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**Technical Assistance for Meharry Medical College Energy
Efficiency Project**

US Department of Energy Grant DE-FG44-95R410630

Final Project Status and Technical Report

**Prepared for the Tennessee Department of Economic and
Community Development by the University of Memphis,
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INTRODUCTION

This report presents the results of a program to provide technical assistance to Meharry Medical College. The purpose of the program is to facilitate Meharry's effort to finance a campus-wide facility retrofit. The US Department of Energy (USDOE) funded the program through a grant (DE-FG44-95R410630) to the Tennessee Department of Economic and Community Development (TECD). The University of Memphis-Technology and Energy Services (UM-TES), under contract to TECD, performed program services. The report has three sections: (1) Introduction; (2) Project Definition, Financing, and Participants; and (3) Opportunities for Federal Participation.

Background

Meharry Medical College submitted an unsolicited proposal, dated June 16, 1994, to the US Department of Energy for funding to implement a major campus-wide retrofit. The proposal listed \$19.06 million in facility improvements including: (1) building automation and control improvements; (2) heating, ventilation, and air-conditioning (HVAC) renovations; (3) mechanical room renovations; (4) lighting upgrades; and (5) targeted structural and building envelope renovations.

On October 28, 1994, representatives of USDOE met with Meharry officials in Nashville to discuss the proposal. Others attending the meeting included representatives of TECD, UM-TES, and Honeywell Inc. TECD administers several USDOE programs in Tennessee and houses the state's energy office. UM-TES is a contractor to TECD and provides technical support for several TECD programs. Honeywell is the primary contractor for a large portion of the Meharry retrofit.

Following the October 28 meeting, USDOE requested that TECD, in cooperation with UM-TES, provide technical assistance to facilitate Meharry's project financing efforts. TECD agreed, and in early 1996, USDOE provided funding for the technical assistance program. Upon USDOE's recommendation, TECD used the funds to contract with UM-TES to provide program services. The USDOE recommendation was based on UM-TES' record of providing services to Tennessee institutions in energy management and project finance. The funding period for the program began March 1, 1995 and ended February 29, 1996.

Program Activities

TES-UM conducted a number of activities to address the program's purpose. This included: (1) meeting and corresponding with Meharry officials to clarify project status and define technical assistance needs; (2) meeting with Honeywell representatives to discuss their role in the project; (3) reviewing project documents, including Meharry's USDOE proposal, a Meharry-Honeywell performance contract, and project financing documents; (4) conducting an analysis of the Basic Science Center building shell addition; (5) researching federal funding sources in the *Catalog of Federal Domestic Assistance* and the *Federal Assistance Monitor*; (6) reviewing federal procurement regulations which could affect the use of USDOE funds for the Meharry project; and (7)

performing project monitoring and other activities to fulfill program requirements.

PROJECT DEFINITION, FINANCING, PARTICIPANTS

The Meharry project can be broken down into four components: (1) energy efficiency measures included in the Meharry-Honeywell contract; (2) Hubbard Hospital renovations; (3) Basic Science Center structural improvements and interior renovations; and (4) Basic Science Center building shell addition. The only project components that have not been fully financed are the Basic Science Center structural improvements, interior renovations, and building shell addition. Of these, only the building shell addition offers any potential for energy-related federal funding. Dr. John Maupin, Meharry President, and Ms. Ophelia Long, Senior Vice-President for Administration, specifically requested that TECD and UM-TES focus program efforts on finding funding for the building shell. The following paragraphs discuss the four project components.

Meharry-Honeywell Performance Contract

On September 1, 1994, Meharry entered into a ten year performance contracting agreement with Honeywell Inc. to implement cost-effective energy efficiency measures listed in the June 16, 1994 proposal to USDOE. The performance contract calls for Honeywell to provide retrofit services in the following buildings: (1) Central Plant; (2) Basic Science Building; (3) Learning Resource Center; (4) New Dental School; (5) Dental Annex; (6) Old Hubbard Hospital; (7) Comprehensive Health Center; (8) International Center; (9) Mental Health Center; (10) Computer Center; and (11) Student Center.

Key components of Honeywell retrofit services include the installation of a campus wide automation system and a thermal fluid heating system. The thermal fluid system replaces the campus steam system. A summary of energy efficiency measures installed under the performance contract is in the appendix. In addition to retrofit services, the contract calls for Honeywell to provide comprehensive maintenance services over the ten year period. To facilitate project installation and maintenance, Honeywell is providing a full-time Technical Resource Manager (TRM). TRM duties include developing a PC-based maintenance management program, establishing a PC-based energy auditing program, performing monthly energy savings analysis, identifying additional energy savings opportunities, and assessing training needs.

The total performance contract amount is \$8,125,804: \$7,538,704 for Asset Modernization Services (facility retrofits), and \$587,100 for Comprehensive Maintenance Services. Under the contract, Honeywell guarantees that its retrofit and maintenance services will achieve \$18,816,720 in total savings: \$985,000 per year in energy savings, and \$896,672 per year in avoided operational costs. The measurement of energy savings involves a comparison between annual energy consumption with base year consumption, adjusted for weather, billing period, occupancy and other factors. Operational cost avoidance includes the maintenance dollars that Meharry agreed it would save by

implementing the performance contract. This includes staffing costs, system replacement, equipment service costs, tools and materials.

Although the Meharry-Honeywell contract began September 1, 1994, permanent financing was not in place until July 15, 1995. Honeywell provided \$5 million in interim financing during the ten month period between the contract start and date of permanent financing. The permanent financing for the performance contracting project came from \$17,085,000 in 7.75% Revenue Bonds issued by the Health and Educational Facilities Board of the Metropolitan Government of Nashville and Davidson County. The debt service requirement for the revenue bonds is in the report's appendix. According to the Private Placement Memorandum, the Health and Educational Facilities Board will loan bond proceeds to Meharry for a number of renovation and campus improvement projects, including the "acquisition, construction, renovation and equipping of certain heating, cooling, and air compression equipment, lighting equipment, a chilled water plant and distribution system, a heating plant and distribution system, a life safety and access control system, a temperature control system, and sprinkler system." Other projects to be financed with the bond-funded loan include parking facilities, a helipad, and asbestos abatement. Meharry's obligations under the Loan Agreement are secured by a first mortgage lien on and security interest in the equipment and other projects funded with bond proceeds. This includes a security interest in the energy efficiency equipment and savings guarantees provided under the Meharry-Honeywell performance contract.

The retrofit portion of the performance contract was scheduled for completion in March, 1996. A preliminary energy savings report showed that the project has produced approximately \$400,000 in energy savings during the installation phase. Honeywell will provide its first complete energy savings report to Meharry in May.

Hubbard Hospital Renovations

Hubbard Hospital renovations are being funded through proceeds from a 1994 \$48,725,000 bond issue by the Health and Facilities Board. \$29.6 million of the bond issue is designated for Hospital renovations and equipment. Meharry is meeting its obligations for the issue with lease payments from the Metropolitan Government of Nashville and Davidson County pursuant to a December 1, 1994 agreement. Although Hubbard Hospital is currently unoccupied, it will be used as the community's public hospital when renovations are completed. McDevitt Street Bovis is the contractor for the Hubbard Hospital renovation. Jones and Jones Construction Company is the minority partner.

Basic Science Center Improvements

Although the Basic Science Center is included in the Meharry-Honeywell performance contract, the facility requires additional non-mechanical improvements to correct structural, building shell, and interior problems. Since its construction in 1975, the building has experienced gradual shifting and interior damage to walls, ceilings, and floors. A 1989 study by L.Quincy Jackson Architects and Geotek Engineering found that the building's cantilevered beams were underdesigned for the weight of its brick veneer

shell. The weight of the shell was bending the beams downward, causing brick loss and vertical column fatigue. As a result of the study, the exterior brick veneer was removed. This slowed shifting and prevented additional interior damage. A 1994 study by L.Quincy Jackson Architects recommended measures to correct the building's structural problems, and interior damage. The \$4,760,000 estimated cost for the renovation includes structural supports, interior repairs, and a new building shell. A list of the prescribed measures and their estimated cost is presented in the appendix. Meharry has a \$1 million National Institutes of Health (NIH) grant to help with improvements to the Basic Sciences Center. The grant has a 50 percent match requirement and a June, 1996 end date.

Basic Science Center Building Shell

In early 1996, the UM Mechanical Engineering Department examined the energy efficiency potential of an Exterior Insulated Finish System (EIFS) building shell for the Basic Science Center. EIFS is a construction technique in which the building is covered with expanded polystyrene foam insulation and a stucco overcoat. The lightweight shell increases the thermal resistance of the exterior wall from R8 to R22. This would reduce heat flowing through the walls by over 60 percent in summer and winter. This heat flow, however, requires only a very small portion of the building's energy consumption. Consequently, the EIFS addition will only reduce energy costs by \$500 per year. Although the EIFS does not produce tremendous energy cost savings, it is a reasonable approach to covering the exterior wall with a lightweight, insulated surface. The estimated cost of installing the EIFS is \$300,000. This is much less than the amount listed in the 1994 L.Quincy Jackson study. Unfortunately, the person who performed the earlier study has died and no background information on the cost estimate is available. As a result the UM Mechanical Engineering Department was unable to determine reasons for the cost discrepancy. Additional EIFS information and supporting calculations are contained in the report's appendix.

OPPORTUNITIES FOR FEDERAL PARTICIPATION

The Basic Science Center building shell is the only energy-related component of the Meharry project that has not been financed or initiated. This section first presents a possible strategy for obtaining federal assistance for the building shell addition. It next addresses procurement issues affecting federal assistance. It then turns to opportunities for promoting the Meharry retrofit. The section closes by summarizing a USDOE role in Meharry's energy management efforts.

Strategy for Federal Participation in the Building Shell Addition

Federal funding opportunities for retrofit projects are extremely limited. As stated in the previous section, Meharry has successfully obtained a \$1 million grant from the National Institutes of Health (NIH) for Basic Science Center renovations. Other facility renovation programs offer grants for specialized areas outside Meharry's interests. These include grants for emergency shelters, military construction, and community

development. USDOE has traditionally provided facility retrofit assistance through the Institutional Conservation Program (ICP). ICP funding, however, has been limited in recent years and is not included in the upcoming federal budget. Although there may be one additional ICP cycle in Tennessee, the building shell addition does not produce sufficient energy savings to meet program requirements. The report's appendix contains a list of federal assistance programs that were reviewed as possible funding sources.

In the absence of traditional retrofit funding, Meharry may want to consider presenting the Basic Science Center building shell as a research and development opportunity in energy efficient materials. Although the addition of a building shell does not greatly reduce building energy costs, it does provide an excellent opportunity for testing a lightweight, adhesive material for durability and energy efficiency value. The Basic Science Center has been extensively studied and monitored over the past few years. This has produced data that can be used to evaluate the energy efficiency aspects of a newly developed, innovative building shell material.

If Meharry decides to pursue a research and development strategy, it should request, through USDOE, assistance from the Oak Ridge National Laboratory (ORNL) Building Research Center. The ORNL Buildings Technology Center conducts development and validation testing of energy efficient building envelopes, heating and cooling equipment, and other technologies. Cooperative research and development agreements (CRADAs) at the Center have included the participation of Dow Chemical, DuPont, Dow Corning, the National Roofing Contractors Association, and other organizations. Meharry should ask the Center to: (1) review the UM-TES Basic Science Center report and identify additional data needs; (2) identify appropriate building envelope materials that are in the development, testing, or demonstration stage; and (3) identify companies interested in developing the material and using the Meharry Basic Science Center as a test site.

In addition to requesting technical assistance from ORNL, Meharry should discuss with USDOE the possibility of submitting an unsolicited proposal for Conservation Research and Development Program (CRDP) funding. Through CRDP, USDOE provides financial assistance to nonprofit institutions to develop and transfer energy conservation technologies to the scientific and industrial communities. Financial assistance ranges from \$50,000 to \$500,000, with an average award of \$200,000. USDOE has awarded grants for research on high performance heat pumps, thermally efficient commercial buildings, and high temperature materials. The report's appendix includes additional CRDP information.

Another USDOE technology initiative is the Small Business Innovation Research (SBIR) program. This USDOE program provides grants to small businesses for research and commercialization of energy-related technologies. SBIR has three phases. Under Phase I, USDOE makes grants to small businesses for evaluating the scientific and technical merit of a technology. Phase II awards go to successful Phase I participants for further development of the technology. Under Phase III, participating small businesses use non-federal investment to pursue commercialization. In order to participate in SBIR, Meharry

would have to serve as a commercial application site for a small business entering SBIR Phase III. Unfortunately, the 1996 SBIR funding priorities do not list building insulation materials as a targeted research area. Meharry could, however, communicate its interest in serving as a commercialization application site if building insulation materials become a SBIR priority in the future.

Issues Affecting Federal Assistance

In order to obtain technology-related funding, Meharry will have to effectively demonstrate the research and development value of the building shell addition. In this respect, several criteria must be met. First, the building shell material must be a new, innovative technology that is in the development or commercialization stages. Second, the Basic Science Center must be shown to be an appropriate demonstration and test site for the new technology. Third, Meharry must show its willingness to serve as a test site and share research results with other potential users. To address these criteria, Meharry will need the early involvement and active support of USDOE and ORNL to identify potential private sector participants wanting to test newly developed building shell materials. In addition, Meharry will need one or more nonprofit partners with material testing and development capabilities.

USDOE uses three types of instruments for funding research projects: procurement contracts, grants, and cooperative agreements. The choice of award lies within USDOE's administrative discretion. USDOE uses a procurement contract to purchase property or services for agency use. It uses a grant when it does not anticipate substantial project involvement, and a cooperative agreement when there will be more extensive USDOE participation. Although USDOE normally uses grant instruments to fund CRDP projects, it may consider using a cooperative agreement when it determines that its participation can enhance project success.

As stated above, Meharry may want to consider submitting an unsolicited proposal to USDOE for CRDP funds. Although Meharry previously took this approach with its June 16, 1994 proposal, a second, more focused attempt may be warranted. USDOE may accept an unsolicited proposal if the proposal: "demonstrates a unique and innovative concept, or demonstrates a unique capability of the submitter, offers a concept or services not otherwise available to the Government; and does not resemble the substance of a pending competitive action" (USDOE, 1991, p.8). The proposal must clearly show that program objectives and activities are relevant to the USDOE mission. The proposal must also clearly present the rationale of the approach, research and demonstration methods, qualifications of participants, and needed level of funding.

A number of federal regulations govern USDOE acceptance and funding of unsolicited proposals, notably: (1) Title 48 Code of Federal Regulations (CFR), Chapter 1, The Federal Acquisition Regulation (FAR) *Subpart 15.5-Unsolicited Proposals*; (2) Title 48 CFR, Chapter 9, the Department of Energy Acquisition Regulation (DEAR) *Subpart 915.5-Unsolicited Proposals*; (3) Title 10 CFR, Part 600 Financial Assistance Rules; and (4) OMB Circular No.A-110. Federal Acquisition Regulations provide guidance to

agencies in governing and stimulating the flow of unsolicited proposals. Title 10 CFR, Part 600 and OMB Circular A-110 have more immediate relevance to Meharry's proposal preparation efforts. Relevant paragraphs include:

Title 10 CFR, Part 600.14 Unsolicited applications

DOE may award financial assistance to an applicant who submits an unsolicited application for support of a project that involves an innovative idea, method or approach. DOE shall determine whether the application would result in a procurement contract or in a grant or cooperative agreement.

Title 10 CFR, Part 600.20 Legal authority and effect of an award

(c) DOE funds awarded under a grant or cooperative agreement shall be obligated as of the date the DOE Contracting Officer signs the award, however, the recipient is not allowed to incur costs under an award prior to the beginning date of the budget period shown in the award except as may be authorized in accordance with 600.32, 600.125 (e) or 600.230 of this part.

Title 10 CFR, Part 600.119 Procurement under grants and subgrants

(c) prior approval requirements: (1) A grantee or subgrantee must receive prior written approval from the awarding party before entering into any sole source contract or a contract where only one bid or proposal is received when: ...in the case of a research grant, the value of the contract is expected to exceed \$25,000 in the aggregate, regardless of the grantee's or subgrantee's organizational type.

Attachment O - Circular No. A-110 Procurement Standards

b. All procurement transactions shall be conducted in a manner to provide, to the maximum extent practical, open and free competition.....In order to ensure objective contractor performance and eliminate unfair competitive advantage, contractors that develop or draft specifications, requirements, statements of work, invitations for bids and/or requests for proposals should be excluded from competing for such procurements.

In summary, federal regulations point to the need for Meharry to work with USDOE throughout the process of preparing and submitting an unsolicited proposal. In the event the proposal is funded, Meharry will need to closely coordinate procurement activities with USDOE. This will help Meharry successfully maneuver federal standards for contractor selection in federal research and development programs.

Promotional Opportunities

In addition to pursuing financial assistance for the Basic Science Center building shell, Meharry should also consider promoting its current energy management program. Several federal programs offer opportunities for building owners to obtain national recognition for exemplary energy management efforts. Participants in the US Environmental Protection Agency's Green Lights and Energy Star programs, for example, receive national recognition for reducing pollution emissions through improved

energy efficiency. Participants must agree to implement profitable energy efficiency improvements within a five year period. In order to facilitate the improvements, US EPA offers a variety of services, including energy management training, information on current technologies, and access to project analysis software. US EPA selected Meharry's performance contractor, Honeywell Inc., as the Green Lights manufacturer ally of the year (US EPA, 1995). Meharry may want to consider working with Honeywell and US EPA to become an award-winning Green Lights partner.

In past years, USDOE has given National Energy Awards for exemplary projects in a number of categories, including building technology. Building owners and program sponsors that have made outstanding energy efficiency gains are eligible to apply for National and Special Recognition awards. If the Meharry-Honeywell performance contract produces the expected level of energy savings, Meharry should consider preparing a Nation Energy Award application. Other avenues for promoting Meharry's energy management success include the development and dissemination of case studies, news releases, and journal articles. Meharry may want to consider working with Honeywell and USDOE in pursuing these activities.

USDOE Role in Meharry's Energy Management Efforts

As stated earlier, Meharry has aggressively implemented the energy-related components of its June, 1994 proposal to USDOE through a performance contract with Honeywell Inc. Meharry's energy management success is the culmination of a long-term effort to obtain project financing. A 1989 study of the Meharry campus showed that the mechanical systems, building controls and steam lines were under tremendous strain and needed immediate replacement. Study consultants attempted to interest several energy service companies in the project, but were unsuccessful due to high project costs and uncertain energy savings. In short, Meharry faced the dilemma of needing financing to secure an energy service company, while needing a solid energy service company to secure financing. After years of heating and cooling the campus with leaking steam lines and inefficient mechanical systems, Meharry addressed its dilemma by entering into a performance contract with Honeywell. The negotiated partnership with Honeywell placed Meharry in a position to begin improving its systems while searching for long-term financing. The energy savings guarantees contained in the Meharry-Honeywell performance contract played a important role in obtaining project financing through private placement revenue bonds.

The scope and urgency of Meharry's energy management needs made performance contracting a necessary option. Any available federal funding, possibly through the USDOE Institutional Conservation Program, would have only covered about one percent (approximately \$80,000) of total energy efficiency project costs. By incorporating federal funding into the performance contracting component of the project, Meharry would have taken the chance of delaying the project and interfering with its search for an energy service company. This, in turn, would have disrupted its efforts to obtain private sector financing for the remainder of the project. In short, the size of the project, in

combination with the need for prompt implementation, made it necessary for Meharry to pursue the performance contracting option without federal funding.

Federal energy efficiency programs play a valuable role in helping institutional building owners reduce energy costs and improve operations. Federal programs are also increasingly providing support for important research and development efforts in energy efficiency technology. It is incumbent for potential program participants, in coordination with USDOE, to identify specific project areas where federal assistance is appropriate. This means finding targeted projects where participants can utilize limited federal funding to address USDOE program objectives. While addressing these objectives, participants must meet federal requirements that are essential for maintaining accountability for public funds. In closing, there are two areas that meet these criteria and offer USDOE the opportunity for participation in the Meharry project: (1) financial and technical assistance for the Basic Science Center building shell (as a research and development project); and (2) assistance in promoting the retrofit and Meharry's energy management success.

Sources of Information

Federal Assistance Monitor, CD Publications (January-April, 1996)

Health and Educational Facilities Board of The Metropolitan Government of Nashville and Davidson County, Private Placement Memorandum, Tennessee Revenue Bonds for Meharry Medical College Project (July, 1995), by Stokes and Bartholomew, PA.

Honeywell Inc., Building Services Agreement Between Honeywell Inc. and Meharry Medical College for Asset Modernization Service and Comprehensive Maintenance Services (September, 1995).

L. Quincy Jackson and Associates, Cost Estimate for the Renovation of the Basic Sciences Center (Phases I, II and III (October, 1994).

Meharry Medical College, Unsolicited Proposal Submitted to the US Department of Energy for Revitalization of Energy Systems (June, 1994).

Tennessee Department of Economic and Community Development, "An Analysis of Energy Costs, Potential Energy Savings and Necessary HVAC System Investments at Meharry Medical College," (December, 1989) by Engineering Resource Group, Inc., funded by the US Department of Energy, Institutional Conservation Development Program.

US General Services Administration, "Catalog of Federal Domestic Assistance" (June, 1995 edition)

US Department of Energy, "Guide for the Submission of Unsolicited Proposals," (October, 1991)

US Department of Energy, "Technology Transfer 1995" (January, 1995).

US Department of Energy, Office of Energy Research, "Small Business Innovation Research Program Solicitation," (February, 1996).

US Department of Energy, Oak Ridge National Laboratory, Building Technology Center. World Wide Web Home Page (February, 1996).

US Department of Energy, "Technology Partnership Opportunities," World Wide Web Home Page (February, 1996).

US Environmental Protection Agency, "Green Lights Fourth Annual Report," (June, 1995).

Appendix

1. Meharry Medical College Campus Plan (from Meharry June 16, 1994 Proposal to USDOE)
2. Summary of Energy Efficiency Measures (from Meharry-Honeywell Performance Contract)
3. Debt Service for Revenue Bonds (from Private Placement Memorandum)
4. Cost Estimate for Basic Science Center Renovation (from L. Quincy Jackson Architects Study)
5. Basic Science Center Building Shell Study (from UM Mechanical Engineering Department)
6. Federal Assistance Programs (from Catalog of Federal Domestic Assistance)
7. Conservation Research and Development Program (from Catalog of Federal Domestic Assistance)

BUILDING LEGEND

- 1 OLD HOSPITAL BUILDING
- 2 HUBBARD HOSPITAL
- 3 COMPREHENSIVE HEALTH CENTER
- 4 ELAN MENTAL HEALTH CENTER
- 5 DENTAL SCHOOL
- 6 BASIC SCIENCES CENTER
- 7 LEARNING RESOURCES CENTER
- 8 LYTTLE HALL
- 9 COMPUTER CENTER
- 10 DOROTHY BROWN HALL

- 11 TOWERS STUDENT - FACULTY APTS.
- 12 AMPHITHEATER
- 13 DENTAL SCHOOL ANNEX
- 14 PARKING GARAGE
- 15 GRADUATE STUDIES BUILDING
- 16 CENTRAL HVAC PLANT
- 17 STUDENT CENTER
- 18 INTERNATIONAL CENTER
- 19 WEST WING - (OLD HOSPITAL BUILDING)

SYMBOLS

PARKING

FLOOR PLANS FORMATTED
TO COMPUTER DISK

MEHARRY MEDICAL COLLEGE CAMPUS PLAN - [1]

Summary of Energy Efficiency Measures Included in Meharry-Honeywell Performance Contract

Campus Wide Automation System

1. install a campus wide Excel 5000 building automation system, expandable to include life, safety and security; (the following campus facilities will be networked via fiber optic transmission: (1) Basic Science Center; (2) Dental School; (3) Learning Resource Center; (4) Mental Health Center; (5) Comprehensive Health Center; (6) Central Plant; (7) Old Hubbard Hospital; (8) Computer Center; the following facilities will be connected via standard phone lines: (1) International Center; (2) Student Center; (3) Graduate Studies Building; and (4) Dental Annex)
2. install direct digital controllers connected to the network to control the use of primary mechanical equipment (including the control of every primary air mover, pump and heating and chilled water system)

Central Plant (#16 on Campus Plan)

1. install automation and control system (for control of chilled water and thermal fluid system)
2. install thermal fluid system (includes boilers, pumps and piping)
3. install energy efficient lighting (includes electronic ballasts, T8 lamps)

Basic Science Center (#6 on Campus Plan)

1. install new heating system (includes boilers, pumps, valves and piping)
2. renovate HVAC control system (includes compressor, air dryer, thermostats, reheat valves, etc.)
3. install energy efficient lighting (includes electronic ballasts, T8 lamps)

Basic Science Center Mechanical Rooms (NE, NW, SW, SE, Basement, Roof)

1. upgrade chilled water and hot water pumps and controls (includes inspecting, cleaning, and replacing/repairing motor, pump; and installing variable frequency drives)
2. upgrade air-handling units and controls (includes inspecting, cleaning and replacing/repairing motor and other parts; and installing variable frequency drives)
3. upgrade mechanical room (includes repairing pipe insulation and air duct insulation, removing steam lines and converters where applicable; painting walls and floors)
4. install domestic hot water system (for NE room; includes boiler, circulating pump)

Learning Resource Center (#7 on Campus Plan)

1. renovate HVAC control system (includes compressor, air dryer, thermostats, reheat valves, etc.)
2. install energy efficient lighting (includes electronic ballasts, T8 lamps)
3. install new heating system (includes boilers, pumps, valves and piping)

Learning Resource Center Mechanical Rooms (Penthouse, Basement)

1. upgrade chilled water and hot water pumps and controls (includes inspecting, cleaning, and replacing/repairing motor, pump; and installing variable frequency drives)
2. upgrade air-handling units and controls (includes inspecting, cleaning and replacing/repairing motor and other parts; and installing variable frequency drives)
3. upgrade mechanical room (includes repairing pipe insulation and air duct insulation, removing steam lines and converters where applicable; painting walls and floors)
4. install domestic hot water system (for Basement; includes boiler, circulating pump)

Dental School (#5 on Campus Plan)

1. renovate HVAC control system (includes compressor, air dryer, thermostats, reheat valves, etc.)
2. install energy efficient lighting (includes electronic ballasts, T8 lamps)

Dental School Mechanical Rooms (Penthouse, Third Floor, Basement)

1. upgrade chilled water and hot water pumps and controls (includes inspecting, cleaning, and replacing/repairing motor, pump; and installing variable frequency drives)
2. upgrade air-handling units and controls (includes inspecting, cleaning and replacing/repairing motor and other parts; and installing variable frequency drives)
3. upgrade mechanical room (includes repairing pipe insulation and air duct insulation, removing steam lines and converters where applicable; painting walls and floors)
4. install domestic hot water system (for Basement; includes boiler, circulating pump)
5. install thermal fluid to hot water converter (for Basement, includes piping, controls, valves, insulation)

Dental Annex (#13 on Campus Plan)

1. install energy efficient lighting (includes electronic ballasts, T8 lamps)

Old Hubbard Hospital (#1 on Campus Plan)

1. renovate HVAC control system (includes compressor, air dryer, thermostats, reheat valves, etc.)
2. upgrade air handling units inside building (includes replacing steam heating coil with hot water coil, piping, valves, and controls)
3. install energy efficient lighting (includes electronic ballasts, T8 lamps)

Old Hubbard Hospital Mechanical Rooms (Roof-Aluminum Bldg., Roof-Room 4001, Roof-Nursery Suite, Basement, West Wing Basement)

1. upgrade chilled water and hot water pumps and controls (for Basement and West Wing Basement; includes inspecting, cleaning, and replacing/repairing motor, pump; and installing variable frequency drives)
2. upgrade air-handling units and controls (includes inspecting, cleaning and replacing/repairing motor and other parts; and installing variable frequency drives)

3. upgrade mechanical room (includes repairing pipe insulation and air duct insulation, removing steam lines and converters where applicable; painting walls and floors)
4. install domestic hot water system (for Basement and West Wing Basement; includes boiler, circulating pump)

Comprehensive Health Center (#3 on Campus Plan)

1. install new heating system (includes thermal to hot water converter, piping, valves, controls and insulation)
2. install domestic hot water system (includes thermal fluid to hot water converter, circulating pump, modulating valve and controls, piping, valves, controls; insulation)

International Center (#18 on Campus Plan)

1. install energy efficient lighting (includes electronic ballasts, T8 lamps)
2. install direct digital control on each heating and air-conditioning unit

Mental Health Center (#4 on Campus Plan)

1. renovate HVAC control system (includes compressor, air dryer, thermostats, reheat valves, etc.)
2. install energy efficient lighting (includes electronic ballasts, T8 lamps)
3. install new heating system (includes thermal to hot water converter, piping, valves, controls and insulation)

Mental Health Center Mechanical Rooms (Basement-North, Basement-South)

1. upgrade chilled water and hot water pumps and controls (for Basement-South; includes inspecting, cleaning, and replacing/repairing motor, pump; and installing variable frequency drives)
2. upgrade air-handling units and controls (includes inspecting, cleaning and replacing/repairing motor and other parts; and installing variable frequency drives)
3. upgrade mechanical room (includes repairing pipe insulation and air duct insulation, removing steam lines and converters where applicable; painting walls and floors)
4. install domestic hot water system (for Basement South; includes boiler, circulating pump)
5. install swimming pool heating system (for Basement-South)

Mental Health Center Swimming Pool, Gym and Racquetball Areas

1. replace existing heating and ventilation unit with roof unit (pool area)
2. replace existing HVAC units with new air handling units (gym area)
3. replace existing HVAC units with new unit (racquetball area)
4. install direct digital control

Computer Center (#9 on Campus Plan)

1. install energy efficient lighting (includes electronic ballasts and T8 lamps)

Computer Center Mechanical Room

1. install direct digital control on air handling units

Student Center (#17 on Campus Plan)

1. install energy efficient lighting (includes electronic ballasts and T8 lamps)
2. install direct digital control on heating and air-conditioning units

Exterior Campus Lighting

1. install new lighting for campus parking lots (high pressure sodium)
2. install new lighting and poles along campus streets and walkways
3. mount new lighting on eight campus buildings

Debt Service for Revenue Bonds

<u>Fiscal Year</u>	<u>Principal</u>	<u>Interest</u>	<u>Annual Debt Service</u>
1996	\$1,245,000	\$720,892	\$1,965,892
1997	965,000	1,227,600	2,192,600
1998	1,040,000	1,152,813	2,192,813
1999	1,120,000	1,072,212	2,192,212
2000	1,205,000	985,413	2,190,413
2001	1,300,000	892,025	2,192,025
2002	1,400,000	791,275	2,191,275
2003	1,510,000	682,775	2,192,775
2004	1,625,000	565,750	2,190,750
2005	1,755,000	439,813	2,194,813
2006	1,885,000	303,800	2,188,800
2007	<u>2,035,000</u>	<u>157,712</u>	<u>2,192,712</u>
TOTAL	\$17,085,000	\$8,992,080	\$26,077,080

¹Source: Private Placement Memorandum, July 18, 1995

**COST ESTIMATE FOR THE RENOVATION OF THE
BASIC SCIENCES CENTER
(PHASES I, II, AND III)
OCTOBER 19, 1994**

ITEM	DESCRIPTION	COST\$
A.	Remove and replace existing brick porch wall and caps. (Phase III)	200,000.00
B.	Realignment-replace-add metal studs and new drywall systems (Phase III)	150,000.00
C.	New exterior light wt., skin wall (Phase III)	1,600,000.00
D.	Remove exterior conc., patio pavers water proof and place new pavers (Phase III)	500,100.00
E.	Tear-off, repair and reroof all roof deck (Phase I)	300,000.00
F.	New exterior wall sheating & insul., (Phase I)	95,908.00
G.	Waterproofing	69,000.00
H.	Replace interior perimeter ceil	32,000.00
I.	Electrical (Phase II)	38,000.00
J.	General Plumbing	10,000.00
K.	Building protection and insurance during construction (Phase I)	30,000.00
L.	Structural supports for all cantilever slabs and related columns and brackets (Phase I)	612,000.00
M.	New interior fire proof partitions around structural supports, frames and at reinforced columns (Phase I)	165,000.00
N.	Contingency (Phase III)	317,000.00
O.	Architect, engineering and interior design services (Phase I)	450,392.00
P.	Construction management and contractor overhead (Phase I)	400,200.00
Q.	Tile all floors	7,000.00
	TOTAL DEVELOPMENT COST	\$4,976,600.00

*Source: L. Quincy Jackson & Associates • Architects • Engineers • Planners
Macon Hinton, L.Q. Jackson, M.D. Jackson*

**A Feasibility Study of an
Exterior Insulated Finish System**

for the

**Basic Sciences Center Building
Meharry Medical College
Nashville, Tennessee**

by the

**The Tennessee Energy Institute
and
The Mechanical Engineering Department**

of

The University of Memphis

March 28, 1996

EXECUTIVE SUMMARY

Introduction

The Basic Sciences Center is a multi-level, multi-purpose facility built in 1973 that houses classrooms, laboratories, offices, and large lecture halls for Meharry Medical College. The 288,000 square foot building was designed with the upper three floors overhanging the lower floors. In time, the overhung portions of the building apparently flexed sufficiently to cause fractures in the original brick exterior, resulting in bricks falling from the building. To prevent injuries to persons walking near the building, it was decided to remove all of the brick exterior, leaving simply a concrete exterior that is overlaid with rigid insulation in most places. Besides being unsightly, the current exterior wall does not offer an energy efficient exterior for the building. To remedy both problems, it was decided to investigate the feasibility of installing an Exterior Insulated Finish System (EIFS) on the building.

EIFS is a modern stucco-like construction technique in which the exterior wall of a building is covered with expanded polystyrene (EPS) foam over which a thin coat of stucco is troweled into a fiberglass mesh. To this exterior surface a finish coat is applied that may be colored and textured to appear as though it were a stucco surface.

EIFS is both lightweight and affordable. It has a long life and requires very little maintenance. It is commonly used in hotels, office buildings, and institutional buildings such as the Basic Sciences Center.

Current Energy Use

To model the energy use in the Basic Sciences Center, the commercial computer program HAP 3.20 from Carrier Software Systems was employed. This program requires information regarding the building envelope (i.e. walls, roof, windows, etc.), the lighting system employed, and typical operating schedules. A site visit to the building, inspection of building floorplans, and knowledge of school building usage allowed reasonable estimates to be made for all of the pertinent quantities. Once the information was provided, the program carried out an hour-by-hour simulation for the building for a typical year in Nashville. Output included annual energy consumed by the building's heating, cooling, and lighting, and support systems.

Figure 1 shows the monthly cost of natural gas and electricity used by the building's heating, ventilation, and air-conditioning (HVAC) system and the lighting system as determined by the computer simulation. As can clearly be seen, the predominate energy use in the building is for lighting. As shown in Figure 2, lighting accounts for almost 75% of the building's energy costs. Second to the lighting cost is that associated with cooling the building. It represents 14% of the annual energy cost, or \$18,350 annually. Heating, on the other hand, accounts for less than 3% of the annual energy cost, and amounts to \$3,300 a year.

Component Operating Costs

Basic Sciences Center - Exist.
Nashville (Nashville TMY)

03-25-96
HAP v3.20

Figure 1. Monthly energy costs for the building's lighting, heating, and cooling systems with present wall.

Annual Component Costs

Basic Sciences Center - Exist.
Total Cost = 131467 (\$)

03-25-96
HAP v3.20

Figure 2. Breakdown of total annual energy costs for existing building.

The significant disparity between heating and cooling costs is due primarily to the fact that much of the building's heating requirement is supplied by its lights during the heavily occupied periods each winter day. While the lights help to reduce significantly the wintertime heating bills, they add appreciably to the summertime energy bills since the cooling system must remove not only the heat flowing through the building's exterior but also all of the heat introduced by the lights.

Building EIFS

The feasibility of installing an EIFS consisting of 4" of EPS insulation with a 1/4" stucco overcoat was explored. It was assumed that the present exterior insulation would first be removed. The proposed EIFS would increase the thermal resistance of the exterior wall from a rating of R-8 to R-22, thereby reducing the heat flowing through the walls by over 60% in both winter and summer.

The cost of installing the EIFS on the entire 50,000 square feet exterior wall of the building is estimated to be approximately \$300,000.

Energy Use with EIFS Installed

Once again the building's annual energy consumption was simulated using the HAP 3.20 program. The only change was in the thermal characteristics of the wall. Figure 3 shows the monthly energy consumption for the building with the EIFS in place. Comparing these figures to those of Figure 1, one can easily see that very little change occurs. In fact the annual energy costs fall by only a little over \$500 per year.

The reason for this small reduction in energy costs is that the heat flow through the walls of the building represents only a small portion of the annual heating and cooling energy. Thus, the EIFS, while providing a significantly better thermal barrier for the walls, has little effect on the building's overall energy consumption.

Recommendation

Given the small annual energy savings produced by the EIFS and the capital expenditure required, the economic merits of installing the EIFS are minimal. However, if it is presumed that some type of exterior surface is going to be applied, then the EIFS is a reasonable approach. A brick veneer exterior would cost approximately \$400,000 and would be much heavier. In addition, it would offer less thermal insulation than the proposed EIFS. Thus, the lightweight, cost-effective EIFS represents a reasonable solution to the problem, and is thus recommended for further consideration.

Component Operating Costs

Basic Sciences Center - EIFS
Nashville (Nashville TMY)

03-25-96
HAP v3.20

Figure 3. Monthly energy costs for the building's lighting, heating, and cooling systems with proposed EIFS wall.

Annual Component Costs

Basic Sciences Center - EIFS
Total Cost = 130951 (\$)

03-25-96
HAP v3.20

Figure 4. Breakdown of total annual energy costs for building with proposed EIFS wall.

Appendix
Computer Simulation Results

SPACE DESCRIPTION

Prepared by: University of Memphis

03-23-96

HAP v3.20

Page 1

G SRAL

SCHEDULES

Name.....: Entire Building
 Floor Area.....: 288588.0 sqft
 Building Weight.: 70.0 lb/sqft
 Windows Shaded..? Y
 Partitions Used.? N

Lighting.....: Lighting
 Task Lights.: Lighting
 People.....: Lighting
 Equipment...: Lighting
 Misc. Sens.: Lighting
 Misc. Latent: Lighting

LIGHTING

Overhead Fixture: Recessed
 Lamp Wattage....: 1.50 W/sqft
 Ballast Mult....: 1.10
 Task Lighting...: 0.00 W/sqft

INFILTRATION

Cooling.....: 0.00 CFM/sqft
 Heating.....: 0.00 CFM/sqft
 Typical.....: 0.00 CFM/sqft
 When Fan On.? N

PEOPLE

Occupancy.....: 500 People
 Activity Level..: Sedentary Work
 Sensible.....: 280.0 BTU/hr
 Latent.....: 270.0 BTU/hr

FLOOR

Type.....: Above Conditioned Space

OTHER LOADS

Equipment.....: 20000.0 W
 Misc. Sensible..: 0.0 BTU/hr
 Misc. Latent....: 0.0 BTU/hr

EXTERNAL SHADING	Type 1	Type 2	Type 3
Reveal Depth.....(in)	0.0	0.0	0.0
Overhang			
Projection From Building Surface.(in)	0.0	0.0	0.0
Height Above Window.....(in)	0.0	0.0	0.0
Extension Past RH Side Of Window.(in)	0.0	0.0	0.0
Extension Past LH Side Of Window.(in)	0.0	0.0	0.0
Right Fin			
Distance From Edge Of Window.....(in)	0.0	0.0	0.0
Projection From Building Surface.(in)	0.0	0.0	0.0
Height Above Window.....(in)	0.0	0.0	0.0
Left Fin			
Distance From Edge Of Window.....(in)	0.0	0.0	0.0
Projection From Building Surface.(in)	0.0	0.0	0.0
Height Above Window.....(in)	0.0	0.0	0.0

WALL	Gross Area	WALL	WINDOW			WINDOW			Any
Exp	(sqft)	Type	Type	Qty	Shade	Type	Qty	Shade	Doors?
N	13250.0	2	1	18	0	1	0	0	N
S	13250.0	2	1	18	0	1	0	0	N
E	14100.0	2	1	61	0	1	0	0	N
W	14100.0	2	1	61	0	1	0	0	N

ROOF	Slope	Gross Area	ROOF	SKYLIGHT	
Exp	(deg)	(sqft)	Type	Type	Qty
HOR	-	75500.0	1	2	1

No partition data for this space.

WALL CONSTRUCTION TYPES

Prepared by: University of Memphis
HAP v3.20

03-23-96

Page 1

WALL TYPE 2: (CUSTOM WALL)

Description.....: Existing Wall

Absorptivity.....: 0.500

Layer Description	Thickness	Density	Spec.Ht	R-Val	Weight
Inside surface resistance	-	-	-	0.69	-
8-in (203 mm) HW concrete	8.00	140.0	0.20	0.67	93.3
R-7 (RSI-1.2) board insulation	1.00	2.0	0.22	6.94	0.2
Outside surface resistance	-	-	-	0.17	-
Totals	9.00			8.47	93.5

Thickness: in Density: lb/cuft Weight: lb/sqft
R-value : (hr-sqft-F)/BTU Specific Heat: BTU/lb/F

```
Name: Primary Air System                                03-23-96
Type: CONSTANT VOLUME - Single Zone CAV                HAP v3.20
Prepared by: University of Memphis                     Page 2
*****
```

```
Sensible Cooling Factor.....: 0 %
Latent Cooling Factor.....: 0 %
Heating Factor.....: 0 %
```

ZONE	1	(All Zones the Same)
T-Stat Occupied Cooling....(F):	75.0	
Unoccupied Cooling..(F):	85.0	
Occupied Heating....(F):	75.0	
Unoccupied Heating..(F):	60.0	
Throttling Range....(F):	3.0	
Zone Heating Unit Type.....:	None	
Trip Temperature.....(F):	-	
Design Supply Temperature(F):	-	
Fan Total Static....(in.wg.):	-	
Fan Efficiency.....(%):	-	
Zone Terminal Type.....:	Diffuser	
Reheat Coil.....?	N	
Direct Exhaust Airflow...(CFM):	0.0	
Direct Exhaust Fan KW.....(kW):	0.0	

[illegible]

Cooling Available During Unoccupied Period ? Y

[illegible]

AIR SYSTEM INPUT DATA

Name: Primary Air System

03-23-96

Type: CONSTANT VOLUME - Single Zone CAV

HAP v3.20

Prepared by: University of Memphis

Page 1

1. SPACE SELECTION

Space Name	Qty	Space Name	Qty
SPACES IN ZONE 1 (Zone 1)			
1. Entire Building	1		

SCHEDULE DATA

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03-23-96

HAP v3.20

Page 1 of 1

Schedule Name: Lighting

Hourly Percentages

Hour ---->	00	01	02	03	04	05	06	07	08	09	10	11
DESIGN DAY	10	10	10	10	10	10	10	20	90	100	100	100
Weekday	10	10	10	10	10	10	10	20	90	100	100	100
Saturday	10	10	10	10	10	10	10	10	10	20	20	20
Sunday	10	10	10	10	10	10	10	10	10	20	20	20
Hour ---->	12	13	14	15	16	17	18	19	20	21	22	23
DESIGN DAY	100	100	100	100	100	90	80	60	20	10	10	10
Weekday	100	100	100	100	100	90	80	60	30	20	10	10
Saturday	20	20	20	20	20	20	10	10	10	10	10	10
Sunday	20	20	20	20	20	20	10	10	10	10	10	10

AIR SYSTEM INPUT DATA

Name: Primary Air System
 Type: CONSTANT VOLUME - Single Zone CAV
 Prepared by: University of Memphis

03-23-96
 HAP v3.20
 Page 1

1. SYSTEM NAME AND TYPE

Name.....: Primary Air System
 Type.....: CONSTANT VOLUME - Single Zone CAV
 Number of Zones.: 1

2. SYSTEM DESCRIPTION

COOLING SYSTEM DATA

Is Central Cooling Used.....? Y
 Supply Air.....: 55.0 F
 Coil Bypass Factor.....: 0.100
 Fan Cycled for Cooling.....? N
 Supply Air Reset.....: Greatest Demand
 Maximum Reset Temperature.....: 65.0 F

HEATING SYSTEM DATA

Is Central Heating Used.....? Y
 Fan Cycled for Heating.....? N
 Supply Air Reset.....: Greatest Demand
 Minimum Reset Temperature.....: 90.0 F

OUTDOOR VENTILATION DATA

Type of Control.....: Constant Airflow Rate
 Design Ventilation Airflow.....: 15.0 CFM/person
 Dampers Open During Unocc Per.: N
 Damper Leak Rate.....: 0 %

SUPPLY DUCT DATA

Duct Heat Gain.....: 0 %
 Duct Leakage Rate.....: 0 %

RETURN PLENUM DATA

Is a Return Plenum Used.....? N

SUPPLY FAN DATA

Fan Type.....: Forward Curved
 Configuration.....: Draw-Thru
 Fan Total Static.....: 0.00 in.wg.
 Fan Efficiency.....: 54 %

RETURN FAN DATA

Fan Type.....: None

OUTDOOR AIR ECONOMIZER

Outdoor Economizer Type.....: Integrated Dry-Bulb
 OA Upper Cutoff Temp.....: 150.0 F
 OA Lower Cutoff Temp.....: -60.0 F

PREHEAT COIL

Preheat Coil Used.....? N

PRECOOL COIL

Precool Coil Used.....? N

HUMIDIFICATION

Humidification System Used....? N

DEHUMIDIFICATION

Dehumidification System Used..? N

VENTILATION HEAT RECLAIM

Reclaim Unit Type.....: None

ANNUAL ENERGY COSTS

Building: Basic Sciences Center - Exist.

03-23-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

Page 1 of 1

TABLE 1. COSTS BY ENERGY CATEGORY

Component	Annual Energy	<---- Annual Costs ---->		% of Total
		(\$)	(\$/sqft)*	
Electric	435392 kWh	26124	0.091	19.9 %
Natural Gas	6612 Therm	3306	0.011	2.5 %
Fuel Oil	0	0	0.000	0.0 %
Propane	0	0	0.000	0.0 %
Remote Heating	0	0	0.000	0.0 %
Remote Cooling	0	0	0.000	0.0 %
>>> HVAC Subtotal		29430	0.102	22.4 %
Electric	1700623 kWh	102037	0.354	77.6 %
Natural Gas	0 Therm	0	0.000	0.0 %
Fuel Oil	0	0	0.000	0.0 %
Propane	0	0	0.000	0.0 %
Remote Heating	0	0	0.000	0.0 %
>>> Non-HVAC Subtotal		102037	0.354	77.6 %
>>> GRAND TOTAL		131467	0.456	100.0 %

* Cost per unit floor area is based on the gross building floor area.

Gross floor area.....: 288588 sqft

Conditioned floor area.....: 288588 sqft

ANNUAL COMPONENT COSTS

Building: Basic Sciences Center - Exist.

03-23-96

Weather: Nashville (Nashville TMY)

HAP V3.20

Prepared by: University of Memphis

Page 1 of 1

TABLE 1. COSTS BY COMPONENT

Component	<--- Annual Costs --->		% of Total
	(\$)	(\$/sqft)*	
Air System Fans	0	0.000	0.0 %
Cooling Plants	18350	0.064	14.0 %
Absorption Chillers	0	0.000	0.0 %
Heating Plants	3308	0.011	2.5 %
Pumps	0	0.000	0.0 %
Cooling Towers	7772	0.027	5.9 %
>>> HVAC Subtotal	29430	0.102	22.4 %
Lights	97924	0.339	74.5 %
Electric Equipment	4113	0.014	3.1 %
Miscellaneous Electric	0	0.000	0.0 %
Miscellaneous Fuel Use	0	0.000	0.0 %
>>> Non-HVAC Subtotal	102037	0.354	77.6 %
>>> GRAND TOTAL	131467	0.456	100.0 %

* Cost per unit floor area is based on the gross building floor area.

Gross floor area.....: 288588 sqft

Conditioned floor area.....: 288588 sqft

ENERGY BUDGET BY SYSTEM COMPONENT

Building: Basic Sciences Center - Exist.

03-23-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

Page 1 of 1

TABLE 1. ANNUAL COIL LOADS

Component	(kBTU)	(kBTU/sqft) *
Cooling Loads	4702549	16.295
Heating Loads	463245	1.605

TABLE 2. ENERGY CONSUMPTION BY SYSTEM COMPONENT

Component	<----- Site Energy *----->		<----- Source Energy *----->	
	(kBTU)	(kBTU/sqft) *	(kBTU)	(kBTU/sqft) *
Air System Fans	0	0.000	0	0.000
Cooling Plants	1043480	3.616	1043480	3.616
Absorption Chillers	0	0.000	0	0.000
Heating Plants	661332	2.292	661332	2.292
Pumps	0	0.000	0	0.000
Cooling Towers	441947	1.531	441947	1.531
>>> HVAC Total	2146759	7.439	2146759	7.439
Lights	5568634	19.296	5568634	19.296
Electric Equipment	233893	0.810	233893	0.810
Misc. Electric	0	0.000	0	0.000
Misc. Fuel Use	0	0.000	0	0.000
>>> Non-HVAC Total	5802527	20.107	5802527	20.107
>>> GRAND TOTAL	7949285	27.545	7949285	27.545

* Site Energy is the actual energy consumed.

* Source Energy is the site energy divided by the electric generating efficiency of 100.0 %

* Cost per unit floor area is based on the gross building floor area.

Gross floor area.....: 288588 sqft

Conditioned floor area.....: 288588 sqft

ENERGY BUDGET BY ENERGY SOURCE

Building: Basic Sciences Center - Exist.

03-23-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

Page 1 of 1

TABLE 1. ANNUAL COIL LOADS

Component	(kBTU)	(kBTU/sqft) *
Cooling Loads	4702549	16.295
Heating Loads	463245	1.605

TABLE 2. ENERGY CONSUMPTION BY ENERGY COMPONENT

Component	<---- Site Energy *---->		<---- Source Energy *---->	
	(kBTU)	(kBTU/sqft) *	(kBTU)	(kBTU/sqft) *
Electric	1485558	5.148	1485558	5.148
Natural Gas	661200	2.291	661200	2.291
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Heating	0	0.000	0	0.000
Remote Cooling	0	0.000	0	0.000
>>> HVAC Total	2146759	7.439	2146759	7.439
Electric	5802527	20.107	5802527	20.107
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Heating	0	0.000	0	0.000
>>> Non-HVAC Total	5802527	20.107	5802527	20.107
>>> GRAND TOTAL	7949286	27.545	7949286	27.545

* Site Energy is the actual energy consumed.

* Source Energy is the site energy divided by the electric generating efficiency of 100.0 %

* Cost per unit floor area is based on the gross building floor area.

Gross floor area.....: 288588 sqft

Conditioned floor area.....: 288588 sqft

MONTHLY COMPONENT COSTS

Building: Basic Sciences Center - Exist.

03-23-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

Page 1 of 1

TABLE 1. HVAC COSTS (\$)

Month	Air Sys. Fans	Cooling Plants	Absorpt. Chillers	Heating Plants	Pumps	Cooling Towers
Jan	0	0	0	891	0	0
Feb	0	4	0	513	0	3
Mar	0	61	0	243	0	33
Apr	0	831	0	34	0	449
May	0	2136	0	0	0	1003
Jun	0	3585	0	0	0	1507
Jul	0	4425	0	0	0	1603
Aug	0	3822	0	0	0	1553
Sep	0	2512	0	0	0	1131
Oct	0	932	0	25	0	464
Nov	0	41	0	218	0	25
Dec	0	0	0	1385	0	0
Total	0	18350	0	3308	0	7772

TABLE 2. NON-HVAC COSTS AND TOTALS (\$)

Month	Lights	Non-HVAC Electric Eqpt.	Misc. Electric Eqpt.	Misc. Fuel Use	HVAC Total	Non-HVAC Total
Jan	8622	362	0	0	891	8985
Feb	7797	327	0	0	520	8124
Mar	7537	317	0	0	337	7853
Apr	8528	358	0	0	1315	8886
May	9165	385	0	0	3139	9550
Jun	8528	358	0	0	5092	8886
Jul	8622	362	0	0	6028	8985
Aug	7808	328	0	0	5375	8136
Sep	7985	335	0	0	3643	8321
Oct	9165	385	0	0	1421	9550
Nov	8257	347	0	0	284	8604
Dec	5908	248	0	0	1385	6156
Total	97924	4113	0	0	29430	102037

MONTHLY ENERGY COSTS

Building: Basic Sciences Center - Exist.

03-23-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

Page 1 of 1

TABLE 1. HVAC COSTS (\$)

Month	Electric	Natural Gas	Fuel Oil	Propane	Remote Heating	Remote Cooling
Jan	1	891	0	0	0	0
Feb	7	512	0	0	0	0
Mar	94	243	0	0	0	0
Apr	1281	34	0	0	0	0
May	3139	0	0	0	0	0
Jun	5092	0	0	0	0	0
Jul	6028	0	0	0	0	0
Aug	5375	0	0	0	0	0
Sep	3643	0	0	0	0	0
Oct	1396	25	0	0	0	0
Nov	67	218	0	0	0	0
Dec	1	1384	0	0	0	0
Total	26124	3306	0	0	0	0

TABLE 2. NON-HVAC COSTS (\$)

Month	Electric	Natural Gas	Fuel Oil	Propane	Remote Heating
Jan	8985	0	0	0	0
Feb	8124	0	0	0	0
Mar	7853	0	0	0	0
Apr	8886	0	0	0	0
May	9550	0	0	0	0
Jun	8886	0	0	0	0
Jul	8985	0	0	0	0
Aug	8136	0	0	0	0
Sep	8321	0	0	0	0
Oct	9550	0	0	0	0
Nov	8604	0	0	0	0
Dec	6156	0	0	0	0
Total	102037	0	0	0	0

MONTHLY ENERGY USE BY ENERGY TYPE

Building: Basic Sciences Center - Exist.

03-23-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

Page 1 of 1

TABLE 1. HVAC ENERGY USE

Month	Electric (kWh)	Natural Gas (Therm)	Fuel Oil ()	Propane ()	Remote Heating ()	Remote Cooling ()
Jan	10	1781	0	0	0	0
Feb	123	1024	0	0	0	0
Mar	1560	486	0	0	0	0
Apr	21349	69	0	0	0	0
May	52323	0	0	0	0	0
Jun	84874	0	0	0	0	0
Jul	100463	0	0	0	0	0
Aug	89583	0	0	0	0	0
Sep	60708	0	0	0	0	0
Oct	23273	49	0	0	0	0
Nov	1110	435	0	0	0	0
Dec	17	2767	0	0	0	0
Total	435392	6612	0	0	0	0

TABLE 2. NON-HVAC ENERGY USE

Month	Electric (kWh)	Natural Gas (Therm)	Fuel Oil ()	Propane ()	Remote Heating ()
Jan	149744	0	0	0	0
Feb	135405	0	0	0	0
Mar	130890	0	0	0	0
Apr	148107	0	0	0	0
May	159171	0	0	0	0
Jun	148107	0	0	0	0
Jul	149744	0	0	0	0
Aug	135603	0	0	0	0
Sep	138680	0	0	0	0
Oct	159171	0	0	0	0
Nov	143393	0	0	0	0
Dec	102608	0	0	0	0
Total	1700623	0	0	0	0

MONTHLY ENERGY USE BY SYSTEM COMPONENT

Building: Basic Sciences Center - Exist.

03-23-96

Weather: Nashville (Nashville TMY)

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TABLE 1. JANUARY - JUNE

Component	Jan	Feb	Mar	Apr	May	Jun
Air System Fans (kWh):	0	0	0	0	0	0
Cooling Plants:						
Electric (kWh)	0	74	1009	13858	35600	59751
Nat. Gas (Therm)	0	0	0	0	0	0
Absorption Chillers:						
Electric (kWh)	0	0	0	0	0	0
Nat. Gas (Therm)	0	0	0	0	0	0
Heating Plants:						
Electric (kWh)	10	6	3	0	0	0
Nat. Gas (Therm)	1781	1024	486	69	0	0
Pumps (kWh):	0	0	0	0	0	0
Cooling Towers (kWh):	0	43	548	7491	16722	25123
Lighting (kWh):	143708	129947	125614	142137	152755	142137
Electric Eqpt (kWh):	6036	5458	5276	5970	6416	5970
Misc Electric Eqpt (kWh):	0	0	0	0	0	0
Misc Fuel Use:						
Nat. Gas (Therm)	0	0	0	0	0	0

TABLE 2. JULY - DECEMBER

Component	Jul	Aug	Sep	Oct	Nov	Dec
Air System Fans (kWh):	0	0	0	0	0	0
Cooling Plants:						
Electric (kWh)	73746	63706	41861	15536	686	0
Nat. Gas (Therm)	0	0	0	0	0	0
Absorption Chillers:						
Electric (kWh)	0	0	0	0	0	0
Nat. Gas (Therm)	0	0	0	0	0	0
Heating Plants:						
Electric (kWh)	0	0	0	0	2	17
Nat. Gas (Therm)	0	0	0	49	435	2767
Pumps (kWh):	0	0	0	0	0	0
Cooling Towers (kWh):	26717	25878	18847	7736	421	0
Lighting (kWh):	143708	130137	133090	152755	137613	98472
Electric Eqpt (kWh):	6036	5466	5590	6416	5780	4136
Misc Electric Eqpt (kWh):	0	0	0	0	0	0
Misc Fuel Use:						
Nat. Gas (Therm)	0	0	0	0	0	0

PLANT SIMULATION UNMET LOAD REPORT

Plant: Central Chiller

03-23-96

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TABLE 1. COOLING PLANT STATISTICS

Month	Plant Capacity	--- Plant Capacity Insufficient to Meet Load ---			Total
	Is Sufficient (hr/month)	By 0%-5% (hr/month)	By 5%-10% (hr/month)	By > 10% (hr/month)	
Jan	0	0	0	0	0
Feb	2	0	0	0	0
Mar	22	0	0	0	0
Apr	153	0	0	0	0
May	287	0	0	0	0
June	387	0	0	0	0
July	398	1	1	3	5
Aug	394	0	0	0	0
Sept	311	0	0	0	0
Oct	145	0	0	0	0
Nov	16	0	0	0	0
Dec	0	0	0	0	0
Totals	2115	1	1	3	5

SPACE DESCRIPTION

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G ZRAL

SCHEDULES

Name.....: BUILDING WITH EIFS WALLS
 Floor Area.....: 288588.0 sqft
 Building Weight.: 70.0 lb/sqft
 Windows Shaded..? Y
 Partitions Used.? N

Lighting.....: Lighting
 Task Lights.: Lighting
 People.....: Lighting
 Equipment...: Lighting
 Misc. Sens.: Lighting
 Misc. Latent: Lighting

LIGHTING

Overhead Fixture: Recessed
 Lamp Wattage....: 1.50 W/sqft
 Ballast Mult....: 1.10
 Task Lighting...: 0.00 W/sqft

INFILTRATION

Cooling.....: 0.00 CFM/sqft
 Heating.....: 0.00 CFM/sqft
 Typical.....: 0.00 CFM/sqft
 When Fan On.? N

PEOPLE

Occupancy.....: 500 People
 Activity Level..: Sedentary Work
 Sensible.....: 280.0 BTU/hr
 Latent.....: 270.0 BTU/hr

FLOOR

Type.....: Above Conditioned Space

OTHER LOADS

Equipment.....: 20000.0 W
 Misc. Sensible...: 0.0 BTU/hr
 Misc. Latent.....: 0.0 BTU/hr

EXTERNAL SHADING

	Type 1	Type 2	Type 3
Reveal Depth.....(in)	0.0	0.0	0.0
Overhang			
Projection From Building Surface.(in)	0.0	0.0	0.0
Height Above Window.....(in)	0.0	0.0	0.0
Extension Past RH Side Of Window.(in)	0.0	0.0	0.0
Extension Past LH Side Of Window.(in)	0.0	0.0	0.0
Right Fin			
Distance From Edge Of Window.....(in)	0.0	0.0	0.0
Projection From Building Surface.(in)	0.0	0.0	0.0
Height Above Window.....(in)	0.0	0.0	0.0
Left Fin			
Distance From Edge Of Window.....(in)	0.0	0.0	0.0
Projection From Building Surface.(in)	0.0	0.0	0.0
Height Above Window.....(in)	0.0	0.0	0.0

WALL	Gross Area	WALL	WINDOW			WINDOW			Any
Exp	(sqft)	Type	Type	Qty	Shade	Type	Qty	Shade	Doors?
N	13250.0	1	1	18	0	1	0	0	N
S	13250.0	1	1	18	0	1	0	0	N
E	14100.0	1	1	61	0	1	0	0	N
W	14100.0	1	1	61	0	1	0	0	N

ROOF	Slope	Gross Area	ROOF	SKYLIGHT	
Exp	(deg)	(sqft)	Type	Type	Qty
HOR	-	75500.0	1	2	1

No partition data for this space.

WALL CONSTRUCTION TYPES

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WALL TYPE 1: (CUSTOM WALL)

Description.....: EIFS WALL

Absorptivity.....: 0.500

Layer Description	Thickness	Density	Spec.Ht	R-Val	Weight
Inside surface resistance	-	-	-	0.69	-
8-in (203 mm) HW concrete	8.00	140.0	0.20	0.67	93.3
R-14 (RSI-2.5) board insulation	2.00	2.0	0.22	13.89	0.3
R-7 (RSI-1.2) board insulation	1.00	2.0	0.22	6.94	0.2
Outside surface resistance	-	-	-	0.17	-
Totals	11.00			22.36	93.8

Thickness: in

Density: lb/cuft

Weight: lb/sqft

R-value : (hr-sqft-F)/BTU Specific Heat: BTU/lb/F

Name: Primary Air System 03-23-96
Type: CONSTANT VOLUME - Single Zone CAV HAP v3.20
Prepared by: University of Memphis Page 2

```
Sensible Cooling Factor.....: 0 %
Latent Cooling Factor.....: 0 %
Heating Factor.....: 0 %
```

[illegible]

AIR SYSTEM INPUT DATA

Name: Primary Air System

03-23-96

Type: CONSTANT VOLUME - Single Zone CAV

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1. SPACE SELECTION

Space Name	Qty	Space Name	Qty
SPACES IN ZONE 1 (Zone 1)			
1. Entire Building	1		

Schedule Name: Lighting

Hourly Percentages

Hour ---->	00	01	02	03	04	05	06	07	08	09	10	11
DESIGN DAY	10	10	10	10	10	10	10	20	90	100	100	100
Weekday	10	10	10	10	10	10	10	20	90	100	100	100
Saturday	10	10	10	10	10	10	10	10	10	20	20	20
Sunday	10	10	10	10	10	10	10	10	10	20	20	20

Hour ---->	12	13	14	15	16	17	18	19	20	21	22	23
DESIGN DAY	100	100	100	100	100	90	80	60	20	10	10	10
Weekday	100	100	100	100	100	90	80	60	30	20	10	10
Saturday	20	20	20	20	20	20	10	10	10	10	10	10
Sunday	20	20	20	20	20	20	10	10	10	10	10	10

AIR SYSTEM INPUT DATA

Name: Primary Air System

03-23-96

Type: CONSTANT VOLUME - Single Zone CAV

HAP v3.20

Prepared by: University of Memphis

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1. SYSTEM NAME AND TYPE

Name.....: Primary Air System
Type.....: CONSTANT VOLUME - Single Zone CAV
Number of Zones.: 1

2. SYSTEM DESCRIPTION

COOLING SYSTEM DATA

Is Central Cooling Used.....? Y
Supply Air.....: 55.0 F
Coil Bypass Factor.....: 0.100
Fan Cycled for Cooling.....? N
Supply Air Reset.....: Greatest Demand
Maximum Reset Temperature.....: 65.0 F

HEATING SYSTEM DATA

Is Central Heating Used.....? Y
Fan Cycled for Heating.....? N
Supply Air Reset.....: Greatest Demand
Minimum Reset Temperature.....: 90.0 F

OUTDOOR VENTILATION DATA

Type of Control.....: Constant Airflow Rate
Design Ventilation Airflow.....: 15.0 CFM/person
Dampers Open During Unocc Per.: N
Damper Leak Rate.....: 0 %

SUPPLY DUCT DATA

Duct Heat Gain.....: 0 %
Duct Leakage Rate.....: 0 %

RETURN PLENUM DATA

Is a Return Plenum Used.....? N

SUPPLY FAN DATA

Fan Type.....: Forward Curved
Configuration.....: Draw-Thru
Fan Total Static.....: 0.00 in.wg.
Fan Efficiency.....: 54 %

RETURN FAN DATA

Fan Type.....: None

OUTDOOR AIR ECONOMIZER

Outdoor Economizer Type.....: Integrated Dry-Bulb
OA Upper Cutoff Temp.....: 150.0 F
OA Lower Cutoff Temp.....: -60.0 F

PREHEAT COIL

Preheat Coil Used.....? N

PRECOOL COIL

Precool Coil Used.....? N

HUMIDIFICATION

Humidification System Used....? N

DEHUMIDIFICATION

Dehumidification System Used..? N

VENTILATION HEAT RECLAIM

Reclaim Unit Type.....: None

ANNUAL COMPONENT COSTS

Building: Basic Sciences Center - EIFS

03-25-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

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TABLE 1. COSTS BY COMPONENT

Component	<---- Annual Costs ---->		% of Total
	(\$)	(\$/sqft)*	
Air System Fans	0	0.000	0.0 %
Cooling Plants	18547	0.064	14.2 %
Absorption Chillers	0	0.000	0.0 %
Heating Plants	2473	0.009	1.9 %
Pumps	0	0.000	0.0 %
Cooling Towers	7894	0.027	6.0 %
>>> HVAC Subtotal	28913	0.100	22.1 %
Lights	97924	0.339	74.8 %
Electric Equipment	4113	0.014	3.1 %
Miscellaneous Electric	0	0.000	0.0 %
Miscellaneous Fuel Use	0	0.000	0.0 %
>>> Non-HVAC Subtotal	102037	0.354	77.9 %
>>> GRAND TOTAL	130951	0.454	100.0 %

* Cost per unit floor area is based on the gross building floor area.

Gross floor area.....: 288588 sqft

Conditioned floor area.....: 288588 sqft

ANNUAL ENERGY COSTS

Building: Basic Sciences Center - EIFS

03-25-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

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TABLE 1. COSTS BY ENERGY CATEGORY

Component	Annual Energy	<---- Annual Costs ---->	(\$)	(\$/sqft)*	% of Total
Electric	440704 kWh	26442	0.092	20.2 %	
Natural Gas	4942 Therm	2471	0.009	1.9 %	
Fuel Oil	0	0	0.000	0.0 %	
Propane	0	0	0.000	0.0 %	
Remote Heating	0	0	0.000	0.0 %	
Remote Cooling	0	0	0.000	0.0 %	
>>> HVAC Subtotal		28913	0.100	22.1 %	
Electric	1700623 kWh	102037	0.354	77.9 %	
Natural Gas	0 Therm	0	0.000	0.0 %	
Fuel Oil	0	0	0.000	0.0 %	
Propane	0	0	0.000	0.0 %	
Remote Heating	0	0	0.000	0.0 %	
>>> Non-HVAC Subtotal		102037	0.354	77.9 %	
>>> GRAND TOTAL		130951	0.454	100.0 %	

* Cost per unit floor area is based on the gross building floor area.

Gross floor area.....: 288588 sqft

Conditioned floor area.....: 288588 sqft

ENERGY BUDGET BY SYSTEM COMPONENT

Building: Basic Sciences Center - EIFS

03-25-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

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TABLE 1. ANNUAL COIL LOADS

Component	(kBTU)	(kBTU/sqft) *
Cooling Loads	4742967	16.435
Heating Loads	340481	1.180

TABLE 2. ENERGY CONSUMPTION BY SYSTEM COMPONENT

Component	<----- Site Energy *----->		<----- Source Energy *----->	
	(kBTU)	(kBTU/sqft) *	(kBTU)	(kBTU/sqft) *
Air System Fans	0	0.000	0	0.000
Cooling Plants	1054695	3.655	1054695	3.655
Absorption Chillers	0	0.000	0	0.000
Heating Plants	494282	1.713	494282	1.713
Pumps	0	0.000	0	0.000
Cooling Towers	448889	1.555	448889	1.555
>>> HVAC Total	1997866	6.923	1997866	6.923
Lights	5568634	19.296	5568634	19.296
Electric Equipment	233893	0.810	233893	0.810
Misc. Electric	0	0.000	0	0.000
Misc. Fuel Use	0	0.000	0	0.000
>>> Non-HVAC Total	5802527	20.107	5802527	20.107
>>> GRAND TOTAL	7800393	27.030	7800393	27.030

* Site Energy is the actual energy consumed.

* Source Energy is the site energy divided by the electric generating efficiency of 100.0 %

* Cost per unit floor area is based on the gross building floor area.

Gross floor area.....: 288588 sqft

Conditioned floor area.....: 288588 sqft

ENERGY BUDGET BY ENERGY SOURCE

Building: Basic Sciences Center - EIFS

03-25-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

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TABLE 1. ANNUAL COIL LOADS

Component	(kBTU)	(kBTU/sqft) *
Cooling Loads	4742967	16.435
Heating Loads	340481	1.180

TABLE 2. ENERGY CONSUMPTION BY ENERGY COMPONENT

Component	<----- Site Energy *----->		<----- Source Energy *----->	
	(kBTU)	(kBTU/sqft) *	(kBTU)	(kBTU/sqft) *
Electric	1503681	5.210	1503681	5.210
Natural Gas	494186	1.712	494186	1.712
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Heating	0	0.000	0	0.000
Remote Cooling	0	0.000	0	0.000
>>> HVAC Total	1997866	6.923	1997866	6.923
Electric	5802527	20.107	5802527	20.107
Natural Gas	0	0.000	0	0.000
Fuel Oil	0	0.000	0	0.000
Propane	0	0.000	0	0.000
Remote Heating	0	0.000	0	0.000
>>> Non-HVAC Total	5802527	20.107	5802527	20.107
>>> GRAND TOTAL	7800393	27.030	7800393	27.030

* Site Energy is the actual energy consumed.

* Source Energy is the site energy divided by the electric generating efficiency of 100.0 %

* Cost per unit floor area is based on the gross building floor area.

Gross floor area.....: 288588 sqft

Conditioned floor area.....: 288588 sqft

MONTHLY COMPONENT COSTS

Building: Basic Sciences Center - EIFS

03-25-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

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TABLE 1. HVAC COSTS (\$)

Month	Air Sys. Fans	Cooling Plants	Absorpt. Chillers	Heating Plants	Pumps	Cooling Towers
Jan	0	0	0	624	0	0
Feb	0	3	0	438	0	2
Mar	0	78	0	168	0	43
Apr	0	887	0	28	0	475
May	0	2189	0	0	0	1030
Jun	0	3588	0	0	0	1510
Jul	0	4400	0	0	0	1604
Aug	0	3807	0	0	0	1554
Sep	0	2578	0	0	0	1164
Oct	0	957	0	16	0	475
Nov	0	59	0	144	0	37
Dec	0	0	0	1055	0	0
Total	0	18547	0	2473	0	7894

TABLE 2. NON-HVAC COSTS AND TOTALS (\$)

Month	Lights	Non-HVAC Electric Eqpt.	Misc. Electric Eqpt.	Misc. Fuel Use	HVAC Total	Non-HVAC Total
Jan	8622	362	0	0	624	8985
Feb	7797	327	0	0	442	8124
Mar	7537	317	0	0	289	7853
Apr	8528	358	0	0	1391	8886
May	9165	385	0	0	3219	9550
Jun	8528	358	0	0	5098	8886
Jul	8622	362	0	0	6005	8985
Aug	7808	328	0	0	5361	8136
Sep	7985	335	0	0	3743	8321
Oct	9165	385	0	0	1448	9550
Nov	8257	347	0	0	240	8604
Dec	5908	248	0	0	1055	6156
Total	97924	4113	0	0	28913	102037

MONTHLY ENERGY COSTS

Building: Basic Sciences Center - EIFS

03-25-96

Weather: Nashville (Nashville TMY)

HAP v3.20

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TABLE 1. HVAC COSTS (\$)

Month	Electric	Natural Gas	Fuel Oil	Propane	Remote Heating	Remote Cooling
Jan	0	623	0	0	0	0
Feb	4	437	0	0	0	0
Mar	121	168	0	0	0	0
Apr	1363	28	0	0	0	0
May	3219	0	0	0	0	0
Jun	5098	0	0	0	0	0
Jul	6005	0	0	0	0	0
Aug	5361	0	0	0	0	0
Sep	3743	0	0	0	0	0
Oct	1432	16	0	0	0	0
Nov	96	144	0	0	0	0
Dec	1	1054	0	0	0	0
Total	26442	2471	0	0	0	0

TABLE 2. NON-HVAC COSTS (\$)

Month	Electric	Natural Gas	Fuel Oil	Propane	Remote Heating
Jan	8985	0	0	0	0
Feb	8124	0	0	0	0
Mar	7853	0	0	0	0
Apr	8886	0	0	0	0
May	9550	0	0	0	0
Jun	8886	0	0	0	0
Jul	8985	0	0	0	0
Aug	8136	0	0	0	0
Sep	8321	0	0	0	0
Oct	9550	0	0	0	0
Nov	8604	0	0	0	0
Dec	6156	0	0	0	0
Total	102037	0	0	0	0

MONTHLY ENERGY USE BY ENERGY TYPE

Building: Basic Sciences Center - EIFS

03-25-96

Weather: Nashville (Nashville TMY)

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TABLE 1. HVAC ENERGY USE

Month	Electric (kWh)	Natural Gas (Therm)	Fuel Oil ()	Propane ()	Remote Heating ()	Remote Cooling ()
Jan	7	1247	0	0	0	0
Feb	73	875	0	0	0	0
Mar	2016	336	0	0	0	0
Apr	22712	56	0	0	0	0
May	53643	0	0	0	0	0
Jun	84960	0	0	0	0	0
Jul	100081	0	0	0	0	0
Aug	89345	0	0	0	0	0
Sep	62378	0	0	0	0	0
Oct	23868	33	0	0	0	0
Nov	1601	287	0	0	0	0
Dec	20	2108	0	0	0	0
Total	440704	4942	0	0	0	0

TABLE 2. NON-HVAC ENERGY USE

Month	Electric (kWh)	Natural Gas (Therm)	Fuel Oil ()	Propane ()	Remote Heating ()
Jan	149744	0	0	0	0
Feb	135405	0	0	0	0
Mar	130890	0	0	0	0
Apr	148107	0	0	0	0
May	159171	0	0	0	0
Jun	148107	0	0	0	0
Jul	149744	0	0	0	0
Aug	135603	0	0	0	0
Sep	138680	0	0	0	0
Oct	159171	0	0	0	0
Nov	143393	0	0	0	0
Dec	102608	0	0	0	0
Total	1700623	0	0	0	0

MONTHLY ENERGY USE BY SYSTEM COMPONENT

Building: Basic Sciences Center - EIFS

03-25-96

Weather: Nashville (Nashville TMY)

HAP v3.20

Prepared by: University of Memphis

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TABLE 1. JANUARY - JUNE

Component	Jan	Feb	Mar	Apr	May	Jun
Air System Fans (kWh):	0	0	0	0	0	0
Cooling Plants:						
Electric (kWh)	0	43	1300	14791	36482	59794
Nat. Gas (Therm)	0	0	0	0	0	0
Absorption Chillers:						
Electric (kWh)	0	0	0	0	0	0
Nat. Gas (Therm)	0	0	0	0	0	0
Heating Plants:						
Electric (kWh)	7	5	2	0	0	0
Nat. Gas (Therm)	1247	875	336	56	0	0
Pumps (kWh):	0	0	0	0	0	0
Cooling Towers (kWh):	0	25	714	7920	17162	25166
Lighting (kWh):	143708	129947	125614	142137	152755	142137
Electric Eqpt (kWh):	6036	5458	5276	5970	6416	5970
Misc Electric Eqpt (kWh):	0	0	0	0	0	0
Misc Fuel Use:						
Nat. Gas (Therm)	0	0	0	0	0	0

TABLE 2. JULY - DECEMBER

Component	Jul	Aug	Sep	Oct	Nov	Dec
Air System Fans (kWh):	0	0	0	0	0	0
Cooling Plants:						
Electric (kWh)	73340	63452	42971	15946	990	5
Nat. Gas (Therm)	0	0	0	0	0	0
Absorption Chillers:						
Electric (kWh)	0	0	0	0	0	0
Nat. Gas (Therm)	0	0	0	0	0	0
Heating Plants:						
Electric (kWh)	0	0	0	0	2	12
Nat. Gas (Therm)	0	0	0	33	287	2108
Pumps (kWh):	0	0	0	0	0	0
Cooling Towers (kWh):	26741	25893	19407	7922	609	3
Lighting (kWh):	143708	130137	133090	152755	137613	98472
Electric Eqpt (kWh):	6036	5466	5590	6416	5780	4136
Misc Electric Eqpt (kWh):	0	0	0	0	0	0
Misc Fuel Use:						
Nat. Gas (Therm)	0	0	0	0	0	0

Conservation Related Assistance

81.085 Minority Energy Information Clearinghouse
81.082 Management and Technical Assistance for Minority Business
81.086 Conservation Research and Development
81.087 Renewable Energy Research and Development
15.602 Conservation Law Enforcement Training Assistance
81.052 Energy Conservation for Institutional Buildings
81.091 Socioeconomic and Demographic Research, Data Analytic
14.859 Public and Indian Housing Comprehensive Grant Program
81.089 Fossil Energy Research and Development
81.041 State Energy Conservation
81.081 Energy Task Force for the Urban Consortium
81.048 Priorities and Allocations for Energy Programs and
14.506 General Research and Technology Activity
36.001 Fair Competition Counseling and Investigation of
11.409 Fishing Vessel and Gear Damage Compensation Fund
10.437 Interest Assistance Program
14.852 Public and Indian Housing Comprehensive Improvement
10.063 Agricultural Conservation Program
10.907 Snow Survey and Water Supply Forecasting
14.151 Supplemental Loan Insurance Multifamily Rental Housing
11.612 Advanced Technology Program
77.001 Radiation Control Training Assistance and Advisory
10.903 Soil Survey
10.902 Soil and Water Conservation
10.416 Soil and Water Loans
81.039 National Energy Information Center
10.905 Plant Materials for Conservation
10.664 Cooperative Forestry Assistance
11.430 Undersea Research
15.921 Rivers, Trails and Conservation Assistance
15.214 Non-Sale Disposals of Mineral Material
10.407 Farm Ownership Loans
10.910 Rural Abandoned Mine Program

10.910 Rural Abandoned Mine Program
10.062 Water Bank Program
81.036 Energy-Related Inventions
81.064 Office of Scientific and Technical Information
10.250 Agricultural and Rural Economic Research
81.042 Weatherization Assistance for Low-Income Persons
11.460 Special Oceanic and Atmospheric Projects
15.608 Fish and Wildlife Management Assistance
81.077 University Research Instrumentation
19.204 Fishermen's Guaranty Fund
81.107 Oil Recovery Demonstration
11.417 Sea Grant Support
11.428 Intergovernmental Climate Programs
64.114 Veterans Housing Guaranteed and Insured Loans
17.004 Productivity and Technology Data
62.001 TVA Environmental Research Center
12.110 Planning Assistance to States
81.057 University Coal Research
70.003 Foreign Investment Insurance
10.067 Farmer Owned Reserve Program
10.855 Distance Learning and Medical Link Grants
81.004 University-Laboratory Cooperative Program
81.110 National Resource Center for Plutonium
10.901 Resource Conservation and Development
81.080 Office of Policy and Financial Assistance
81.022 Used Energy-Related Laboratory Equipment Grants
81.079 Regional Biomass Energy Programs
11.426 Financial Assistance for Ocean Resources Conservation and
10.900 Great Plains Conservation
14.218 Community Development Block Grants/Entitlement Grants
11.444 Aquaculture Program
10.770 Water and Waste Disposal Loans and Grants (Section 306C)
10.764 Resource Conservation and Development Loans
15.975 Research Information

81.003 Granting of Patent Licenses
15.614 Coastal Wetlands Planning, Protection and Restoration Act
59.012 Small Business Loans
11.441 Regional Fishery Management Councils
11.457 Chesapeake Bay Studies
20.512 Federal Transit Technical Assistance
81.106 Transport of Transuranic Wastes to the Waste Isolation
10.054, Emergency Conservation Program
66.805 Leaking Underground Storage Tank Trust Fund Program

Facility Renovation Assistance

84.284 School Facilities Infrastructure Improvement
16.586 Violent Offender Incarceration and Truth in Sentencing
59.041 Certified Development Company Loans (504 Loans)
84.216 Capital Expenses
14.860 Head Start Public Housing Early Childhood/Development
14.861 Public and Indian Housing Family Investment Centers
93.887 Project Grants for Non-Acute Care Intermediate and
93.673 Grants to States for Planning and Development of Dependent
93.214 Extramural Research Facilities Construction Projects
15.616 Clean Vessel Act
93.047 Special Programs for the Aging Title VI, Part A, Indian
11.304 Economic Development Public Works Impact Program
23.013 Appalachian Child Development
14.129 Mortgage Insurance Nursing Homes, Intermediate Care
93.333 General Clinical Research Centers
93.229 Demonstration Cooperative Agreements for Development and
11.300 Economic Development Grants for Public Works and
93.148 Cooperative Agreements for Collaborative Demonstration
23.012 Appalachian Vocational and Other Education Facilities and
93.102 Demonstration Grants for Residential Treatment for Women
93.389 Research Centers in Minority Institutions
93.105 Bilingual/Bicultural Service Demonstration Projects in
93.044 Special Programs for the Aging Title III, Part B Grants
47.077 Academic Research Facilities and Instrumentation
93.189 Health Education and Training Centers
96.007 Social Security Research and Demonstration
93.163 Health Services in the Pacific Basin
45.003 Promotion of the Arts Arts in Education
10.500 Cooperative Extension Service
10.760 Water and Waste Disposal Systems for Rural Communities
10.763 Emergency Community Water Assistance Grants
93.101 Grants for Residential Treatment Programs for Pregnant and
93.191 Allied Health Project Grants

93.191 Allied Health Project Grants
 93.965 Coal Miners Respiratory Impairment Treatment Clinics and
 14.231 Emergency Shelter Grants Program
 93.779 Health Care Financing Research, Demonstrations and
 64.022 Veterans Hospital Based Home Care
 93.572 Emergency Community Services for the Homeless
 93.938 Cooperative Agreements to Support Comprehensive School
 84.031, Higher Education Institutional Aid
 16.578 Federal Surplus Property Transfer Program
 64.008 Veterans Domiciliary Care
 83.010 National Fire Academy Educational Program
 14.225 Community Development Block Grants/Special Purpose
 59.021 Handicapped Assistance Loans
 64.018 Sharing Specialized Medical Resources
 83.530 Emergency Management Institute (EMI) Resident Educational
 12.400 Military Construction, National Guard
 64.016 Veterans State Hospital Care
 59.042 Business Loans for 8 (a) Program Participants
 64.015 Veterans State Nursing Home Care
 64.012 Veterans Prescription Service
 64.014 Veterans State Domiciliary Care
 15.850 Indian Arts and Crafts Development
 83.009 National Fire Academy Training Assistance
 59.012 Small Business Loans
 64.010 Veterans Nursing Home Care
 14.227 Community Development Block Grants/Special Purpose
 64.013 Veterans Prosthetic Appliances
 83.527 Emergency Management Institute Training Assistance
 64.101 Burial Expenses Allowance for Veterans
 17.252 Attestations by Employers Using Non-Immigrant Aliens in
 77.005 Financial Assistance for NRC Local Public Document Rooms
 14.167 Mortgage Insurance Two Year Operating Loss Loans, Section
 20.801 Development and Promotion of Ports and Intermodal
 16.105 Civil Rights of Institutionalized Persons

11.111 Foreign-Trade Zones in the United States
20.802 Federal Ship Financing Guarantees
14.862 Indian Community Development Block Grant Program
23.004 Appalachian Health Programs
64.123 Vocational Training for Certain Veterans Receiving VA
14.181 Supportive Housing for Persons with Disabilities
14.151 Supplemental Loan Insurance Multifamily Rental Housing
81.048 Priorities and Allocations for Energy Programs and
59.044 Veterans Entrepreneurial Training and Counseling

Research Facility Assistance

14.407 Architectural Barriers Act Enforcement
10.700 National Agricultural Library
68.001 National Gallery of Art Extension Service
10.001 Agricultural Research Basic and Applied Research
11.415 Fisheries Obligation Guarantee Program
10.164 Wholesale Market Development
12.900 Language Grant Program
17.601 Mine Health and Safety Counseling and Technical Assistance
27.005 Federal Employment for Individuals With Disabilities
16.578 Federal Surplus Property Transfer Program
84.284 School Facilities Infrastructure Improvement
16.301 Law Enforcement Assistance FBI Crime Laboratory Support
64.019 Veterans Rehabilitation Alcohol and Drug Dependence
20.107 Airway Science
84.257 National Institute for Literacy
84.209 Native Hawaiian Family Based Education Centers
14.412 Employment Opportunities for Lower Income Persons and
64.018 Sharing Specialized Medical Resources
11.449 Independent Education and Science Projects and Programs
64.008 Veterans Domiciliary Care
10.477 Meat, Poultry, and Egg Inspection
81.077 University Research Instrumentation
81.036 Energy-Related Inventions
10.854 Rural Economic Development Loans and Grants
11.417 Sea Grant Support
62.001 TVA Environmental Research Center
16.400 Citizenship Education and Training
93.948 Pilot Clinical Pharmacology Training
59.038 Veterans Loan Program
14.225 Community Development Block Grants/Special Purpose
81.004 University-Laboratory Cooperative Program
12.400 Military Construction, National Guard
93.134 Grants to Increase Organ Donations

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10.219 Biotechnology Risk Assessment Research
84.216 Capital Expenses
10.855 Distance Learning and Medical Link Grants
59.021 Handicapped Assistance Loans
20.108 Aviation Research Grants
93.140 Intramural Research Training Award
93.390 Academic Research Enhancement Award
15.921 Rivers, Trails and Conservation Assistance
59.042 Business Loans for 8 (a) Program Participants
11.444 Aquaculture Program
89.001 National Archives Reference Services Historical Research
64.016 Veterans State Hospital Care
47.073 Science and Technology Centers
64.012 Veterans Prescription Service
20.806 State Marine Schools
81.102 Academic Partnerships
64.015 Veterans State Nursing Home Care
20.801 Development and Promotion of Ports and Intermodal
84.167 Library Literacy
12.700 Donations/Loans of Obsolete DOD Property
12.420 Military Medical Research and Development
64.014 Veterans State Domiciliary Care
12.107 Navigation Projects
15.850 Indian Arts and Crafts Development
16.586 Violent Offender Incarceration and Truth in Sentencing
12.101 Beach Erosion Control Projects
14.860 Head Start Public Housing Early Childhood/Development
77.005 Financial Assistance for NRC Local Public Document Rooms
59.012 Small Business Loans
11.445 Stock Enhancement of Marine Fish in the State of Hawaii
84.197 College Library Technology and Cooperation Grants
93.042 Special Programs for the Aging Title VII, Chapter 2 Long
64.010 Veterans Nursing Home Care

14.861 Public and Indian Housing Family Investment Centers
84.244 Business and Education Standards
14.227 Community Development Block Grants/Special Purpose
93.214 Extramural Research Facilities Construction projects
12.800 Air Force Defense Research Sciences Program
64.013 Veterans Prosthetic Appliances
42.001 Books for the Blind and Physically Handicapped
12.600 Community Economic Adjustment
16.105 Civil Rights of Institutionalized Persons

Science Building Assistance

20.107 Airway Science
15.909 Historic American Buildings Survey/Historic American
59.013 Local Development Company Loans
81.086 Conservation Research and Development
59.042 Business Loans for 8 (a) Program Participants
81.087 Renewable Energy Research and Development
66.950 Environmental Education and Training Program
81.052 Energy Conservation for Institutional Buildings
59.041 Certified Development Company Loans (504 Loans)
93.969 Grants for Geriatric Education Centers
84.040 Impact Aid Construction
10.437 Interest Assistance Program
66.951 Environmental Education Grants
10.421 Indian Tribes and Tribal Corporation Loans
14.181 Supportive Housing for Persons with Disabilities
15.912 National Historic Landmark
15.805 Assistance to State Water Resources Research Institutes
81.081 Energy Task Force for the Urban Consortium
10.411 Rural Housing Site Loans
15.918 Disposal of Federal Surplus Real Property for Parks
93.887 Project Grants for Non-Acute Care Intermediate and
10.218 Buildings and Facilities Program
81.041 State Energy Conservation
93.994 Maternal and Child Health Services Block Grant to the
15.915 Technical Preservation Services
14.235 Supportive Housing Program
10.567 Food Distribution Program on Indian Reservations
64.005 Grants to States for Construction of State Home Facilities
14.179 Nehemiah Housing Opportunity Grant Program
11.304 Economic Development Public Works Impact Program
93.291 Surplus Property Utilization
10.415 Rural Rental Housing Loans
96.007 Social Security Research and Demonstration

96.007 Social Security Research and Demonstration
 10.769 Rural Development Grants
 10.203 Payments to Agricultural Experiment Stations Under Hatch
 10.766 Community Facilities Loans
 45.008 Promotion of the Arts Theater
 10.205 Payments to 1890 Land-Grant Colleges and Tuskegee
 10.407 Farm Ownership Loans
 45.001 Promotion of the Arts Design Arts
 93.224 Community Health Centers
 11.300 Economic Development Grants for Public Works and
 88.001 Architectural and Transportation Barriers Compliance Board
 10.066 Emergency Livestock Assistance
 10.768 Business and Industrial Loans
 14.231 Emergency Shelter Grants Program
 93.779 Health Care Financing Research, Demonstrations and
 93.246 Migrant Health Centers Grants
 93.217 Family Planning Services
 83.100 Flood Insurance
 20.106 Airport Improvement Program
 15.914 National Register of Historic Places
 15.904 Historic Preservation Fund Grants-In-Aid
 11.550 Public Telecommunications Facilities Planning and
 93.572 Emergency Community Services for the Homeless
 45.301 Institute of Museum Services
 16.003 Law Enforcement Assistance Narcotics and Dangerous Drugs
 42.007 Reference Services in Science and Technology
 16.001 Law Enforcement Assistance Narcotics and Dangerous
 10.700 National Agricultural Library
 77.001 Radiation Control Training Assistance and Advisory
 16.004 Law Enforcement Assistance Narcotics and Dangerous Drugs
 10.907 Snow Survey and Water Supply Forecasting
 27.009 Training Assistance to State and Local Governments
 16.301 Law Enforcement Assistance FBI Crime Laboratory Support
 43.001 Aerospace Education Services Program

84.303 Challenge Grants for Technology in Education
84.260 National Academy of Science, Space, and Technology
42.006 Library of Congress Constituent and Collection Services
10.903 Soil Survey
84.286 Telecommunications Demonstration Project for Mathematics
11.430 Undersea Research
11.449 Independent Education and Science Projects and Programs
84.256 Education Grant Program for the Freely Associated States
12.901 Mathematical Sciences Grants Program

81.086 Conservation Research and Development

(Conservation)

FEDERAL AGENCY: OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY,
DEPARTMENT OF ENERGY

AUTHORIZATION: Department of Energy Organization Act of 1977, as amended, Public Laws 95-911 and 97-377; Federal Nonnuclear Energy Research and Development Act of 1974, Public Law 93-577.

OBJECTIVES: To conduct a balanced long-term research effort in the areas of buildings, industry, transportation. Grants will be offered to develop and transfer to the nonfederal sector various energy conservation technologies.

TYPES OF ASSISTANCE: Project Grants.

USES AND USE RESTRICTIONS: Assistance may be used in the form of cost-shared contracts, cooperative agreements, or grants to non-profit institutions and organizations to develop and transfer energy conservation technologies to the scientific and industrial communities, State, and local governments.

ELIGIBILITY REQUIREMENTS:

Applicant Eligibility: Profit organizations, private nonprofit institutions/organizations, State and local governments may apply.

Beneficiary Eligibility: Profit organizations, private nonprofit institutions/organizations, State and local governments benefit.

Credentials/Documentation: Costs will be determined in accordance with OMB Circular No. A-87 for State and local governments.

APPLICATION AND AWARD PROCESS:

Preapplication Coordination: Preapplication coordination is recommended for unsolicited proposals. The standard application forms as furnished by the Federal agency and required by OMB Circular No. A-102 must be used for this program. This program is excluded from coverage under E.O. 12372.

Application Procedure: Unsolicited proposals are to be submitted in accordance with DOE "Guide for the Submission of Unsolicited Proposals." This program is subject to the provisions of OMB Circular No. A-110.

Award Procedure: Evaluations will be conducted by the personnel assigned to the individual Energy Conservation technology/end use sector programs at DOE headquarters in Washington, DC. This responsibility may also be delegated to DOE Operations Offices around the Nation.

Deadlines: None.

Range of Approval/Disapproval Time: From 60 to 120 days.

Appeals: None.

Renewals: Grants may be modified or extended.

ASSISTANCE CONSIDERATIONS:

Formula and Matching Requirements: This program has no statutory formula, but cost-sharing is encouraged.

Length and Time Phasing of Assistance: Assistance is available from two months to two years.

POST ASSISTANCE REQUIREMENTS:

Reports: Quarterly progress and expenditure reports, and a final report at the conclusion of the grant time period.

Audits: In accordance with the provision of OMB Circular No. A-128, "Audits of State and Local Governments," State and local governments that receive financial assistance of \$100,000 or more within the State's fiscal year shall have an audit made for that year. State and local governments that receive between \$25,000 and \$100,000 within the State's fiscal year shall have an audit made in accordance with Circular No. A-128, or in accordance with Federal laws and regulations governing the programs in which they participate.

Records: None.

FINANCIAL INFORMATION:

Account Identification: 89-0215-0-1-999; 89-0224-0-1-271; 89-0125-0-1-272.

Obligations: (Grants) FY 94 \$4,100,000; FY 95 est \$3,760,000; and FY 96 est \$3,750,000.

Range and Average of Financial Assistance: \$50,000 to \$500,000; \$200,000.

PROGRAM ACCOMPLISHMENTS: Numerous awards for ongoing research and development projects were made.

REGULATIONS, GUIDELINES, AND LITERATURE: "Guide for the Submission of Unsolicited Proposals," Office of Procurement and Assistance Management, Department of Energy, Washington, DC 20585.

INFORMATION CONTACTS:

Regional or Local Office: Not applicable.

Headquarters Office: Energy Efficiency and Renewable Energy Programmatic offices, Office of Building Technologies, Residential, Commercial and Institutional Buildings, Regina, Washington. Telephone: (202) 586-0098. Use the same number for FTS. Office of Transportation Technologies, Beatrice Cunningham. Telephone: (202) 586-0098. Use the same number for FTS. Office of Utility Technologies, Power Generation and Distribution, Contact: Gloria Elliott. Telephone: (202) 586 - 4142. Use the same number for FTS.

RELATED PROGRAMS: None.

EXAMPLES OF FUNDED PROJECTS: Grants have been awarded to perform: (1) Research on high performance heat pumps; (2) research on thermally efficient commercial buildings; (3) research in vehicle engines; (4) research on high temperature materials; and (5) research on industrial separation processes.

CRITERIA FOR SELECTING PROPOSALS: Merit of proposals will be determined by: (1) Technical merit; (2) potential energy contribution; (3) relevance to current program objectives; (4) responsibility of cost of proposal; and (5) amount of cost-sharing by potential recipients.

APPLICANTS: 1434;1534;3534;3634

BENEFICIARIES: 14;15;35;36

FUNCTIONS: IK,IL

CIRCULARS: A102;A110;A87