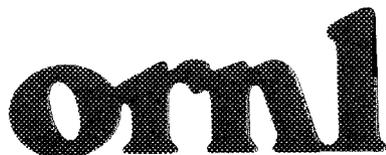




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ORNL/M-835



**OAK RIDGE
NATIONAL
LABORATORY**

MARTIN MARIETTA

Monthly Progress Report

**Building Thermal Envelope Systems
and Materials (BTESM) and Research
Utilization/Technology Transfer
Progress Report for DOE Office of
Buildings and Community Systems**

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APR 1989

April 1989

Prepared for the
U.S. Department of Energy
Conservation and Renewable Energy
Office of Buildings and Community Systems
Building Systems Division

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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Monthly Progress Report

BUILDING THERMAL ENVELOPE SYSTEMS
AND MATERIALS (BTESM) AND RESEARCH
UTILIZATION/TECHNOLOGY TRANSFER
PROGRESS REPORT FOR DOE OFFICE OF
BUILDINGS AND COMMUNITY SYSTEMS

APRIL 1989

Compiled by G. L. Coleman/Sherry D. Samples
for
George E. Courville, Program Manager
Energy Division

Prepared by the
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
operated by
Martin Marietta Energy Systems, Inc.
for
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

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HIGHLIGHT

NOTICE OF PROCEEDINGS

Mathematical Modeling of Low Slope Roof Systems: Symposium Proceedings

The Proceedings of the Mathematical Modeling Symposium held in Oak Ridge, Tennessee on September 15-16, 1988 is now available for \$38 a copy from the Building Thermal Envelope Systems and Materials Program of the Oak Ridge National Laboratory.

The focus of the Symposium was on mathematical modeling and analysis. The presentations discuss how models increase our understanding and ability to predict roof system performance, how modeling complements laboratory and field measurements, and how computers will ultimately impact roof systems design and contractor competitiveness. The theme question, "How can we make mathematical modeling useful to the roofing industry?" was discussed at the conclusion of the Symposium and is detailed in the Proceedings.

To order your copy, please fill in the bottom portion of this page and return it with your check and number of copies to the address listed below. The charge is necessary to partially cover the cost of producing the proceedings.

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Ms. Sherry Samples
Oak Ridge National Laboratory
P. O. Box 2008, Bldg. 3147
Oak Ridge, TN 37831-6070

Building Thermal Envelope Systems and Materials (BTESM) and Research
Utilization/Technology Transfer Progress Report for DOE Office of
Buildings and Community Systems

ABSTRACT

The Monthly Report of the Building Thermal Envelope Systems and Materials (BTESM) Program is a monthly update of both in-house ORNL projects and subcontract activities in the research areas of building materials, wall systems, foundations, roofs, building diagnostics, and research utilization and technology transfer. Presentations are not stand-alone paragraphs every month. Their principal values are the short-time lapse between accomplishment and reporting and their evolution over a period of several months.

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I. BUILDING THERMAL ENVELOPE SYSTEMS AND MATERIALS (BTESM)

A. IMPLEMENTATION

1. Administration/Technical Support/Selected Projects

This task includes overall management for the BTESM Program with the emphasis on assuring that individual R&D projects are performed via the best available expertise whether it be at universities, private labs, professional associations, or national labs (including ORNL). Also included are implementation of major conferences, workshops, and seminars, assurance of BTESM staff participation in committee work (BTECC, NIBS, ASTM, ASHRAE, etc.), BTESM National Program planning jointly with the total building community, technical support to DOE, and oversight of selected technical projects not delegated to other tasks.

a. Management (George E. Courville/Pat M. Love, ORNL)

George Courville and Dave McElroy participated in a Steering Committee meeting for the joint government/industry project for field testing of isocyanurate foams with alternate blowing agents. Other participants are with SPI, PIMA, NRCA, EPA, and DOE. This project, scheduled to get under way in May, involves laboratory and field testing of the mechanical and thermal properties of foams with CFC-11, HCFC-123, and HCFC-141b.

DOE/ASHRAE/BTECC/CIBSE Thermal Performance of the Exterior Envelopes of Buildings IV Conference Organizing Committee: The Organizing Committee will meet on Monday, June 26, 1989, at the ASHRAE meeting in Vancouver. The meeting will be held from 9 a.m. to 12 noon in the Stanley Room at the Hyatt. The conference will be December 4-7, 1989, in Orlando, Florida. It will be held at the Hyatt Orlando Hotel with a single or double room rate of \$69. Registration will be \$350 in advance and \$375 at the door. Registration forms will be available in June and may be obtained by contacting Ms. Gabrielle Coleman, ORNL, P.O. Box 2008, Building 4508, Oak Ridge, TN 37831-6092, or by phoning (615) 576-0875. Preregistration will be taken at the ASHRAE meeting in Vancouver in June.

The Request for Proposal for a Moisture Guidebook has closed. Our Purchasing Division is preparing a proposal to the qualifying bidder. The winning bid will be announced soon.

Comments and suggestions are being solicited for the latest edition of the Buildings Bibliography. Those of you wishing to express opinions on the difference between a full publication and an abbreviated publication with electronic data base accessibility should contact this office.

TSA Audit/Inspection: The BTESM Program Roof Research Center is one of many experimental facilities at national laboratories that is undergoing a strenuous inspection for safety features. The inspection will be conducted by high ranking officials from DOE and representatives from various public and private organizations. The inspection will target safety, emergency procedures, operating procedures, documentation of chemicals, and inspection of equipment documentation. Failure of the facility to meet any of these required procedures could result in immediate shut-down of the facility. Several mock walk-through inspections by Martin Marietta Energy Systems, Inc., and ORNL officials have resulted in the upgrading of several areas and produced a Safety Manual required to meet specifications.

Seminar: A seminar titled, "The Effect of Aging on the R-Value of Foamed Board Insulation Products," will be presented on June 7, 1989, at the auditorium of the American Health Care Building, 1201 L Street, Washington, D.C., from 9:00 a.m. to 12 noon. It will be jointly sponsored by the Building Thermal Envelope Materials Program (BTEM), the Research Coordinating Committee (RCC), and the Building Thermal Envelope Coordinating Committee (BTECC). For more information, please contact Dave McElroy of this office at (615) 574-5976.

EVENTS

- April 10 H. A. Fine, University of Kentucky, visited ORNL.
- April 11 The Technical Operations Committee of the National Roofing Contractors Association held its Spring meeting at the Roof Test Center at ORNL. In addition to their business meeting, the group toured the Center and discussed roofing projects with the Center staff.
- April 12 R. Kammerud, Lawrence Berkeley Laboratories, visited ORNL.
- April 13 Gyula Sebestyen, the Secretary General of the International Council for Building Research, Studies, and Documentation (CIB), visited with George Courville and Roger Carlsmith of ORNL.
- April 17 Geoffrey Frohnsdorff, Chief of the Building Materials Division of the Center for Building Technology at NIST, visited with staff of the BTESM Program.

- April 18 George Courville visited Pittsburgh, PA,
concerning the CFC project.
- April 19 R. Collier and J. Wright of Purdue
University visited ORNL.
- April 27 David Jones of the Fibers Division of DuPont
visited with staff of the BTESM Program.

b. REPORTS PUBLISHED THIS PERIOD

NISTIR 88-3908: *Interlaboratory Comparison of Two Types of Line-Source Thermal -Conductivity Apparatus Measuring Five Insulating Materials* (January 1989).

CONF-8809314: *International Symposium Proceedings - Mathematical Modeling of Roof Systems, September 15-16, 1988* (May 1989).

c. CONFERENCES AND MEETINGS OF INTEREST*

1989

May 17-18: ORNL and DOE, the Naval Civil Engineering Laboratory, and the Single Ply Roofing Institute are co-sponsoring the first of a pair of workshops on roof uplift resistance test procedures. This first session, through a small group of roof uplift experts, will define issues and prepare preliminary recommendations. A second, industry wide session is scheduled for the Fall of 1989. For more information, contact George Courville, ORNL, P.O. Box 2008, Building 3147, Oak Ridge, Tennessee 37831-6070 or call (615) 574-1945.

June 19-23: XIth International Congress CIB '89, Paris, France, "Quality for Building Users Throughout the World," sponsored by the International Council for Building Research. For more information, write CSTB, Relations exterieures, 4, avenue du Recteur-Poincare, 75782 Paris Cedex 16, France.

June 23-24: The International Building Performances Simulation Association (IBPSA) announces Building Simulation '89, "Technology Improving the Energy Use, Comfort, and Economics of Buildings Worldwide," to be held at the Hyatt Regency in Vancouver, Canada. For more information, write Dr. Marianne B. Scott, MCC Systems Canada, Inc., 30 Wellington Street East, #202, Toronto, Ontario, Canada M5E 1S3, or call (416) 368-2959.

June 25-28: ASHRAE Semi-Annual Meeting in Vancouver, B.C. The BTESM Program is providing the Chair for a seminar on "Simplified Techniques for Assessing Thermal Bridges." For more information, contact George Courville, ORNL, P.O. Box 2008, Building 3147, Oak Ridge, Tennessee 37831-6070.

September 12-14: Energy and the Environment Conference & Exhibition, sponsored by Electric Utility Consultants, Inc., co-sponsored by DOE-Office of Fossil Energy, National Coal Association, and RCG/Hagler, Bailly, Inc. The Conference will be held in Denver, Colorado. For additional information contact Electric Utility Consultants, Inc., P.O. Box 20351, Englewood, CO 80156, or call (303) 770-8800.

September 18-20: Second California Thermal Insulation Conference, Sacramento Hilton, Sacramento, California. For more information, write Dr. Sarfraz A. Siddiqui, California Bureau of Home Furnishings and Thermal Insulation, 3485 Orange Grove Avenue, North Highlands, CA 95660-5595, or call (916) 920-7005.

*Please provide Sherry Samples with notices.

September 28-29: International Workshop on Long-Term Thermal Performance of Cellular Plastics, to be held at the Grandview Inn Resort, Huntsville, Ontario. Further information may be obtained from: The Society of the Plastics Industry of Canada, 1262 Don Mills Road, Suite 104, Don Mills, Ontario M3B 2W7, or call (416) 449-3444.

October 1-4: 32nd Annual Polyurethane Conference, sponsored by the Society of the Plastics Industry, Inc., to be held at the Westin St. Francis in San Francisco, CA. For more information, write The Society of the Plastics Industry, Inc., 355 Lexington Avenue, New York, NY 10017, or call (212) 351-5425.

October 15-18: 21st International Thermal Conductivity Conference, Lexington, KY. For more information, contact H. A. Fine, University of Kentucky, Lexington, KY 40506-0046, or call (606) 257-3713.

October 26-29: ASHRAE Far East Conference on Air Conditioning in Hot Climates, Kuala Lumpur, Malaysia. For more information, contact Barbara Trent, Program Coordinator, ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA, 30329, or call (404) 638-8400.

December 4-7: Thermal Performance of the Exterior Envelopes of Buildings IV Conference, sponsored by ASHRAE/DOE/BTECC/CIBSE, in Orlando, FL. For more information, write Gabrielle Coleman, Oak Ridge National Laboratory, P.O. Box 2008, Building 4508, Oak Ridge, Tennessee 37831-6092, or call (615) 576-0875.

1990

June 17-20: Second Symposium on Roofing Research and Standards Development, sponsored by ASTM, San Francisco, CA. The symposium will be held in conjunction with the June 17-20, 1990 standards development meetings of Committee D-8. For more information, contact Thomas J. Wallace, 2899 Stamford Street, Philadelphia, PA 19153, or call (215) 897-6253.

September 3-6: International Symposium on Energy, Moisture, Climate in Buildings, sponsored by CIB International Council of Building Research, to be held in Rotterdam, The Netherlands.

d. Consultant's Report

Paul R. Achenbach
McLean, Virginia 22101

ORNL/Sub-7973

No report.

B. BUILDING MATERIALS PROGRAM

1. ORNL BUILDING MATERIALS EVALUATION

D. L. McElroy, R. S. Graves, T. G. Kollie, and D. W. Yarbrough
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6092

This project has six tasks.

1. Development and Use of Analytical Models for Heat Transfer.

DOE Printing Procurement prepared 25,000 copies of the Insulation Fact Sheet which were distributed to CAREIRS, ORNL, and two state energy offices.

Results on computer-controlled transient tests using the unguarded thin heater apparatus on a gypsum specimen containing 30 wt % wax were obtained.

2. Development and Use of Flat Insulation Testers with Self-Guarding Screen Heaters.

The ASTM proposed Standard C1114, Thermal Transmission Properties by Thin Heater Apparatus, passed the February ASTM Society ballot. The Standard C1114 will be in the 1989 ASTM Book of Standards, Vol. 04.06 with an approved date of March 1989.

Steady-state and step-change-in-heat flux transient tests were completed on a four-inch stack of half-inch thick, 62.4 lb/ft³ gypsum board specimen containing 30 wt % wax (n-octadecane, C₁₈H₃₈, melting point 75°F). The thermal conductivity (k) is 1.62 Btu·in/h·ft²·°F, from 70 to 90°F, and approximately 30% greater than gypsum board without wax and within 6% of the calculated k for a two phase material.

3. Measurement of the Behavior of Loose-Fill Attic Insulation Using Field/Laboratory Tests.

ORNL staff provided approval for initiating a loose-fill insulation test program. A specimen preparation procedure is to be drafted.

4. Development of an Appropriate Government Chlorofluorocarbon (CFC) Alternative Research Plan on Alternative Materials for CFC-Based Insulations.

We initiated a chlorofluorocarbon (CFC) technologies review of foamed-board insulation for buildings for Dr. M. P. Scofield, Building Materials Project Manager. The review emphasizes alternative technologies for rigid foams to reduce usage of CFCs that harm the environment.

The first planning meeting was held on the Industry/EPA/DOE/ORNL sponsored Cooperative Project on Behavior of Roof Board Containing CFC-11, HCFC-123, or HCFC-141b. A prototype production of boards using CFC-11 was witnessed and test boards are expected as early as June.

Two producers are preparing sets of powder-filled evacuated panels to be foamed into the walls of portable coolers, which will then be tested for ice-melting rates.

5. Exchange of Technical Results with Building Materials Community.

Six experts were contacted and have agreed to participate in a seminar on the Effect of Aging on the R-Value of Foamed Board Insulation Products. The seminar will be from 9-12, Wednesday, June 7, 1989, in Washington, D.C., and is sponsored by the Building Thermal Envelope Materials RCC of BTECC.

We provided an overview of Building Materials projects to Dr. Ron Kammerud to help him initiate an analysis of research opportunities based on energy impact.

6. Coordination of Subcontracted Research at Other Facilities.

The Advisory Panel on Reflective Insulation Testing reviewed the third draft of the Handbook on Reflectives. Holometrix, Inc., staff expect this and the testing program to be completed by June.

Acceptance testing was continued for the Advanced R-Matic Apparatus built by Holometrix, Inc., for ORNL. Initial tests with SRM 1450b indicate a repeatability of $\pm 0.8\%$ and a reproducibility of $\pm 2.0\%$. Tests are being completed to allow a series of heat flux transducer calibrations.

Ten specimens of wood and wood products are being obtained from the Forest Products Laboratory for thermal property tests.

ACTS

- | | |
|-----------|---|
| April 1-6 | D. L. McElroy, R. S. Graves, and D. W. Yarbrough attended the Spring 1989 ASTM C-16 meeting in Kansas City. |
| April 18 | R. S. Graves and D. L. McElroy at Mobay, Pittsburgh. |

2. THERMAL INSULATION STUDIES

David W. Yarbrough and Nan Chiou
Department of Chemical Engineering
Tennessee Technological University
Cookeville, Tennessee 38505

ORNL/Sub-7715/81

An abstract for a paper reporting the loose-fill cellulosic insulation project has been submitted to the Second California Thermal Insulation Conference that is scheduled for the coming Fall. An ORNL/TM that reports the data is also in preparation. A paper on the absorption/desorption of vapor phase organic compounds by spray-applied cellulosic insulation has also been submitted to the California Conference.

3. INVESTIGATION OF THE SUBSTITUTION OF ENVIRONMENTALLY ACCEPTABLE BLOWING AGENTS IN FOAM INSULATION: MEANS TO ACHIEVE EQUIVALENT OR APPROVED ENERGY EFFICIENCY

Glicksman, Burke, Mozgowiec, Page
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

ORNL/Sub-09099/1

A no-cost extension has been issued to the contractor.

4. STANDARD REFERENCE MATERIAL DEVELOPMENT

D. R. Smith
Chemical Engineering Science Division
National Institute of Standards and Technology
Boulder, Colorado 80303-3328

ORNL/IA-21428/54

NISTIR 89-3908 entitled, "Interlaboratory Comparison of Two Types of Line-Source Thermal-Conductivity Apparatus Measuring Five Insulating Materials," has been published and is now available.

NISTIR 89-3913 entitled, "Interlaboratory Comparison of the Guarded Horizontal Pipe-Test Apparatus," has passed final review and has been submitted for printing.

Work is continuing on the report on microporous fumed silica insulation board giving thermal conductivity as a function of both temperature and pressure.

At the Spring (April 2-5, 1989) meeting of ASTM C-16 in Kansas City, participants in the last (1987) interlaboratory comparison of the high-temperature guarded hot plate (HTGHP) voiced the desire to hold another round robin. In the next four to six months, material for the round robin will be obtained, procedural guidelines will be drawn up, and willing participants will be identified. Laboratories having a HTGHP measuring at least up to 350°C, and desiring to participate, should inform David R. Smith of NIST-Boulder of their intent.

5. ACOUSTICAL MEASUREMENT OF ATTIC INSULATION

D. R. Flynn
National Institute of Standards and Technology
Gaithersburg, Maryland 20899

ORNL/IA-21513

ORNL comments on draft report, NISTIR 88-3882, An Acoustical Technique for Evaluation of Thermal Insulation, were reviewed at ORNL and returned to NIST.

6. DOCUMENT ZIP-SORT INSULATION PROGRAM

S. Petersen
National Institute of Standards and Technology
Gaithersburg, Maryland 20899

ORNL/IA-21513

No report.

**7. BUILDING MATERIALS AND SYSTEMS RESEARCH PROGRAM
TECHNICAL SUPPORT**

**Erv Bales
Buildings Engineering and Architectural Research Center
(BEAR)
New Jersey Institute of Technology
Newark, New Jersey 07102**

ORNL/Sub-55982

No report.

8. RESEARCH AND DEVELOPMENT DATA TO DEFINE THE THERMAL
PERFORMANCE OF REFLECTIVE MATERIALS USED TO CONSERVE
ENERGY IN BUILDING APPLICATIONS

A. O. Desjarlais
Thermatest Division of Holometrix, Inc.
Cambridge, Massachusetts 02139

ORNL/Sub-SA835/21

1. Phase I Horizontal Heat Flow Tests: As reported in the February 1989 progress report, the horizontal heat flow experimentation has been completed.
2. Phase II Vertical Heat Flow Tests: Three tests were completed on Test Panel 11A with XEPS studs, one airspace, a cavity emittance of 0.05, three temperature/temperature difference combinations, and heat flow up (Test Nos. V-4, V-5, and V-6). The vertical heat flow experimentation is now completed.
3. Due to traveling delays, Holometrix, Inc., was unable to attend the Advisory Panel meeting on April 2, 1989, in Kansas City. However, favorable comments have been received from the third draft of the Reflective Insulation Handbook and an updated data listing was circulated to the members during the subsequent ASTM meeting. A "final" version of the handbook will be forwarded to ORNL in May for review.
4. The first draft of the final report is in preparation and is scheduled to be delivered to ORNL in mid-May.

9. RESIDENTIAL INSULATION CORROSIVENESS

**E. E. Stansbury
Consultant
5800 Woodburn Drive
Knoxville, Tennessee 37919**

ORNL/Sub-SB716/15

A report on the status of the round robin test program for evaluation of the corrosiveness of residential building thermal insulations was presented at the meeting of the ASTM C16.31 Corrosion Task Group in Kansas City on April 4, 1989. Several modification in the procedure were discussed, the more significant being a change of the test temperature from 120°F to room temperature. The change was based on comments that the higher temperature was specified in the ASTM C665 and C739 standards in order to accelerate the corrosion rate. This is not necessary for the electrochemical test and the requirement of a controlled temperature cell complicates the test procedure. The scope of the work to be done by the time of the fall meeting and in the subsequent six months leading to a draft standard was presented.

9. RESIDENTIAL INSULATION CORROSIVENESS

E. E. Stansbury
Materials Science and Engineering Department
University of Tennessee
Knoxville, Tennessee 37919

Martin Marietta Energy Systems, Inc.
7685 PAU16/11
Consultant's Report

Based on the decision of the ASTM C16.31 Corrosion Task Group to restrict the electrochemical procedure for evaluating the corrosiveness of insulations to room temperature rather than 120°C, measurements have been in progress to establish the reproducibility of polarization curves for all round robin test materials at the lower temperature.

A group of cellulosic insulations have been received on which the standard C739 corrosiveness test has been performed. These insulations will be used for evaluation by the electrochemical method and provide a basis for inter-comparison of the two test methods.

An inexpensive PC has been interfaced to the BAS potentiostat. Software has been written to present the potential/current data in either tabular or graphical form on the screen and to a file on disk. The latter file is then used by programs to convert the electrochemical data into corrosion rates.

10. ASSESSMENT OF THE U.S. BUILDING MATERIALS INDUSTRY:
R&D NEEDS AND CAPABILITIES

Dr. James Williams
RCG/Hagler, Bailly, Inc.
Washington, DC 20024-2518

ORNL/Sub-SB964/11

The final camera-ready report has been received at ORNL.

11. THERMAL RESISTANCE MEASUREMENTS OF FOAM INSULATION PRODUCTS

R. Zarr
National Institute of Standards and Technology
Gaithersburg, Maryland 20899

ORNL/IA-21513/9

Progress Report for March 1989:

FY 1988 Milestone 2 (Shakedown Tests): The computer program used for controlling the hot plate was extensively modified to not only control but acquire data too. The program as developed now consists of one master-menu program to load and chain five other programs that:

1. Check the status of the IEEE-488 bus;
2. Set the clocks of the controlled and mainframe;
3. Edit a data file containing PID constants;
4. Edit a parameter file containing information about test specimens;
5. Move the apparatus plates before and after testing (this program not written); and
6. Control and collect data from the test via the mainframe.

The control program consists of about 20 subprograms that allow control scans every 10 seconds with data acquisition, reduction, and storage of 35 values every minute. Another set of shakedown tests are planned for the modified program.

C. BUILDING ENVELOPE SYSTEMS**ORNL Staff:****G. E. Courville, J. E. Christian, K. E. Wilkes
P. W. Childs, and K. W. Childs**

This task includes work done at ORNL and work by others on DOE-funded projects on Building Envelope Systems and is divided into Wall Performance, Advanced Wall Systems, Foundation Systems, Roof Systems, and Building Diagnostics. Each of these project areas is treated separately on the following pages.

WALL PERFORMANCE

1. THERMAL MASS SIMPLIFIED DESIGN TOOL ASSESSMENT

**J. E. Christian
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070**

No significant progress to report for the month of April.

2. EVALUATION OF AN ENVELOPE THERMAL TESTING UNIT

**R. Grot and J. Fang
National Institute of Standards and Technology
Gaithersburg, Maryland 20899**

IAA with DOE-HQ

Report on "Accuracy and Guidelines for Using a Portable Thermal Testing Unit" not received at ORNL.

3. DYNAMIC EVALUATION OF THERMAL BRIDGES

D. Burch
National Institute of Standards and Technology
Gaithersburg, Maryland 20899

ORNL/IA-21513/9

Progress Report for March 1989:

FY 1988 Milestone 1 (Complete Finite-Difference Analysis to Obtain Transfer Function Coefficients for Seven Thermal Bridges): A steady-state finite-difference analysis of several of the thermal bridges was carried out to investigate their effect on the overall heat transfer coefficient (U_o) for the commercial building.

4. VALIDATION OF MOISTURE-TRANSFER MODEL

D. Burch
National Institute of Standards and Technology
Gaithersburg, Maryland 20899

ORNL/IA-21513/9

Progress Report for March 1989:

FY 1988 Milestone 3 (Final Research Report Describing the Mathematical Model and Its Experimental Verification). Work was commenced on a final report of the wall moisture accumulation experiment. The report will be completed during the next reporting period.

Milestone 4 (Complete Preparation of Calibrated Hot Box for Moisture Research). A test of the calibrated hot box was completed to determine whether the climate chamber could be operated for a 2-month period without accumulating excessive amounts of frost on the refrigeration coil. During the test, a desiccant dryer maintained the dew-point temperature of the air in the conditioning chamber below the refrigeration coil surface temperature, thereby providing for frost-free operation of the refrigeration coil. During the next reporting period, a humidification system will be installed on the metering chamber to maintain a steady relative humidity in the metering chamber.

ADVANCED WALL SYSTEMS

1. DEVELOPMENT OF A CATALOG OF SIGNIFICANT
THERMAL BRIDGES IN BUILDING ENVELOPES

Adrian Tuluca and Deane Evans
Steven Winter Associates, Inc.
New York, New York 10001

ORNL/Sub-SA407/12

A preliminary draft has been received at ORNL and is being reviewed.

K. W. Childs
Oak Ridge Gaseous Diffusion Plant
Oak Ridge, Tennessee 37831-7039

A draft of the thermal bridge catalog, except for the introduction, was received from Steven Winter Associates, Inc., and reviewed.

**2. PARAMETER ANALYSIS OF MOISTURE CONDENSATION AND STORAGE
IN RESIDENTIAL BUILDING WALLS**

**Anton TenWolde
U.S. Department of Agriculture
Forest Products Laboratory
Madison, Wisconsin 53705-2398**

ORNL/IA-21801/4

No report.

**3. JOINT U.S./USSR PROJECT ON MULTI-DIMENSIONAL
HEAT TRANSFER CALCULATIONS**

**K. W. Childs
Oak Ridge Gaseous Diffusion Plant
Oak Ridge, Tennessee 37831-7039**

An interesting development coming out of the Soviet-American discussions on thermal bridge calculations (reported last month) was a proposal from Yuri Matrosov for an additional phase of the cooperative effort. In this proposal the Soviets would develop a thermal bridge classification scheme and furnish simplified calculation techniques. This information would be based on the two- and three-dimensional finite-difference modeling they have done over the past ten years. The American and Soviet participants would jointly organize this information in a manner to be used in a computer program for a personal computer. The U.S. would have the primary responsibility in the development of the program. We do not currently have funding from DOE to continue the cooperative effort. In order to obtain additional funding we will need to make a proposal to DOE. The Soviet proposal may have merit, but we cannot recommend that DOE fund additional work until we have a chance to evaluate the information the Soviets supply. No additional activity is expected on this project until next fiscal year.

FOUNDATION SYSTEMS**1. BUILDING FOUNDATIONS RESEARCH AGENDA**

**J. E. Christian
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070**

The visuals for the June 1, 1989, Program Review were prepared. The three presentations on foundations are titled: Codes and Standards Activities, Foundation Project Summaries and Focus, and Slab-on-Grade Insulation Experiment: Design, Construction, and Research Plan. A fourth presentation was prepared by David Wasserman on Foundation Thermal Performance Modeling.

A copy of the report describing details of the slab insulation experiment is being prepared for peer review. The ORNL CON report is entitled, "ORNL Slab-on-Grade Edge Insulation Experiment: Design, Construction, and Research Plan."

2. SLAB FOUNDATION BENCHMARK MODEL

**D. Wasserman and Jeff Christian
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070**

A users guide for this program is in preparation. The work statement for an extension of David Wasserman's subcontract is being prepared. This includes several tasks which will begin to incorporate soil moisture behavior effects on foundation heat transfer.

3. FOUNDATION THERMAL PERFORMANCE SIMPLIFIED PREDICTION TOOL

Jeff Christian
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070

Regression equations representing the foundation thermal performance load data base used in the Building Foundation Handbook were installed in a PC program for providing customized optimum foundation insulation levels. The program enables the user to input site specific climate, R-value levels, energy and capital costs, as well as other economic conditions used in the calculation of "optimal" foundation insulation levels.

A second set of regression coefficients were developed for an equation predicting the delta loads resulting from different foundation insulation levels. This produced good curve fits for the heating loads, but the cooling delta load predictions occasionally produced very different values than the data base. For most climates, foundation insulation effects in the cooling season are much smaller than the heating season effects. In other words, the heating energy savings tend to dictate the total savings and resulting optimum insulation level.

This work has led to even further reduction in the data base to a single factor. Heating load factors, when used in Equation 1, have been generated for accurately predicting the heating energy load savings.

$$\text{delta load} = \text{delta } u * \text{HLF} * \text{HDD} \quad (1)$$

where

delta u = difference between U-value of foundation
uninsulated vs insulation case of interest

HLF = heating load factor

HDD = heating degree day base 65°F

The heating load factor is a single value which can be used to predict foundation insulation heating season savings for climates with greater than 2500 HDD. A comparable set of cooling load factors have been generated, but once again, produce a poor curve fit to the handbook data. One major conclusion from this effort to reduce the large data base for 13 climates into a simplified procedure for estimating foundation insulation savings is that the heating load data can be simplified quite easily. However, to determine the cooling season effects, a much more complex procedure is needed.

4. IMPACT OF CFC RESTRICTIONS ON U.S. BUILDING FOUNDATION THERMAL PERFORMANCE

Jeff Christian
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070

A short write-up was prepared on energy impacts of CFC restrictions in the foundation area for Peter Scofield, DOE (HQ). This write-up discusses the importance of continued R&D to avoid the lost momentum toward broad acceptance of foundation insulation levels with equivalent payback as insulation levels recommended and commonly practiced for above grade envelope components.

Some possible extended work on the testing of alternatives for roof foam insulation products with substitute blowing agents for CFC-11 has generated some discussions about an integrated facility for testing roofs as well as foundations. A tentative site has been selected and preliminary cost estimates generated for several options.

5. MOISTURE IN BUILDING MATERIALS AND CRAWL SPACES

Erv Bales
Buildings Engineering and Architectural Research Center
(BEAR)
New Jersey Institute of Technology
Newark, New Jersey 07102

ORNL/Sub-55982

No report.

ROOF SYSTEMS**1. ROOFING RESEARCH CENTER**

**G. E. Courville
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Oak Ridge, Tennessee 37831-6070**

The agenda for the upcoming Workshop on Uplift Resistance Testing includes five technical presentations that outline the state-of-the-art of uplift testing and six in-depth Table Top Discussions on topics of current interest. Topics to be highlighted include the need for test procedures applicable to all roofing systems, the feasibility of a specific proposal for full scale testing on roof sections, and the status of dynamic testing techniques.

Arrangements have been finalized for Mr. Carsten Rodin Pedersen of the Technical University of Denmark to spend six months at the Center starting in May to work on moisture movement in roof systems. Mr. Pedersen will work with Ken Wilkes of ORNL.

Publication of the update of the Users Manual for the Roof Research Center has been delayed by the lengthy administrative review process at ORNL.

2. LARGE SCALE CLIMATE SIMULATOR

P. W. Childs, G. E. Courville, and W. P. Levins
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070

Jacques Bodine of Vista Scientific came to ORNL on April 10 and discussed the LSCS compressor failure with ORNL Energy Division and Plant and Equipment (P&E) Division personnel. In addition to installing a replacement high-stage compressor, two modifications were recommended, one for a more positive and simpler compressor oil return system, and one to allow for more precise temperature control of the LSCS. ORNL P&E personnel were to install the replacement compressor and implement the oil system modification, while Vista will carry out the temperature control system modification.

The new compressor was ordered and arrived at ORNL on April 12. It was installed and found to have a faulty oil pump in it. A second oil pump was sent by the vendor, and it too was defective. A third oil pump was obtained, this time from ORNL stores, and it appeared to operate properly. A temporary version of the modified oil system was installed to the compressor system until the necessary parts could be obtained for a permanent installation. The LSCS was in operational condition by the end of the month.

The attic platform is almost all constructed. Instrumentation has not yet been installed.

3. THERMAL PERFORMANCE OF INSULATED CONCRETE ROOF SYSTEMS

George E. Courville
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070

Data are being collected for this system.

4. SIMPLIFIED TRANSIENT ANALYSIS OF ROOFS (STAR)

Kenneth E. Wilkes
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070

A draft of a paper entitled, "Model for the Thermal Performance of Low-Sloped Roofs," was completed and submitted to the Conference on the Thermal Performance of the Exterior Envelopes of Buildings that will be held in December. This paper describes the STAR model and its validation and gives examples of its use.

Work was started on a user interface for the STAR model. The interface will consist of a number of screens that will allow for a more user friendly input of data. Also, a computer program was written to generate custom sets of weather data for use with the STAR model. The program uses solar algorithms and daily temperature profiles as used in the DOE-2 model.

5. ESTIMATION OF THERMAL PROPERTIES OF ROOF INSULATION FROM TRANSIENT TEMPERATURE AND HEAT FLUX MEASUREMENTS

James V. Beck
Michigan State University
East Lansing, Michigan 48824

ORNL/Sub-18475/34

In the past month, revising and editing continued on the user's guide for PROPOR, a computer program for calculating thermal properties from transient temperatures and heat fluxes in roofs. In addition, some improvements were made in the computer code to simplify the input.

6. SMALL SCALE STUDIES OF COMBINED MOISTURE AND HEAT
TRANSFER IN HORIZONTAL ROOF INSULATION SYSTEMS

Glicksman, Motakef, Perkins, Shapiro
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

ORNL/Sub-27486

The half of the MIT report that discusses the moisture probe concept is now available. ORNL has sent recent findings on the temperature dependency of the probe to MIT for comments.

7. ROOF REFLECTANCE DESIGN GUIDELINES

Edwin I. Griggs
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070

Internal review of the Guidelines is complete. Suggested changes are being incorporated into the document. It will be ready for a limited industry review in late May.

8. THE PERFORMANCE OF A SPRAY-APPLIED POLYURETHANE FOAM ROOF IN RTRA

George E. Courville and Kathy Daniels
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070

The first year of data collection is now into its final month. The issues that will be discussed in the May report are thermal drift, performance of the permeable (silicon) coating versus the impermeable (butyl-hypalon) coating, and the difference in heat transfer and roof temperatures across the two roofs (white and gray). Two dry samples of the spray-applied polyurethane foam are in the process of being tested in the R-matic at TTU and the advanced R-matic at ORNL for color reflectance, density, and thermal resistance values. These values will provide an interesting comparison between a roof aged at room temperature and one aged in East Tennessee weather. The results of this test are expected to be incorporated into the May report.

9. IEA ANNEX 19 ON LOW SLOPE ROOF SYSTEMS

George E. Courville
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070

The U.S. team has prepared drafts of the introduction and three technical sections of the Annex document. These will be presented at the Annex meeting in June.

10. AN ATTIC SYSTEMS DIAGNOSTIC PLATFORM

W. R. Huntley
Consultant
Knoxville, Tennessee 37922

Carpentry, shingling, and painting of the Attic Systems Diagnostic Platform (ASDP) has been completed. Sheet metal dusting to provide air flow to the eave vents is also in place.

The air measurement system for the ASDP will consist of two hot wire probes which will be calibrated within their respective 6-inch diameter ducts. Each 6-in. duct will be connected to supply air to one of the two eaves. Total air flow to the attic space will be controlled from about 22 to 450 ft³/min (cfm) up to about 2 cfm/ft² of attic space. The hot wire probes are on order. All other components of the air system have been delivered.

Detailed layout of the thermocouples within the ASDP is now under way. About 150 thermocouples will be required for the first test series.

11. A ROOF MOISTURE STUDIES DIAGNOSTICS PLATFORM

Kenneth E. Wilkes
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070

Design of test specimens was completed and fabrication work was initiated on cells for an experiment to validate a mathematical model for moisture movement in insulated roof systems.

BUILDING DIAGNOSTICS

1. ASTM STANDARD FOR INFRARED ROOF MOISTURE SURVEYS

**George E. Courville
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070**

Three negatives were received from the latest ASTM C-16 ballot on this standard, and one from the D-8 ballot. All will be addressed and the standard will be readied for another ballot.

2. SOLAR REFLECTANCE MEASUREMENTS IN THE FIELD

**George E. Courville
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6070**

The lengthy internal review of the document, "Guide for Estimating Differences in Building, Heating, and Cooling Energy Due to Changes in Solar Reflectance of a Low-Sloped Roof," has postponed preparation of a final draft for industry review.

II. RESEARCH UTILIZATION AND TECHNOLOGY TRANSFER

April 1989

A. MANAGEMENT

1. Administration/Technical Support/Selected Projects (Marilyn A. Brown, ORNL)

The program seeks:

- to assure the prompt transfer of new technologies, methods, and data developed in the Buildings and Community Systems R&D program to public and private sector audiences in forms that are accessible and easy to use; and
- to strengthen and enhance the involvement of these audiences in the identification of user information needs, the definition of R&D problems, and technology utilization.

Overview of Projects:

In support of the Technology Transfer/Research Utilization Program, ORNL/DOE is currently funding a variety of projects. Many of these are cost-shared efforts involving only minimal BCS expense. The organizations and principal investigators are shown below.

Education and Training Activities

- Institute on Energy and Engineering Education (ACEC--Alex Willman)
- Summer Institute on Energy and Design (ACSA--McCommons)
- Design + Energy: Development of a Case Studies Curriculum (ACSA--Richard McCommons)
- Curriculum Materials for Energy-Related Architecture Courses (SBSE--Joel Loveland)

Publications Support:

- Development of summary research briefs on selected technical topics for the trade press (Sumner Rider & Associates, Inc.,--Richard Braun)
- Two technical guides:
 - Energy Conservation in Utilities (SERI--Pat Taylor)
 - Recent Advances in Energy Conservation for Residential Buildings (SERI--Rebecca Vories)

- Program Overviews (SERI--Noni Strawn and ORNL--Marilyn Ayers)
- 1988 BCS Research-in-Progress Report summarizing current BCS R&D projects (OSTI--Jessie Rushing)

Outreach Activities

- Coordination with CAREIRS on the production of fact sheets for consumers (ORNL/DOE)
- Center for the Analysis and Dissemination of Demonstrated Energy Technologies (CADET--Marilyn Brown)

Support to BCS Program Managers

- Mailing list and guidelines for working with the trade press (Karen Haas Smith)
- Information meetings and progress reports on technology transfer for BCS program managers (ORNL--Marilyn Brown)

Evaluation and Tracking of Technology Transfer Activities

- Inventory of BCS technology transfer activities (ORNL--Marilyn Brown)
- Case studies of OBCS innovations (ORNL--Marilyn Brown, Linda Berry, and Rajeev Goel)

Events

Technology Adoption in the Existing Buildings Industry

Applied Management Sciences, Inc., completed its report entitled, "Technology Adoption Strategy for the U.S. Department of Energy's Existing Buildings Efficiency Research Program." The report will be edited and revised to conform to ORNL publication formatting, and will be published in May as an ORNL report.

OBCS Technology Transfer Plan

Barbara Farhar from the Solar Energy Research Institute (SERI) visited Marilyn Brown at ORNL on April 17 and 18 to discuss the development of a technology transfer plan for OBCS.

Case Studies of Office of Buildings and Community Systems Innovations

A summary of the ORNL report entitled, "Commercializing Government-Sponsored Innovations: Lessons learned from Twelve Successful Case Studies," was published in *The Electric Letter*. This resulted in several dozen requests for copies of the report.

IEA's Center for the Analysis and Dissemination of Demonstrated Energy Technologies

A variety of activities took place in April to support U.S. involvement in the IEA's Center for the Analysis and Dissemination of Demonstrated Energy Technologies (CADET).

- Cees Hoedemakers visited with Marilyn Brown and Marty Broders at ORNL on April 24 and 26 to discuss project activities.
- Noburu Kimura and Asahiko Tokuoka from Japan's New Energy Information Center of the New Energy and Industrial Technology Development Organization (NEDO) visited Marilyn Brown and Marty Broders at ORNL on April 27 to discuss the U.S. involvement in CADET.
- ORNL received and tested copies of the latest CADET database of information on demonstration projects. Copies of the database were sent to several members of the U.S. National Team for review.
- Planning began for the September meeting of the CADET Executive Committee in Washington, D.C. A draft agenda for a one-day meeting of the U.S. CADET National Team, to take place the day before the Executive Committee meeting, was also prepared.
- Two brochures describing GRI-supported technologies were reviewed, revised, and resubmitted for final review. A draft brochure on low-E windows was also prepared.

**B. 1988 INSTITUTE ON ENERGY AND
ENGINEERING EDUCATION**

Alexander J. Willman, P.E.
ACEC Research and Management Foundation
Washington, D.C. 20005

ORNL/Sub-7910/94

During this reporting period, ACEC/RMF reviewed plans for the 1990 Institute program, depending upon the total financial support received from ORNL/OBCS and private sources. In addition, the following technology transfer activities were proposed with budgets developed for each:

- A survey of educators who have attended the Institute symposium, to determine the types of building energy software they are now using and plan to use for future courses
- Review of the *Energy Bibliography for Engineering Educators* by ACEC members and distribution to all schools of engineering
- Development of ASEAM 2.1 case studies for educators on new data disk with supplementary written information, such as floor plans, elevations, building sections and equipment data

Plans for conducting the Institute symposium in late May 1990 were reviewed with ACEC/RMF management. A decision will be made in early July regarding the date and location.

C. BUILDING AND ENERGY CASE STUDIES

Richard E. McCommons, AIA
Association of Collegiate Schools of Architecture
1753 New York Avenue, NW
Washington, D.C. 20006

ORNL/Sub-89609/59

No report.

**D. TECHNOLOGY TRANSFER PROGRAM
FOR THE
OFFICE OF BUILDINGS
AND
COMMUNITY SYSTEMS**

**P. Rush, R. M. Braun, M. Bell
Sumner Rider & Associates, Inc.
New York, New York**

ORNL/Sub-78981/30

Sumner Rider & Associates, Inc., is preparing a technical article on six OBCS-sponsored microcomputer software design tools: SUPERLITE 1.0, SOLAR 5, WINDOW 3.1, ASEAM2.1, DOE2, and SOLAR 5. The article will examine the need for whole-building energy analysis tools, review the products and special features of the software, and refer to the market penetration of the packages. The article is being prepared for use by a trade publication serving the design and construction industry.

SR&A is developing a summary information paper on the national and regional impact of the National Appliance Energy Conservation Act of 1987 (NAECA). The paper will incorporate analysis by scientists of the Energy Analysis Program, LBL, and by the American Council for an Energy-Efficient Economy. The paper will examine the issues surrounding appliance standards and their impact on chlorofluorocarbon levels. Distribution would be to trade and consumer publications.

Agency has distributed a summary information paper on ASEAM 2.1 to 34 building design and construction and energy-related publications. PROFESSIONAL BUILDER magazine has requested a case history on a residential application. ACEC Research & Management Foundation is investigating such an application.

An SR&A report on radiant barrier research conducted by ORNL and the TVA in test homes in Tennessee is under review. The report is to be distributed to a broad list of national consumer and trade publications.