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The high cost of energy and the curtailment of primary preferred fuel has upset many long-standing maintenance and operation policies, forcing institutions to look quickly for ways to reduce energy usage. This booklet is designed to assist institutions of higher education in establishing or upgrading energy conservation programs. The development of the Campus Energy Management Program is discussed including elements of the program; commitment; energy conservation committee; an energy management officer; energy use and cost information; and results, measurement, and evaluation techniques. Energy consumption reduction categories that are detailed include "quick-fix" systems, "refit" systems, and systems capable of being converted. Each of these categories is presented in detail along with a checklist of ideas to implement and sustain an energy management program on the campus. (JSF)

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Volume I

Guidelines

Federal Energy Administration

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State Energy Conservation Programs

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December 1976

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Energy Conservation Now

FOREWORD

The Federal Government has developed a variety of programs through the Federal Energy Administration to foster large energy savings in the areas of building construction, maintenance, and operation. This publication has been prepared for institutions of higher education by the Energy Task Force through Federal Energy Administration Contract No. CO-04-50247-00 with the Association of Physical Plant Administrators of Universities and Colleges. Its purpose is to assist colleges and universities and other non-profit institutions to mount and sustain effective energy management programs.

A clearly recognized feature of such an undertaking is the need for a cooperative campus effort involving the president, chief financial officer, and director of physical plant. With this need in mind the Energy Task Force, representing the American Council on Education (ACE), National Association of College and University Business Officers (NACUBO), and Association of Physical Plant Administrators of Universities and Colleges (APPA), developed these guidelines to assist institutions of higher education in establishing or upgrading energy conservation programs.

The guidelines that follow are the result of an extensive analysis of existing energy management programs augmented by administrative and technical expertise drawn from numerous resources. The Federal Energy Administration recognizes the valuable contributions of many of the institutions that provided comprehensive and authoritative energy conservation information that was extremely helpful to all participants. Case Studies of successful energy conservation efforts by a broad segment of the higher education community are presented in the second volume.

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INTRODUCTION

There is little doubt that for the foreseeable future colleges and universities will have to deal with decreasing energy supplies, increasing prices, periodic shortages, and tightened budgets. Programs of effective energy management must be vigorously pursued if stable academic environments are to be maintained and forced closings avoided.

Since 1973 energy costs on campuses have doubled, and, on some, tripled. Prior to that time cost emphasis was primarily directed toward materials and labor rather than oil, gas, and electricity.

The high cost of energy and the curtailment of primary preferred fuel has upset many long-standing maintenance and operation policies, forcing institutions to look quickly for ways to reduce energy usage. During this search, administrators found that many college buildings consume large quantities of energy by virtue of their design. Alterations to many of these facilities would be difficult and costly. Therefore, initial low cost alternatives were taken, permitting time for study in order to devise long range methods to lower the amount of energy consumed.

In spite of design limitations, these low cost conservation measures already in use by colleges and universities have saved 15% to 25% of the energy previously used. In some individual buildings the percentage has been higher.

When developing an energy management program the unique character of the college or university community must be recognized. The diversity of energy use within an institution, the decentralized decision making process which characterizes higher education management, the transient population of students and faculty, and the life support services provided by many institutions are factors for consideration when establishing an energy management program within the educational structure. Few physical services of an institution can thus be seriously curtailed or terminated without disrupting the function and viability of the campus community.

To support the academic, social and administrative functions of the college, a Campus Energy Management Program should continually examine and refine energy use patterns. The result of this energy management effort will be to eliminate the waste of energy on the campus while effectively and economically allocating energy resources to support the campus community. This effort requires the whole-hearted cooperation of all members of the campus community.

CHAPTER I
Development of the Campus Energy Management Program

ELEMENTS OF THE CAMPUS ENERGY MANAGEMENT PROGRAM

1. Commitment
2. Energy Conservation Committee
3. Energy Management Officer
4. Energy Use and Cost Information
5. Results, Measurements and Evaluation

COMMITMENT

To be successful a Campus Energy Management Program should command the enthusiastic support of the college president or chief executive officer. Such support will assist in gaining the cooperation of campus leaders and their active participation in effecting and implementing the energy management program. Such support will also assist in persuading the community to share the commitment to participate in the energy management program.

Effective energy management requires some difficult decision-making and adherance to these decisions. If such policy is to be successful the decisions must be supported by the president and clearly communicated to the campus community.

THE ENERGY CONSERVATION COMMITTEE

Having gained the support of the president, many institutions have also found the formation of a Campus Energy Conservation Committee to be of significant value in an effective energy management program. The diversity of energy use within an institution as well as the changing academic and social priorities make it necessary for the entire campus to be involved when making energy conservation decisions.

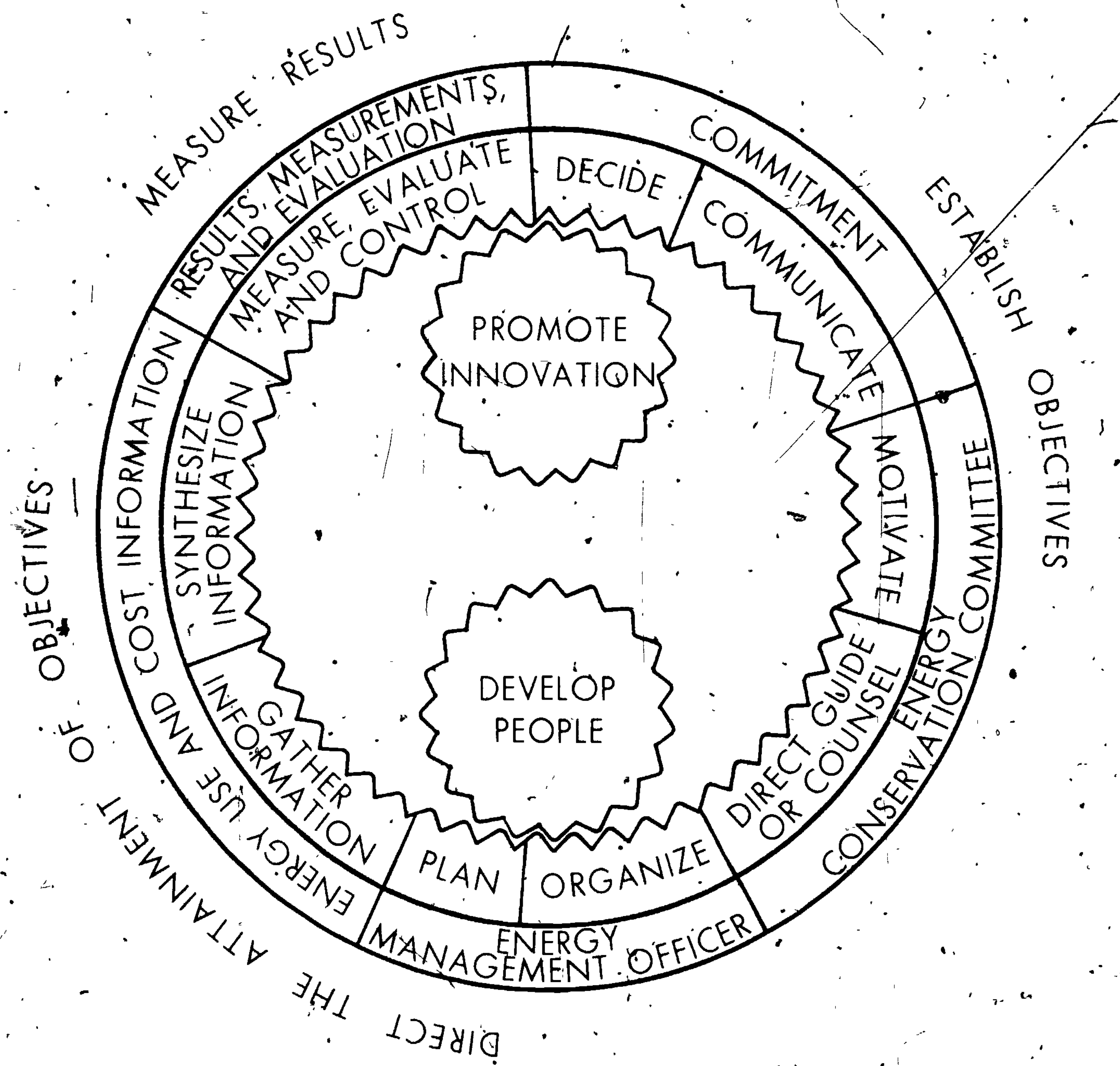
Representation on an energy conservation committee could come from the full spectrum of people and groups associated with the institution, but should include individuals from all groups that influence the cost and/or usage of energy: faculty (department heads), administration (registrar, admissions), student body (student leaders), auxiliary enterprises (housing, food service), physical-plant, and technical experts (engineering consultants).

The committee's purpose is to develop an energy management plan that seeks the most efficient use of energy resources on the campus by establishing realistic goals, policies and methods for evaluating the results of these policies.

One of the most effective plans for committee action is the selection of working sub-committees with specific task objectives and realistic time schedules.

The Energy Conservation Committee should also assist in the development of guidelines for pursuing the variety of energy conservation opportunities available to an institution. The

Elements of the Campus Energy Management Program



committee should: Review initial low-cost measures which quickly reduce energy waste (Quick Fix); establish measures which involve the rehabilitation of existing facilities (Refit); and develop projects which involve major engineering and systems changes (Systems Convert).

In addition, the committee should set energy conservation guidelines and criteria for the construction of new facilities as well as examine the variety of methods for financing energy conservation measures on campus.

The ability of the Energy Conservation Committee to make effective recommendations for specific energy conservation projects will be dependent upon the committee's understanding of the institutional energy use. Interpretation of basic and detailed data as described in the next section will allow the committee to establish procedures, schedules and tasks for further energy conservation study. Such further study will ultimately result in a list of carefully conceived energy conservation priorities which can be presented to the proper administrative officers for action.

Communication to the campus community of the committee's action and the results of these projects are most important.

ENERGY MANAGEMENT OFFICER

The institution should give the responsibility for the management of the program to a full-time Energy Management Officer, usually recruited from the physical plant staff. Savings in energy should easily justify the loss in management time of the *manager* from other areas of responsibility or justify a new addition to the staff. The responsibility of the Energy Management Officer should be assigned to a person who is in the position to manage effectively, carry out programs and be technically qualified to coordinate the activities of the energy conservation committee.

ENERGY USE AND COST INFORMATION

The Energy Information Collection System consists of the following three levels:

A. Overall Campus Energy Use: A total of the energy input to the campus and identification of each energy source.
B. Building Energy Use: Energy supplied to each building, identifying the system use in each building.
C. Generation and Distribution System Survey: Central plant operation for steam, electricity, chilled-water, etc., and the distribution of these throughout the campus.

The implementation of the energy management program requires that intelligent decisions be made based on data obtained from a systematic survey of the institution. Forms are provided in the Appendix that can be used to evaluate the campus facilities.

The *Energy Survey Form* Appendix A may be used to evaluate the overall campus energy use or to determine the building energy use prior to implementing a detailed conservation study.

A more thorough analysis of each building will require the expertise and ability of a competent professional, utilizing detailed building information forms similar to that found in Appendix B titled *Building Information Survey*.

Cost is an essential factor for consideration when setting or reevaluating priorities. Many energy reduction projects that might have been merely marginal investments before the price of fuels and electricity began their rapid increase are now economically justifiable. Before any investment is undertaken, some quantitative measure of profitability is desirable so that the investment's expected return can be compared with that for alternate investment opportunities. *Life Cycle Costing Techniques* can be used as one method to measure the institutions' energy investment opportunities. This process attempts to measure the *total cost of ownership* over the expected life of the energy reduction effort.

RESULTS, MEASUREMENTS AND EVALUATION

In order to determine how effective the conservation program is in promoting conservation of energy over a given period of time, it is desirable to establish baseline data. Total energy usage information should be collected and charted to provide factual information for the management of the campus energy program. Examples of various charts for allocation and display of this information are shown in Appendix C.

One measure that reduces all energy use figures into a common denominator is the BTU's per square foot of space. This, of course, is not the only index or criteria since many other indices, charts, and tables are used.

Several colleges have utilized such indices as BTU, BTU per FTE, BTU per degree day, BTU per FTE per degree day, and energy dollars spent per FTE per year. It should be noted that these indices will vary widely from institution to institution and must be objectively evaluated.

Once a *baseline* is established for overall use of energy on campus and for various classifications of building types, a building-by-building survey should be initiated. Data gathered from this activity can be checked against overall campus energy usage figures to establish a measure of performance for each building. In addition, buildings that are users of large quantities of energy, and therefore prime conservation targets, can be identified from the survey.

Further refinement of this building data is necessary in order to pinpoint conservation opportunities and to measure consumption reduction progress. A functional classification of facilities by category of use, i.e., laboratory buildings, administrative buildings, gymnasiums, academic buildings, etc., is often helpful in this refinement process, especially at institutions with a diversity of facilities. Within each facility category a further breakdown to identify and direct their efforts towards those facilities consuming the largest amount of energy.

Most institutions of higher education utilize central steam-boiler plants for campus distribution of steam. In some cases, the same steam is also used to generate electricity by passing the steam through turbines prior to distribution for heating purposes.

Analysis of the effective use of steam generation within power plants is certainly an important component of an energy management program, since power plant inefficiencies can cause significant increase in the consumption of energy. While initial evaluation of the effective use of steam can be based on such a unit as *pounds of steam per unit of fuel*, detailed evaluation of various individual processes of power plant such as combustion, water treatment, and the elimination of soot accumulation should be done by trained professionals.

Similar expertise should also be employed for the analysis of purchased electricity or in-house electrical generation systems as designed voltage and rate structure vary significantly from one institution to the next.

CHAPTER II
Energy Consumption Reduction Categories

At most educational institutions an Energy Management Program can be classified into three categories of energy consumption reduction opportunities. The three categories may be classified as Quick Fix, Refit, and Systems Convert. Each category offers a greater opportunity for consumption reduction than the one that precedes it, and each involves an increasing rate of capital expenditure. When considering each category, planned maintenance should be considered as an essential part of the energy management program. Listed below are the three categories with the estimated reduction in energy consumption and the estimated level of expense per square foot in order to effect such consumption reduction.

CHART OF ENERGY CONSUMPTION REDUCTION CATEGORIES

CATEGORY		ESTIMATED REDUCTION IN ENERGY CONSUMPTION	ESTIMATED LEVEL OF EXPENDITURE PER SQ. FT.
I.	Quick Fix	10%	$ 0.00
II.	Refit	20-25% (including I)	$ 0.25–1.20
III.	Systems Convert	30-40% (including I & II)	$ 1.25–2.00

QUICK FIX

Quick Fix can be defined as energy reduction measures that achieve rapid and significant energy savings at negligible cost with little or no disruption of the academic environment. Non-technical energy measures such as adjusting temperatures and lighting levels will quickly eliminate obvious wastes and result in energy reductions of at least 10 percent for most institutions. Minimal lead-time is required for the implementation of the Quick Fix measures, especially if campus-wide cooperation can be gained.

The building and mechanical systems are designed to provide the campus community with comfortable living and working conditions and to support educational and research activities. It is everyone's responsibility to utilize buildings and mechanical systems without wasting energy.

To do this successfully people must be made aware of the ways to conserve energy. Quick Fix activities could include *turn the lights off* campaigns, consolidation of activities into fewer buildings, adjustment of work schedules to utilize daylight hours, and maintenance reviews of buildings and equipment. These and many other suggestions are presented in Chapter III. Since not all Quick Fix suggestions will work on every campus, selection should be made with care. The rapid results generally produced by Quick Fix measures should be publicized and used to encourage support for the other phases of the Energy Management Program. Preliminary surveys of most campuses show a 10% to 25% reduction already achieved without major changes such as described in the following Refit and Systems Convert sections.

A discussion of preventive maintenance is beyond the scope of this publication, but it is very important to note that a prime requisite of energy efficient systems is proper maintenance. A review of preventive maintenance procedures may well be an appropriate topic for a Conservation Sub-committee. Such routine tasks as cleaning filters, testing controls, and adjusting belt tensions are all too easy to defer. However, the cost for unnecessary energy consumed by such improperly maintained items easily can add up to thousands of dollars each year. Information is available from APPA which has published many papers on this subject.

REFIT

Refit can be defined as an energy reduction measure which requires moderate capital investment to achieve additional energy savings of 10% to 15%. Emphasis in the Refit category is based on an effort to analyze the different types and amounts of energy consumed within an institution by using charts and forms similar to those found in the Appendix. Prior to committing capital for specific energy conservation measures, each campus should analyze its own needs and decide which Refit measures will be the most cost-effective (Chapter IV). Campuses should publicize their Refit priorities and the resulting energy saving in order to maintain the energy awareness and support of the entire community.

SYSTEMS CONVERT

Systems Convert can be defined as a major change of a system design. Systems Convert is the most sophisticated and expensive category of the energy consumption reduction measures (Chapter V). Not all institutions or buildings within a given institution can benefit from these highly technical measures. Institutions that specialize in scientific and medical research generally offer the best opportunity for significant savings of energy as a result of a Systems Convert Program. Normally these measures would be applied after a thorough Quick Fix and Refit programs have been successfully implemented. These two conservation measures are usually prerequisites for the type of major capital investment that would be required in the Systems Convert category.

SUMMARY

The accumulative impact of these three consumption reduction measures can bring about institutional energy savings ranging from 30% to 40% at a cost that should not exceed $2.00 per gross square foot. An energy management program along the Quick Fix, Refit, and Systems Convert line will insure that an institution is investing its time, effort, and money wisely at a pace that does not outstrip its energy management technology or its technical capacity to invest human and financial resources effectively. Refit and Systems Convert measures require careful planning and scheduling to minimize inconveniences and disruptions. Therefore, it is recommended that competent professional advice be employed to undertake Refit and Systems Conversion studies. Such studies should first be directed toward buildings identified by the *building information survey* as major consumers of energy where possible energy problems could exist.

The checklists provided in Chapters III, IV, and V provide those responsible for energy management programs with cost-effective ideas to implement and sustain an energy management program on the campus. The lists do not pretend to be all inclusive but are rather a broad sampling of the wide variety of opportunities for energy management which exist in institutions of higher education across the country.

CHAPTER III
Quick Fix Checklists

OPERATIONS

1. Adjust student and staff hours to maximize daylight working hours.
2. Consolidate activities into fewer buildings.
3. Encourage enforcement of *No Smoking* in buildings to permit reduction of fresh air.
4. Schedule custodial/janitorial work involving electrical equipment such as buffers, scrubbers, vacuums, etc., at night to reduce peak demand cost.
5. Install signs on exterior walls near delivery doors providing instructions to keep doors closed.
6. Post signs near electric power consuming machinery urging it be used sparingly and preferably during off-peak hours.
7. Cold rooms, environmental rooms, refrigerators, freezers, ovens, and similar equipment not in productive use should be turned off.
8. Schedule the use of laboratory equipment to reduce or curtail its use. If necessary, it should be used other than during peak demand periods (10 a.m. to 3 p.m.).
9. *ON* schedules should be established for office equipment such as copying machines, calculators, typewriters, etc. The practice of turning on a copier the first thing in the morning and leaving it on all day is convenient but uses a significant amount of electricity. Early afternoon hours should be avoided in scheduling.
10. Establish a policy to screen requests for purchase of additional energy-consuming devices.
11. Turn off water-using laboratory equipment when not in use.
12. Encourage a limitation on student showers to no longer than five minutes and preferably three minutes.
13. Share your shower.
14. Laboratory aspirators use two gallons of water per minute. Turn them off when not needed.
15. Use *Lights Out* reminders at switches, office and building exits.
16. Have security personnel check for excess lighting left on after departure of custodial personnel and instruct them to turn off those lights discovered and report those which they cannot control.
17. Encourage building occupants and visitors to use the stairway rather than the elevator when only a few stories are involved and when security permits.
18. Locate wall hangings, displays and furniture away from supply and return air grilles and registers to prevent obstruction of air flow.
19. Utilize task lighting as contrasted to area lighting.
20. Place in proximity to one another those persons whose tasks require similar lighting levels.
21. Have persons working after hours work in proximity to one another to lessen lighting and HVAC (Heating, Ventilating and Air-Conditioning) requirements.
22. Prepare on-campus sign showing by thermometer/graphics the current energy use compared to the same month of the previous year. This can be shown by BTU's consumed (billions) or by dollar costs. Electricity, fuel, natural gas, and possibly gasoline can be included together or separately. Degree days for each month can also be indicated for valid comparison purposes.

23. All students, faculty, and staff should be encouraged to make suggestions that can increase the effectiveness of efforts to conserve energy.
24. Encourage reporting any malfunctioning heating or cooling equipment, drafty windows, doors, open vents or chimneys. Identify areas that are too hot in winter and too cool in summer. Opening doors and windows increases the waste, except between seasons when separate heating/cooling systems are being adjusted. In the latter case, attempts to adjust thermostats to proper comfort levels should be made first.
25. Encourage students, faculty, and staff to utilize blinds and curtains to help insulate the building. Closed blinds and curtains on South and West exposures will help keep a building cool in summer, while opening the blinds or curtains will help warm the building.
26. Use a minimum number of lights when night cleaning is to be continued, making sure they are turned off as areas are cleaned.
27. Encourage custodial personnel to report energy wastage, with incentive awards to recognize cooperation and contributions.
28. Encourage the wearing of appropriate clothing by everyone to compensate for lower temperatures in the winter and higher temperatures in the summer.
29. Students should not be permitted to use idle classrooms indiscriminately as study halls. Provide alternate facilities such as consolidation into a single unscheduled classroom.
30. Periodic checks should be made of student residence halls to see that unnecessary electrical use is curtailed.
31. The cooperation of students should be requested to eliminate the traditional water fights and use of shower rooms for steam baths.
32. Establish a Student Energy Advisory Group with representation on an Administrative/Faculty counterpart group to provide energy-saving input, and to solicit student cooperation in campus-wide conservation projects.
33. Survey student residences that are not fully occupied to ascertain if consolidation will enable an entire building to be shut down.
34. Send letters to all users of campus heating/cooling systems asking their cooperation in energy conservation measures. Include sufficient information to enable them to comply.
35. The Physical Plant Department should designate one member of administrative staff as key contact for energy conservation information or assistance.
36. There should be a narrative report submitted that describes briefly any conservation action taken in each building toward compliance with the approved plan.
37. Cost data should be accumulated for charges to physical plant budgets required to implement and maintain an energy conservation program.
38. Schedule vacations during energy intensive periods. Climatic conditions are a major determinant.
39. Check to insure that all outside door closures are working properly; that weather seals are intact and are installed in other locations where practicable. Inspect all windows to see that they are kept closed when the buildings are in the heating or cooling mode.
40. Develop detailed shutdown program for maximizing energy savings during holidays and semester breaks, and an abbreviated program for over weekends.
41. Reduce thickness of ice for hockey arenas to 1-1/2 inches.

VEHICLE/TRANSPORTATION

1. Establish and enforce a maximum speed of 55 miles per hour for all school-owned vehicles.
2. Replace standard-size vehicles with compact cars wherever possible.
3. Organize a car pool with central coordination by campus volunteers or paid staff.
4. Adjust carburetors for leanest fuel mixture.
5. Keep engines in fine tune through regular preventive maintenance.
6. Urge departments or schools to consolidate local trips for package pickup where possible. Set up a departmental or school pickup system if volume warrants.
7. Consolidate field trips.
8. Elimination of all motor pool practices, except for medical, police and maintenance.
9. Charge people in car pools reduced parking fees.
10. Encourage use of campus bus system.
11. Prohibit anyone living within six blocks of campus from parking on campus.
12. Start *Wednesdays are for walking* program.
13. Put *conserve fuel* stickers on auto dashboards.
14. Explore use of three-wheel motor carts for physical plant personnel on campus. Post office may have surplus vehicles for sale.
15. Follow octane requirements specified in vehicle manuals. Higher octane than specified is inefficient.
16. Make sure tires are inflated to manufacturer's specifications and that wheels are aligned.
17. Do not leave vehicle idling while making pickup or delivery calls.
18. Encourage drivers not to *gun* the engine when starting; nor should they allow for long warmup periods.
19. Encourage drivers to avoid jackrabbit starts and sudden stops.
20. Reduce services requiring gasoline-powered vehicles.

UTILITIES

1. Adjust valves for minimum water use.
2. Reduce domestic water temperatures to 120°F.
3. Install flow (2 gpm) limiting shower heads.
4. Good planned maintenance to prevent faucet drips.
5. Reduce lighting levels to the standards in Appendix D.
6. Be sure to disconnect the ballast from fluorescent fixtures if lamps are removed.
7. Schedule lighting maintenance and relamping programs to maintain good lamp efficiency.
8. Use efficient lighting for exterior such as mercury.
9. Reduce campus lighting to a minimum.
10. Reduce compressed air pressure when possible.
11. Check for compressed air leaks.
12. Closely review electrical distribution system for such things as excessive line loss.
13. Consider using lower watt (35 vs 40) fluorescent light tubes for relamping — also low energy high power factor ballasts.
14. Check closely for percentage of make-up water at the plant. Monitor boilers for make-up water; investigate a change of 5% or more.

15. Operate air and steam distribution systems at lowest pressure while maintaining adequate flow.
16. Correct leaks by retorquing flanged connections, repacking valves and expansion joints.

HEATING, VENTILATING AND AIR CONDITIONING

1. Establish a ventilation operation schedule so exhaust system operates only when it is needed.
2. Shut off laboratory hoods in air conditioned areas when not needed.
3. Minimize traffic through controlled humidity areas.
4. Obtain professional assistance and guidance before instituting any significant operational change. As an example, resetting a thermostat to 68° during the heating season may cause the cooling system to be activated, wasting more energy than is conserved.
5. Reduce use of heating and cooling systems in spaces which are used infrequently or only for short periods of time.
6. Turn heat and air conditioning off during last hours of occupancy.
7. Reduce all heating in garages, docks and platform areas to the lowest level without freeze-up.
8. Consider closing outside air dampers during the first and last hours of occupancy and during peak loads.
9. During cooling season evening and night hours, flush the building with cooler outdoor air.
10. In lobbies, corridors, and vestibules consider closing supply registers and radiators and reducing thermostat settings or turning off the electric heaters.
11. When sill height electric heaters are used, adjust thermostat so heat provided is just sufficient to prevent cold downdrafts from reaching the floor.
12. Turn off humidifiers whenever the building is closed for extended periods of time, except when process of equipment requirements take precedence.
13. Curtail humidification for areas such as hallways, equipment rooms, laundry areas, and similar spaces.
14. Turn off portable electric heaters and portable fans when not needed.
15. Turn on self-contained units, such as window and through-the-wall units, only when needed. Turn off when the space is to be unoccupied.
16. In mild weather, run room cooling fans at lower speeds.
17. Turn off all non-critical exhuast fans.
18. Turn off reheat in all areas during summer, except where equipment requirements necessitate humidity control.
19. Reduce internal heat generation as much as possible during the cooling season. Typical sources of heat generation including lighting, machines, cooking equipment, etc.
20. Turn off infrared food warmers when no food is being warmed.
21. Inspect and clean refrigeration condensers routinely to ensure sufficient air circulation.
22. Inspect and repair walk-in or reach-in refrigerated area doors without automatic closers for tight gaskets.
23. Avoid using fresh hot or warm water for dish scraping.
24. Keep refrigeration coils free of frost build-up.
25. Clean and maintain refrigeration on water chillers and cold drink dispensers.
26. Reduce temperature or turn off frying tables and coffee urns during off-peak periods.
27. Preheat ovens only for baked goods. Discourage chefs from preheating any sooner than

necessary.

28. Run the dishwasher only when it is filled.
29. Cook with lids in place on pots and kettles. It can cut heat requirements in half.
30. Thaw frozen foods in refrigerated compartments.
31. Fans that cool workers should be directed so they do not cool cooking equipment.
32. Do not run water unnecessarily.
33. Inspect rotating equipment such as pumps and fans for normal operation and performance.
34. Reduce air volume to meet minimum requirements; therefore, reducing fan power input requirements. Fan brake horsepower varies directly with the cube of air volume. Thus, for example, a 10% reduction in air volume will permit a reduction in fan input by about 27% of original. This modification will limit the degree to which the zone serviced can be heated or cooled as compared to current capabilities.
35. Raise supply air temperatures during the cooling season and reduce them during the heating season. This procedure reduces the amount of heating and cooling which a system must provide, but, as with air volume reduction, limits heating and cooling capabilities.
36. Reduce hot deck temperatures and increase cold deck temperatures. While this will lower energy consumption, it also will reduce the system's heating and cooling capabilities as compared to current capabilities.
37. Lower hot water temperature and raise chilled water temperature in accordance with space.
38. Consider installing static pressure controls for more effective regulation of pressure bypass (inlet) dampers.
39. Consider installing fan inlet damper control systems if none now exist.
40. Inspect nozzles in air induction units. If metal nozzles, common on most older models, are installed, determine if the orifices have become enlarged from years of cleaning.
41. Set induction heating and cooling schedules to minimally acceptable levels.
42. Reduce secondary water temperatures during the heating season.
43. Reduce secondary water flow during maximum heating and cooling periods by pump throttling or, for dual-pump systems, by operating one pump only.
44. Consider manual setting of primary air temperature for heating, instead of automatic reset by outdoor or solar controllers.
45. Lower hot deck temperature and raise cold deck temperature.
46. Reduce or eliminate the need for using outdoor air for odor control by installing chemical or activated charcoal odor-absorbing devices.
47. If a food preparation air exhaust hood is oversized, modify it so no more air than necessary is exhausted.

CHAPTER IV
Refit Checklists

GENERAL

1. ~~Repaint~~ or clean exterior finish to improve reflective characteristics. When repainting, use light surfaces to reflect both heat and light.
2. Remove partitions to create an open space effect permitting freer movement of air and reduction in lighting requirements.
3. Perform alterations to increase building flexibility.
4. Install a vestibule for the front entrance of a building, where practical. Fit with self-closing weather-stripped doors. Provide sufficient distance between doors.
5. Utilize revolving doors for the front entrance. Such devices allow far less air to infiltrate with each entrance or exit. Use of revolving doors in both elements of a vestibule is even more effective. If high peak traffic is involved, supplement revolving doors with swinging doors.
6. If the building has a garage without a garage door, install a motorized one to enable easier opening and closing.
7. Make delivery entrances smaller. The larger the opening, the more air that infiltrates when doors are open.
8. Use an expandable enclosure for delivery ports to reduce infiltration. It can be adjusted to fit the back of a truck reducing the amount of air which otherwise would infiltrate.
9. Where open space is available, plant trees or large shrubs to act as windbreaks. A windbreak can have positive value on reducing wind impact, at least on lower floors. Trees and shrubs also reduce solar penetration.
10. Install adjustable outdoor shading devices, such as sunshades, which reflect solar heat before it enters the building. Adjustable sunshades enable entrance of warming rays during the heating season.
11. Give preferential treatment to those windows most exposed to direct sunlight or high levels of reflected sunlight.
12. Reglaze with double or triple-glazing, or with heat absorbing and/or reflective glazing materials.
13. Add reflective materials to the window side of draperies to reflect solar heat when draperies are drawn.
14. Install opaque ~~light-colored~~ indoor shading devices, even if exterior shading devices are used.
15. Use opaque or translucent insulating materials to block off and thermally seal all unused windows.
16. Install storm windows and doors where practical.
17. Repaint or resurface roof to make it more reflective.
18. Where roof insulation is not practical, insulate the top floor ceiling with blown insulation over plaster ceilings or batts over lay-in ceiling. In most cases, ceiling insulation will require a vapor barrier placed on the warm side of the ceiling to prevent structural damage caused by rot, corrosion or expansion of freezing water.
19. Add or improve insulation under floors over garages or other unconditioned areas.
20. Use microwave ovens for thawing and fast-food preparation whenever they can serve to reduce power requirements.

UTILITIES SYSTEMS

1. Examine steam, heating water and chilled water distribution systems for best routing.
2. Repair or otherwise install insulation on all hot and cold lines, valves and fittings.
3. Repair or replace faulty steam traps.
4. Inject high pressure condensate in flash tank below surface of condensate being retained in flash tank to recover steam being flashed.
5. Use condensate water from air conditioner cooling coils for lawn sprinkling when required by climatic conditions, condensate return to power plant or make-up water to cooling towers.
6. Determine if the chilled water plant can be shut down when outdoor temperature is below 50°. Add control valves and controllers allowing chilled water to flow from chillers to condenser water cooling tower to enable *free cooling*. Add similar controls to the condenser water system.

STEAM SYSTEMS

1. Install insulation on all mains, risers, and branches, economizers, water heaters, and condensate receiver tanks where none now exist or add to existing installation.
2. Add additional shut-off valves for more efficient zone control.
3. Install recorder pressure gauges and thermometers where none now exist to enable continual monitoring of the system.

WATER SYSTEMS

1. Engage consultant to review all mechanical systems for proper sizing and operation, such as pump and valve sizing, pipe sizing, sequence of operation, etc.
2. Rezone and balance to minimize over-cooling and overheating.
3. Install insulation on all hot and chilled water pipes, valves and fittings, heat exchangers and vessels where none exist.
4. Install flow sensing elements and thermometers where none now exist to enable continual monitoring of the system.

AIR DISTRIBUTION SYSTEMS

1. Test, adjust and balance entire air distribution system in accordance with methodology suggested in the ASHRAE Handbook and Product Guide.
2. Insulate all ductwork carrying conditioned air through unoccupied spaces with at least 1-1/2 " of external fibrous insulation or its thermal equivalent.
3. 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 with high efficiency and low air flow resistance; removal of unnecessary dampers and other obstructions from ductwork and replacing high resistance inlets and outlets with grilles and diffusers of lower resistance.
4. Relocate air outlets or rearrange ductwork so that air entering the space does not first come into contact with hot surfaces.

CONTROL ADJUSTMENT AND MODIFICATIONS

1. The controls originally installed probably were designed more in light of initial costs than for their ability to conserve energy. Consider a program of modification to update and modernize the control system.
2. Add controls to shut-down air and water to unoccupied space. Inspect locations of thermostats. Relocate if they currently are installed near outside walls, in areas that are seldom used, or if they are subject to outside drafts.
3. Consider replacing pilots of gas burning equipment with electric ignition devices.
4. Limit the use of reheat to areas where humidity control is needed because of equipment needs.
5. Install thermostats for control of all heating equipment where none currently exist.
6. Consider installation of night set-back and morning start-up controls so that heating and cooling operations for each zone can be scheduled on the basis of occupancy patterns.
7. Consider installation of program clocks and manual overcall timers in control circuits to enable savings through scheduled operation of fans, refrigeration equipment, heating equipment, etc. Additional economies may result from decreased costs of labor and maintenance.
8. The most prevalent types of systems and steps which can be taken to make them more energy efficient are discussed as follows.
9. Use the cooling coil for both heating and cooling by modifying the piping. This will enable removal of the heating coil, which provides energy savings in two ways. First, air flow resistance of the entire system is reduced so that air volume requirements can be met by lowered fan speeds. Second, system heat losses are reduced because surface area of cooling coils is much larger than that of heating coils.
10. Consider installing demand reset controls which will regulate hot and cold deck temperatures according to demand.
11. Reduce secondary water flow during the minimum heating and cooling periods by pump throttling or, for dual-pump systems, by operating one pump only.
12. Reduce air flow to all boxes to minimally acceptable level.
13. When no cooling loads are present, close cold ducts and shut down the cooling system. Reset hot deck temperature according to heating loads and operate as a single duct system.
14. Self-Contained Systems — If multiple units are involved, consider installation of centralized automatic shut-off and manual override controls.

ELECTRIC POWER

1. Power factor improvement increases the efficiency of a power distribution system. Correction can be made through installation of capacitors at utilization equipment locations.

VENTILATION

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

2. Consider cutting off direct outdoor air supply to toilet rooms and other potentially "odorous" areas. Permit air from other areas to migrate into such areas through door grilles and be exhausted.
3. Consider installation of heat recovery devices.
4. Consider adding controls to shut down the ventilation system whenever the building is closed for an extended period of time, as during the evening, weekends, etc., except when the economizer cycle is in use.
5. Reduce volume of toilet exhausts in buildings which have multiple toilet exhaust fans having a total fan capacity in excess of outside air requirements. This can be done by wiring a fan interlock into toilet room lights through a timed relay, so the fan is activated only when lights are on. An administrative request plus signs to the effect that lights should be turned off when the room is not in use will help ensure that lights (and thus fans) are off when the room is not being used. Another method involves dampering down air volume so only that amount of air required by code is removed.

DOMESTIC HOT AND COLD WATER

1. 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).
2. Consider replacing existing hot water faucets with spray type faucets with flow restrictors where practical.
3. Consider having a plumber install a pressure reducing valve on the main hot water service to restrict the amount of hot water that flows from the tap.
4. Consider relocating the water heater as close to the point of use as possible.
5. Minimize the requirement for make-up from heating/cooling. Use automatic controls for cooling water flow.
6. Flow of apparently clean water into drains is suspect and should be investigated with possible reuse in mind.
7. Provide hand flush valves for urinal flushing operations rather than continuous water flow system.

LIGHTING

1. Select lamps which are the most efficient and which are compatible with the application.
2. When natural light is available in a building, consider the use of photocell switching to turn off banks of lighting in areas where the natural light is sufficient for the task.
3. Use photocell and/or astronomical time clock controls for outdoor lighting whenever feasible.
4. Use time controls for those areas of a building which are used infrequently and only for brief periods. These controls turn off lights automatically after being activated for a set period of time.
5. Provide selective switching and do not rely on central panelboards. This design approach precludes the potential for turning on only the amount of lighting that is actually needed.
6. Remodel light switches in all classrooms to provide for key operations so that they can be shut off after class and only turned on again by individual with key.

7. Remodel lighting switches in auditoriums and other large lecture halls to provide for on-off operation by faculty.

ELEVATORS-ESCALATORS

1. Seal elevator shafts around cabs at floor stations.
2. Perform a traffic review to determine if a building is properly elevatored. If over-elevatored take one or more elevators out of operation during periods of light traffic.
3. If your building has automatic loading-shedding or demand-limiting equipment, connect elevators to the system to enable automatic shut-down of one or more to limit peak demand.
4. Consider installing capacitors at points of utilization to increase power factor and so reduce KWH losses (and resulting power costs) in the internal distribution system.
5. Utilize demand-type elevator controls on elevators having through trip or collective type of controls so elevators may be adjusted to ensure that the fewest number of cabs travel the shortest distance which demand on the system allows.
6. If escalators are involved, consider this alternative: operate escalators only during peak periods.

CHAPTER V
Systems Convert Checklists

GENERAL

1. If remodeling or modernization is contemplated, add insulation to all exterior walls as well as those separating conditioned from non-conditioned spaces. As a general guide, the "U" value for the gross external walls (including windows and doors) of 0.35 – .40 BTU/hr. sq. ft. °F is considered to be an attainable minimum goal.
2. If window or thru-the-wall air conditioning units are relatively old, replace them with more efficient air-to-air heat pumps or similar units having a higher evaluation efficiency rating.
3. There are many types of environmental systems available which are efficient in their use of energy. It is recommended that competent professional advice be employed to undertake a system conversion study. Studies should first be made of buildings targeted by the energy audit program as major consumers of energy with possible energy problems.
4. Equipment, systems and techniques have been developed and are being used to recover and store waste or "free" heat from exhaust air, flues, turbines, gas or diesel engines, incinerators, building lighting systems, building occupants, etc. Studies should be made by a professional consultant who is fully acquainted with application of such systems. These systems do offer energy savings and good potential for significant payback.
5. Where major building rehab programs are to be undertaken, install new lighting systems that will make full utilization of task lighting and non-critical low level area lighting. Choose fixtures and lamps with energy efficiency in mind. Lighting systems should be utilized as an effective heat source in the HVAC program. Refer to Appendix D for recommended light levels.

CENTRAL CAMPUS ENVIRONMENTAL SYSTEMS

1. Many completed computer control systems on campuses clearly demonstrate the economic value of these projects. In some cases the payback period is as short as two years; normal experience seems to indicate that a three to five year payback is routine.
2. A feasibility study of computerized systems management is strongly recommended as the first step in systems convert. Data collected during the study of these systems is essential for a well-considered program of *Refit and Convert*.

UTILITY SYSTEMS

1. Carry out complete Electrical Energy System review and evaluation program. Investigate line loss, power factor and distribution arrangements for potential loss reduction and energy savings. Correct excessive transformer capacity or overloaded transformers. Tertiary transformation, low or high operating voltage and poor regulation without affecting satisfactory performance cause substantial energy waste and should be corrected.

STEAM SYSTEMS

1. Modify equipment as necessary to recover heat going to the sewer or otherwise wasted. Recovered heat can be used to heat a portion of the building, to preheat make-up water to the domestic hot water heater or be returned to the boilers.

AIR DISTRIBUTION SYSTEMS

1. If air volume has been decreased to effect energy savings, determine resulting load on the fan motor. If it is less than 80% of name plate rating, consider replacing motor with a smaller one.
2. Use constant static pressure control across the fan to maintain minimum fan horsepower requirements.

CONTROL ADJUSTMENT AND MODIFICATIONS

1. To determine the efficiency of a heating/cooling system have it tested and balanced in accord with the ASHRAE Handbook and Product Directory (available from ASHRAE, 345 E. St., New York, NY 10017). The extent of testing required and its cost will depend primarily on the type of system involved. In all cases the testing and balancing should be conducted by a qualified consultant.
2. If close temperature and humidity control are not required, convert the system to variable volume by adding variable volume valves and eliminating terminal heaters.
3. Consider installing fan static pressure control systems if none exist.

VENTILATION

1. Consider installing economizer enthalpy controls to air handling units.

DOMESTIC HOT AND COLD WATER

1. Install single tap at wash basins that will provide water at a tepid temperature, except for food service and others involving health or research services.

LIGHTING

1. Use alternate switching or dimmer controls when spaces are used for multiple purposes and require different amounts of illumination for the various activities.

ELEVATORS-ESCALATORS

1. Consider utilizing solid state motor drives instead of motor generator sets. This has high energy saving potential.

OPERATIONS

1. Where practical, place heat-producing equipment such as duplicating machines in one area for easier control of heating and cooling.

APPENDIX A
BTU CONVERSION CALCULATIONS
ENERGY SURVEY FORM

Annual Energy Consumption		Conversion Factor		Total BTU/Year
Electricity				
_____ kwh	x	3412	=	_____ 10^6 BTU/Yr
Purchased Steam				
_____ (M) lbs	x	1,000,000	=	_____ 10^6 BTU/Yr
Natural Gas				
_____ MCF	x	1,000,000	=	_____ 10^6 BTU/Yr
Oil (No. 2)				
_____ Gallons	x	139,000	=	_____ 10^6 BTU/Yr
Oil (No. 6)				
_____ Gallons	x	153,000	=	_____ 10^6 BTU/Yr
Coal				
_____ Tons	x	_______	=	_____ 10^6 BTU/Yr
Other				
_____	x	_______	=	_____ 10^6 BTU/Yr

APPENDIX A
ENERGY CONSERVATION PROGRAM FOR COLLEGES AND UNIVERSITIES
ENERGY SURVEY FORM
CONTINUED

Institution ______________________ No. ________ HEGIS No. ________ Gross Square Feet ________________ FTE ____________

Building: ______________________ No. ________ HEGIS No. ________ Gross Square Feet ________________ FTE ____________

			Purchased Electricity				Purchased Steam				Other Purchased Energy			
Month 1	Heating Degree Days 2	Cooling Degree Days 3	KWH 4	KW Demand 5	Total Elec Cost 6	10^6 BTU 7	M (lbs.) 8	Demand lbs. 9	Total Cost 10	10^6 BTU 11	Units 12	Demand 13	Total Cost 14	10^6 BTU 15
Jan.														
Feb.														
March														
1st Qtr.														
April														
May														
June														
2nd Qtr.														
July														
Aug.														
Sept.														
3rd Qtr.														
Oct.														
Nov.														
Dec.														
4th Qtr.														
TOTAL PER YEAR														

ENERGY SURVEY FORM
CONTINUED

Month	FUEL *												Total Energy	$\frac{BTU}{SF}$
	Oil			Coal			Gas			Other				
Month 1	Quan. Gals. 16	Total Cost 17	10^6 BTU 18	Quan. Tons 19	Total Cost 20	10^6 BTU 21	Quan. MCF 22	Total Cost 23	10^6 BTU 24	Quan. 25	Total Cost 26	10^6 BTU 27	Total Energy 10^6BTU 28	$\frac{BTU}{SF}$ 29
Jan.														
Feb.														
March														
1st Qtr.														
April														
May														
June														
2nd Qtr.														
July														
Aug.														
Sept.														
3rd Qtr.														
Oct.														
Nov.														
Dec.														
4th Qtr.														
TOTAL PER YEAR														

* See page 23 for Conversion Values

APPENDIX B

ENERGY CONSERVATION PROGRAM FOR COLLEGES AND UNIVERSITIES

BUILDING INFORMATION SURVEY

0.0 College or University ____________________

0.1 Surveyed by ____________________

0.2 Survey Date __________ **0.3** Full Time Enrollment (FTE) __________

1. GENERAL INFORMATION

1.000 IDENTITY

.001 Name of Building ____________________ .002 No. ______

.003 Location ____________________

.004 Type(s) of occupancy/Use (HEW designation) ____________________

____

.005 Person(s) in charge of building ____________________

____

1.100 PHYSICAL DATA:

.101 Building orientation ____________________

.102 No. of floors ____________________ .103 C/C Height ____________________

.104 Floor area, gross sq. ft. ____________________ .105 Perimeter __________ Ft.

Construction Type: (Specify for Walls-masonry, curtain, frame etc.)

.111 North Wall __________ .112 "U" Value[1] __________

.113 South Wall __________ .114 "U" Value __________

.115 East Wall __________ .116 "U" Value __________

.117 West Wall __________ .118 "U" Value __________

1.200 ROOF:

.201-.203 Type: __________ Flat ☐ Pitched ☐

Color __________ Dark ☐ Light ☐

"U" Value __________

.204 Area __________ sq. ft.

1.300 GLAZING:

	Wall	Exposure Type[2]	"U" Factor	%Glass/Ext.Wall Area	Radiant Factor
.301-.304	North Wall				
.305-.308	South Wall				
.309-.312	East Wall				
.313-.316	West Wall				

1.400 GLASS SHADING EMPLOYED INSIDE (check one)

.401-.407 Shade ☐ Blinds ☐ Drapes ☐ Open Mesh ☐ Drapes Opaque ☐ None ☐

Other ☐ ____________________

1.500 SKETCH OF BUILDING SHOWING PRINCIPAL DIMENSIONS:

(Use seperate piece of paper - Optional: Include photograph)

1. *"U" value = overall coefficient of heat transfer.*
2. *Type: Single, double, insulating, reflective, etc.*

1.600 BUILDING OCCUPANCY AND USE:

	Days		Number		Time am/pm		Time am/pm	Hours
.601-.603	M	Occupied by[3]	______	people from	______	to	______	Hours
.604-.606	T	" "	______	" "	______	"	______	"
.607-.609	W	" "	______	" "	______	"	______	"
.610-.612	T	" "	______	" "	______	"	______	"
.613-.615	F	" "	______	" "	______	"	______	"
.616-.618	S	" "	______	" "	______	"	______	"
.619-.621	S	" "	______	" "	______	"	______	"

2. ENVIRONMENTAL CONDITIONS (DESIGN)

2.000 OUTDOOR CONDITIONS

.001 Heating Degree Days ______ per year

.002 Cooling Degree Days ______ per year

.003-.006 Winter Day ___ °FDB ___ %RH Night ___ °F DB ___ %RH

.007-.010 Summer Day ___ °FDB ___ %RH Night ___ °F DB ___ %RH

2.100 MAINTAIN INDOOR CONDITIONS

.101-.104 Winter: Day ___ °FDB ___ %RH Night ___ °F DB ___ %RH

.105-.108 Summer. Day ___ °FDB ___ %RH Night ___ °F DB ___ %RH

3. SOURCES OF BUILDING ENERGY

3.000 ENERGY RESOURCES

.001-.004 Oil ☐ Gas ☐ Steam ☐ Chilled Water ☐

.005-.007 HTHW ☐ Elec. ☐ Other ☐

.100 Electric

.101 ____ KW Capacity @ ____ Volts

.102 ____ From ______ Owned System

.103-.104 Transformed from ____ Volts Metered at ______

.200 Boiler in Building

.201-.202 Boiler No. ______ Rating ______ MBH

.203-.204 Boiler No. ______ Rating ______ MBH

.205-.206 Boiler No. ______ Rating ______ MBH

.207-.211 Firetube ☐ Watertube ☐ Elec. Resistance ☐ Electrode ☐ Other ☐

.212-.213 Fuel used ______ Standby ______

.214-.216 Boiler eff. ____ % ____ %CO, ______ °F Stack Temperature

.217-.218 Hot water supply temperature ___ °F, Return temperature ___ °F

.219-.221 Steam pressure ____ psig, temperature ___ °F, Condensate temperature ___ °F

.222-.223 Condensate Pumps (number) ______ with total HP ______

.300 Cooling

.301-.302 (number) ______ Total capacity (tons) ______

.303-.306 Type Centrifugal ☐ Reciprocating ☐ Absorption ☐ Heat Pump ☐

.307 Capacity controlled by ______

.308 Chiller Operation, Starting controls ______

.309 Chiller Operation Stopping controls ______

.310-.311 Chilled water temperature ____ °F, return ____ °F From Central Plant

.312-.313 Condenser water temperature in ____ °F, out ____ °F From Central Plant

3. *Account for 24 hours a day. If unoccupied, put in zero.*

.400 Heat Dissipation Devices:

.401 Evaporative condenser ______

.402 Air Cooled condenser ______

.403 Cooling tower ______

.404 Other ______

.405 Condenser/cooling tower fan HP ______

.406-.407 Chilled water pumps ______ ; Total HP ______

.408-.409 Condenser water pumps ______ , Total HP ______

.500 Energy Conservation Devices

.501 Condenser water used for heating ______

.502 Demand limiters ______

.503 Energy storage ______

.504 Heat recovery device ______

.505 Enthalpy control of supply-return-exhaust damper ______

.506 Recuperators ______

.507 Others ______

4. SYSTEMS AND EQUIPMENT DATA

4.000 HEATING UNITS

.001 Baseboard ☐
.002 Convectors ☐
.003 Fin Tube ☐
.004 Induction ☐
.005 Fan coil ☐
.006 Unit heaters ☐
.007 Radiators ☐
.008 Others ☐

4.100 HVAC SYSTEMS (AIR HANDLING SYSTEMS CHECK AS APPROPRIATE):

.101 Single zone ☐
.102 Fan coil ☐
.103 Variable air volume ☐
.104 Terminal reheat ☐
.105 Heat pump ☐
.106 Multizone ☐
.107 Induction ☐
.108 Dual duct ☐
.109 Heat pump ☐

4.200 INTERIOR SYSTEM DESIGNATION

.201 Single zone ☐
.202 Fan coil ☐
.203 Variable air volume ☐
.204 Terminal reheat ☐
.205 Heat pump ☐
.206 Multizone ☐
.207 Induction ☐
.208 Dual duct ☐
.209 Self-contained ☐

4.300 PRINCIPLE OF OPERATION

.301 Perimeter

.302 Heating/Cooling/On/Off ☐

.303 Air volume variation ☐

.304 Air mixing control ☐

.305 Temperature variation ☐

.310 Interior:

.311 Heating/Cooling/On/Off ☐

.312 Air volume variation ☐

.313 Air mixing control ☐

.314 Temperature variation ☐

4.400 FANS—SUPPLY, EXHAUST, AND HOOD

No.	LOCATION	HP	CFM	TYPE	SUPPLY	EXH/HOOD
.401-.415[4]	____	____	____	____	☐	☐
.416-.450	____	____	____	____	☐	☐
.451-.475	____	____	____	____	☐	☐
.476-.499	____	____	____	____	☐	☐

4.500 SELF CONTAINED COOLING UNITS

.501-.502 Type: Thru-the-wall Air Conditioners ____ Others ____

.503-.504 No. of units ____ Basic module served ____

.505 Capacity (tons) ____

4.600 OPERATING SCHEDULE

.401 Operation (hours/days)		Weekdays	Saturday	Sunday	Holidays
.402-.405	Refrigeration cycle mach.	____	____	____	____
.406-.409	Fans-supply	____	____	____	____
.410-.413	Fans-return/exhaust	____	____	____	____
.414-.417	Fans-exhaust only	____	____	____	____
.418-.421	HVAC aux. equipment	____	____	____	____
.422-.425	Lighting-interior	____	____	____	____
.426-.429	Lighting-exterior	____	____	____	____

4.700 LIGHTING

.501 Interior

.502 Lighting type ____

.503-.504 Hallway/corridor ____ Watts/SF ____

.505-.506 Use areas ____ Watts/SF ____

.507-.508 Circulation areas within use space ____ Watts/SF ____

.510 Exterior

.511-.512 Lighting type ____ Total KW ____

4.800 DOMESTIC HOT WATER

.601 Use

.602-.605 ____ gals/day x ____ °F Temp.diff. x 8.3 BTU/gal x ____ °F = ____ BTU/day

.606-.607 Heater: Size ____ gph ____ °F temperature rise

.608-.611 Energy source: Gas ☐ , Oil ☐ Electric ☐ Other ☐

4.900 OTHER EQUIPMENT (Elevators, Data Processing, Kitchen, etc.)

.701	Equipment	Hours per Week Quantity	Operation	Size and Capacity BTU	KW	HP	Other
.702-.707	Elevators	____	____	____	____	____	____
.708-.713	Escalators	____	____	____	____	____	____
.714-.720	____	____	____	____	____	____	____
.721-.727	____	____	____	____	____	____	____

4. *Survey may require more space to list units than provided.*

5. ENERGY ANALYSIS

5.000 ENERGY RELEASED INSIDE BUILDING

.001-.003 Boiler: Oil ______ gal/mo x ______ BTU/gal = ______ 10^6BTU

.004-.006 Boiler: Coal ______ ton/mo x ______ BTU/ton = ______ 10^6BTU

.007-.009 Boiler: Gas ______ MCF/mo x ______ BTU/MCF = ______ 10^6BTU

5.100 UTILITY

.101-.103 Steam: ______ lbs/mo x ______ BTU/H = ______ 10^6BTU

.104-.106 HTHW: ______ gal/mo x ______ BTU/gal = ______ 10^6BTU

.107-.109 Electricity: ______ kw/mo x ______ BTU/kw = ______ 10^6BTU

5.200 SOLAR: ______ SF/mo x ______ BTU/sf = ______ 10^6BTU

5.300 PEOPLE: ______ persons x ______ Hrs/mo x ______ BTU/hr-pers. = ______ 10^6BTU

.301 TOTAL ALL ENERGY RELEASED INSIDE BUILDING = ______ 10^6BTU

5.400 HEAT LOSS SUMMARY

.201-.202 ______ Degree Days for ______ month

.203-.207 Shell ______ SF x ______ BTU/hr-SF-°F x ______ °F (Inside temp-Avg.Outside temp.)[5] x ______ HrsUse/mo = ______ BTU/mo

.208-.212 Window: ______ SF x ______ BTU/hr-SF-°F x ______ °F (Inside temp-Avg.Outside temp.)[5] x ______ HrsUse/mo = ______ BTU/mo

.213-.217 Roof ______ SF x ______ BTU/hr-SF-°F x ______ °F (Inside temp-Avg.Outside temp.)[5] x ______ HrsUse/mo = ______ BTU/mo

.218 SUB TOTAL BUILDING SHELL LOSS ______ BTU/mo

.219-.222 Fresh/Exhaust Air Loss

______ CFM x ______ °F[6] x 1.08 x ______ HrsUse/mo = ______ BTU/mo

.223-.225 Hot Water ______ gal/mo x ______ °F[7] x 8.3BTU/gal°F = ______ BTU/mo

.226 HEAT LOSS BUILDING TOTAL = ______ BTU/mo

5.500 COOLING SUMMER

Heat Gain from outside

.301-.302 ______ Degree Days for ______ months

.303-.306 Shell: ______ SF x ______ BTU/hrSF°F x ______ °F[8] ______ hr use/mo = ______ BTU/mo

.307-.310 Window: ______ SF x ______ BTU/hrSF°F x ______ °F[8] ______ hr use/mo = ______ BTU/mo

.311-.315 Roof. ______ SF x ______ BTU/hrSF°F x ______ °F[8] ______ hr use/mo = ______ BTU/mo

.316 SUB TOTAL BUILDING SHELL GAIN ______ BTU/mo

.317-.320 Fr.Air/Exh.Sensible ______ CFM x ______ °F[8] x 1.08 ______ hr use/mo = ______ BTU/mo

.321-.324 Fr.Air/Exh.Dehum. ______ CFM x ______ Grains Moist.[9] x .68 x ______ hr use/mo = ______ BTU/mo

Heat Gain from inside

.400 Electric

.401-.404 Lighting ______ KW + Process ______ KW + Motors ______ KW = ______ Total KW

.405-.407 ______ Total KW x 3412 BTU/kw x ______ hr/mo = ______ BTU/mo

.500 Solar

.501-.504 ______ BTU/hr-SF x ______ hr/mo x ______ SF = ______ BTU/mo

.600 People = ______ BTU/mo

.700 Other = ______ BTU/mo

.701 Heating Systems Losses = ______ BTU/mo

.702 Miscellaneous moisture = ______ BTU/mo

.703 Hot water = ______ BTU/mo

.704 Stills, Sterilizers = ______ BTU/mo

.705 Reheat = ______ BTU/mo

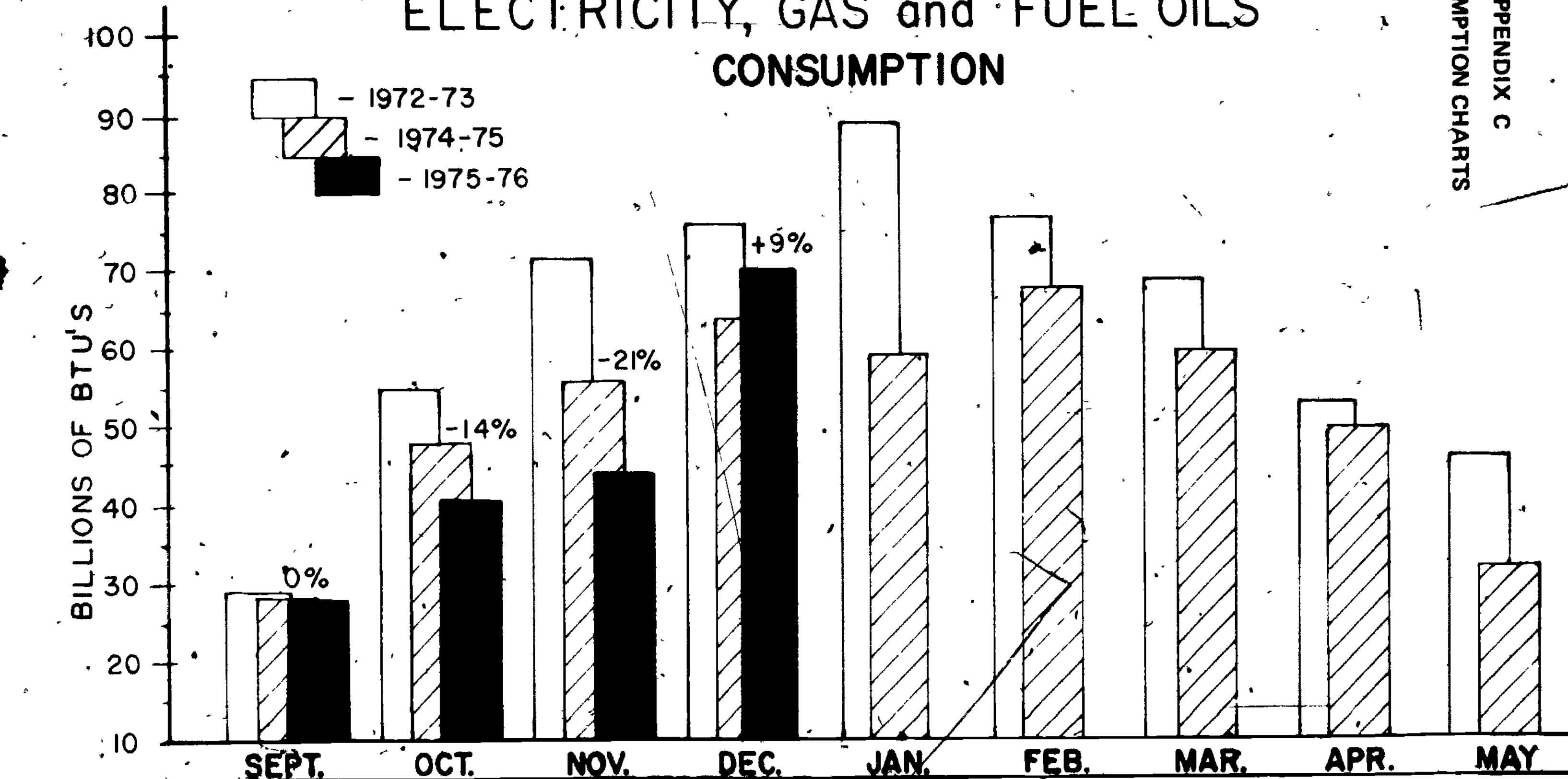
.800 TOTAL ALL COOLING ______ BTU/mo

5. *Inside temperature from line 2.101 minus Average outside temperature °F*
6. *Difference between Exhaust Air and outside air temperature*
7. *Difference H.W. temperature °F minus C.W. temperature °F outside air temperature °F*
8. *Average outside temperature °F minus inside temperature from line 2.101*
9. *Grains In minus Grains out*

General note: SF = Gross Square Feet

UNH ENERGY

ELECTRICITY, GAS and FUEL OILS
CONSUMPTION



DEGREE DAYS	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY
'72-'73	311	631	862	1143	1264	1074	796	567	424
'74-'75	364	641	768	1068	1222	1121	1038	750	304
'75-'76	313	576	675	1129					

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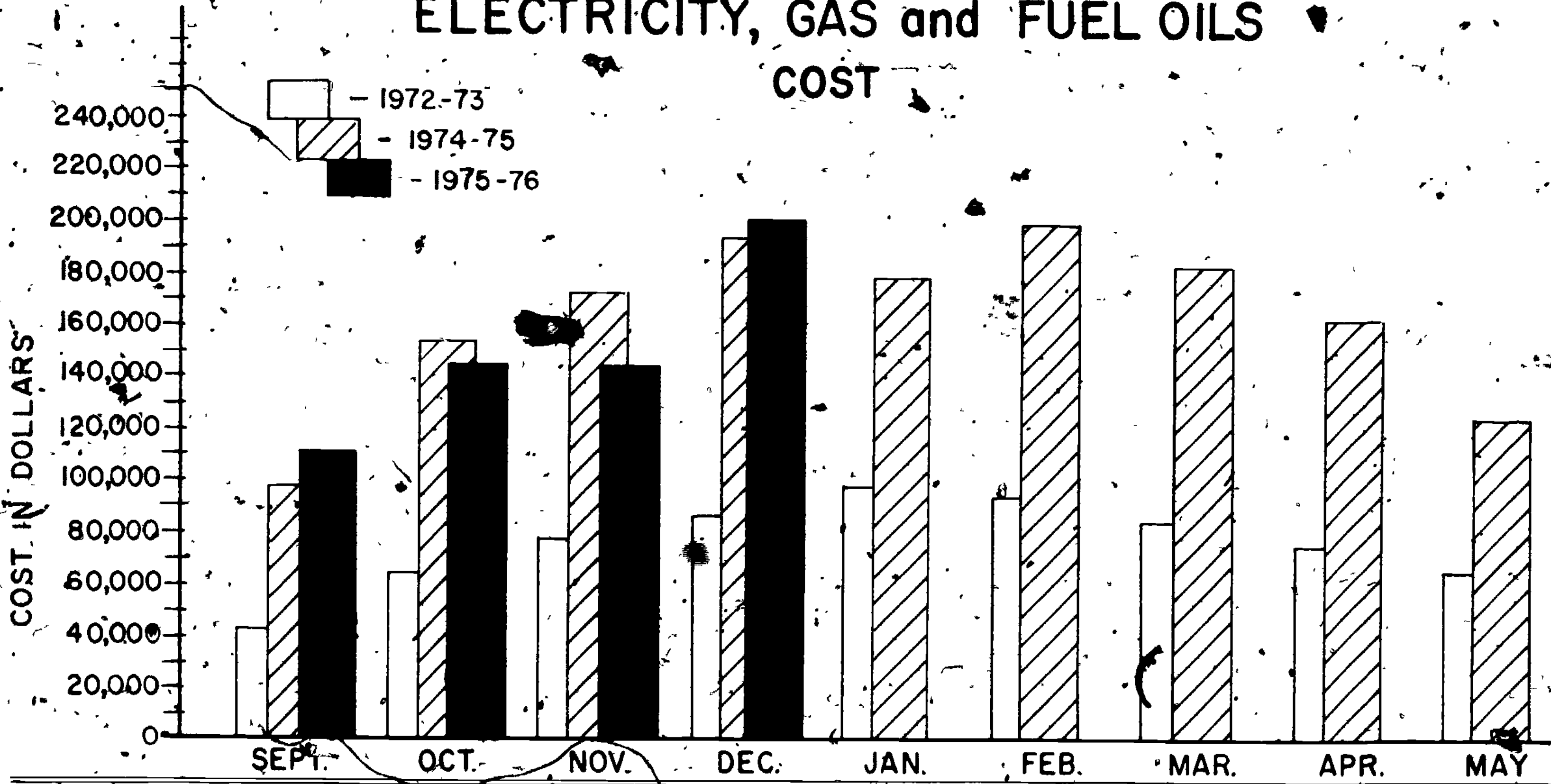
University of New Hampshire

UNH ENERGY

ELECTRICITY, GAS and FUEL OILS



BTU'S IN BILLIONS		SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY
	'72-'73	28.9	54.9	72.1	75.6	88.3	76.1	68.3	54.0	46.3
	'74-'75	28.2	47.5	55.3	64.1	58.6	66.8	59.3	48.3	31.8
	'75-'76	28.1	40.7	43.4	70.0					

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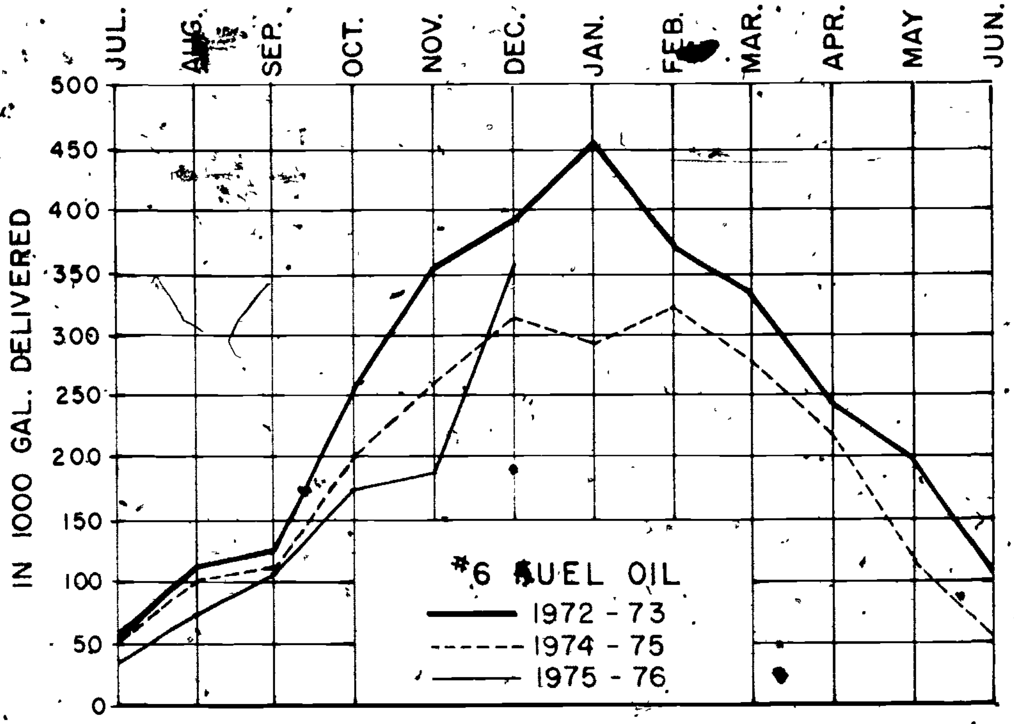
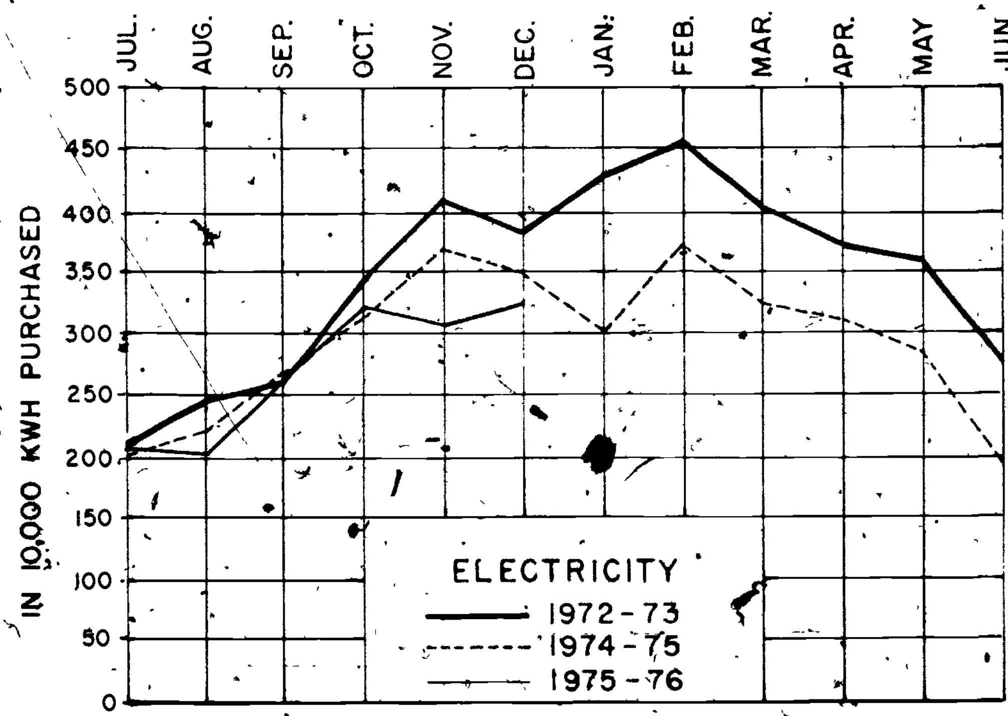
University of New Hampshire

U.N.H. ENERGY CONSUMPTION





DEGREE DAYS									
1972-73	311	631	862	1143	1264	1074	796	567	424
1974-75	364	641	768	1068	1222	1121	1038	750	304
1975-76	313	576	675	1129					

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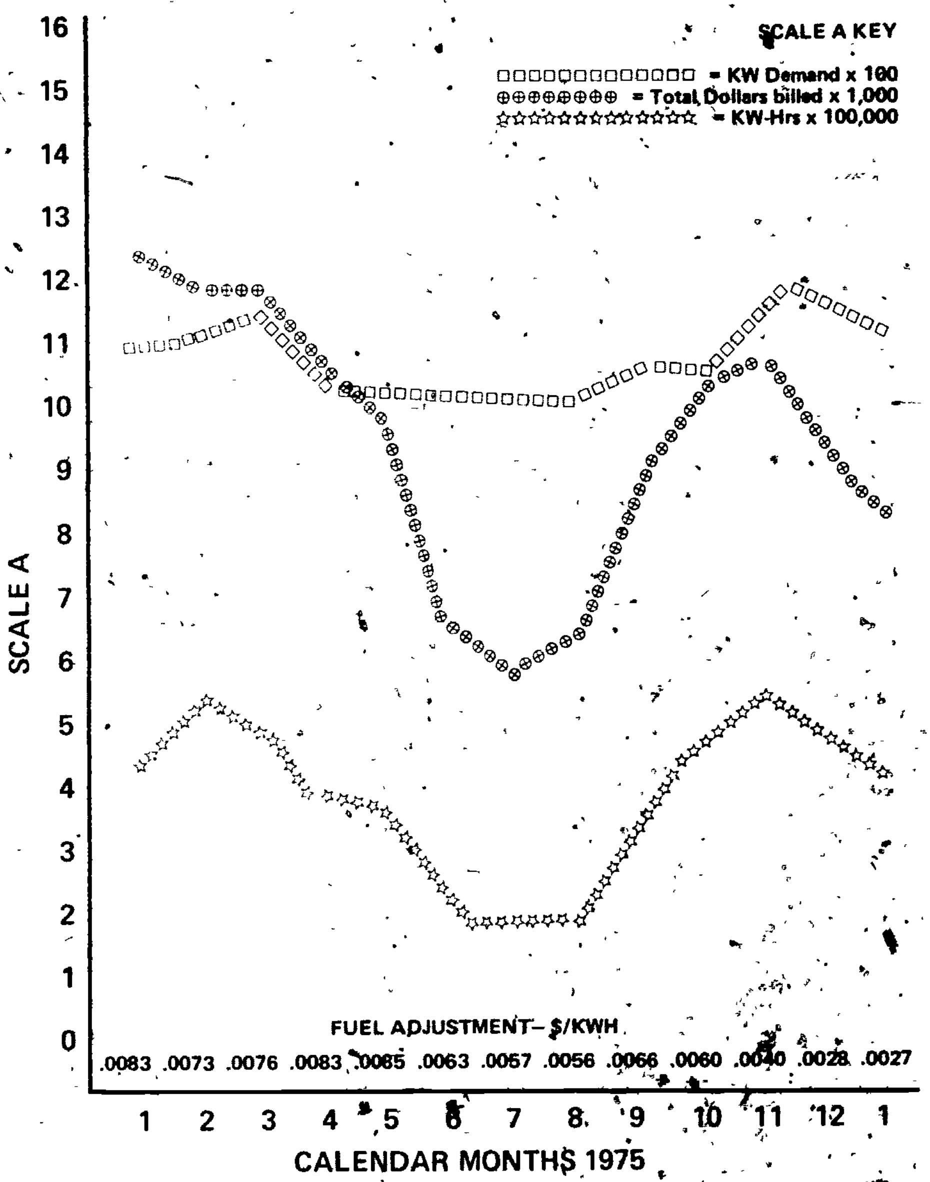
University of New Hampshire

COLBY COLLEGE
ELECTRIC UTILITY PROFILE



APPENDIX D

RECOMMENDED LIGHTING LEVELS

The Illuminating Engineering Society recommends the following lighting levels for various uses and occupancies:

ILLUMINATION LEVELS

	Minimum Foot Candles
Libraries	
Reading Rooms and carrels	70
Stacks	30
Book Repair and Bindings	70
Check in & out, catalogs, card files	50
Offices	
Designing, detailed drafting	110
Accounting, bookkeeping and business machines	85
Regular office work, reading, transcribing, active filing and mail sorting	70
Corridors and stairways	20
Washroom	20
Classroom Space	
Regular classroom work	50
Chalk boards	100
Drafting rooms	100
Auditoriums	
Assembly only	20
Study Hall	50

	Minimum Foot Candles
Laboratories	
General Work	50
Close work	100
Lecture Rooms	
General	50
Special/demonstration/exhibit	100
Dormitory Rooms	
Concentrated and prolonged study	50
Lounge /Lobbies	10
Kitchen	30
Exterior	
Parking areas	5
Roadways	5

The variations in intensity measured in lumens / watt for different lamp types are as follows:

Lamp Type	Intensity
Incandescent	16-20 lumens/watt
Fluorescent	60 "
Mercury	60 "
Metal Additive	43 "
Hi Pressure Sodium	95 "

Translated into gallons of fuel oil per year these intensity ratings used the following in a typical laboratory of 100,000 s.f. operating 3,000 hours/year:

Lamp Type	Fuel Oil Consumption per year
Incandescent	100,000 gallons
Mercury	46,000 "
Metal Additive	34,000 "
Fluorescent	30,000 "
Hi Pressure Sodium	22,000 "

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Gae P. Russo – Kent State University
Ted B. Simon – Michigan State University
David I. Newton – Executive Director

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