					
Heating/Cooling Interlocks - Many cases of heating bucking cooling due to improper controls. Recommended Action:					
Off-Hour Setback (or off) - Maintain comfort conditions only during necessary hours. Recommended Action:					

Thermostats, Controls (cont'd)

	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Security Locks - Lock thermostats and controls to prevent readjustment. Recommended Action:					
Economical Cycle - Cool building with outside air when possible to prevent control overshoot. Recommended Action:					
Variable Morning Warm-Up - On warmer mornings building warm-up can be started later and still have comfort by opening time. Recommended Action:					
Heating Equipment Properly Adjusted - to highest efficiency. Recommended Action:					
Properly Sized - over or undersized equipment will not function as efficiently. Recommended Action:					
Adjustable Temperatures - Can set points on temperatures delivered be adjusted to minimums? Recommended Action:					

Heating Equipment (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Operation When Not Needed - (temp. lockout) - Interlock prevents overheating areas. Recommended Action:					
Waste Heat Reclamation - Use of heat exchangers Recommended Action:					
Use of Infrared - Can IR be used for spot heating rather than forced air? Recommended Action:					
Reheat - List all areas when thermostat reheat or boosters are installed to see if system is operating properly and efficiently. Recommended Action:					
Ventilation (air handling) Minimum Makeup Air - Heating or cooling makeup air is expensive. Recommended Action:					
Air Leaks - Is duct work tight (leaks waste energy)? Recommended Action:					

Ventilation (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Filters - Are they clean and the proper porosity for fan system? Recommended Action:					
Insulation - Is duct work insulated in nonconditioned spaces or areas where temperatures could be different (heating vs. cooling)? Recommended Action:					
Variable Speed Fans - Can fans be slowed when maximum air is not required? Recommended Action:					
Exhaust Fans - Are fans running when not necessary? Recommended Action:					
Conditioned Air to Unoccupied Areas - Can conditioned air be directed only to occupied areas? Recommended Action:					
Dampers and Controls - Are they functional and properly controlled and adjusted? Recommended Action:					

Ventilation (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Double Duct Systems - Energy wasteful if not properly instrumented, controlled and adjusted. Recommended Action:					
Zone Control - Are zones properly arranged to fit operation of building? Recommended Action:					
Unoccupied Periods - Determine which ventilating and A/C systems can be shut down during unoccupied periods in summer and winter. Recommended Action:					
Unoccupied Areas - Determine which ventilating equipment and fans are not required at night. Recommended Action:					
Controlling Exhaust Fans - Check method used to control operators of exhaust fans; often can be centralized to save labor. Recommended Action:					

Ventilation (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
High Rate Exhaust - Often high rate exhaust spaces, such as kitchens, rob conditioned air from other areas. Recommended Action:					
Minimum Make-up Air - Heating and cooling air is expensive; accurate measurements are needed to determine minimum amount. Recommended Action:					
Air Conditioning Properly Adjusted - To manufacturer's specifications? Recommended Action:					
Properly Sized - Over or undersized equipment will be inefficient. Recommended Action:					
Adjustable Temperatures - So that air is cooled no more than necessary. Recommended Action:					
Operation When Not Needed (temp. lockout) - Interlock prevents overcooling areas. Recommended Action:					

Air Conditioning (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Waste Heat Reclamation - Through use of double bundle condensers and heat exchangers. Recommended Action:					
Routine Cleaning of Coils - For maximum heat transfer. Recommended Action:					
Cooling Tower Maintenance and Adjustment (if appropriate) - For maximum heat transfer. Recommended Action:					
Unnecessary Humidity Loads - Dehumidification is expensive. Can exhaust hoods be used instead? Recommended Action:					
Precooling (Condenser Air or Makeup Air) - Evaporative cooling, dry cooling, and heat exchangers can cut on compressor loads. Recommended Action:					
73 Refrigerant Lines Insulated - Energy lost [illegible] refrigerant lines cannot cool the building. Recommended Action:					74

Lighting (Switching and Controls)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Manual Wall Switches - Many buildings have no provision for local control of lighting. Recommended Action:					
Automatic/Time Switches - Photocells or time switches can control inside lighting as well as outside lights. Recommended Action:					
Multiple Level Switches - To dim lights or turn off part of the lights when higher lighting is not necessary. Recommended Action:					
Flexibility - To turn off lights whenever they are not needed. Recommended Action:					
To Utilize Dayli[illegible] - Use of daylight wherever and whenever possible. Recommended Action:					
Laundry Equipment Operations - Is equipment only operated as needed? [illegible]mmended Action:					

Laundry (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Ventilation and Exhaust - Should be shut down when not required. Recommended Action:					
Washers and Dryers - Cycled to save time, money and wash clothes properly? Recommended Action:					
Water Temperature - Is this properly controlled to meet regulations, but not waste energy? Recommended Action:					
Reheat - Can exhaust air from laundry room and dryers be utilized to reheat other areas? Recommended Action:					
Chemicals - Can these be utilized to replace the use of very hot water? Recommended Action:					
Treated Fabrics - Can these save energy by requiring less drying time and ironing? Recommended Action:					

Domestic Hot Water and Kitchen	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Maximum Temperature Requirements - Maximum temperature on hot water units are often higher than required. Which ones can be reduced? Recommended Action:					
Cold Water - New chemical products often allow cold water to be used in cleaning. Recommended Action:					
Preheat - Waste heat can often be used to preheat domestic water. Recommended Action:					
Flow Restrictions - Restrictors used in showers and faucets can inexpensively save energy costs. Recommended Action:					
Local Water Heaters - Local heaters can often save the energy lost by long distribution lines. Recommended Action:					
Change in Energy Source - Conversion to an alternate energy source for heating water can often save dollars.					

Domestic Hot Water and Kitchen (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Preheat Cooking Equipment - Instructions properly placed on preheating can save BTU's. Recommended Action:					
Hoods, Fans - Supplying direct outside tempered air to hood ducts can often prevent removal of air from non-kitchen areas. Recommended Action:					
Meal Preparation - Preparing several meals at the same time utilizes equipment more efficiently. Recommended Action:					
Building Operation					
Morning Warm-Up (cool down) Minimized - Mild weather start-up can be much shorter than extreme weather leadtime. Recommended Action:					
Minimum Elevator Use, Off-Hours - Can some be shut down? Recommended Action:					

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Building Operation (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Janitorial Service During Working Hours - How much can be done during normal hours, e.g., trash collection? Recommended Action:					
Coordination of After-Hours Janitorial Services - Minimize the time lights are on. Recommended Action:					
Drawing Draperies or Blinds - Reduce heat loss at night. Recommended Action:					
Doors Closed - During normal hours to reduce heat transfer. Recommended Action:					
Flywheel Effect of Heating/Cooling - Can equipment be shut off before building closes? Recommended Action:					
Weekend Partial Operation - Can building be zoned so that only that portion of building in use will be turned on? Recommended Action:					

Building Operation (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Off-Hours Ventilation - Minimized or off. Recommended Action:					
Hot Water to Restrooms - Can temperature be reduced? Recommended Action:					
Refrigerated Drinking Fountains - Turned off during off-hours if control can be operated. Recommended Action:					
Uninsulated Hot/Cold Water Lines - Can they be insulated? Recommended Action:					
Leaking Faucets, Valves, Steam Traps - Repair. Recommended Action:					
Equipment (Xerox, Typewriters, Etc.) Running When Not in Use - Can energy savings be effected without reducing efficiency of operation? Recommended Action:					

Building Operation (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Convert In-Plant Electric Distribution System to Higher Voltage or Frequency Recommended Action:					
Power Factor Improvement - Can reduce in-plant energy losses. Recommended Action:					
Waste Heat Storage (hot water tanks) - Can it be stored and used later? Recommended Action:					
Spot Infrared Heating Rather Than General in Hi-Bay and Production Areas - Heat only the personnel - Considerable savings can be accrued. Recommended Action:					
Train Maintenance Personnel in Efficient Operation of Building - No control or equipment is effective unless the operating personnel understand how to utilize it efficiently. Recommended Action:					
Equipment Running When Not in Use - [illegible] it be turned off? Recommended Action:					

Building Operation (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Supplemental Lighting on When Not in Use Can it be turned off? Recommended Action:					
Supplemental Equipment on When Not in Use - Can it be turned off? Recommended Action:					
Under Part Load Conditions, Put All Load on One Boiler Rather Than Part Load on Several Boilers - Boilers are generally more efficient closer to full load operation. Recommended Action:					
Motors Properly Sized - Operate most efficiently. Recommended Action:					
Train Employees in Efficient Operation of Equipment and Processes - No equipment is better than the operator. Employee understanding and training is a must. Recommended Action:					

	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Boiler Economizers (add on) - If stack temperatures are high enough, a boiler economizer could recapture considerable energy. Recommended Action:					
Elevators					
Reduce Use - Posting signs to control use, such as recommending stairs, can be useful. Recommended Action:					
Lighting & Ventilation - Should be minimal within safety requirements. Recommended Action:					
Shut Down - Motors can be programmed to shut off when not in use by time delay switch. Recommended Action:					
Operation - Some elevators can be deactivated when not in use or during slow periods of usage. Recommended Action:					
Building Interior					
Walls					
Type of Surface - Good condition, easy to clean. Recommended Action:					

Building Interior (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Ceiling Type of Surface - Good condition, easy to clean. Recommended Action: ______					
Color of Surface - Light colors. Recommended Action: ______					
Insulation - Generally, the more the better if the building is heated or cooled. Recommended Action: ______					
Windows, Skylights Utilized for Light - Clean, unobstructed. Recommended Action: ______					
Heat Loss and Gain - Same as outside - possibility of double glazing. Recommended Action: ______					
Infiltration - Tight fit, caulking, latches function. Recommended Action: ______					

Building Interior (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Doors Automatic Closing - Between conditioned and unconditioned spaces. Recommended Action: ______					
Doors Insulation - Possible on large doors. Recommended Action: ______					
Infiltration - Weather stripping. Recommended Action: ______					
Building Exterior Walls Type of Surface - Good condition, air-tight. Recommended Action: ______					
Color of Surface - Light to reflect summer heat. Recommended Action: ______					

Building Exterior (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Roof Type of Surface - Good condition, air-tight. Recommended Action:					
Color of Surface - Light color and/or reflective. Recommended Action:					
Ventilation - Attic ventilators visible, adjustable. Recommended Action:					
Windows Shading, Shielding - Reflective film or outside shading best; inside shading next. Recommended Action:					
Maintained - Glass clean, no broken glass, windows fit. Recommended Action:					

Building Exterior (cont'd)	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Opened/Closed - Possible ventilation in summer, closed in winter unless extenuating reasons. Recommended Action:					
Entryways Open Doors - Doors should be closed when heating or cooling is operating. Recommended Action:					
Loading Docks - Doors closed into heated space or seals around trucks - automatic or remote controls. Recommended Action:					
Trucks - Automatic or remote controls. Recommended Action:					

Building Exterior (cont'd)

	WHO	DOES WHAT	BY WHEN	COST	COMPLETED
Exterior Lighting Floodlighting - Not excessive, off during daylight, use automatic controls. Recommended Action: ______					
Signs - Off during daylight, use automatic controls. Recommended Action: ______					

A. What, in your opinion, constitutes the main difference between a mini-audit and a maxi-audit?

B. Have you conducted a mini-audit of your school? ___ yes ___ no. When are you planning this audit if you have not done so? ______________________

Who did or will assist in this audit?

______________________ ______________________

______________________ ______________________

C. Does your school have an energy task force or committee to assist in energy conservation? Would you like to see one? ___ yes ___ no. Why?

D. In reviewing the attached mini-audit form, list ten areas of energy waste you anticipate you will uncover.

1. ______________________ 2. ______________________
3. ______________________ 4. ______________________
5. ______________________ 6. ______________________
7. ______________________ 8. ______________________
9. ______________________ 10. ______________________

E. On the following pages you will find an energy audit form. Although all terms used may not be familiar to you until the instructor defines them, be sure you understand these terms before the course is completed.

The purpose of this audit is to assist schools in saving energy. It is intended to be a self-help document to assist the operator in immediate conversion efforts.

facility information

1. Building______________ Function______________ Yr. Built________
2. Building Address______________ City__________ State________ Zip________
3. Business Phone______________ Building Manager__________ Building Operator__________
4. Mechanical Engineer______________ Electrical Engineer__________ Other__________

building data

1. Gross Floor Area__________ Gross SqFt X Ceiling Height__________ Ft = Volume__________ CuFt
2. Total Glass Area__________ SqFt Type of Glazing: Single________ Fixed________ Double________ Operable________
3. Exterior Wall Area__________ SqFt Material: Masonry______ Wood______ Other______ Concrete______ Stucco______ ______
4. Total Roof Area______ SqFt Color______ Condition: Good__ Fair__ Poor____
5. Insulation Type: Roof__________ Wall__________ Floor__________
6. Insulation Thickness: Roof__________ Wall__________ Floor__________
7. Operating Conditions: Summer; Indoor:___ °F___ %RH* Outdoor:___ °F___ %RH*
8. Operating Conditions: Winter; Indoor:___ °F___ %RH* Outdoor:___ °F___ %RH*

*Percent Relative Humidity

Building Data (cont'd)

	Time Period		Average Occupancy	Day(s)	Hours Per Wk.	Weeks Per Yr.
9.	______	- ______	______	______	______	______
10.	______	- ______	______	______	______	______
11.	______	- ______	______	______	______	______
12.	______	- ______	______	______	______	______

yearly energy consumption summary

Fuel	Gross Yearly Quantity Current	Base	Conversion Factor	BTU Consumption	BTU/GSF	Dollar per Square Ft. current	Base
Electrical	KW		x 3,413				
Natural Gas	CCF		x 100,000				
#2 Oil	Gal		x 139,000				
#6 Oil	Gal		x 150,000				
Steam	Lb		x 900				
Coal	Ton		x26,200,000				
Propane Gas	Gal		x 92,000				
TOTALS							

	A		B		C		D		E		F		G	
Month	Reading Date		Gas Used CCF		Gas Cost		Gas Cost Adjstmt.		Total & Cost (C + D = E)		$/CCF (E ÷ B = F)		Degree Days	
	From	To	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base
1					$	$	$	$	$	$	$	$		
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
TOTAL					$	$	$	$	$	$	$	$		
BTU Conversion Factor			x100,000	x100,000										
Total BTU's														

NATURAL GAS ____________________ CCF/YR.

Natural Gas Rate No. ______

Notes: This form is intended to be a working document. If it is kept monthly, you will see how effective your Energy Conservation Programs are.

"Current" means current month
"Base" means the base month of your base year.

Building _

	A		B		C		D		E		F		G	
Month	Reading Dates		KWH Used		Measured Demand KWH		$ Cost		(FCA) Fuel Cost Adjstmt. ($)		Total Cost (D + E = F)		$/KWH F ÷ B	
	From	To	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base	Current	Base
1							$	$	$	$	$	$	$	$
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
TOTAL							$	$	$	$	$	$	$	$
BTU Conversion Factor			x3,413	x3,413										
Total BTU's														

ELECTRICITY ________________ KWH/YR.

Electricity Rate No. ____

Notes: This form is intended to be a working document. If it is [illegible] t monthly, you will see how [illegible] ective your Energy Conservation Programs are.

"Current" means current month
"Base" means the base month of your base year.

Building ____________________

MONTH	READING DATES		OIL USED GAL.		$ COST		COST/GALLON		DEGREE DAYS		GALLONS USED PER DEGREE DAY	
	from	to	current	base	current	base	current	base	current	base	current	base
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
	TOTAL											
	CONVERSION FACTOR:											
			x139,000	x139,000								
	TOTAL BTU											

Notes: This form is intended to be a working document. If it is kept monthly, you will see how effective your Energy Conservation Programs are.
"Current" means current month
"Base" means the base month of your base year.

NO. 2 FUEL OIL ______________ GAL/YEAR

CURRENT YEAR ______________

BASE YEAR ______________

WATER

CURRENT YEAR __________ BASE YEAR __________

READING DATES		WATER USED (GALLONS)		COST ($)		$/GALLON		$ SEWAGE	
FROM	TO	CURRENT	BASE	CURRENT	BASE	CURRENT	BASE	CURRENT	BASE
1									
2									
3									
4									
5									
6									
TOTAL									

LIGHTING

FLUORESCENT:

PERCENTAGE GROSS SQ.FT. ________ (%) USAGE __________ (HR/WK)

INCANDESCENT:

PERCENTAGE GROSS SQ.FT. ________ (%) USAGE __________ (HR/WK)

AVERAGE LIGHTING LEVEL __________ (WATTS/SQ.FT.)

TOTAL INTERIOR LOAD __________ (KW) TOTAL EXTERIOR LOAD __________ (KW)

LAUNDRY INVENTORY

UNDER FUEL TYPE; N.G. = Natural Gas, E= Electricity

WASHING DATA

No. Of Washers	Washer Capacity	Total Weekly Loads
	lbs.	
	lbs.	
	lbs.	
	lbs.	
	lbs.	
	lbs.	

DRYING USAGE

No. of Dryers	Dryer Capacity	Total Weekly Loads	Fuel Type
	lbs.		
	lbs.		
	lbs.		
	lbs.		
	lbs.		
	lbs.		

MECHANICAL EQUIPMENT

OCCUPANCY SCHEDULE

_______________ HOURS/WEEKDAY

_______________ HOURS/SATURDAY

_______________ HOURS/SUNDAY

_______________ WEEKS/YEAR

_______________ FROM (MONTH)

_______________ THRU (MONTH)

HEATING SYSTEM

____
FUEL TYPE

____
RATED INPUT CONSUMPTION

____
RATED OUTPUT CAPACITY

SYSTEM TYPES

- O BOILERS
- O DISTRICT SERVICE
- O UNITARY DIRECT FIRED
  - O FURNACES
  - O PACKAGE EQUIPMENT

Describe Heating System Operations

____

____

____

COOLING SYSTEM

____
FUEL TYPE

____
RATED INPUT CONSUMPTION

____
RATED OUTPUT CAPACITY (TONS)

SYSTEM TYPES

- O ABSORPTION
- O ELECTRIC DRIVE
- O STEAM TURBINE DRIVE
- O WATER COOLED PACKAGED UNIT
- O AIR COOLED PACKAGED UNIT

Describe Cooling System Operations

____

____

____

OPERATION PROFILE

_____________ HOURS/WEEKDAY

_____________ HOURS/SATURDAY

_____________ HOURS/SUNDAY

IF NOT 52 WEEKS A YEAR:

_____________ WEEKS/YEAR

_____________ FROM (MONTH)

_____________ THRU (MONTH)

OPERATION PROFILE

_____________ HOURS/WEEKDAY

_____________ HOURS/SATURDAY

_____________ HOURS/SUNDAY

IF NOT 52 WEEKS A YEAR:

_____________ WEEKS/YEAR

_____________ FROM (MONTH)

_____________ THRU (MONTH)

SUPPLY AIR SYSTEM

	TOTAL CFM	MINIMUM % OUTSIDE AIR	VELOCITY
O SINGLE ZONE			
O MULTIZONE, 2-PIPE			
O MULTIZONE, 4-PIPE			
O TERMINAL REHEAT			
O DUAL DUCT			
O VAV*			
O VAV THROTTLING			
O VAV THROTTLING W/TERMINAL REHEAT			
O VAV BYPASS			

ECONOMIZER CYCLE

O NONE ....

O YES ..... CHANGEOVER TEMPERATURE ______ °F DRY BULB

O SYSTEM SHUTDOWN WITH OPEN WINDOWS FOR VENTILATION WHEN WEATHER PERMITS

ENTHALPY CONTROL TO OPTIMIZE USE OF OUTSIDE AIR FOR BUILDING COOLING

RETURN AIR PLENUM

O NO ....

O YES.... O- VIA CEILING GRILLS O- VIA LIGHT TROFFERS **

PERIMETER SYSTEM

SYSTEM TYPE ______________ TOTAL CFM ______________ CFM

DIRECT CONNECTED MINIMUM OUTSIDE AIR ________ (%) % PERIMETER ZONE SERVICE ____________ (%)

AGGREGATE CAPACITY:

HEATING ______________ BTU COOLING ______________ BTU

DOMESTIC HOT WATER

DAILY USAGE:

______________ GALLONS/DAY TEMPERATURE RISE ________ °F

** Troffer - A vent in the reflector package of a ceiling mounted fluorescent light fixture.

To be useful, records should not be elaborate - they should be adequate. Lesson Two suggested design and construction of several charts to assist you in your plant management and also to give you a basic record system to give you an idea of the progress you are making. Let us review what we have done so far:

Three-year fuel consumption record by months and three-year average. This was the bench mark we established to see whether any of the changes we have suggested are effective in relation to previous practice.

Three-year electricity consumption record by months and three-year average current consumption record by months and by year. This builds our historical record and is used also for comparison on a month-by-month basis with the three-year average to demonstrate gains or losses from changes in practice.

COST CHARTS (Billing Records)

Charts to establish setup and setback times depending upon outside temperatures.

These were designed for experimental purposes only and need not be kept other than in summary form after best practice is determined for your building.

MAINTENANCE CHECK LISTS

These were set up for daily, weekly, monthly and annual service checks for fuel, electric, boiler and air conditioning systems.

EQUIPMENT INVENTORY CARDS

One other very important record series consists of a card filing system, properly indexed (5 x 8 cards, or similar size, is recommended) on which the following information as a minimum should be entered:

NAME OF ARTICLE	MANUFACTURER (address if available)
MODEL NO.	NAME & ADDRESS OF SUPPLIER (Tel. No. if handy)
SERIAL NO.	DATE OF ACQUISITION OR INSTALLATION
COST	DESCRIPTION (size, color, capacity, etc.)
MFGR'S RECOMMENDED MAINTENANCE SCHEDULE (lubrication, kind of lubricant, cleaning, tightening, etc.)	
RECORD OF REPAIRS (what was done, when it was done, who did it, cost, etc.)	
ANY OTHER PERTINENT DATA YOUR NEEDS SUGGEST	
RATED LIFE EXPECTANCY	

These cards should be kept in a suitable, convenient filing drawer. Along with each card, if available, a manufacturer's manual, guarantee, schematic, wiring diagram, etc. should be filed with the card. If these items are kept elsewhere in the district, cross-reference your card to show where the data is kept, who is responsible and the telephone number.

RECORDS SHOULD BE ORGANIZED

- Alphabetical, cross-referenced for similar terminology
- Conveniently kept
- Notations should be made immediately. Do not promise yourself that you will catch up with them in your spare time. DO IT NOW!

A good set of records is your first resource in an emergency. Records also form the basis of intelligent budgeting, which is our next lesson.

BUDGETING

In the last lesson we learned that a good historical record is the best basis for intelligent budgeting. Many times school districts do not involve custodial and maintenance personnel in budgeting because these personnel have not kept adequate records and have not demonstrated knowledge of the problems. Your participation in this course should help change that picture.

Budgetary functions you have a vital interest in are:

New Equipment	Operational Costs
Maintenance Costs	Alterations and Additions
Supplies, Materials	Labor Costs
Time	

Let us look briefly at each of these.

NEW EQUIPMENT

Inventory cards - what do they tell us of our needs for new equipment?

When was the equipment installed?

What is its anticipated useful life?

How many years has present equipment been used?

When should it be retired? (Waiting for the final breakdown and emergency replacement is costly.)

What does the repair history tell us of probable useful life in relation to frequency and cost of repairs?

What will replacement costs be?

MAINTENANCE COSTS

Inventory Cards

Record Sheets (History of repairs and costs)

SUPPLIES, MATERIALS

What are your records showing with reference to increased or decreased needs for supplies and materials?

Changes anticipated for next year?

Increased costs?

OPERATIONAL COSTS

Record Sheets

Fuel cost history - what are your projections for next year?

Are there anticipated changes in building utilization or schedules that may affect this history?

Electrical costs - what are your projections for next year?

Changes in building utilization? Additional electrical equipment placing new demands? Rate changes? Have you anticipated rising costs in your projections?

ALTERATIONS AND ADDITIONS

Here again, your record series may well point the way for building changes which will help pay for themselves - such things as individual room thermostats, zone controls, double doors in the vestibules for air locks, etc.

LABOR COSTS

Salary increases

Need for additional part-time or full-time help

Possible reductions

What effect will changes in building utilization or scheduling bring about?

Costing - Every one of the items suggested above has a dollar value. In these times when school district budgets are under heavy pressure, we must realize that every dollar expended must be studied.

Justification - The real service of good record keeping is now apparent. Not only do we attach a dollar figure to the items above mentioned, but now we can attach a justification statement to our request. We no longer say we think we need a new steam trap - now we can say we need a new steam trap because the temperature of the condensate has been steadily increasing. We no longer say we think we need some soda ash to soften our water; we say the pH factor shows we need it, and our records show an increasing amount of scale and sediment.

Who knows, but we may be able to point out that our records show our improved management has reduced fuel consumption to the point that we can more than pay for the new desk we are asking for this year.

TIME

One other scarce commodity we deal with is time. Every move we make, every procedure we follow takes time. Ordinarily we think of budgeting only in relation to the dollar costs. Good budgeting also pays dividends in better allocation of the costs of time.

Work Schedules - Good practice has demonstrated over and over that development of a good work schedule is the best time saver you can devise. If you do not have a work plan already, prepare one in accordance with the following outline. If you do have a work plan, re-think it in the light of what you have covered in this course.

What is your job description? (Make a list of the things you are expected to do.) Now examine the tasks. When are they expected to be done? Make a chart showing which tasks are to be done - several times a day; daily; weekly; monthly, yearly; other times (twice a week, every six weeks, etc.).

Now, budget these tasks into your daily schedule. But think how you can combine these tasks with your energy conservation lessons. Always carry a handy notebook with you. As you sweep Room 20, look for signs of radiator air leaks. Jot down that the air valve needs replacement in the corner radiator. As you wash the windows in Room 5, note that recaulking a frame will cut down a previously unnoticed draft. Room 12 is overheating - you notice as you enter and begin to sweep. Jot down a reminder to check the valves and controls in the period you have set aside for repairs.

Every task you perform has possibilities for energy conservation if you learn to think through and work through you daily schedule.

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APPENDIX

Slide Narration and Slides*

*Slides are present only in instructor's copies of course initially presented to institutions. Slide Narration is included in all copies to serve as a list of suggested conservation actions.

1 Title Slide.

Conservation

As authorities on the operation of the school plant and its energy usage, custodial and maintenance personnel should work with principals to encourage the faculty, staff and students to practice energy conservation.

2 Decals have proved to be successful in reminding people that lights should be turned off when not in use.

3 Encourage use of natural light when possible. It is not necessary to turn the lights on in this hallway since there is sufficient natural light. Lights in background are in an adjacent classroom.

4 Here is a case where a school is paying for unnecessary lighting in an unoccupied cafeteria.

5 Lighting should only be turned on during the time the cafeteria is in use and natural light should be used as much as possible. Note use of row lighting. Dividing the lighting into rows and keeping the row next to the windows turned off on sunny days is a good conservation policy.

6 Use of outside security and parking area lighting should be evaluated. Schedules for minimum use should be prepared and timers or photo-cells utilized.

7 Keep doors and windows closed to prevent air leaks from heating and cooling systems, but open them to use "free" cool air during the warmer months. Door closers should be maintained for proper operation.

8 In heating season, blinds can be opened during day to take advantage of solar gain and closed at night to cut down on heat loss. During periods when air conditioning is being used, blinds can greatly reduce solar gain.

9 Window air conditioning units should be covered or removed during heating months.

10 Exhaust fans should not be run when not needed since they cause a loss of conditioned air.

11 Schedule the use of special, non-essential equipment such as a kiln so that usage does not occur during peak load times, i.e., on hottest or coldest day of the year or when kitchen is in use.

12 When practical, schedule after school activities such as basketball games immediately after school.

13 Heat and light just the areas of the building that are to be used during after hours activities, such as conference and meeting rooms.

Retrofitting

Small and large retrofitting can effect a savings depending, of course, on projected life of building.

14 Weatherstripping windows such as this one which no longer closes tightly can reduce air leakage. Doors should also be checked for the need of weatherstripping or replacement with metal insulated doors.

15 In areas such as corridors, cafeterias, conference rooms, closets and toilets, lighting levels can be reduced and still be adequate. If replacing lighting, fluorescent fixtures are more economical than incandescent.

16 Instead of lighting a total area, consider installing task lighting as has been done for this bulletin board display. Task lighting also works well for teacher's desks, study carrels, drafting tables, shop tool areas and library book shelves. Note in the slide the use of a clerestory window to light a corridor.

17 Thermostat settings should be controlled by authorized personnel. The newer type guards are recommended since the old type still allows manipulation of the thermostat.

18 Providing larger water storage will effect a savings if peak pricing or time of day billing of electric power exists. Larger storage allows shifting of electric water heating load to an off peak time.

19 Installation of flow restrictors on shower heads can reduce hot water use greatly.

20 The installation of a drop ceiling with insulation can be cost effective especially on the top floors of buildings.

21 Evergreen trees left during construction or planted on the north side of a building serve as an effective windbreak and reduce heating costs.

22 Enclosures around the base of mobile units should be added to reduce heat losses through floors. Mobile units should be placed on the south or east side of a building with long sides running north to south. These units were well placed in the protecting L formed by the building.

23 Old style foundation vents to crawl spaces should be closed off in some manner during the heating season or replaced with the type of vent shown which has its own closing device.

24 On south, south-east and south-west windows, roof overhangs allow solar gain during winter and shade from solar gain at other times. The overhang shown is not quite long enough to be effective. It could be increased or deciduous trees to shade would help.

Heating and Cooling Systems

The area in which the largest savings can be effected is the HVAC system.

25 HVAC controls should be thoroughly understood by those responsible for their operation. A periodic evaluation of the system and its operating record should be made and the written operating procedure updated.

26 Many situations can be improved with the installation of zone control valves.

27 In many of the schools in which a hot water heating system was initially installed, zoning has been provided by the use of hot water circulator pumps. The example shown here has seven zone control pumps.

28 Fresh air intakes should be dampered during heating season and closed completely during non-operating hours.

29 A preventative maintenance program is helpful in assuring proper burner operation and as a results, a fuel savings.

30 Boiler combustion tests should be run on boilers periodically.

31 Heating surfaces of boilers should be kept clean to insure proper heat transfer to heating medium.

32 A program should be established for the periodic cleaning or replacement of filters as needed to insure optimum equipment performance.

33 Radiator stop valves should be checked periodically for proper operation. A leaking radiator valve causes unnecessary heat build up in a room.

34 Seven-day clocks and override zone control timers provide a means to prevent heating and/or cooling during periods when building is unoccupied.

35 It is important to understand rate schedules and how your electric power bill is determined. Shown is a kilowatt-hour meter which also includes a demand (kilowatt) reading.

36 Credit Slide.