ENERGY CONSERVATION IN DEPARTMENT OF HIGHWAYS AND TRANSPORTATION BUILDINGS

by

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Virginia Highway & Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Highways & Transportation and the University of Virginia)

In Cooperation with the U. S. Department of Transportation
Federal Highway Administration

Charlottesville, Virginia

September 1978
VHTRC 79-R11

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FOREWORD

This is the final report of Task 4 of the project "Energy Conservation in Transportation in Virginia." It is essentially complete within itself; however, for a general overview of the transportation energy situation and activities and plans of the Virginia Highway and Transportation Research Council relating to energy conservation, reference should be made to the interim report on this project entitled "The Outlook for Transportation Energy — An Overview and Summary of Conservation Plans in Virginia."

A final report on Task 1 of this same project has also been published. It is entitled "Energy Use and Conservation in Highway Construction and Maintenance."

ABSTRACT

This report reviews the policy of the Virginia Department of Highways and Transportation toward energy conservation in the operation of its buildings and recommends further measures for conserving energy.

The major conclusions are:

1. The established policy within the Department is to conserve energy whenever possible, and top level administrators support efforts to improve the energy-efficiency of all Department buildings.

2. In the design of new buildings the Department utilizes energy-conserving criteria promulgated by the State Division of Buildings and Engineering. Individual designs are reviewed by that Division only upon the request of the Department.

3. The program for upgrading the energy-efficiency of existing buildings is informal to the extent that, in the case of structures of lesser importance (area headquarters, etc.), the initiation of action is largely left to local field personnel who may not have the time for such planning. In addition, no special funding has been made available statewide to accomplish needed improvements. As a consequence, energy-conserving improvements often are coincidental to general renovation projects.

4. Increased productivity of personnel as a result of increased comfort levels may be a valid consideration when improvements to buildings are contemplated.

Recommendations include specific measures which can be taken by the Department at little or no cost or where payback within a relatively short time (5 years or less) can be expected.

A longer range program to upgrade the energy-efficiency of all existing buildings,which would be based on a study of energy usage for various types of buildings and heating plants, is also recommended. Also, the savings from the installation of energy-conserving measures in typical buildings would be evaluated and considered in assigning priorities for capital improvements in other buildings of similar types.

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INTRODUCTION

The Virginia Department of Highways and Transportation maintains and operates approximately 1,750 buildings, varying in structure from multistoried office complexes to small utility buildings at area headquarters. Of this number 1,000 to 1,400 may require some degree of heating or cooling. Most of these buildings were constructed when there was little concern for energy conservation and consequently they were not designed or constructed for maximum efficiency in the use of energy. Efforts are being made to improve the energy-efficiency of these structures and the potential for reductions in fuel use and, hence, operating costs is substantial.

Prior to the significant increase in the cost of energy triggered by the oil embargo of the OPEC in 1973 and the dramatic increase in the cost of imported petroleum, very little attention was given to the amount of energy used for heating or cooling buildings or the energy required for heating water or for lighting. While insulation and storm windows were often installed, the primary factor was that of increasing the comfort of occupants of the building and, possibly, to reduce operating costs. Building design was rarely based on energy considerations. Costs per square foot of usable floor space, along with some consideration for a pleasing architecture, were most likely the major considerations in selecting the building design, especially in the case of commercial buildings.

As the costs of energy increased sharply, soaring utility bills for businesses and private homes alike made it imperative that conservation measures be sought. In designing new buildings, efficient design with respect to proper insulation and more efficient heating and cooling plants soon became major considerations.

Conservation measures in existing buildings also increased in importance. The qualitative effects of increasing insulation and installing additional insulation, storm windows and doors, etc. are well recognized. However, the quantitative savings and the relation of the cost of installing conservation measures to the savings that might be expected vary with the climate and with the type of building and its directional orientation. The outlay capital required for installing energy-conserving devices or additional insulation serves as a deterrent to optimizing energy conservation. There is a need to know and understand the most effective procedures and, in particular, there is a need to be able to calculat the "payback" time for energy-conserving capital improvements; that is, the point at which the projected value of the energy saved is equal to the cost of installation. While more information and general guidelines are becoming available each day, each structure must be examined individually to determine the needed measures and the payoff for similar changes will differ from building to building, depending on local conditions and the past heat-efficiency of each building.

The initial objective of this study was to review the literature concerning the procedures available for conserving energy in highway department operations. However, such information in the literature is most often reported relative to specific installations. These data serve to illustrate the kinds of activities available for conserving energy, but cost ratios and savings are totally dependent on local conditions. Consequently, the usual state of the art report based on published literature is not wholly adequate for this subject area. However, two useful publications that can serve as guidelines for energy-saving opportunities are available. These are the "Energy Conservation Program Guide for Industry and Commerce" (NBS Handbook No. 115)[1] and the publication of the Department of Housing and Urban Development entitled "In the Bank — or Up the Chimney".[2] The latter reference was prepared for private residential buildings but many of the principles discussed apply to small office buildings also. It has been reprinted and is being distributed by the Energy Division of the State Office of Emergency and Energy Services.

EXISTING POLICY

The Virginia Department of Highways and Transportation is well aware of the overall need to conserve energy in the operation of its building, as is the Division of Engineering and Buildings. This latter organization is responsible for the construction and maintenance of essentially all of the state government buildings. Althougl

that responsibility does not extend to the Department, the Department follows closely the policy and recommendations of the Division. The Division has issued a number of memoranda to the heads of all state agencies and institutions concerning energy conservation measures. These memoranda are not binding requirements but have the effect of establishing state policy.

With respect to buildings now being designed and constructed, a uniform building code including increased insulation requirements and other energy saving features has been adopted. Appendix A includes a copy of the memorandum issued November 21, 1973, concerning desirable U factors to be attained in the design of state buildings. The Addendum No. 1 dated November 27, 1974, also included in Appendix A, adds specific suggestions concerning other design features to conserve energy.

This policy should assure that all new state structures will include energy-efficient features consistent with present knowledge and standards and within cost limitations. Such a policy is being followed by the Department in nearly all its construction. However, the authors observed one instance where storm windows were omitted in the design of an interstate rest area, apparently in the interest of aesthetic considerations.

A much more immediate need within the Department is the upgrading of existing buildings for efficient energy use. There is also a need for improved efficiency in the operation of such buildings. In these activities the recommendations issued by the Division of Engineering & Buildings have been called to the attention of all building managers. However, except where extensive renovations have been planned, funds for such changes must be taken from general operating or maintenance budgets and the work must often be done with Department personnel. This lack of specific funding and need for using agency personnel have hampered full implementation of conservation measures. There also has been no systematic check of individual buildings to determine areas of greatest waste or the measures with the best return (shortest payback time).

Appendix B includes copies of the major memoranda and directives issued by the Division of Engineering and Buildings concerning energy conservation in existing buildings. Although the memoranda issued in 1973 and 1974 were related to the shortages created by the OPEC oil embargo and the later issuances in 1978 were related to shortages created by the coal strike, the recommendations listed still represent existing policy and provide some guidelines for efficient operation of existing systems.

Addendum No. 1 on Submission of Capital Outlay Requests for the 1976-1978 Biennium, issued November 27, 1974, and reproduced as Appendix C, urges surveying present buildings to determine what alternatives or improvements are both necessary and practical with respect to energy conservation. The items listed are:

Existing heating system,
heating system controls,
air conditioning systems,
air conditioning system controls,
insulation of piping,
insulation of ducts,
insulation of floors, walls, and ceilings, where appropriate,
replacement of conventional window units with double-glazed window units,
installation of storm windows, and
construction of storm entrances or vestibules at the entrance of buildings.

Collectively Appendices A, B, and C reflect the policies now in effect with respect to building construction maintenance and operation for the Virginia Department of Highways and Transportation as well as for other state agencies.

IMPLEMENTATION OF POLICY BY THE DEPARTMENT

The General Services Supervisor of the Department's Purchasing Division reports that efforts are being made to improve existing Department buildings to the extent possible within existing budgetary restraints. However, no schedule for completion of specific programs has been adopted and, to a considerable extent, individual field personnel must initiate plans for improvements at their own installations. For major modifications to office buildings, consultants have been employed to provide energy recommendations and these are usually incorporated in the contract.

The complexity of the problem is illustrated by a review of the type and number of buildings owned and operated by the Department. The maintenance and replacement budget for 1977-1978 lists almost 1,800 units classed as buildings. The types of these are given in Table 1. It is not possible to determine from this compilation the total number of these buildings requiring heat, since the number of storage buildings that require some heat cannot be determined. It is also not known how many "service stations" have a separate personnel

shelter not otherwise listed. However, the list includes 90 administrative buildings, about 69 of which would be classed as "major" buildings. About 450 of the installations are classed as warming houses, timekeeper offices, or small specialty shops in area and residency headquarters that require heating to normal comfort levels for personnel. Many of these also employ window type air conditioning. Approximately another 50 installations are district or residency equipment repair shops that offer special problems because of the high ceilings, large open spaces and, generally, a type of construction making the addition of insulation very difficult. The 84 well houses involving water pumps must be heated sufficiently to prevent freezing. The service stations (262) and storage buildings (327) represent an additional 589 units which may or may not require heat, depending on the individual situation and use of the building. Thus somewhere between 1,000 to 1,400 installations may require some type of heating system.

Table 1

Types of Buildings Operated by Virginia Department of Highways and Transportation

Administrative Buildings		
Central Office	5	
District Offices	8	
Materials Buildings (Districts)	7	
Residency Offices	49	
Other (Survey Crews, etc.)	21	90
Equipment or Maintenance Buildings		
Area Headquarter Offices, Warming Buildings, Timekeeper Offices	282	
Specialty (signs, landscape, traffic and safety, etc.) Offices and Shops	115	
District Shops	8	
Residency Shops	42	
Area Shops (including blacksmith)	59	
Hangers	1	
Warehouses (Districts)	2	
Service Stations	262	
Truck Sheds (include some storage)	269	
Storage Buildings	327	
Chemical Storage (salt)	206	
Well houses and Wells	84	
Powder Sheds	7	1,664
TOTAL		1,754

For the major office buildings involving complex heating and cooling and air distribution and ventilation systems, each building must be surveyed to determine the measures necessary for optimizing energy use. This can be done most efficiently by consultants who are experts in the energy field. For existing area headquarter offices and other small buildings, the measures needed will likely be obvious and in many cases can be handled as in-house maintenance work. The chief problems in these areas are those of funding for purchase of items such as storm windows, shades, etc. and the labor. There is also a need for continued motivation on the part of those involved.

GUIDELINES FOR EFFECTIVENESS

Despite considerable knowledge of the things required to conserve energy in buildings, there are no clear-cut relationships between qualitative and quantitative factors to serve as guidelines to those measures likely to be the most effective in the payback time for capital improvements. Such information is greatly needed.

Some general ideas on the relative effectiveness of various measures can be attained by reference to an article in the May, 1978, issue of the Virginia Engineer.[3] This issue contains the results of a survey conducted by the Consulting Engineers Council of Metropolitan Washington. It shows that returns of $17.50 to $45.85 were received for each $1 invested in energy conservation measures. Recommendations range from "no cost" measures to those requiring substantial capital investment. It is of interest to note those options considered most effective by responders to this survey. Asked to rate various options on a scale of 1 to 10, with 1 indicating very little importance and 10 extreme importance, the average ratings for some of the options were as follows:

Modifications of ventilation system	10.0
Reducing infiltration	8.2
Modifying heating system	8.1
Modifying lighting system	8.1
Modifying cooling system	7.7
Improving operational techniques	7.6
Improving insulation	7.6
Modifying glazing characteristics	7.3
Adding heat recovery	7.1
Improving maintenance	7.0
Adding demand control	6.6
Adding building automation	5.8
Adding solar energy options	4.6
Modifying the domestic hot water system	4.5
Improving elevator and escalator performance	3.5

These ratings, of course, were based on subjective evaluations involving a large number of building types, including multifamily dwellings, commercial office buildings, governmental buildings, industrial buildings, institutional buildings (schools, hospitals, etc.) and shopping centers.

It was also reported in this article that the consultants provided comprehensive energy analyses for only about one-third of the buildings for which their services were retained — which implies that audits in many cases were performed by in-house personnel with consultants being called in primarily to work on major options.

The use of consultants is essentially the pattern that is now being followed by the Department of Highways and Transportation and it should be continued. Large buildings and complexes should be audited by consultants; however, it is believed that for small "standard type" buildings, checklists can be provided for estimating basic needs and potential payoff. The state government employed consultants to examine a number of the administration buildings surrounding the Governor's Mansion in Richmond, the so-called seat of the government. The Highway Annex Building was included in this study conducted by Wiley & Wilson, Inc.[4] Their report estimates that annual energy costs could be reduced by 47% if all recommendations are adopted. On the basis of 1977 costs this amounts to a potential saving of about $43,000 in that year. The estimated expenditures for making the necessary changes are about $35,600; so all costs would be recovered in the first year. This level of savings amounts to about one-half million dollars in ten years. It should be noted that most of these potential savings would result from deactivating heating and cooling systems during the periods the building is not occupied — nights (9:30 p.m. — 7:30 a.m.), weekends, and holidays. Most of the capital expenditures would result from the installation of an automatic control system. The cost for manual control was estimated to be approximately $9,000 per year. Consideration is now being given to implementation of specific portions of the consultant's report. A Department study has also been made for renovations to the Bristol District office and installations are under way. Overall savings should be substantial. Varying types of energy-conserving improvements are also being made in other district and residency units.

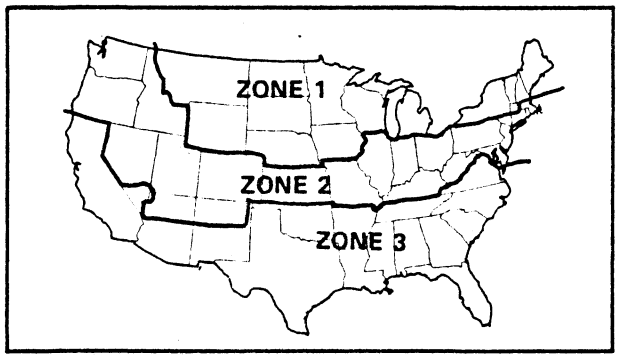
ENERGY SAVING OPTIONS

As previously stated, the amount of energy saved and the options needed in any specific case vary with climate, building conditions, and past efficiency of adjustments. Thus, an accurate estimate of

savings is not possible without specific information. However, the following generalizations will provide some insight into the potential effect of the most commonly considered options.

1. Turn down heating thermostats in winter.

   Reference 2 estimates that turning down heating thermostats 5° will result in a 25% saving in fuel bills for zone 3, which includes Virginia, as shown in Figure 1.



	ZONE 1	ZONE 2	ZONE 3
5° turn-down	14%	17%	25%
8° turn-down	19%	24%	35%

Figure 1. Estimated fuel saving by indicated reduction of thermostat control temperature for areas of the United States. (Source: "In the Bank — or Up the Chimney", Department of Housing and Urban Development, Washington, D. C.)

2. Turn up cooling thermostats in summer.

   A saving of 3% is estimated for each degree of cooling. Thus, if air conditioning thermostats can be operated at 80° instead of 75°F, a 15% saving would result.

3. Reduce hot water temperature.

   Operating water heaters at 130° in lieu of 160° is estimated to save 25% to 30% of the water heating cost.

4. Insulate.

   The present statewide building code for homes in Virginia requires insulation values of R-19 in attics and R-11 in walls and in floors over unheated air spaces. (R-19 is equivalent to 6 in. of fiberglass insulation and R-11 is equivalent to 3-1/2 in. of this material.) However, reference 2 recommends that if electric heat is being used, attics be insulated to R-38 for maximum economy. A publication issued by the Energy Division of the Virginia Office of Emergency and Energy Services (previously the Virginia Energy Office) states that consideration is being given to modifying the building code to require R-30 for attics and R-19 for sidewalls and floors.(5) Reference 5 also indicates that savings in heating costs for a "typical" home in Virginia would be about 18% if insulation in homes meeting present insulation standards were upgraded to the proposed (R-30 attic and R-19 wall) standards. The same percentage would likely apply to many small buildings now operated by the Department. Since many of these buildings do not now have properly insulated attics and walls, substantially greater savings are possible, along with increased comfort of personnel working in such buildings.

5. Install storm doors and windows.

   As is well known, heat losses through windows are substantial. A single thickness of glass has an R-value of approximately 1 and that of a double pane (or storm window installation) is approximately 2. Thus storm windows reduce heat loss through the window glass to about 1/2 of that of the single pane. However, even with storm windows heat losses at windows are about 7 times greater than losses through normally insulated walls (R-14). Properly operated draw-drapes, shades or blinds will reduce

these heat losses. Reference 5 estimates that for typical Virginia conditions an annual saving of $5.37 per window results from installing storm windows over single pane conventional windows. (Based on a 32 in. by 54 in. window and heating with an electric furnace.)

6. Regular maintenance — air filters, fans.

   Filters should be changed or cleaned each 30-60 days during a heating season. Fan blades should be cleaned at least once a year. Regular maintenance of systems can reduce energy consumption by 10%.

CONCLUSIONS

1. The established policy within the Virginia Highway and Transportation Department is to conserve energy whenever possible, and top level administrators support efforts to improve the energy-efficiency of all Department buildings.

2. In the design of new buildings the Department utilizes energy conserving criteria promulgated by the State Division of Buildings and Engineering. Individual designs are reviewed by that Division only upon the request of the Department.

3. The program for upgrading the energy-efficiency of existing buildings is informal to the extent that, in the case of smaller structures (area headquarters, etc.), the initiation of action is largely left to local field personnel who may not have the time for such planning. In addition, no special funding has been made available statewide to accomplish needed improvements. As a consequence, energy-conserving improvements often are coincidental to general renovation projects.

4. Increased productivity of personnel as a result of increased comfort levels may be a valid consideration when improvements to buildings are contemplated.

RECOMMENDATIONS

As a result of the studies previously outlined and the conclusions therefrom, a two-phase program of energy-conserving measures and activities is recommended. The first of these is capable of immediate consideration for implementation by the administration of the Department, while the second is of a more long-range planning nature and will require additional study before implementation can be accomplished.

Phase I

The measures recommended in Phase I are either given in response to critical needs or are readily implementable at little or no cost to the Department. The administration of the Department is encouraged, insofar as possible, to make available special funds for those measures where costs are identifiable. All measures recommended in this phase are believed to be capable of providing payback of their costs within 1 to 5 years.

1. Heated areas which are not presently insulated or are inadequately insulated should be insulated to the R values recommended for the state.

2. Storm windows and doors should be installed where no prior provisions, such as thermopane glass, have been made.

3. Existing buildings should be recaulked as the need arises, approximately every 2 to 5 years.

4. Hot water supplies should be operated at temperatures not in excess of 130°F where the principal use of those supplies is personal cleanliness and comfort.

5. Central heating and cooling systems should be fitted with automated controls to optimize energy use at nights and on weekends.

6. Awnings, shades, or blinds should be installed as needed to reduce summer air conditioning loads.

7. Incandescent lights should be replaced with more energy-efficient fluorescent or other lighting.

8. Personnel should be further encouraged to develop and maintain energy-conserving habits — such as turning off unneeded lights, heaters, and air conditioners, and properly operating blinds and drapes.

Phase II

It is recommended that a formal, long-range program for upgrading existing buildings which are now to some degree energy-inefficient be established. This program should be preceded by a detailed study, now in the planning stage at the Research Council, of energy-use records for all major administrative offices in the state and, to the extent feasible, for area headquarters. Such records should include the type of fuel used for heating and cooling and the distribution (air, steam, hot water) system and method of control (individual room or central control). Available records of energy use before and after recent modification of existing installations should be particularly sought. Based on the actual state records and other published data, an analysis should be made of the potential energy savings for various options and the payback time for capital improvements should be estimated. Costs of improvements and accurate records of energy use should be monitored over several seasons to establish estimated savings. Those measures providing the best potential for energy saving could thus be identified and the priorities for their implementation established.

A factor to be considered in the above studies is the increased productivity of personnel resulting from increased comfort — warm enough in winter and cool enough in summer. Some installations, especially the large equipment repair shops, apparently now operate at a comfort level (especially in very cold weather) that adversely affects productivity. In such cases it is possible that increased insulation may not actually reduce energy usage, but the comfort level would be increased with a corresponding increase in productivity.

The end result of such a study should be a recommended program for optimizing energy use in all Department buildings. Such a program should include timetables for completion of modifications and should provide for specific funding where needed. Strong central direction for implementation of the program should also be provided.

Examples of energy-conserving measures which might result from the Phase II studies are:

1. The addition of insulation to major buildings which are currently insulated to below the recommended R values;

2. the installation of energy-efficient heating and cooling systems;

3. the use of carpets on office floors; and

4. specific guidelines and/or requirements to further develop and maintain energy-conserving habits for all personnel (Item 8, Phase I) — such as turning off unneeded lights, heaters, and air conditioners, and properly operating blinds and drapes.

REFERENCES

1. U. S. Department of Commerce, National Bureau of Standards, "Energy Conservation Program Guide for Industry and Commerce (NBS Handbook 115)," U. S. Government Printing Office, Washington, D. C., 1974.

2. Virginia Energy Office, "In the Bank — or Up the Chimney" (Reprint from U. S. Department of Housing and Urban Development, Washington, D. C.), Richmond, Virginia, 1977.

3. "Implementing Energy Audit Pays Huge Dividends", The Virginia Engineer, Vol. 28, No. 5, May 1978.

4. Wiley & Wilson, Inc. "Energy Conservation Planning C-4 (1976-78)", Commonwealth of Virginia, Division of Engineering and Buildings, Richmond, Virginia, September 30, 1977.

5. Energy Division of Emergency and Energy Services, "What Every Home Buyer Needs to Know About Energy Costs," Richmond, Virginia, 1978.

APPENDIX A

DESIRABLE U FACTORS TO BE ATTAINED IN THE DESIGN OF STATE BUILDINGS

0334

COMMONWEALTH OF VIRGINIA
GOVERNOR'S OFFICE
OFFICE OF ADMINISTRATION
DIVISION OF ENGINEERING AND BUILDINGS
NINTH STREET OFFICE BUILDING
RICHMOND, VIRGINIA 23219

H. DOUGLAS HAMNER, JR.
DIRECTOR

TELEPHONE 770-3263

November 21, 1973

TO THE HEADS OF ALL STATE AGENCIES AND INSTITUTIONS:

Subject: Desirable U factors to be attained in the design of State buildings

Since it has become increasingly evident that there exists a critical need to conserve energy both now and in the future, together with the continuing effort to effect reasonable economies, we feel it is necessary to give much closer attention to the design of the exterior surfaces of State buildings.

Therefore, on all projects which have not advanced beyond the preliminary drawing stage, it is expected that the use of glass in the exterior surfaces of buildings should not exceed 17.5% of the gross outside wall area. Certainly a lesser percentage will be not only accepted, but very desirable. At the same time, should the characteristics or circumstances of a particular project indicate the need to exceed this percentage, approval must be obtained from the Division of Engineering and Buildings, with such approval based on the merits of the particular project and supported by specific data pertaining to the overall U factor for that building.

Henceforth, each set of plans presented to this office for review must include the consultant's computations as to the percentage of glass versus gross exterior wall area.

For buildings designed with capabilities for both heating and cooling, the use of double glazed solar glass is recommended. For buildings provided with heating capabilities only, the use of double glazed clear glass should be carefully considered to determine if its use can be economically justified within the expected normal life of the building.

Further, building projects for which working drawings are either in process or completed having both heating and cooling capabilities and not containing specified requirements for double glazed solar glass, you are requested to have your consultant compute the additional cost for this in order that a final joint decision might be made.

For buildings heated or cooled to the acceptable human comfort level (temperature in mid-70s), the U factor for exterior walls should be no greater than .19, and for roof-ceiling areas the U factor should be no greater than .10. Where building space is to have no ceiling, the U factor for the roof should be no greater than .13.

Consultants and owners should carefully consider the siting of new buildings with respect to the exterior design of the building so as to give justifiable consideration to the exposure of the exterior walls containing the greater percentage of glassed area.

The above is established as a guide which is considered reasonable for the sole purposes of accomplishing energy conservation and effecting reasonable economies. Nothing contained herein is directed toward inhibiting the creativity or ingenuity of any consultant, nor does this office feel that it will.

H. Douglas Hamner, Jr.

HDHJr:pr

ADDENDUM NO. 1 November 27, 1974

DESIRABLE U FACTORS TO BE ATTAINED IN THE DESIGN OF STATE BUILDINGS

H. DOUGLAS HAMNER, JR., DIRECTOR
DIVISION OF ENGINEERING AND BUILDINGS
209 NINTH STREET OFFICE BUILDING
RICHMOND, VIRGINIA 23219

This Addendum supplements the memorandum of November 21, 1973, to the Heads of all State Agencies and Institutions. Please reproduce and insert this Addendum in all copies of the Manual for the Planning and Execution of Capital Outlays, and please make available a copy to all architectural and engineering consultants to your agency or institution

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The Division of Engineering and Buildings issued a memorandum, dated November 21, 1973, on "Desirable U Factors to be attained in the design of State buildings". To supplement that memorandum, the following consists of criteria for the information and guidance of the administration of our agencies and institutions and their consulting architects and engineers in the development of plans and specifications for all appropriate projects in our capital outlay budget.

The following design criteria shall apply to all building design which has not progressed beyond the stage of approved preliminary plans and specifications. Architectural and engineering firms designing capital outlay projects for the agencies and institutions of the Commonwealth of Virginia are urged to give high priority to energy conservation design concepts to include, but not be limited to, the following:

1. Window shading, interior and/or exterior, shall be completely described in the preliminary submittals and shall be taken into consideration when calculating cooling loads.

2. Above grade cantilevered structures should be avoided as this design concept is costly, especially if properly insulated. If unusual circumstances allow this design to be approved in a given instance, the U factor shall be no greater than that used for the walls.

3. Concrete slab floor at or above grade: Perimeter insulation shall be installed having a resistance sufficient to limit the heat loss (BTU/hour per linear foot of exposed edge) to a maximum of 22.

4. Domestic hot water temperature control settings should be 120° F. maximum, unless the specific use of the facility requires higher temperatures. This capability shall be incorporated in the controls for heating equipment for adjustment by the Owner.

5. Heating and cooling systems shall be designed using the following criteria:

   Heating - Use ASHRAE Guide median of annual extremes for outside temperature and 72° F. for inside temperature.

   Cooling - Use ASHRAE[1] Guide 2-1/2% figures for outside Wet Bulb and Dry Bulb temperatures and 76° F. for inside temperature.

   Submit the ventilation design criteria being used with the submission of preliminary plans.

6. The Designer shall give primary consideration to the type of HVAC system to be installed in each building with a view toward selecting the most economical system in the use of energy, without incurring an unreasonable penalty in initial cost.

   Methods of energy conservation, such as enthalpy transfer from exhaust to outdoor air intake, should be considered and applied where economically feasible. System design load shall be carefully calculated and diversity of operation considered in equipment selection. Equipment efficiencies should always be regarded as important.

7. Generally, the Designer is expected to avoid using systems requiring the reheating of cooled air for the purpose of zone control.

8. High velocity air systems are heavy consumers of fan energy. This must be recognized in their application.

9. Systems shall be designed to use outdoor air for cooling, unless impractical. Windows shall have operable sash unless documented to be impractical.

10. Utilization of time clocks for system shutdown and/or night setback features should be made for all systems for areas which are unoccupied for a substantial portion of the 24-hour day and/or weekends.

11. Space thermostats shall have a range of 55° F. to 85° F. and shall incorporate the feature of separation of heating and cooling control points, so that heating energy will not be used to maintain temperatures greater than that established for heating nor cooling energy used to maintain temperatures less than that established for cooling, both in accordance with applicable memoranda. Air conditioning renovation projects will provide an interlock system so that the heating and cooling systems cannot operate simultaneously.

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(1) American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

12. Ventilation rates and total air circulated should be kept to the minimum as required by applicable codes or recognized special space requirements.

13. Generally, (a) humidity control for comfort cooling shall not be installed; and (b) humidification for human comfort shall not be installed.

14. Energy sources for heating and cooling systems shall be determined from an analysis of the efficiency of use and economy of those available for each project. Parameters for analysis should be obtained from the Division of Engineering and Buildings.

15. Lighting levels shall be based on the minimum Illuminating Engineering Society (IES) standards in accordance with the planned activity. In areas requiring high illumination carefully evaluate multiple switching for reducing the lighting level during those times when high illumination is not necessary.

    Use of light colored surfaces on walls, ceilings, and floors is encouraged to reduce the required wattage to meet IES minimum standard illumination levels.

16. Specify efficient light sources (higher lumens per watt output).

17. Subject to the total building design concept, light switches should be provided for all areas for extinguishing lights in unoccupied offices or spaces.

18. Schematic submittals for each building shall acknowledge compliance with this directive and also state what special efforts for energy conservation are planned for the HVAC system. Preliminary submittals shall include sufficient data to show compliance with the above.

19. A life cycle analysis for a structure may be required based on the circumstances of a given project. Recommendations from the appropriate administration and its consultants in this regard will be appreciated and carefully reviewed.

APPENDIX B

MEMORANDA AND DIRECTIVES ON ENERGY CONSERVATION IN EXISTING STATE BUILDINGS

COMMONWEALTH OF VIRGINIA
GOVERNOR'S OFFICE
OFFICE OF ADMINISTRATION
DIVISION OF ENGINEERING AND BUILDINGS
NINTH STREET OFFICE BUILDING
RICHMOND, VIRGINIA 23219

H DOUGLAS HANNER, JR.
DIRECTOR

TELEPHONE 770-326

November 9, 1973

TO THE HEADS OF ALL STATE AGENCIES AND INSTITUTIONS:

This is intended to supplement the Governor's directive of November 8, 1973, dealing with a State-wide energy conservation program. The following suggestions are offered to aid you in complying:

1. Set thermostats and other control devices to maintain a maximum temperatu in heated spaces of 68° F. except in hospitals, treatment or other specific areas where higher temperature is necessary for health or for technical requirements. Room tempe atures must be checked with thermometers rather than relying on the scales of control de

2. Reduce temperatures in heated spaces by at least 5° F. below reduced setting called for in Item No. 1 when area is not occupied or during sleeping hours in residential facilities.

3. Maintaining a proper level of humidity in heated air is important to comfort. Humid air will feel comfortable at a lower temperature than will dry air. Humidifying equipment and controls in buildings so equipped should be maintained and adjusted to provide humidity at design conditions.

4. Adjust dampers so as to reduce to a minimum the induction of cold outside air into the heating system, and do not operate exhaust systems when buildings are unoccupied.

5. Blinds, shades, drapes, or other window coverings should be kept closed at night in order to reduce the heat loss through windows. Advantage should be taken of the sun's heat by opening window coverings to admit sunlight when available.

6. It is imperative that windows and outside doors be kept closed when heating is required.

7. Check caulking and weather stripping of all doors and windows, replacing or repairing as needed.

8. Insulate exposed heating pipes or duct work.

9. Turn off heating equipment and close door to space that is to be unoccupied for several hours.

10. Use lights only when necessary. Turn out lights when leaving an area and do not leave lights burning in unoccupied spaces.

11. Operate powered equipment only when needed.

12. An energy conservation directive should be published by each agency and institution, disseminated to all personnel, and posted.

13. Follow-up measures to insure maximum compliance should be instituted.

14. Central steam heating systems must be inspected on a continuing basis and all traps, expansion joints, and other equipment repaired and maintained to prevent leaks both in the distribution systems and in the buildings.

15. Maintenance forces should regularly inspect and properly maintain the temperature controls to assure proper functioning.

16. All systems carrying hot water such as condensate returns, hot water heating systems, and domestic hot water systems, with particular emphasis on unions, valve stems, and faucets, should be inspected and leaks repaired.

17. The design of new buildings shall be checked in the planning stage to assure incorporation of maximum energy conserving provisions.

18. Survey lighting levels in buildings using a light meter. Where these levels exceed 20 footcandles in corridors or lobbies and 100 footcandles on work surfaces in offices, lamps should be removed to reduce the level to those figures. Judgment should be exercised in the removal of lamps so that they are not taken from fixtures where light is most needed.

19. A priority list of buildings to be shut down, closed, and taken out of service if fuel supplies become insufficient should be prepared immediately and kept for implementation if required.

20. Contact your suppliers of energy for additional suggestions on conservation.

The Division of Engineering and Buildings stands ready to render technical assistance, if requested.

H. Douglas Hamner, Jr.

HDHJr:pr

cc: The Governor of Virginia

COMMONWEALTH OF VIRGINIA
GOVERNOR'S OFFICE
OFFICE OF ADMINISTRATION
DIVISION OF ENGINEERING AND BUILDINGS
NINTH STREET OFFICE BUILDING
RICHMOND, VIRGINIA 23219
TELEPHONE 770-32

H DOUGLAS HAMNER, JR.
DIRECTOR

November 14, 1973

TO THE HEADS OF STATE AGENCIES AT THE SEAT OF GOVERNMENT:

(For reproduction and dissemination to agency personnel)

The following energy conservation measures are to be instituted immediately in all spaces occupied by State personnel unless technical requirements prevent compliance

1. Thermostats will be set to provide for a maximum temperature of 68° F. in heated occupied spaces and set back where possible to 63° F. during periods when unoccupied.

2. Supplemental heating units, such as plug-in electric heaters, are prohibited

3. Lighting for ornamental purposes will be discontinued or reduced to allow for needed security lighting only.

4. Corridor and lobby lighting, as well as in other areas, will be reduced. Lamps or tubes will be removed from fixtures wherever it is possible to do so without reducing the lighting levels below established standards.

5. Persons must turn off lights when leaving their offices and also turn off heat if it is possible to do so.

6. In areas having the thermostates under their control, the occupants are responsible for maintaining heating at not over 68° F. and for cutting back to not over 63° F. when leaving at the end of the day. This applies also for absences during the day where practical.

7. Our Section of Buildings and Grounds' personnel will implement measures required in Items 1 through 4 above on orders from this office.

8. Each agency must designate one person to contact our Section of Buildings and Grounds' Service Clerk for service requests or complaints from the agency. All serv calls must be made to Extension 3578. Service persons in the various buildings have been instructed to respond to calls from the service desk only and will not take requests from other sources unless in an emergency.

9. The personnel of the Division of Engineering and Buildings are instructed to note and report violations of energy conservation measures. Your assistance in this will be appreciated.

Your cooperation in assuring compliance in your agency is solicited.

H. Douglas Hamner, Jr.

HDHJr:pr

COMMONWEALTH OF VIRGINIA
OFFICE OF THE GOVERNOR
DIVISION OF ENGINEERING AND BUILDINGS
RICHMOND 23219

H DOUGLAS HAMNER, JR.
DIRECTOR
209 NINTH STREET OFFICE BUILDING
804 770-3263

May 17, 1974

TO THE HEADS OF ALL STATE AGENCIES AND INSTITUTIONS:

Energy Conservation Program of the Governor

This is to remind you that our State government has a continuing energy conservation program, and to request that you bring this to the attention of your employees at all levels with sufficient frequence to obtain their continued cooperation. The energy conservation measures that have been outlined in previous directives and memoranda describe practices that should be observed during both summer and winter until notice to the contrary is published.

For your guidance during the coming summer months, provisions outlined in the memorandum of July 10, 1973 (shown on the back of this memorandum), are still applicable and are to be supplemented by other measures which may appear to you and your staff to be desirable. During the summer, an important measure that should be followed is the maximum use of window coverings (shades, venetian blinds or draperies where authorized) to prevent transmission of solar heat into interior space.

House Joint Resolution No. 63, agreed to by both houses of the 1974 session of the General Assembly, encourages the conservation of energy in the planning, design, construction, and maintenance of State-owned buildings throughout the Commonwealth. This resolution requested the Governor to take such action as is appropriate to assure that the design of all State-owned buildings shall be consistent with the establishment of a policy to conserve all forms of energy to the greatest practical extent.

Your usual conscientious and cooperative efforts are extremely necessary and will be appreciated in this very necessary program.

H. Douglas Hamner, Jr.

pr

cc: Governor of Virginia
Members of the Governor's Cabinet

COMMONWEALTH OF VIRGINIA
GOVERNOR'S OFFICE
OFFICE OF ADMINISTRATION
DIVISION OF ENGINEERING AND BUILDINGS
NINTH STREET OFFICE BUILDING
RICHMOND, VIRGINIA 23219

H DOUGLAS HAMNER, JR
DIRECTOR

TELEPHONE

July 10, 1973

TO THE HEADS OF STATE AGENCIES AND INSTITUTIONS:

As an aid for the implementation of the Governor's directive of July 6, 1973, calling for a 7% reduction in energy consumption by the State Government, the following suggestions are offered;

1. Maintain the temperature of air conditioned spaces at not less than 77°F.

2. Do not operate air conditioning equipment in space that is unoccupied for several hours.

3. Where possible reduce the amount of outside air brought through the cooling equipment.

4. Use lights only when necessary. Turn out lights when leaving area and do not leave lights burning in unoccupied spaces.

5. Keep outside doors and windows closed when cooling or heating equipment is in use.

6. Operate motors, pumps and other equipment only when needed.

7. Publish a list of conservation of energy measures and assure its distribution to all employees. Institute measures to assure compliance.

The Division of Engineering and Buildings is willing to provide technical assistance if requested.

H. Douglas Hamner, Jr.

COMMONWEALTH of VIRGINIA
Division of Engineering and Buildings
209 Ninth Street Office Building

H. DOUGLAS HAMNER, JR.
DIRECTOR

RICHMOND, VIRGINIA 23219
(804) 786-3263

February 14, 1978

Division of Engineering and Buildings Energy Conservation Directive No. 1

Subject: Energy Conservation

On February 13, 1978, Governor Dalton called on all Virginians to conserve electrical energy to the extent possible in light of the shortage of coal pursuant to the current coal strike. This is to request that you advise all employees of the necessity of this.

The following suggestions have been offered on many past instances to aid you in complying with the Governor's energy conservation program and are still in effect:

1. Set thermostats and other control devices to maintain a maximum temperature in heated spaces of 68° F. except in hospitals, treatment or other specific areas where a higher temperature is necessary for health or for technical requirements. Room temperatures must be checked with thermometers rather than relying on the scales of control devices.

2. Reduce temperatures in heated spaces by at least 5° F. below reduced setting called for in Item No. 1 when area is not occupied or during sleeping hours in residential facilities.

3. Maintaining a proper level of humidity in heated air is important to comfort. Humid air will feel comfortable at a lower temperature than will dry air. Humidifying equipment and controls in buildings so equipped should be maintained and adjusted to provide humidity at design conditions.

4. Adjust dampers so as to reduce to a minimum the induction of cold outside air into the heating system, and do not operate exhaust systems when buildings are unoccupied.

5. Blinds, shades, drapes, or other window coverings should be kept closed at night in order to reduce the heat loss through windows. Advantage should be taken of the sun's heat by opening window coverings to admit sunlight when available.

6. It is imperative that windows and outside doors be kept closed when heating is required.

7. Check caulking and weather stripping of all doors and windows, replacing or repairing as needed.

8. Insulate exposed heating pipes or duct work.

9. Turn off heating equipment and close door to space that is to be unoccupied for several hours.

10. Use lights only when necessary. Turn out lights when leaving an area and do not leave lights burning in unoccupied spaces.

11. Operate powered equipment only when needed.

12. An energy conservation directive should be published by each agency and institution, disseminated to all personnel, and posted.

13. Follow-up measures to insure maximum compliance should be instituted.

14. Central steam heating systems must be inspected on a continuing basis and all traps, expansion joints, and other equipment repaired and maintained to prevent leaks both in the distribution systems and in the buildings.

15. Maintenance forces should regularly inspect and properly maintain the temperature controls to assure proper functioning.

16. All systems carrying hot water such as condensate returns, hot water heating systems, and domestic hot water systems, with particular emphasis on unions, valve stems, and faucets, should be inspected and leaks repaired.

17. The design of new buildings shall be checked in the planning stage to assure incorporation of maximum energy conserving provisions.

18. Survey lighting levels in buildings using a light meter. Where these levels exceed 20 footcandles in corridors or lobbies and 100 footcandles on work surfaces in offices, lamps should be removed to reduce the level to those figures. Judgment should be exercised in the removal of lamps so that they are not taken from fixtures where light is most needed.

19. A priority list of buildings to be shut down, closed, and taken out of service if fuel supplies become insufficient should be prepared immediately and kept for implementation if required.

20. Contact your suppliers of energy for additional suggestions on conservation.

The Division of Engineering and Buildings stands ready to render technical assistance, if requested. Such an effort as this cannot be effective unless every employee becomes personally conscious of the absolute necessity for an overall and concentrated effort in this regard.

H. Douglas Hamner, Jr.

HDHJr:di

Distribution: Heads of all State Agencies and Institutions
The Honorable John N. Dalton
The Governor's Secretaries

COMMONWEALTH of VIRGINIA

Division of Engineering and Buildings

209 Ninth Street Office Building

DOUGLAS HAMNER, JR.
ECTOR

RICHMOND, VIRGINIA 23219
(804) 786-3263

February 14, 1978

Division of Engineering and Buildings Energy Conservation Directive No. 2

Subject: Energy Conservation

On February 13, 1978, Governor Dalton called on all Virginians to conserve electrical energy to the extent possible in light of the shortage of coal pursuant to the current coal strike. This is to request that you advise all employees of the necessity of this.

The following energy conservation measures are still in effect and should be continued in all spaces occupied by State personnel unless technical requirements prevent compliance:

1. Set thermostats and other control devices to maintain a maximum temperature in heated spaces of 68° F. except in hospitals, treatment or other specific areas where a higher temperature is necessary for health or for technical requirements. Room temperatures must be checked with thermometers rather than relying on the scales of control devices.

2. Reduce temperatures in heated spaces by at least 5° F. below reduced setting called for in Item No. 1 when area is not occupied or during sleeping hours in residential facilities.

3. Supplemental heating units, such as plug-in electric heaters, are prohibited.

4. Lighting for ornamental purposes will remain discontinued or reduced to allow for needed security lighting only.

5. Corridor and lobby lighting, as well as in other areas, will remain reduced. Lamps or tubes will be removed from fixtures wherever it is possible to do so without reducing the lighting levels below established standards.

6. Persons must turn off lights when leaving their offices and also turn off heat if it is possible to do so.

7. In areas having the thermostats under their control, the occupants are responsible for maintaining heating at not over 68° F. and for cutting back to not over 63° F. when leaving at the end of the day. This applies also for absences during the day where practical.

8. Our Section of Buildings and Grounds' personnel will continue to implement measures required in Items 1 through 5 above on orders from this office.

9. Each agency must designate one person to contact our Section of Buildings and Grounds' Service Clerk for service requests or complaints from the agency. All service calls must be made to Extension 6-3578. Service persons in the various buildings have been instructed to respond to calls from the service desk only and will not take requests from other sources unless in an emergency.

10. The personnel of the Division of Engineering and Buildings are instructed to note and report violations of energy conservation measures. Your assistance in this will be appreciated.

All State agencies at the seat of government are to comply to the extent possible with additional energy conservation suggestions identified in the Division of Engineering and Buildings Energy Conservation Directive No. 1. Such an effort as this cannot be effective unless every employee becomes personally conscious of the absolute necessity for an overall and concentrated effort in this regard.

H. Douglas Hamner, Jr.

HDHJr:di

Distribution: Heads of All State Agencies at the Seat of Government
The Honorable John N. Dalton
The Governor's Secretaries

APPENDIX C

ADDENDUM NO. 1 November 27, 1974

SUBMISSION OF CAPITAL OUTLAY REQUESTS FOR THE 1976-1978 BIENNIUM

H. DOUGLAS HAMNER, JR., DIRECTOR
DIVISION OF ENGINEERING AND BUILDINGS
209 NINTH STREET OFFICE BUILDING
RICHMOND, VIRGINIA 23219

This Addendum shall be added to and considered a part of the memorandum of September 30, 1974, to the Heads of all State Agencies and Institutions.

On September 30, 1974, we transmitted Capital Outlay Request forms for the forthcoming biennium through a letter of transmittal and certain instructions contained therein.

This is to advise that we feel particular emphasis should be placed on surveying existing buildings to determine what alterations or improvements are both necessary and practical with respect to energy conservation. Items to be surveyed include, but are not necessarily limited to, the following:

existing heating systems
heating system controls
air conditioning systems
air conditioning system controls
insulation of piping
insulation of ducts
insulation of floors, walls, and ceilings, where appropriate
replacement of conventional window units with double-glazed window units
installation of storm windows
construction of storm entrances or vestibules at the entrances of buildings

In light of all indications that point to a worsening condition with respect to all forms of energy over the coming years, it appears to behoove all of us to take every reasonable step to conserve energy in every form.

NOTE

Please periodically remind all of your employees of previously established energy conservation measures regarding their strict adherence and soliciting their thoughts and suggestions for additional steps to achieve conservation.