chnology Publications

4: 1979

The photographs used in this publication are courtesy of the U.S. Department of Housing and Urban Development. They represent the spectrum of CBT's research: to provide the technical bases for improving buildings, building components and building practices.

Building Technology Publications

Supplement 4: 1979

Karen Porterfield, Editor

Center for Building Technology
National Engineering Laboratory
National Bureau of Standards
Washington, D.C. 20234

June 1980

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Introduction

This report presents the National Bureau of Standards' Center for Building Technology (CBT) publications for 1979. It is the fourth supplement to NBS Special Publication 457, *Building Technology Publications 1965-1975,* and lists CBT documents issued or recorded during the period January 1 to December 31, 1979. It includes titles and abstracts of each NBS publication and each paper published in non-NBS media, key word and author indexes, and general information and instructions on how to order CBT publications.

This report communicates the results of CBT research to various technical audiences, as well as to the general public. Publications constitute a major end product to CBT's efforts and, in 1979, appeared in several NBS publication series (Building Science Series, Technical Notes, Special Publications, NBS Interagency Reports, and Grant/Contract Reports) as well in non-NBS media such as technical and trade publications. Publications appearing in non-NBS media have each been assigned a five-digit number. NBS publication series abbreviations are:

BSS - Building Science Series

TN - Technical Note

SP - Special Publication

NBSIR - National Bureau of Standards Interagency Report

GCR - Grant/Contract Report

This document is divided into three main sections. The first, *Titles and Abstracts,* provides the report title, author(s), date of publication, selected key words, and an abstract of each NBS publication and each paper published in an outside source. The *Author Index* cites each CBT author and gives the publication title and/or number referencing documents listed in this supplement. The *Key Word Index* is a subject index, listing word summaries of the building research topics for each publication and paper. By selecting a main word or subject, which are listed alphabetically, the user is able to locate reports of interest through the subject-related words found in the key word index.

CBT is part of the National Engineering Laboratory, National Bureau of Standards. NBS undertakes basic and applied research in various areas. Interested readers will find other NBS publications listed in NBS Special Publication 305-11, *Publications of the National Bureau of Standards 1979,* from which parts of this report have been taken.

Obtaining Publications

Most current CBT publications (excluding *NBS Interagency Reports and Grant/Contract Reports)* are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Microfiche and paper copies of most CBT publications may be ordered through the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. Two other sources are depository libraries (libraries designated to receive government publications) and Department of Commerce District Offices. The current price list and availability of publications listed in this report are given in Appendix C.

The depository libraries listed in Appendix A receive selected publication series of the National Bureau of Standards for general reference use. While every Government publication cannot be sent to all depository libraries, certain designated Regional libraries are required to receive and retain one copy of all Government publications made available either in printed or microfiche form. To obtain information on which publications are available, please contact the depository library in your area.

Department of Commerce District Offices are maintained in the cities listed in Appendix B. Their purpose is to provide ready access at the local level to publications, statistical statements, and surveys. Each District Office serves as an official sales agent of the Superintendent of Documents, U.S. Government Printing Office. These offices make available for local purchase a wide range of Government publications. The reference library maintained by each District Office contains many Government and private publications, periodicals, directories, reports, and other reference materials.

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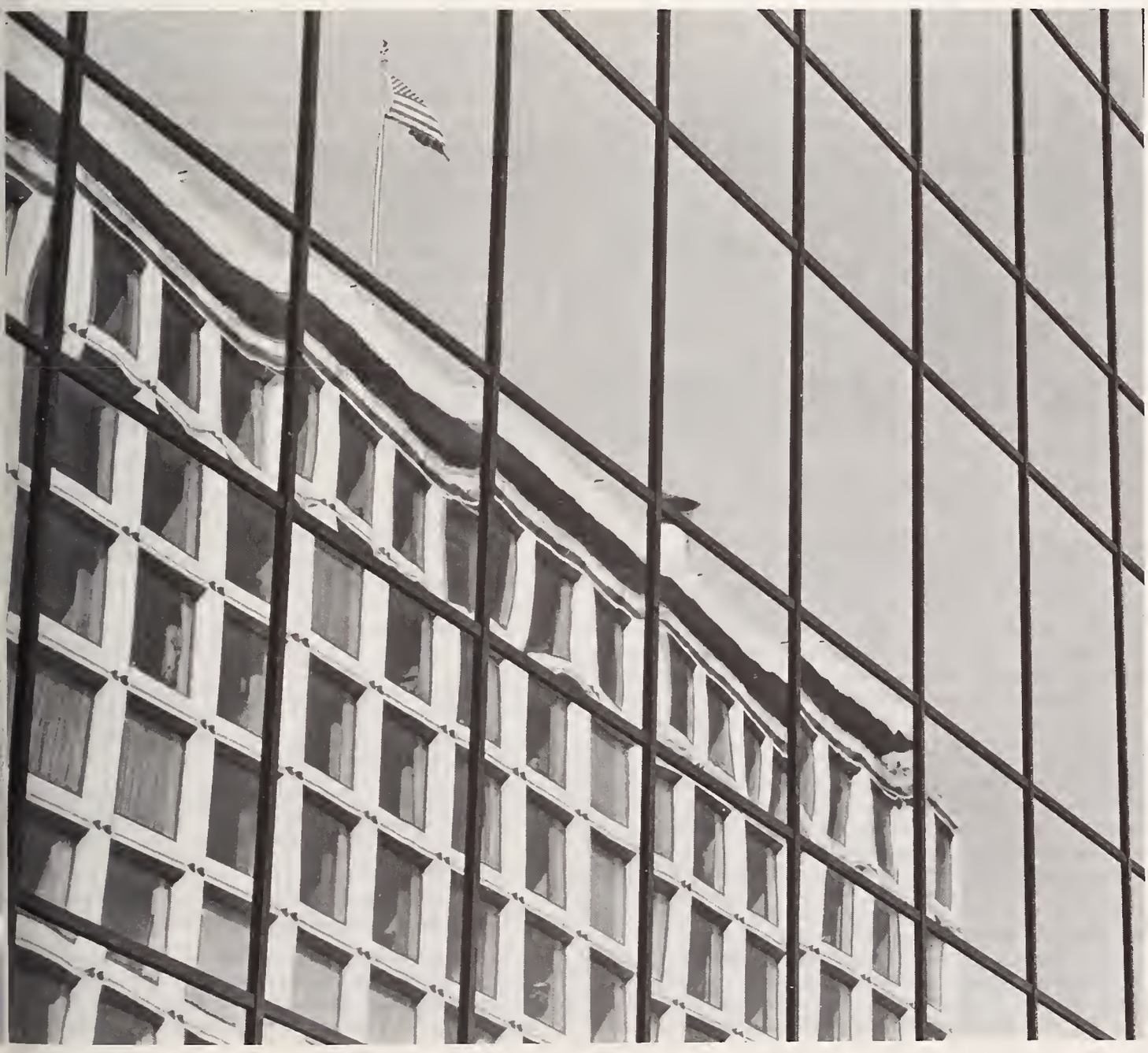

Building Science Series

Building Science Series reports disseminate technical information developed at the Center on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

BSS75. **Building research at the National Bureau of Standards 1968-1974,** N. Gallagher, Ed., *Nat. Bur. Stand.* (*U.S.*), *Bldg. Sci. Ser. 75*, 126 pages (Mar. 1979) SN003-003-02029-0.

Key words: building technology; Center for Building Technology; history of building research.

This report details the progress of building research at the Center for Building Technology from the year 1968 to 1974. Starting with the backlog of needed research in building techniques, components, and materials that faced researchers in the 60's, this history covers the evolution of the performance concept for building specifications, cooperation with states and codes-generating organizations, and specific technical accomplishments. The report continues with discussions of programs involving the building community, research on the needs of the building users, and technology transfer. A special chapter is devoted to energy conservation in buildings and how CBT's test methods and other programs—including solar—were pressed into this vital national struggle.

BSS95. **The development of an improved compression test method for wall panels,** C. W. C. Yancey and L. E. Cattaneo, *Nat. Bur. Stand.* (*U.S.*), *Bldg. Sci. Ser. 95*, 108 pages (Feb. 1979) SN003-003-01697-7.

Key words: compression; eccentric loading; flat-end; kern; loading rate; pin-end; test method; wall panels; walls.

An experimental and analytical investigation of the primary factors involved in the testing of prototype wall panels under axial compression loading is reported. The objective of the investigation was to develop a method of testing wall specimens that incorporates the best features of ASTM Standard Method E 72 while at the same time incorporating improvements in the areas of deficiency in the Standard. Twenty-five laboratory tests were conducted on samples composed of five types of wall panel construction. The panels were tested to failure under either of two different eccentricities of load, while being supported with one of two types of idealized end conditions. Selected test results and detailed descriptions of the laboratory procedures used are presented. A computer-aided analytical study of the variables affecting the degree of uniformity of loading was conducted. Equations based on the analogy of beams supported on elastic foundations were used in the analysis. A study of the statistical parameters commonly used to interpret test results was conducted to establish useful guidelines for predicting structural performance on the basis of small sample test results. A compression test method applicable to traditional and innovative wall constructions is presented. The principal additions in the revised test method are as follows: (a) a provision for variable eccentricity, (b) a procedure for selecting a load distribution assembly which will be compatible with the test-panel.

BSS107. **Soil and rock anchors for mobile homes—A state-of-the-art report,** W. D. Kovacs and F. Y. Yokel, *Nat. Bur. Stand.* (*U.S.*), *Bldg. Sci. Ser. 107*, 164 pages (Oct. 1979) SN003-003-02121-1.

Key words: anchors; mobile home foundations; soil anchors; soil mechanics; wind upset.

Available anchor hardware is surveyed and evaluated and pull-out capacity data are compared with hypotheses for predicting anchor pull-out capacity based on soil mechanics principles. The evidence suggests that our ability to predict anchor pull-out capacity by soil mechanics principles is inadequate, and that there is a need for the standardization of test procedures and soil classification and for further test data. Suggestions for future research are presented.

BSS115. **Fire safety for high-rise buildings: The role of communications,** R. A. Glass and A. I. Rubin, *Nat. Bur. Stand.* (*U.S.*), *Bldg. Sci. Ser. 115*, 47 pages (Apr. 1979) SN003-003-02016-8.

Key words: buildings; communications systems; fire safety; high-rise; model codes; people movement; systems design.

This literature survey reviews the communications requirements for fire safety in buildings from the standpoint of the building occupant and the control operator. It traces the development of the problem of communications in buildings and the specialized needs that exist today.

An examination is made of the purposes of a communications system in buildings as well as some of the psychological design requirements necessary for such a system.

The communications requirements of the building occupants are also covered, with emphasis on the types of information communicated by signals and the integration of those signals into an overall system design.

Personnel requirements for staffing a control center are also discussed, along with common problems in several operational communications systems.

Detailed examples of communications systems are provided. Portions of several model codes which cover communications systems are presented. Suggested areas for future research on fire safety in buildings are identified.

BSS117. **Experimental verification of a standard test procedure for solar collectors,** J. E. Hill, J. P. Jenkins, and D. E. Jones, *Nat. Bur. Stand.* (*U.S.*), *Bldg. Sci. Ser. 117*, 126 pages (Jan. 1979) SN003-003-02008-7.

Key words: measurement; solar collector; solar energy; solar radiation; standards; standard test; testing.

A proposed procedure for testing and rating solar collectors based on thermal performance was published by the National Bureau of Standards (NBS) in 1974. Subsequently, the American Society of Heating, Refrigerating, and Air Conditioning

(ASHRAE) developed a modified version of the NBS procedure which was adopted in early 1977 as ASHRAE Standard 93-77. A test facility for water-heating and air-heating collectors has been built at NBS and was used to support the development of Standard 93-77. The purpose of this report is to describe the recently adopted test procedure, the NBS test facility, and the tests that were conducted to support the development of the procedure.

BSS118. **Extreme wind speeds at 129 stations in the contiguous United States,** E. Simiu, M. J. Changery, and J. J. Filliben, *Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 118*, 318 pages (Mar. 1979) SN003-003-02041-9.

Key words: building (codes); probability distribution functions; statistical analysis; storms; structural engineering; wind pressure; wind speeds.

The purpose of this report is to present information on recorded and predicted wind speeds at 129 airport stations in the contiguous United States at which reliable records are available over a number of consecutive years. This information is provided to serve as basic documentation from which appropriate decisions can be made on values of design wind speeds to be specified in building codes and standards or on specific projects. Included in the report are: recorded wind speeds and anemometer elevations, predicted wind speeds based on probability distributions of the largest values, estimates of the sampling errors inherent in the predicted wind speeds, a description of the statistical procedure used in the analysis of the data, and a discussion of the results of the analysis.

BSS119. **Economic evaluation of windows in buildings: Methodology,** R. T. Ruegg and R. E. Chapman, *Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 119*, 118 pages (Apr. 1979) SN003-003-02042-7.

Key words: building economics; daylighting; economic analysis; energy conservation; engineering economics; life-cycle costs; solar heat gain; thermal efficiency; window; window management.

This study, which is one part of a National Bureau of Standards interdisciplinary project on windows, is aimed at improving the cost-effectiveness of window selection and use in buildings. It develops and illustrates a life-cycle costing evaluation model and computer program for assessing for alternative window systems the net dollar impact of acquisition, maintenance and repair, heating and cooling energy gains and losses, and artificial lighting and daylighting tradeoffs. The method is applicable to the evaluation of many different window sizes, designs, accessories, and uses, both for new and existing residential and commercial buildings. Two step-by-step examples of evaluating selected window alternatives in a residence and in an office building in Washington, D.C., serve to illustrate the application of the method.

A companion report, *A Regional Economic Assessment of Selected Window Systems*, presents the results of eight additional residential case studies and eight additional commercial case studies. While the emphasis of this report is on the method of evaluation, the companion report focuses on summarizing the results of a regional analysis in a form that will be convenient for use by building owners, operators, designers, financiers, and builders—those whose interest centers on the actual implementation of research results.

BSS120. **Guidelines for stair safety,** J. Archea, B. L. Collins, and F. I. Stahl, *Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 120*, 129 pages (May 1979) SN003-003-02063-0.

Key words: accidents; architectural design; architectural psychology; architectural research; building codes; building design; building regulatory standards; floor coverings; home safety; safety standards; stair safety; stairway design.

This report summarizes information and research in the area of stair use and provides design guidelines for improving stair safety. These guidelines are directed toward seven major categories of stairway design and construction: (1) structural integrity and quality of stairs, (2) physical attributes of stair surfaces, (3) appearance of stair surfaces, (4) handrails, (5) physical attributes of the surrounding stairway environment, (6) appearance of the surrounding stairway environment, and (7) signs and symbols.

In general, the recommendations offered in this report derive from the premise that stairway accidents are caused by human perceptual errors, which are frequently triggered by some flaw in the design or construction of stairways themselves. Evidence describing the severity and frequency of residential stairway hazards, and supporting premises underlying design guidelines were obtained from epidemiological, experimental, exploratory, and survey research sources. General directions for future investigation are suggested.

Technical Notes

Technical Notes present data which are complete in themselves but are not as comprehensive in scope or as definitive in treatment of the subjects as reported in Building Science Series.

TN971. **Guidelines for cost-effective lead paint abatement,** R. E. Chapman and J. G. Kowalski, *Nat. Bur. Stand. (U.S.), Tech. Note 971*, 88 pages (Jan. 1979) SN003-003-02014-1.

Key words: abatement; building economics; building materials; economic analysis; housing; lead-based paint; lead poisoning.

Public and private concern about the potential for lead poisoning in children due to the ingestion of lead-based paint chips has resulted in a Federally sponsored program to develop technologies by which the lead-based paint hazard may be eliminated from the nation's housing. Through this program lead-based paint abatement techniques were tested in field deleading operations conducted in Boston, Massachusetts. The major focus of the program was on the collection of data on the direct costs of labor, materials and special equipment associated with these abatement techniques. Data were also collected on contractors' bids so that markup ratios could be calculated.

This report provides an overview of the statistical analysis of these direct cost data by abatement technique and building component (i.e, walls, doors and frames, windows and frames, and miscellaneous trim). An overview of the statistical analysis of the markup ratio is also included. Cost models are developed for each abatement technique which identify the key factors which affect direct cost and markup. Guidelines are given so that these models can be used by municipal officials and building owners to estimate deleading costs as well as provide input to policy evaluation and formulation.

TN979. **Lead paint abatement costs: Some technical and theoretical considerations,** R. E. Chapman and J. G. Kowalski, *Nat. Bur. Stand. (U.S.), Tech. Note 979*, 153 pages (Feb. 1979) SN003-003-02022-2.

Key words: abatement; building economics; building materials; cost estimation; econometric models; economic analysis; housing; lead-based paint; lead poisoning.

Public and private concern about the potential for lead poisoning in children due to the ingestion of lead-based paint chips has resulted in a Federally sponsored program to develop technologies by which the lead-based paint hazard may be eliminated from the nation's housing. The nature and design of the Experimental Hazard Elimination Program (EHEP) is thought to be unique in that it permitted the costs of the alternative lead paint abatement techniques to be rigorously analyzed.

The focus of this report is on the design, implementation and analysis of EHEP and the cost information it produced. Statistical analyses which permitted the development of econometric models capable of estimating abatement technique costs and expected contractor markup are described. Structural equations relating changes in the values of certain key factors to variations in direct cost and contractor markup are also presented. Guidelines, including a national deleading cost estimate, are given so that these econometric models can be used by municipal officials and building owners to estimate deleading costs as well as provide input to policy evaluation and formulation.

TN980. **Historic preservation incentives of the 1976 Tax Reform Act: An economic analysis,** S. F. Weber, *Nat. Bur. Stand. (U.S.), Tech. Note 980*, 32 pages (Feb. 1979) SN003-003-02015-0.

Key words: adaptive reuse; buildings; demolition; economics; historic preservation; life-cycle costing; redevelopment; rehabilitation; tax incentives.

The Tax Reform Act (TRA) of 1976 includes several provisions which affect the financial position of owners of income-producing historic buildings. This report analyzes the effect of the TRA on the after-tax cost of two basic alternatives facing the owner: (1) rehabilitate the structure, or (2) demolish it and redevelop the site. A life-cycle minimization model was developed, programmed in BASIC language, and applied in an after-tax comparison of six alternative situations representing rehabilitation and redevelopment both before and after the TRA. Under the assumptions of the model used in this analysis, the TRA has made the rehabilitation option significantly more attractive than previously. The former tax bias in favor of demolition and redevelopment has been reversed. Until now, this information on the life-cycle tax advantages of rehabilitating historic buildings has been unavailable. This report will help corporate investors make cost-effective decisions regarding historic preservation of nonresidential buildings and provide policy makers with information on the effectiveness of these tax incentives. The approach utilized could be adapted to analyze incentives for other types of building rehabilitation.

TN985. **Fire effects on reinforced concrete members,** B. Ellingwood and J. Shaver, *Nat. Bur. Stand. (U.S.), Tech. Note 985*, 42 pages (Aug. 1979) SN003-003-02104-1.

Key words: concrete (reinforced); fire load; fire resistance; fire tests structural engineering; temperature; thermal analysis.

Fire ratings for structural assemblies in the U.S. are currently measured by endurance of or temperature rise in components subjected to a standard test. Analytical procedures show considerable promise for alleviating the extensive testing required, and for placing fire resistant structural design on a limit states basis. In this study, thermal and structural analyses for reinforced concrete members are validated using experimental data. Temperature distributions computed in reinforced concrete members for several realistic fire exposures are examined and compared to the distributions measured in a standard test. Parameter studies show the effect of typical variations in thermal diffusivity, emissivity and conductivity. Structural responses for the different fire exposures are also briefly compared.

TN992. **An investigation of air-infiltration characteristics and mechanisms for a townhouse,** S. J. Treado, D. M. Burch, and C. M. Hunt, *Nat. Bur. Stand. (U.S.), Tech. Note 992*, 36 pages (Aug. 1979) SN003-003-02090-7.

Key words: air infiltration; residential; air permeability of houses; energy conservation; pressurization technique; tracer-gas technique.

Air infiltration measurements using a tracer-gas technique and the pressurization technique were performed on a three-bedroom townhouse having a gas-fired, forced-air furnace system, in order to quantify the amount of air infiltration due to various mechanisms. These mechanisms include combustion and draft-diverter air requirements, air leakage from supply-air ducts, and air leakage through the solid parts of the building envelope as well as air leakage through cracks around windows and doors. A thermographic survey was also performed in conjunction with pressurization of the structure, in an attempt to identify specific leaks. An apparatus for measuring the air permeability of building materials was used to analyze the significance of air permeation through solid building elements. Based on the findings of the study, general guidelines are presented for reducing air infiltration in residences.

TN996. **Mechanical properties of adobe,** J. R. Clifton and F. L. Davis, *Nat. Bur. Stand. (U.S.), Tech. Note 996*, 45 pages (May 1979) SN003-003-02066-4.

Key words: adobe; adobe soil; compressive strength; creep; flexural strength; mechanical properties; moisture; nondestructive testing; preservation.

Relationships between the compressive strength and creep, and the moisture contents of adobe were investigated. Moisture was found to have a deleterious effect on these mechanical properties of adobe, its severity increasing with increasingly higher relative humidities and higher moisture contents. It was concluded that rain and ground water would have a greater deleterious effect on the mechanical properties of adobe than high relative humidities.

The physicochemical properties of adobe, mix proportions, drying conditions, and shrinkage of specimens were also found to influence the compressive strength of adobe. Procedures for preparing, curing and testing of adobe specimens are given.

A nondestructive test method, based on measuring the penetration resistance of adobe, was found to give reliable predictions of the compressive strength and moisture content of adobe specimens.

TN998. **Impact of building regulations on rehabilitation—Status and technical needs,** J. G. Gross, J. H. Pielert, and P. W. Cooke, *Nat. Bur. Stand. (U.S.), Tech. Note 998*, 50 pages (May 1979) SN003-003-02062-1.

Key words: building code; building research; code administration; existing buildings; model codes; preservation; regulation; rehabilitation; renovation.

This report presents the results of a study of the impact of regulations on building rehabilitation and includes a discussion of the activities of the Building Rehabilitation Technology Program of the Center for Building Technology. Particular activities discussed relative to existing buildings include: (a) development of the technical bases for regulations and an improved regulatory process, (b) development of new technology and evaluation tools, and (c) development of responsive and cost-effective decision tools. A new code concept is outlined which could be a replacement for the "25-50 percent" rule presently in codes for new construction. This rule often controls the amount of work that may be required in the rehabilitation of existing buildings. The status of existing code documents for buildingrehabilitation is provided along with an overview of other publications which discuss the impact of building regulations on rehabilitation.

TN999. **A study of the dynamic flue-gas temperature and off-period mass flow rate of a residential gas-fired furnace,** C. Park, W. J. Mulroy, and G. E. Kelly, *Nat. Bur. Stand. (U.S.), Tech. Note 999*, 41 pages (July 1979) SN003-003-02092-3.

Key words: automatic stack damper; flue-gas temperature profile; gas-fired furnace; off-period mass flow rate; part-load performance; seasonal efficiency.

The flue-gas temperature and mass flow rate through a gas-fired furnace were studied in the laboratory. Temperature profiles were measured under cycling conditions and compared with profiles predicted mathematically using data obtained while the furnace was cooling down from steady-state operation and warming up from equilibrium. The mass flow rates at various flue-gas temperatures were measured using both a vane anemometer and a tracer-gas technique, and these results are compared with the mass flow rate predicted by the theoretical equations. The effect on the off-period flow rate of automatic stack dampers having different sized damper openings was experimentally determined. Theoretical equations are presented for predicting the effectiveness of a stack damper as a function of the ratio of the area of the damper to the area of the stack and a system friction factor.

TN1100. **Analysis of tentative seismic design provisions for buildings,** J. R. Harris, S. J. Fenves, and R. N. Wright, *Nat. Bur. Stand. (U.S.), Tech. Note 1100*, 599 pages (July 1979) SN003-003-02084-2.

Key words: building codes; buildings; building standards; classification; decision tables; earthquake-resistant design; information networks; network; seismic design; systems analysis.

This report presents the results of a thorough study of the internal logic of the *Tentative Provisions for the Development of Seismic Regulations for Buildings* developed by the Applied Technology Council. The methods of analysis employed in the study provide objective measures of clarity, completeness, and consistency and an alternative form in which to examine the technical validity of the provisions. These methods include decision logic tables for examining individual provisions, information networks for representing the precedence among provisions, and classification of the provisions to study their scope and arrangement. A formal representation of the provisions is presented by the data items, decision tables, networks, and classification systems developed in the study. An index and several alternate arrangements of the provisions are also included. Opportunities for improvement of the tentative provisions are identified and discussed, and considerations for their future development and implementation within various national standards are highlighted.

TN1107. **The use of aerial infrared thermography to compare the thermal resistances of roofs,** D. M. Burch, *Nat. Bur. Stand. (U.S.), Tech. Note 1107*, 38 pages (Aug. 1979) SN003-003-02102-4.

Key words: aerial flyovers; aerial infrared thermography; energy conservation; roof heat-loss survey.

The paper investigates whether a comparative roof survey using aerial infrared thermography can be used to rank the roofs of residential and commercial buildings according to their thermal resistance. Mathematical models are presented for predicting the apparent radiance temperatures of these roof systems. These models are used to investigate the differences in apparent radiance temperature between roofs having various thermal resistances. These predicted differences are then compared with predicted differences in apparent radiance temperature caused by typical variations in roof emittance, local outdoor temperature, and local wind speed throughout the macroclimate. The transmission characteristics of the atmosphere are reviewed, and the required dew-point spread for preventing dew or frost formation on a roof is examined.

Special Publications

This series includes proceedings of conferences sponsored by the Center and other special publications appropriate to this grouping including project summaries, list of publications, wall charts, pocket cards, and bibliographies.

SP439-1. **Center for building technology: A perspective—1979,** M. Olmert, *Nat. Bur. Stand. (U.S.), Spec. Publ. 439-1*, 31 pages (May 1979) SN003-003-02056-7.

Key words: building research; criteria; energy; engineering; industry construction; measurement techniques; standards.

The mission of the Center for Building Technology is threefold. They are 1) advance building technology by providing technical and scientific bases for criteria and standards that improve the usefulness, safety, and economy of buildings; 2) facilitate, for the public benefit, the implementation of improved building technology by providing technical assistance to all sectors of the building community; and 3) develop improved techniques by which the end-users in buildings, communities and industrial processes conserve energy. This report presents an overview of the Center for Building Technology's research areas through its accomplishments and ongoing projects.

SP446-2. **Building technology project summaries 1977-1978,** M. Olmert and N. Raufaste, Eds., *Nat. Bur. Stand. (U.S.), Spec. Publ. 446-2*, 108 pages (Jan. 1979) SN003-003-02021-4.

Key words: building research; building technology; codes; criteria; project summaries; standards; technical bases.

The Center for Building Technology provides the technical and scientific bases for criteria and standards that improve the usefulness, safety, and economy of buildings while conserving building materials and energy. The Center's activities support the building technology program of the Federal, State and local government; assist design professions, building officials and the research community by developing design criteria that improve buildings; and assist manufacturers of building products by developing criteria for evaluating innovative building materials. This report summarizes the Center's projects for calendar year 1977. It enables individuals to get a clear impression of CBT research activities.

SP457-3. **Building technology publications 1978—Supplement 3,** J. R. Debelius, Ed., *Nat. Bur. Stand. (U.S.), Spec. Publ. 457-3*, 106 pages (July 1979) SN003-003-02096-6.

Key words: abstracts; Center for Building Technology; key words; publications.

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This report provides the primary means of communicating the results of CBT programs to its varied technical audiences, as well as to the general public. Publications constitute a major end product of CBT's efforts and in 1978 appeared in several NBS publication series (Building Science Series, Technical Notes, Special Publications, Handbooks, and NBS Interagency Reports).

SP536. **Selected papers dealing with regulatory concerns of building rehabilitation,** P. W. Cooke, Ed., *Nat. Bur. Stand. (U.S.), Spec. Publ. 536*, 93 pages (Feb. 1979) SN003-003-02032-0.

Key words: adaptive reuse; building codes; buildings; building safety; code enforcement; construction; fire safety; housing; preservation; regulations; rehabilitation.

This publication consists of a collection of six papers common to the subject of rehabilitation and preservation of existing buildings and how our present system of regulating construction for the public benefit presents various barriers that must be more fully understood in order that rational solutions can be developed and implemented. The papers have been reprinted from the Proceedings of previous national conferences dealing with building regulatory research held under the joint sponsorship of NBS and the National Conference of States on Building Codes and Standards. *This publication includes the following papers (indented):*

Building codes: Preservation and rehabilitation, R. J. Kapsch, *SP536*, pp. 1-16 (Feb. 1979).

Key words: adaptive reuse; architecture; building codes; building regulations; building safety; construction; performance; preservation; rehabilitation; renovation.

There has been a large rise in interest in the last ten years in building reuse, rehabilitation and preservation projects. This trend is expected to continue in the foreseeable future. Such projects pose difficulties for the building regulatory system since many of these buildings were originally constructed prior to the existence of building codes. Most of these buildings do not meet modern levels of building regulation and application of building regulations to them poses difficulties as these regulations are essentially designed for new construction. The potential impact of these regulations includes the increase of project costs and damage to the fabric of the building intended to be preserved. Yet safety and health must be achieved in existing buildings as well as new. This paper summarizes studies and other activities that are presently being conducted by a number of organizations on this subject. One such study conducted by NBS has indicated that numerous State and local jurisdictions and model code organizations are adopt-

ing historic building waiver clauses and similar regulations as a partial answer to this problem. The National Trust for Historic Preservation sponsored the first national conference, in 1974, on this question and is currently cooperating with NBS in a study of the effectiveness of selected historic building waiver clauses. The National Endowment for the Arts has sponsored a grant that would identify tradeoffs that could be used in building regulations. NBS has also sponsored a study, reported in a separate paper in these Proceedings, on how a standard designed for existing buildings might be structured and formatted. NBS is also studying, for the Department of Housing and Urban Development, technological aspects of neighborhood conservation, including the role of building regulations. As of this writing, no final or definitive answer has been developed for the problem of achieving contemporary levels of safety and health in existing buildings.

Information structure of building codes and standards for the needs of existing buildings, B. Smith, *SP536*, pp. 17-53 (Feb. 1979).

Key words: building codes and standards; building code structure; existing buildings; historic preservation; performance attributes; performance evaluation.

With the increased occurrence of rehabilitation and preservation projects, the problem of code compliance for these buildings is growing in magnitude. We are no longer dealing with isolated historic buildings, but with both entire historic districts and an ever increasing number of recycled, adaptively used buildings. The problem of code compliance for these projects frequently causes the destruction of the historic integrity of the building, the replacement of serviceable materials and, at the same time, increases project costs. The compliance problems may stem from the organization and format of the model codes which are based on new construction materials and techniques. This study examines the present organization and format of the three model codes and develops a decision flow chart which analyzes how these model codes are used. The regulatory problems facing rehabilitation and preservation projects are then reviewed. From this investigation, a proposed decision process, based on the needs of rehabilitation and preservation projects is developed. Such a decision process could be used if and when building regulations are developed for the unique needs of these type projects.

Contractor understanding relative to rehab costs, R. S. Harrington, *SP536*, pp. 55-61 (Feb. 1979).

Key words: building codes; community development; construction costs; contractors; housing; rehabilitation; standards.

The nature of rehabilitation, with its nonvisible elements and its potential for self-help, makes it extremely difficult to accurately estimate the costs involved. The uncertainty is passed on by the Contractor in the fees he charges. Uncertainty exists, as well, in the standards for accomplishing the work at hand. Specifications are normally cumbersome, Work Write-Ups lacking in detail. Therefore understanding is diminished and costs rise, while quality falls below standards.

With the pending increase in neighborhood code rehabilitation projects, there is the need to increase the supply of competent contractors interested and experienced in rehab. This requires both a method for offering standardization of specifications and work write-ups with more detail, and the ability to assure a steady flow of work into bidding channels.

The role of fire prevention and control in building construction and regulations, W. H. McLain, *SP536*, pp. 63-74 (Feb. 1979).

Key words: building codes; control measures; fire codes; fire safety; governmental actions; life safety; regulation; risk assessment; societal goals.

Fire prevention and control is an important feature of the modern building codes. Building set-back limits, structural design, and limitations on interior finish materials are among the building design parameters that reflect the public need for fire safety. Historically, codes have been developed to reduce mass urban fires and to limit property damage from the structural collapse of single building units. For example, a standard time-temperature curve has been developed and widely used (ASTM E119) for classification of building structural components in terms of a fire-time rating. More recently, there has developed an increased concern about life safety. Smoke and toxic gas produced by materials subjected to fire exposures are being evaluated and in some cases form part of a developing set of new regulations. The implementation of these new regulations poses a number of difficult problems to the local code regulatory and enforcement officials. An analysis is made of some of the alternative approaches which may be considered to aid the local building official in this important area of control.

Rehabilitation as an instrument in meeting housing need: Can it really work?, J. Heron, *SP536*, pp. 75-81 (Feb. 1979).

Key words: decision criteria; demolition; housing needs; physical condition rehablitation.

There is an increasing trend in city planning toward rehabilitating older buildings and conserving neighborhoods that might have become slums, but the rehabilitation process is slow and unreliable. Few builders are interested in rehabilitation, most preferring new construction in the suburbs. A major question is: can the rehabilitation process be changed to attract more builders and become a high-volume business?

The suggested answer is that criteria to identify buildings needing rehabilitation and to specify what repairs need to be made must be developed, using the cumulative knowledge of builders who have done such work and the insight of people involved in building regulation. These criteria should deal with the fundamental structural and safety characteristics of buildings, to provide a yardstick for selecting the right buildings and deciding how much work is required.

Building codes and historic preservation in Savannah Georgia, M. Rosenthal, *SP536*, pp. 83-93 (Feb. 1979).

Key words: barriers; building codes; code enforcement; historic district; historic preservation; regulations; rehabilitation; safety.

The City of Savannah has the largest registered urban historical district in the United States. Over 900 structures have been restored or are awaiting restoration. Building code barriers that once existed were overcome through cooperation and communications with results that satisfy the intent of code criteria while also maintaining the integrity of historic preservation. The experience gained in Savannah suggests that code compliance responsibilities in historic preservation projects rest jointly with designers, preservationists, owners and builders as well as code en-

forcement personnel. Recommendations include the need for guidelines in the use of codes for dealing realistically with building rehabilitation projects.

SP542. **Possible contributions of cement and concrete technology to energy conservation,** G. Frohnsdorff, P. W. Brown, and J. R. Clifton, *Nat. Bur. Stand. (U.S.), Spec. Publ. 542*, 76 pages (May 1979) SN003-003-02059-1.

Key words: cement; concrete; energy-saving opportunities; research needs.

A workshop on Possible Contributions of Cement and Concrete Technology to Energy Conservation by the Year 2000 was held at the National Bureau of Standards on October 3 and 4, 1977. The purpose of the workshop was to identify and record ideas on possible contributions of cement and concrete technology to energy conservation in the near term and by the Year 2000. This included consideration of current technology as well as areas in which technological advances might be realized.

The workshop was divided into working groups on cement composition, cement production, blending materials, concrete production, efficient use of concrete, and institutional factors. The essential results from the six working groups were statements of Energy-Saving Opportunities, Research Needs, and Unresolved Issues. The statements, which are the major part of this report, are presented without critical analysis. They suggest, however, that there are a large number of possible opportunities which should be evaluated for their ability to contribute to energy conservation in the cement and concrete industries.

SP548. **Summer attic and whole-house ventilation.** Proceedings of a Workshop held at the National Bureau of Standards, Gaithersburg, MD, July 13, 1978, M. H. Reppert, Ed., *Nat. Bur. Stand. (U.S.), Spec. Publ. 548*, 153 pages (July 1979) SN003-003-02089-3.

Key words: attic ventilation; energy conservation; solar absorptance of roofing materials; whole-house ventilation.

These are the proceedings of the Summer Attic and Whole-House Ventilation Workshop sponsored by the National Bureau of Standards in collaboration with the Department of Energy and the attic ventilation industry. The purpose of the Workshop was to provide a forum for technical discussion to assess summer energy savings that might be achieved from the use of static and powered attic ventilation and wholehouse ventilation equipment. Papers on experimental and mathematical model studies relating to attic and whole-house ventilation were presented. In addition, a paper on roof solar absorptance and its effect on the cooling requirement of a residence was presented.

After each paper was presented, participants of the Workshop were given an opportunity to question the speaker concerning his paper. The resulting questions and responses are included at the end of each of the papers. *These proceedings include the following papers (indented):*

Solar reflectivity of common roofing materials and its influence on the roof heat gain of typical southwestern residences, J. A. Reagan and D. M. Acklam, *SP548*, pp. 1-13 (July 1979).

Measurement of attic temperatures in Florida, T. I. Wetherington, Jr., *SP548*, pp. 15-24 (July 1979).

Forced ventilation for cooling attics in summer, G. S. Dutt and D. T. Harrje, *SP548*, pp. 25-38 (July 1979).

Effect of powered attic ventilation on ceiling heat transfer and cooling load in two townhouses, R. A. Grot and C. I. Siu, *SP548*, pp. 39-56 (July 1979).

Attic ventilation research conducted by Arkansas Power and Light Company, F. B. Clark, *SP548*, pp. 57-72 (July 1979).

Ventilating residences and their attics for energy conservation—An experimental study, D. M. Burch and S. J. Treado, *SP548*, pp. 73-104 (July 1979).

Analysis of attic ventilation test, D. Brewster and T. Arkfeld, *SP548*, pp. 105-117 (July 1979).

A model for predicting the thermal performance of ventilated attic-ceiling-roof combinations, B. A. Peavy, *SP548*, pp. 119-149 (July 1979).

SP549. **Proceedings of the National Conference on Regulatory Aspects of Building Rehabilitation.** Proceedings of a Conference held at the National Bureau of Standards, Gaithersburg, MD, Oct. 30, 1978, S. A. Berry, Ed., *Nat. Bur. Stand. (U.S.), Spec. Publ. 549*, 220 pages (Aug. 1979) SN003-003-02107-5.

Key words: building; code administration; codes; evaluation; existing buildings; performance standard.

This document contains the edited Proceedings of the National Conference on Regulatory Aspects of Building Rehabilitation held Oct. 30, 1978, at the National Bureau of Standards.

It contains a total of 18 presented papers, all of which address the subject of rehabilitation—currently a critical issue in the Nation's effort to revitalize its cities and house its citizens.

Public sector as well as private sector programs and experiences toward achieving this goal are covered in one general and three technical sessions. *These proceedings include the following papers (indented):*

Public programs for housing rehabilitation, A. Rechler, *SP549*, pp. 19-21 (Aug. 1979).

HUD rehabilitation guidelines, R. J. Kapsch, *SP549*, pp. 23-27 (Aug. 1979).

Application of Article 22 of the Massachusetts State Building Code, P. Folkins, *SP549*, pp. 33-38 (Aug. 1979).

Impact of new construction oriented codes on building rehabilitation, R. P. Kuchnicki, *SP549*, pp. 39-42 (Aug. 1979).

Code requirements for existing buildings: A new approach, K. M. Schoonover, *SP549*, pp. 43-50 (Aug. 1979).

A "professional practice" approach to the rehabilitation process, W. E. Lewis, *SP549*, pp. 71-84 (Aug. 1979).

A fire evaluation system for health care facilities, H. E. Nelson, *SP549*, pp. 85-102 (Aug. 1979).

Rehabilitation standards: What are they? Who is to develop, maintain, and enforce them?, B. A. Cummings, *SP549*, pp. 103-106 (Aug. 1979).

Rehabilitation, performance and the 'real world' of the code official, J. Stein, *SP549*, pp. 119-123 (Aug. 1979).

An architect's view of rehabilitation regulation, F. A. Stahl, *SP549*, pp. 125-129 (Aug. 1979).

Administration of a rehabilitation code in a major city, C. C. Lederer, *SP549*, pp. 131-134 (Aug. 1979).

SP552. **Research and innovation in the building regulatory process.** Proceedings of the 3d Annual NBS/NCSBCS Joint Conference held in Annapolis, MD, Sept. 12, 1978, in conjunction with the Eleventh Annual Meeting of the National

Conference of States on Building Codes and Standards, Inc. (NCSBCS), P. W. Cooke, Ed., *Nat. Bur. Stand. (U.S.), Spec. Publ. 552*, 358 pages (July 1979) SN003-003-02091-5.

Key words: administrative procedures; building codes; building regulations; buildings; construction; economic impacts; environmental considerations; innovative practices; regulatory research; standards development.

The third NBS/NCSBCS Joint Conference on Research and Innovation in the Building Regulatory Process was held in Annapolis, MD, on September 12, 1978. The proceedings of the Joint Conference include the opening remarks, the Keynote Address and the 24 papers presented at the technical sessions dealing with various aspects of building regulatory research and innovative administrative application of building codes and standards. The eight technical sessions were organized around the following themes: Regulatory Aspects of Fire Safety; Standards Development Activities and the Building Regulatory Process; Accommodating Provisions for the Elderly and Handicapped in Building Regulations; Implementation of Energy Conservation Building Regulations at the State Level; Application of Computers and Information Systems for Building Regulation and Construction; Energy Conservation, Solar Energy and the Built Environment; Issues Concerning the Intent, Formulation and Economic Impact of Regulations; Metrication, Industrialized Buildings and Complex Structures.

In addition, three other research papers covering Lighting, Tax Shelters, Resource Zoning, and Land Use Planning are also included. *These proceedings include the following papers (indented):*

A defensible technique for determining code equivalency in buildings, G. N. Berlin, *SP552*, pp. 13-27 (July 1979).

Key words: building fires; equivalency; evaluation; fire safety; models; research; standards; systematic procedure.

New materials, construction methods, and contents are rapidly changing the nature and magnitude of the fire problem in the United States. These changes often provide a situation that is not covered explicitly in existing codes or that requires amendments to allow their installation. In some cases, these changes in construction or materials provide a safer environment. It is desirable to take advantage of these changes and to encourage similar advances within the framework of the codes. An important step in that direction is the development of rigorous procedures for objectively evaluating the equivalency of such changes to the accepted standards.

A systematic procedure for measuring the hazards of building fires has been developed as part of a project funded by the Department of Housing and Urban Development. This procedure, called the "Building Firesafety Model" incorporates data derived from actual fire tests to describe the rate of fire growth, the likelihood of entrapment, and estimates of structural damage.

It is expected that this tool will assist government officials, architects and engineers in evaluating the design (or rehabilitation) of buildings with regard to the level of fire safety. Such a tool could potentially be used to evaluate the comparative levels of fire safety implied by compliance with codes and to identify voids in fire test data. In addition, the model can be used for evaluating the allocation of fire service resources and pre-fire tactical planning.

The liability of municipalities and municipal officials for negligence in the regulation of buildings, V. Brannigan, *SP552*, pp. 29-37 (July 1979).

Key words: duty; liability; municipal corporations; negligence; sovereign immunity; tort.

Building and fire codes and inspections have spawned lawsuits charging both cities and individuals with negligence. This paper explores the development of municipal liability, the elements of a negligence action, and specific defenses and immunities which are available to a city and individual. Special attention will be given to high risk activities of municipalities.

Buildings engineer emergency response team, S. S. Koren, *SP552*, pp. 39-44 (July 1979).

Key words: crisis; flood recovery effort; missing link; rebuilding.

Code enforcement embraces the cycle of Construction-Crisis-Reconstruction.

Baltimore County has added a code enforcement team to its emergency forces. This allows both staff assistance to other county emergency forces as well as immediate participation in the reconstruction phase.

The development and implementation of building standards in France, I. Martinez, *SP552*, pp. 45-56 (July 1979).

Key words: building standards; foreign building standards; French building standards; French standards system; marking and certification; types of French standards.

The systems available today in the U.S. for developing standards are being subjected to much scrutiny and criticism. Many of the organizations involved in the standardization process are striving for better ways to produce standards. Attempts are being made to make the process more dynamic, more representative for general interest groups and better able to handle revisions and updatings.

One way to obtain a wide perspective of the options available is to examine standards development practices in other countries. It is difficult to find a foreign country that has a well-developed standards promulgation system and enough points in common with the U.S.—in the economic, political, geographic, and technological areas—to be used as a reference.

The French standards system, discussed here, does not coincide exceptionally well with the U.S. system. However, a study of the procedures used in France might give some insight and suggest different ways of approaching the problem. Hopefully, elements of interest and specific relevant procedures which might be adapted to U.S. practices will emerge.

A case history of the integrity of the National Electrical Code, D. J. MacFadyen, *SP552*, pp. 57-78 (July 1979).

Key words: appeals process; consensus standards; electrical distribution systems; flat conductor cable; National Electrical Code; technological innovation.

A new system for surface-mounted branch-circuit building wiring is being commercialized that holds substantial promise for flexibility and cost-effectiveness. This system is based on the flat conductor cable technology developed by the National Aeronautics and Space Administration for aerospace use. NASA sponsored a project to commercialize flat cable-based building wiring systems, which included a NASA contractor and a consortium of twelve major American corporations.

One of the most critical aspects of making advanced wiring systems available to the public is the development of code provisions to allow their use. The process of establishing a new National Electrical Code Article 328 permitting flat conductor cable wiring systems involved use

of every procedural step available in the Code-making regulations of the National Fire Protection Association. Unfounded technical objections and procedural irregularities on the part of opponents to the new technology necessitated the use of every protest and appeals process available under those regulations. It was only at the highest level of the Code-making organization—the NFPA Board of Directors—that the final favorable action was taken on the basis of proper technical justification.

The adoption of Article 328 as an amendment to the 1978 National Electrical Code was a victory, not only for the public and the proponents of the Code change, but also for the NFPA and the whole concensus approach to Code making. The checks, balances, and recourses in the system were shown to be adequate to assure that the Code change was ultimately resolved on technical merit.

Federal Government activities relative to the development of voluntary consensus standards, D. R. Mackay, *SP552*, pp. 79-93 (July 1979).

Key words: consensus standards; Federal policies; Federal voluntary standards policy; voluntary standards; voluntary standards system.

Federal government agencies have been involved in voluntary standards activities for many years and have made significant contributions to the development of consensus standards covering many product areas. This involvement of Federal agencies has strengthened the voluntary standards system and has tended to reduce the need for government regulations.

The policy established by one Federal regulatory agency—the Consumer Product Safety Commission—regarding the involvement of its staff in the development of voluntary standards is discussed in this paper along with the criteria that have been imposed on the staff in an attempt to reduce the appearance of any conflict of interest between these activities and the agency's regulatory responsibilities.

The philosophy and requirements of the proposed circular published by the Office of Management and Budget is also described in this paper. The restrictions on Federal agency involvement in voluntary standards activities and the objectives of this proposed uniform Federal agency policy are discussed.

The paper also presents a summary of the voluntary standards activities of several Federal regulatory agencies and compares the similarities as well as the differences of some Federal agency policies and programs.

The formulation of sensible regulations for accessible rehabilitation housing, A. E. Osterberg, *SP552*, pp. 95-100 (July 1979).

Key words: accessible; disabled; housing; regulations.

In order to achieve better housing alternatives for America's elderly and disabled populations, sensible regulations covering accessibility are necessary. A more accessible housing market could help reverse the present rise in the number of dependent care settings. The regulation of new construction in terms of accessibility will soon be easier with the publication of the American National Standards Institute, Inc. (ANSI) standard on accessibility for the physically disabled. While the document is expected to be comprehensive in terms of new construction, the same standards may not be appropriate in regards to the adaptation of existing housing. Additional research on adaptation is necessary in order to formulate guidelines for making existing housing units accessible for wheelchair bound individuals.

The new research should include a study of a variety of existing housing units which have been adapted and modified by disabled users to become more accessible. Methods for programming designs of housing projects with future adaptations in mind need to be explored. Until these new research findings become available, regulatory officials will have little to guide them in regulating housing adaptations.

Designing for access to, movement within, and egress from building and sites: Effective research for more reasonable regulation, F. I. Stahl, *SP552*, pp. 101-113 (July 1979).

Key words: architectural barriers; building design; building site planning; environmental psychology; evaluation; fire escape; human research; measurement; pedestrian movement; regulation; safety; standards.

This paper discusses needs for a more complete and effective technical basis for design standards impacting occupants' access to, movement within, and egress from buildings and building sites. It is suggested that a major cause of injury and death from fire, and of inconvenience and psychological stigmatization to physically handicapped persons, results (even in code-complying buildings and sites) from adherence to design regulations narrowly founded upon physical and engineering principles alone. This paper recommends that psychological aspects of dangerous and stressful situations guide the development of standards for emergency egress facility design, and that such therapeutic objectives as "normalization" guide development of barrier-free design regulations. Finally, this paper outlines particular programmatic themes and research tasks, and discusses the role of the National Bureau of Standards in improving the technical basis for egress and accessibility design regulations.

Communication techniques in building code implementation, T. J. Rosenberg, *SP552*, pp. 115-120 (July 1979).

Key words: accessibility standards; building codes; code administration; communication; physically handicapped; public awareness; public relations.

Communication is essential in any process of change. Occasionally, when a building code is altered, changes are made which substantially influence users of the built environment. This is certainly true of building code specifications regarding accessibility for physically handicapped persons.

North Carolina pioneered the development of code requirements for accessibility. Since implementation of the fundamental provisions in 1973, the State has embarked on a vigorous educational campaign to increase understanding of environmental barriers, needs of disabled people, laws and codes. This project has included the production of illustrated handbooks, brochures, manual and automatic slide presentations, radio and television announcements and newspaper articles.

This report explains the selection and development of appropriate media for presentation to audiences including the building community, owners, consumers and others. The techniques are pertinent to other areas of concern, such as energy efficiency in buildings, which affect a wide spectrum of interests.

A summary of Kentucky's experience in implementing a statewide energy code, J. R. Groves, Jr., *SP552*, pp. 121-130 (July 1979).

Key words: design professionals; energy audits; energy codes; Kentucky Fire Marshal's office; lighting and thermal

efficiency standards; local governments; new construction plans review; training and education.

In the near future, every state will have to adopt some form of energy code. Compatibility with existing codes and code enforcement procedures will be a major consideration in the adoption and implementation process. Public Law 94-163 made funds available to states for the adoption of a five-part energy conservation program. Of primary significance where codes and standards are concerned are the lighting and thermal provisions of that plan. To implement those provisions has called for the adoption of an energy code.

For many states, the energy code represents one of if not the most all inclusive code application and enforcement effort in the area of code enforcement. Especially in those primarily rural states where building code applications has been limited to the more urban areas, the adoption of a uniform energy code which applies to all new buildings including single family residences has posed special problems.

Energy conservation in building codes and standards, R. W. Lisle, *SP552*, pp. 131-140 (July 1979).

Key words: building official; energy code; energy efficient; enforcement; implementation and effective U value; on-site construction.

Many states have recently adopted energy model codes and standards or are considering the adoption of such regulations.

This paper explains what has happened in New Mexico since the adoption of an energy model code two years ago. (September 10, 1976.) The implementation of the code in the real world of on-site construction projects has revealed several special problems with enforcement and/or interpretation of the code. The effective U values being developed and implemented in New Mexico are adding a new perspective to the traditional understanding of the thermal conductance characteristics of building envelopes. It may be more cost-effective to paint a south facing wall a dark color than to add insulation.

Implementation of energy conservation standards, J. T. Quinn, *SP552*, pp. 141-151 (July 1979).

Key words: education; energy utilization codes; illustrated handbook; legislation; thermal envelope criteria; thermal performance criteria.

Energy conservation in new buildings is one area where a code will affect virtually all aspects of the building construction. It is an area that can create confusion, misunderstanding and even resentment over a short time span. This can be further heightened when the code is implemented in areas where no code enforcement previously existed.

Chapter XXXII "Efficient Energy Utilization in New Buildings" of the North Carolina State Building Code was by necessity implemented over a short time frame, and enforced without exception across the state. The Engineering and Building Codes Division of the North Carolina Department of Insurance used its previous experience in new code implementation, the research presented by NCSBCS, ERDA, and DOE, and some innovative ideas of its own to bring this code into reality across the state, and it is hoped this experience may be of some benefit to other states as energy conservation codes are implemented by those states.

The uses of an integrated data base in municipal computer assisted regulatory systems, N. S. Remmer, *SP552*, pp. 153-165 (July 1979).

Key words: computer facilities; integrated data base; municipal governments; regulatory.

Computer based systems are becoming more prevalent as the basic means of administrative and financial control of municipal governments. With the availability of computer hardware or the access to computational facilities well established in most cases, the consideration of the additional uses for the municipality of such facilities becomes important.

Two of the many areas receiving considerable attention at this time relate to building regulatory functions and housing inspection functions. Several cities have already instituted departmental programming for use in normal administrative and control functions. The system in Chicago for the building department has already been reported at the 1976 NBS Conference. The Boston Housing Inspection Department has incorporated the use of the computer extensively for their daily operational functions. Many other cities are in the process or have recently installed systems to computerize one or more aspects of their housing or building regulatory functions.

The City of Worcester, population of about 180,000, has been studying for almost two years the potential for a system that would not only provide computerization of normal building and housing inspection administrative and control function, but could provide a base for many interrelated functions, and process specialized data for many coordinated municipal programs.

The size of the city precludes the availability of separate computer facilities for each department. Therefore, the study developed requirements based on a central computer and interdepartmental accessibility of data and results. By looking at a coordinated system, it became apparent that many benefits could be derived for a choice of proper initial hardware and careful software considerations. Studies by departmental personnel and interns from Clark University indicated the following as some examples of potential use: 1) Correlation between housing inspection abatement notices and building or demolition permit issuances. 2) Evaluation of potential arson sites based on coordination of housing inspections and building inspection records and outstanding tax and water bills. 3) Evaluation of overall neighborhood physical characteristics to determine blight areas, potential blight areas and establish the boundaries of such areas. 4) Coordination of Fire Dept. building data and building and housing data.

In addition, there is the potential for coordination of municipal programs involving many other functions and integrated programs involving the building inventory or its infrastructure.

The results of the studies so far indicate that while the normal control and administration functions of computer programs, such as used in Chicago and Boston, have great potential, the readily available spinoffs from the data base and information have even more important potential for municipal planning and control of all city programs relating to buildings and their infrastructure.

Exploiting the computer to control the application of design criteria to construction, R. E. Larson, *SP552*, pp. 167-183 (July 1979).

Key words: design criteria; guide specifications; habitability criteria; Computer-Aided Engineering and Architectural Design System (CAEADS).

The U.S. Army Corps of Engineers is sponsoring the development of a Computer-Aided Engineering and Architectural Design System (CAEADS) to aid the programmer, planner, designer, and constructor of facilities. One of the basic objectives of CAEADS is to provide for systematic application of design and habitability criteria that are the counterpart of building codes and standards adopted by federal, state, and municipal agencies. This paper will describe the overall conceptual design of CAEADS and then go into some detail on the specific system features that deal with criteria.

Construction labor demand system: An overview, W. F. Hahn, *SP552*, pp. 185-196 (July 1979).

Key words: building trades; construction industry; forecasting; labor information systems; manpower projections; modelling.

Currently under development by the Department of Labor is an extensive modelling effort designed to provide accurate forecasts at a local level of future construction levels and on-site labor requirements. The Construction Labor Demand System (CLDS) is a computerized management information system that provides continuously updated forecasts for local regions, for specific types of construction, and for precise construction trades.

Actual construction project information is the nucleus of the CLDS system. Information on hundreds of thousands of current and planned projects are included in CLDS. Each project is time-phased to completion and estimates generated of the associated craft requirements.

Forecasts of construction initiations are accomplished through econometric modelling. Initiation forecasts are transformed into pseudo-projects within CLDS and pseudo-projects are combined with hard project data for the generation of forecasts of construction activity.

A conversion subsystem translates construction activity into demand for labor. Over 200 conversion profiles translate activity levels into time-phased flows of requirements by occupation.

Proposed criteria for establishing energy consumption standards for existing buildings, R. R. Somers II, T. C. Scott, and L. S. Fletcher, *SP552*, pp. 197-209 (July 1979).

Key words: conservation; energy cost; existing buildings; regulation; retrofit; standards.

Rising energy costs recently have compelled many municipalities and industries to undertake energy conservation programs in the hopes of reducing energy expenditures. The current lack of government and industrial standards specifying acceptable levels of energy use by existing structures, however, makes it difficult for these organizations to determine if their facilities are wasting fuel. This paper proposes that standards be established for the overall energy efficiency of existing buildings in terms of quantities which can be computed readily from available data, without need for elaborate computer programs and/or engineering analyses. The paper discusses the type of standards needed to meet these objectives, techniques for formulating the standards, and facility classifications (based upon building functions) for which guidelines should be developed. By being able to pinpoint buildings using excessive energy without costly or time-consuming analyses, government and business groups can direct conservation efforts and funding to the most inefficient facilities, where conservation programs will be of the greatest value.

Proposed solar energy legislation likely to affect the building regulatory process, R. J. Smith, *SP552*, pp. 211-216 (July 1979).

Key words: building regulation; energy conservation; legislation; solar energy.

A number of researchers have identified and discussed numerous legal barriers to the effective utilization of various types of solar energy. Much of the literature also makes specific recommendations for legislation directed at removal of these barriers to solar utilization. This paper discusses the context in which the legislation has been drafted, the key features of the legislation, and their potential effect on the building regulatory process. The objective is to give state and local building regulatory officials and code administrators an overview of what sorts of legislation may be introduced at the state and local level so that they may be better prepared to deal with both the legislative proposals, and their implementation.

Critical performance standards for passive solar buildings, J. K. Holton, *SP552*, pp. 217-224 (July 1979).

Key words: passive solar systems; performance standards; system classification.

An outline of a limited number of performance standards and evaluation criteria for passive solar buildings is presented. Three levels of criteria are described which are intended to categorize these into a few most needed criteria concerning basic thermal performance, health and safety, and two levels of additional criteria that are thought desirable to assess long term usefulness of passive installations. Status of development of the criteria is also discussed.

A case for more rational and explicit building regulations, H. M. Markman, *SP552*, pp. 225-247 (July 1979).

Key words: building codes; code enforcement; fire prevention codes; fire safety; master planning; regulation; standards.

Building regulations are unique in that they are as much a statement of social attitudes and policies as they are of engineering and technology. To be responsive to one concern is not enough. The consensus of the literature on the Beverly Hills Supper Club Fire in Southgate, Kentucky, was that the codes as written are adequate and that this incident should have not occurred. The fault was said to lie in the improper enforcement of the applicable codes. While this statement may be true, the broader social and policy issues were nowhere addressed.

Safety is a relative rather than absolute concept. No safety is obviously not acceptable; total safety is not affordable, if possible at all. To date, the building regulatory community has fixed the level of safety with minimal input or interest from the public at large. But inflation, the increasing cost of regulation, and the resistance to excessive government spending will lead to greater public interest in the regulatory process. Regulations will be scrutinized as to their necessity, effectiveness, and utility as a means of efficiently allocating protection costs between the public and private sectors.

The challenge for the building regulatory community is to recognize and meet this growing public concern.

Formulation and expression analysis of standards and regulations, J. W. Melin and R. L. Tavis, *SP552*, pp. 249-266 (July 1979).

Key words: decision tables; formulation analysis; information networks; regulations; standards.

A systematic technology for the translation of a standard, building code, regulation or specification into a graphical network and decision tables is presented. This

technology leads to a clear concise expression which aids in the understanding of the document. It may also be used to improve the clarity, consistency, completeness of the provisions. A brief example is used to illustrate the process of using the technology.

Life-cycle benefit-cost analysis of housing safety regulations, J. L. Walters, *SP552*, pp. 267-282 (July 1979).

Key words: building codes; building regulations; cost-benefit analysis; life-cycle analysis; safety regulations.

Increasingly the public is demanding that proposed building safety regulations be justified by evidence that they generate benefits commensurate with their costs. This paper discusses a methodology developed by the author to assess the life-cycle costs and benefits of performance standards for increased safety in the home. The methodology was developed, under contract with the Department of Housing and Urban Development, for the assessment of the life-cycle costs and benefits of proposed performance standards for mobile homes. However, with appropriate modifications, it can be applied to the analysis of virtually any building regulations for increased safety.

The need for life-cycle analyses of building regulations is being increasingly acknowledged, and some excellent efforts have been made to develop comprehensive practical methodologies, but not all of the fundamental issues have been addressed at this time. Therefore, this paper focuses principally on fundamental conceptual issues. A secondary purpose is to describe the basic methodology for actually measuring the costs and benefits of regulatory options.

Regulatory implications of adopting a metric building code for the Province of Alberta, Canada, A. J. M. Aikman, *SP552*, pp. 283-291 (July 1979).

Key words: building codes; construction; metric.

With the notable exception of the United States and Canada the majority of the world's countries use the metric system of measurement. Canada is now converting to the metric system on a voluntary basis. The period of conversion is spread over a number of years with each section of the economy establishing its own targets. The construction industry established January 1, 1978 as the date to begin using metric measurements. The Province of Alberta is experiencing a rapid and smooth transition from foot-pound units to SI (metric) units and the construction industry is in the forefront.

The Alberta Construction Association receives major credit for its educational programmes and government has co-operated fully by responding to the industry's requirements rather than by dictating its own ideas. The province introduced a metric building code in April 1978 with no opposition because it was supported by all groups involved in construction.

An approach to third party approval for industrialized housing, C. M. Edwards, *SP552*, pp. 293-309 (July 1979).

Key words: agencies; approval process; evaluation; industrialized housing products; inspection; regulation; third party.

The Commonwealth of Pennsylvania a few years ago found themselves in a unique position of trying to determine which agencies were qualified to represent the state for the evaluation and inspection of industrialized housing products to be sold in the state. This paper is a summary of the experience of Pennsylvania in this area. The use of Third Party agencies was not created by Pennsylvania, but it is believed that the approach used by Pennsylvania deviated from previous practices at the time.

It is the hope of the writer of this paper that by summarizing the Pennsylvania experience, others will be stimulated to refine the approval process for selection and use of third party agencies.

Structural inspection of complex structures, C. G. Cooper and G. P. Berson, *SP552*, pp. 311-320 (July 1979).

Key words: code enforcement; county building code; critical structures program; expense; inspection requirements; pre-construction conference.

This paper provides a look at what a local county government, burdened with the responsibility of inspecting all new construction, has done to insure quality construction, proper inspection and code compliance for large or complex structures, with a minimum of expense to the taxpayers.

Lighting and building codes for energy conservation, M. S. Millet, J. R. Bedrick, G. S. Spencer, and G. B. Varey, *SP552*, pp. 321-335 (July 1979).

Key words: building codes; building performance simulation; computer applications; energy conservation; illumination standards; lighting distribution simulation; visual performance.

The role of lighting within the purpose of building codes is discussed. A review is made of the continuing controversy over the visual performance criteria being used as the basis for IES (Illuminating Engineering Society) recommended levels of illumination. These levels are the present design procedure base levels for the ASHRAE 90-75 and NCSBCS *Code for Energy Conservation* lighting power budget procedure. The third section of the paper lists the objectives of an energy-conserving building code for lighting and compares the NCSBCS code with a lighting power budget approach recommended for Seattle by the Citizens' Task Force on an Energy-Conserving Building Code, on which the author serves. The final issue discussed is an alternative for the future, a performance standard. Thorough evaluation of lighting alternatives for energy conservation will require detailed analysis, such as computer simulation, that looks at the interaction of the building components and systems. A lighting computer program which has been developed at the University of Washington to predict illumination levels from daylight and from artificial light sources is described briefly, and its inclusion in a larger building performance simulation outlined.

Tax shelter in construction: Public objectives and private incentives, U. P. Gauchat, *SP552*, pp. 337-346 (July 1979).

Key words: building; private interests; public objectives; taxation; tax incentives.

Building as an activity is strongly conditioned by both the taxation system and the building regulatory mechanism. Since both of these systems represent public commitments and funds, it is reasonable to assert that the ensuing consequences should, whenever possible, be mainly in the public interest. The main purpose of the regulatory system is to protect the public by maintaining adequate health and safety standards. An ostensible goal of the incentives as related to building is to further public objectives by encouraging specific activities perceived to be of societal value, which are not adequately covered by a free market situation. It is felt that current tax incentives in building, however, are not always in the public interest, but rather serve private interests instead.

It is felt that some conceptual changes in the building process and pattern of ownership could best combine the

intent of the regulatory and taxation systems with public interest objectives. It is suggested that the tax incentives in building could be designed to draw distinctions between those aspects of building which are market-related (and hence in the private interest) and those portions which are health and safety oriented (and hence in the public interest). It is futher suggested that tax incentives in building bear a direct relationship to the degree of public utility involved.

The implications of this proposition are examined in the light of increasing economic pressures to produce large quantities of housing efficiently and economically.

Resource zoning and land use planning: An examination of urban infrastructures, U. P. Gauchat and D. L. Schodek, *SP552*, pp. 347-360 (July 1979).

Key words: infrastructure; land use; resource zoning; urban; zoning regulations.

Buildings cater to the full array of human activities. They are disposed over the landscape in a range of patterns and densities. Each pattern not only designates spatial arrangements of building masses, but also sponsors a series of mostly invisible supply and distribution networks.

Existing infrastructures, particularly in urban areas, tend to be old, badly maintained and often in less than excellent condition. Each network has a maximum carrying capacity which is determined by the type of system and its state of repair. While it is possible to envision far more technologically advanced infrastructure systems than we now possess, the extent of the investment in our current systems is so vast as to mitigate against any radical changes in the forseeable future. Land use policies therefore must more directly begin to face the issue of how best to cope with an infrastructure system of a fixed or even declining quality and capacity.

The capacity of existing infrastructure systems, particularly of water and sewerage, can be a determining factor in imposing density and other land use constraints. Thus, many typical city zoning ordinances are directly or indirectly influenced by the character of the existing infrastructure. Zoning regulations based mainly on these considerations may not, however, be the most socially or economically advantageous.

This paper proposes an approach to land use planning involving the concept of Resource Zoning. This type of zoning draws a clear distinction between ordinances that relate to social goals and those that relate to constraints imposed by the existing infrastructure. It is felt that the idea of Resource Zoning would not only prove valuable in the context of land use planning but could also provide the necessary incentive for the development of innovative practices in the design of service systems for individual buildings.

SP553. **Water supply and drainage in buildings.** Proceedings of an International Symposium, National Academy of Sciences, Washington, DC, Sept. 28-30, 1976, L. S. Galowin and J. R. Debelius, Eds., *Nat. Bur. Stand. (U.S.), Spec. Publ. 553*, 232 pages (Aug. 1979) SN003-003-02101-6.

Key words: building water systems; CIB; international plumbing research; plumbing and drainage; U.S. research in plumbing.

This report contains the papers presented at the International Symposium on Water Supply and Drainage convened on September 28-30, 1976 at the National Academy of Sciences, Washington, DC, and conducted by the U.S. National Committee for the International Council for Building Research, Studies and Documentation (CIB) Counterpart Commission W-62. The meeting provided the opportunity to exchange information and identify general needs and common perspectives of plumbing in on-going research applications and practices in the United States and other countries. *These proceedings include the following papers (indented):*

Water requirements and procedures for estimating the demand for water in buildings, R. V. Benazzi, L. Guss, R. Orend, R. S. Wyly, and T. P. Konen, *SP553*, pp. 3-13 (Aug. 1979).

Protecting water quality in buildings, G. Williams, T. P. Konen, F. Liposki, J. R. Myers, L. Nielsen, W. Mikucki, and W. Staton, *SP553*, pp. 15-19 (Aug. 1979).

Water and water-related conservation in buildings, A. J. Fowell, A. Bransdorfer, P. Fletcher, R. J. Orend, H. J. Pavel, and G. H. Williams, *SP553*, pp. 21-31 (Aug. 1979).

Hydraulics of gravity drainage systems, R. S. Wyly, R. V. Benazzi, T. P. Konen, R. R. Manfredi, and L. S. Nielsen, *SP553*, pp. 35-51 (Aug. 1979).

Performance concepts for water supply and drainage systems in buildings, L. S. Galowin, W. J. Downing, L. S. Nielsen, M. J. Orloski, and R. S. Wyly, *SP553*, pp. 53-70 (Aug. 1979).

Alternative concepts for transporting and treating wastes within buildings, T. P. Konen, R. S. Bevans, W. J. Boegly, D. Savitsky, and C. Cole, *SP553*, pp. 71-77 (Aug. 1979).

CIB W-62 purpose, methodology and fields of work, K. Ovesen, *SP553*, pp. 81-88 (Aug. 1979).

Standardization structure in Europe, F. Perrier, *SP553*, pp. 89-99 (Aug. 1979).

Certification and agreement system in Europe, D. Trinkler, *SP553*, pp. 101-108 (Aug. 1979).

Research laboratories with CIB interest, R. Hanslin, C. D. J. Webster, and V. Nielsen, *SP553*, pp. 109-128 (Aug. 1979).

Cost benefit of plumbing: Large fringe benefits for sanitary installations by thorough analysis of system, T. Rosrud, *SP553*, pp. 131-135 (Aug. 1979).

Economic water supply design based on performance requirements, E. Olsson, *SP553*, pp. 137-159 (Aug. 1979).

Production, transport and use of hot water, F. Perrier, *SP553*, pp. 161-173 (Aug. 1979).

Performance requirements for taps: A consensus from Scandinavia, V. Nielsen, *SP553*, pp. 175-192 (Aug. 1979).

Code structure and standardization in the United States, M. Snyder, *SP553*, pp. 193-205 (Aug. 1979).

Potential savings from using reduced-size venting in the United States, H. Marshall, R. Ruegg, and R. Wyly, *SP553*, pp. 207-225 (Aug. 1979).

SP565. **A history of walkway slip-resistance research at the National Bureau of Standards,** S. C. Adler and B. C. Pierman, *Nat. Bur. Stand. (U.S.), Spec. Publ. 565*, 36 pages (Dec. 1979) SN003-003-02142-3.

Key words: friction; measurement; reference standards; safety research; walkway slip-resistance.

This report summarizes NBS research in the area of walkway and shoe slip-resistance measurement since 1924 and outlines current activities that will provide a technical basis for slip-resistance measurement. The work of Sigler, Hunter, Boone and

Brungraber represents the historic perspective. Current activities in data base development and identification of standard reference surfaces contribute to a rational basis for quantitative slip-resistance criteria for building codes and standards. Proposed future research thrusts include personal factors such as human biokinetic and perceptual variables, as well as environmental factors such as lighting in the built environment. This research will contribute to the development of new intervention strategies to reduce deaths and injuries due to slips and falls.

NBS Interagency Reports

The Interagency Reports are a special series of interim or final reports on work generally performed by NBS for outside sponsors (both government and non-government). When released by the National Bureau of Standards, and the Sponsor, initial distribution is handled by the Sponsor. Public availability is by the National Technical Information Service (NTIS), Springfield, Va. 22161. This series must be ordered from NTIS by the order number listed at the end of each entry.

NBSIR 77-1289. **The measurement of wind loads on a full-scale mobile home,** R. D. Marshall, 132 pages (Sept. 1977). Order from NTIS as PB297463.

Key words: aerodynamics; building; codes and standards; full-scale testing; mobile homes; wind loads.

An experimental investigation of wind loads acting on a full-scale mobile home is reported. The objectives of the investigation were (1) the direct measurement of surface pressures and overall drag and lift forces, (2) the formulation of recommended loads for the design of mobile homes and their anchoring systems to resist forces due to wind and (3) the measurement of deflections and the identification of failure modes with application of simulated wind loads.

Measurements were obtained for a variety of wind speeds and relative wind directions using a mobile home with nominal plan dimensions of 12 by 60 ft (3.7 by 18.3m). Wind speeds were measured at five levels ranging from 3 to 18m and the mean velocity profiles were found to be best described by a power law with exponent $\alpha = 0.18$. Extreme negative pressure fluctuations were found to occur on the end walls and along the perimeter of the roof. The resonant component of response of the mobile home to drag and lift forces is negligible for basic wind speeds up to 90 mph (40 m/s) and the average maximum lift loads are not strongly influenced by the presence or absence of skirting.

Recommended design loads are based on the average maximum event in a time interval of 1000 seconds and are tabulated for assumed basic wind speeds of 70 and 90 mph (31 and 40 m/s) and a moderately open wind exposure.

NBSIR 78-1496. **Preliminary data on the field performance of storage-type residential water heaters,** R. A. Grot and L. S. Galowin, 27 pages (Apr. 1979). Order from NTIS as PB295431.

Key words: energy usage; load profiles; water heaters.

The early results of a field experiment for determining the performance of gas and electric residential storage water heaters are presented. Energy requirements for hot water supply and hot water consumption and usage pattern data are presented and analyzed using statistical techniques in order to display average load curves and the variation about the average. It is shown that the daily energy usage of these water heaters is approximately a linear function of the energy content of the drawn daily water consumption. This fact allows a simple procedure to be used for evaluating the effects of retrofit actions on the performance of the water heater.

NBSIR 78-1501. **Quantified occupant-use factors affecting energy consumption in residences,** R. E. Clark and S. R. Hastings, 143 pages (July 1979). Order from NTIS as PB298052.

Key words: appliance energy consumption; energy consumption of residences; lighting energy consumption; occupant factors; residential air conditioning; service hot water; space heating; ventilation.

Predicting energy consumption for a building requires three types of data: climatic data, component performance data, and occupant-use data. Historically, few data on occupant use of a building have been collected, and the data which are collected are not easily referenced. Consequently, it is common for energy analysts to establish values for occupant variables merely on the basis of their own personal experience. In response to this dilemma, this report assembles residential energy-use data, as could be found, from field metering studies, surveys, utility company estimates, and government sponsored statistical projections. From these data the authors have determined recommended occupant-use values based on their analysis and judgments. These "recommended values" represent the best judgment of the present authors, but are not to be interpreted as "NBS recommended" values. Data, and assessment of their validity for input in models for predicting energy consumption, are organized into six groups by energy end-use: (1) heating, (2) service hot water, (3) appliances, (4) lighting, (5) air conditioning, and (6) ventilation. The use of more soundly derived values for occupant-use variables will result in a better correlation between the energy use predicted for buildings being designed today and the actual energy use of the buildings when occupied.

NBSIR 78-1521. **French schools—A report of the U.S. team visit to France from November 13 to 23, 1977,** P. Driscoll, Coordinator, 42 pages (Mar. 1979). Order from NTIS as PB296148.

Key words: building technology; France/NBS cooperative program; French schools.

By June 1970, the National Bureau of Standards and the Centre Scientifique et Technique du Batiment had effectively begun a cooperative program in building technology. The purpose of this program was to increase jointly the French and United States capability to develop building sciences and technology, seek answers to significant building problems, and reduce costly and wasteful duplication of parallel national efforts. This collaboration has provided opportunities for representatives of both nations to exchange ideas, skills, information and techniques in attacking problems of particular mutual interest. These opportunities have included the exchange of selected literature, with translations of main papers and publications; the exchange of long-term interns working in the

organization of the other country on subjects requiring special facilities; work by one organization for the benefit of the other not as well equipped, either in staff or in equipment; and the exchange of missions of experts from one country to the other to study special work. It is precisely this exchange of missions of experts, to study specific work, that produced the report which follows.

NBSIR 79-1705. **State solar energy legislation of 1977: A review of statutes relating to buildings,** R. M. Eisenhard and L. A. Santucci, 396 pages (Feb. 1979). Order from NTIS as PB295642.

Key words: buildings; design; energy; legislation; solar; standards; State.

This report reviews State legislation on solar energy, as applied to buildings, which was enacted in 1977. Acts involve tax incentives, sun rights, standards for solar units, and State support of promotion of solar research, solar demonstrations, and solar loans. The Acts are identified and abstracted, and responsible State agencies and officials identified. The Acts, supporting forms and other documents are included in the Appendices.

NBSIR 79-1706. **CSA weatherization demonstration project plan,** R. Crenshaw, R. Clark, R. Chapman, R. Grot, and M. Godette, 81 pages (Mar. 1979). Order from NTIS as PB293498.

Key words: Community Services Administration; heating balance point analysis; low-income residences; marginal cost/benefit analysis in weatherization; optimum weatherization retrofit combinations; thermal analysis of residences.

This report comprises the plan of a research and demonstration effort to determine the fraction of energy that may be saved by installing weatherization retrofits in poor peoples' homes throughout the United States. Two broad groups of weatherization retrofits are considered for application in each dwelling: 1) "architectural," those affecting the building shell, and 2) "mechanical," those affecting space heating and service hot water systems. The optimum combination of weatherization options is defined as that set of retrofits which maximizes net savings (the difference between savings in fuel usage and the cost of the retrofits) over 20 years for a particular house and climatic environment. The retrofits will be selected through present-value benefit/cost analysis. The savings will be established through analysis of utility billings and fuel delivery records before and after weatherization. The report presents the background of the demonstration, the research tasks associated with the demonstration, a description of the diagnostic tests to be used, the rationale for economic decisions, the tests for evaluating mechanical systems, and the calculation methods used in selecting architectural options.

NBSIR 79-1709. **Description of the data acquisition and instrumentation systems: Jersey City total energy project,** C. Bulik, W. G. Rippey, C. W. Hurley, and D. E. Rorrer, 160 pages (Mar. 1979). Order from NTIS as PB294926.

Key words: data acquisition system; digital tape recorder; fuel measurement; instrumentation; total energy; transducers; weather station.

Under the sponsorship of the Department of Housing and Urban Development (HUD), the National Bureau of Standards (NBS) gathered engineering data on an operating diesel total energy plant which supplies all electrical power, hot water, and chilled water to a 485 unit apartment/commercial building complex in Jersey City, New Jersey. Engineering data was continuously collected from April 1975 to December 1978 by a data acquisition system (DAS) which recorded the outputs from approximately 200 sensors located in the plant and site buildings.

This report describes the design and operation of the instrumentation system and the data acquisition system used to monitor the total energy plant and certain utility services to the site buildings. The report contains a description of the types, characteristics and locations of instruments used to measure physical variables. The capabilities and operational modes of the data acquisition system components are described in detail. The report also contains a brief description of the total energy plant and site, instrument costs, data processing procedures and some of the instrumentation problems encountered.

NBSIR 79-1713. **Final report on the "BFIRES/Version 1" computer simulation of emergency egress behavior during fires: Calibration and analysis,** F. I. Stahl, 179 pages (Mar. 1979). Order from NTIS as PB295063.

Key words: architectural research; building fires; computer-aided design; environmental psychology; fire research; fire safety; human performance; modeling technique; programming; sensitivity analysis; simulation.

This report documents computer simulation experiments designed to calibrate and analyze BFIRES, a computer program which simulates building occupants' egress behavior during fires. This report demonstrates that emergency egress behavior under certain specified conditions can be systematically conceptualized, and simulated through the use of a digital computer. Important findings concerning the calibration and sensitivity of BFIRES are also discussed. In particular, it is shown that: (a) a variety of general egress situations may be simulated through the application of BFIRES; (b) every such event is unique, and is defined by the set of user-supplied input parameter values which describe the building, the threat, and the occupants; (c) BFIRES may be used in simulated environments of known (or desired) spatial dimension, and events of known (or desired) temporal duration; and (d) BFIRES simulation outcomes are sensitive to variations in a number of parameters of immediate interest to the building design and regulatory communities.

NBSIR 79-1728. **A low-cost method for measuring air infiltration rates in a large sample of dwellings,** R. A. Grot, 14 pages (Apr. 1979). Order from NTIS as PB295444.

Key words: air infiltration; air sample bags; energy conservation; retrofit; sulfur hexafluoride; tracer gas; weatherization.

A method for collecting air infiltration data in a large sample of dwellings is presented. The method consists of a tracer gas dilution technique employing air sample bags which are analyzed in a central laboratory. The method will be applied to a Community Services Administration optimal weatherization demonstration in approximately 300 dwellings on 16 sites throughout the United States. The method will yield air exchange rates under typical heating season condition for each dwelling in the demonstrations. Preliminary data on air infiltration rates in low-income housing in Portland, Maine are presented.

NBSIR 79-1729. **Pedestrian movement on ramps—A preliminary investigation,** G. E. Turner and B. L. Collins, 62 pages (Mar. 1979). Order from NTIS as PB294856.

Key words: building circulation; building ramps; pedestrian circulation; pedestrian flow; pedestrian movement; pedestrian ramps; ramps.

The research described in this report was a preliminary investigation of pedestrian movement characteristics on two specific building ramps. Variables of pedestrian movement such as speed, flow, and area were studied, as well as the relationships between these variables. In addition, the specific measurements of speed, flow and area were compared with similar measurements determined by other researchers not only for ramps,

but also for stairs and level surfaces. Finally, suggestions were made for additional research into the characteristics of pedestrian movement on various elements of the building circulation system.

NBSIR 79-1730. **Protecting adobe walls from ground water,** J. R. Clifton and F. Davis, 29 pages (Mar. 1979). Order from NTIS as PB295041.

Key words: adobe building materials; chemical grouts; damp course membrane; metallic membrane; permeability; preservation technology.

Two methods for creating impervious membranes in existing adobe walls were investigated. They were the injection of chemical grouts and installation of a metallic membrane. Chemical grouting was unsuccessful because of the low permeability of the tested adobe materials. The metallic membrane did prevent the migration of moisture in the adobe underneath the membrane, weakening the adobe. Further, soluble salts migrated to the surface of the wet adobe. Alternative methods for protecting adobe structures from ground water and runoff water are discussed, including the installation of effective drainage systems and upgrading the foundations.

NBSIR 79-1732. **Computer analysis of energy requirements in single-family residences: A limited case study of the effects of envelope design,** W. L. Carroll and J. P. Barnett, 31 pages (July 1979). Order from NTIS as PB299448.

Key words: building energy consumption analysis; computerized building energy analysis; cooling load calculation; energy conservation; heating load calculation; NBSLD analysis of residences; residential energy conservation; thermal mass effect in buildings.

A number of design variations of a typical one-story single-family residence were analyzed to determine annual heating and cooling energy requirements. The National Bureau of Standards Load Determination computer program, NBSLD, was used to accomplish the analysis. Design details for each of the residence variations are described in detail. Annual heating and cooling energy requirement calculations are presented and discussed. The results show only a small dependence on the thermal mass of the building envelope for the two climates studied (Washington, D.C. and Orlando, Florida). The thermal properties of the windows had a greater effect. Concluding the report are technical generalizations based on the present study, and recommendations for further work in order to produce a definitive study of the effect of selected building design parameters on energy consumption.

NBSIR 79-1736. **Evaluation of hand-held infrared thermometers for wall thermal resistance determinations,** S. J. Treado and D. M. Burch, 26 pages (July 1979). Order from NTIS as PB298057.

Key words: infrared thermometers; in situ evaluation of insulation; R-value measurement by spot radiometer; thermal resistance of walls.

Hand-held infrared (IR) noncontact surface thermometers from two manufacturers were tested to evaluate their effectiveness in measuring surface temperatures for the determination of the thermal resistance of walls. Two phases of the test were performed, first a laboratory test of a wood-frame wall, followed by a field test of a brick veneer wood-frame wall. During both phases of testing, additional measurements of thermal resistance were made for comparative purposes, using multijunction thermopiles and heat flow meters. An error analysis of the thermal resistance measurement procedure utilizing IR surface thermometers was also performed.

NBSIR 79-1737. **Testing of pebble-bed and phase-change thermal energy storage devices according to ASHRAE Standard 94-77,** D. E. Jones and J. E. Hill, 48 pages (May 1979). Order from NTIS as PB295898.

Key words: ASHRAE Standard 94-77; Glauber's salt; latent heat storage; pebble bed; phase-change unit; solar energy storage; thermal energy storage device.

The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) has recently adopted ASHRAE Standard 94-77—Methods of Testing Thermal Storage Devices Based on Thermal Performance. Experiments have been completed at the National Bureau of Standards in which a 7 m^3 (250 ft^3) pebble-bed and a similarly-sized 264 MJ (250,000 Btu) phase-change unit utilizing sodium sulfate decahydrate, both using air as the transfer fluid, were tested in accordance with this Standard. A description of the test procedure, test apparatus, and detailed test results is given. Some problems were encountered in using the Standard for these kinds of thermal energy storage devices, and modifications to the Standard are recommended based on these experiments.

NBSIR 79-1757. **Data reduction processes for the Jersey City total energy project,** D. E. Rorrer, W. G. Rippey, and Y. L. Chang, 117 pages (May 1979). Order from NTIS as PB296482.

Key words: computerized processing; data editing; data flow; data processing; data reductions; raw data conversion to engineering units; total energy; total energy data flow.

The major processes used in the reduction of the data obtained from the Jersey City, New Jersey, Total Energy Site are discussed. These discussions begin with the acquisition of the raw engineering data and carry through to the final data presentation in a form from which the summary performance reports of the Total Energy Site are produced.

The major functions of the Jersey City total energy data editing and conversion software program developed by the National Bureau of Standards are described in some detail. Included are descriptions of the command structure, overall data flow, data editing, data conversions, error processing, and the creation of data output tapes for use in further analysis. The more important subroutines which are used to handle the individual operations are also discussed. The equations used in the calculation of engineering units are described, along with their derivations where appropriate.

The report assumes that the reader has a basic familiarity with computer and engineering terminology.

NBSIR 79-1760. **Evaluation of safety symbols,** B. L. Collins and B. C. Pierman, 38 pages (June 1979). Order from NTIS as PB298175.

Key words: communication; evaluation methods; fire safety; hazard warnings; pictograms; safety information; standardization; symbols.

The increasing use of symbols to convey fire safety information nonverbally is described. In addition, the trend toward international standardization of symbols is discussed for transportation and other systems. The need for further research on symbols is discussed in terms of the advantages and disadvantages of symbol use. Advantages include rapid and accurate communication without the barriers of verbal language. Disadvantages include the too rapid proliferation of different symbols and inappropriate or misleading application. Furthermore, the failure to evaluate the understandability of each symbol is cited as a major problem. A case study which documents some of the advantages and disadvantages of a set of proposed fire-safety symbols is presented. Finally, areas for further research on symbol evaluation are discussed.

NBSIR 79-1762. **Residential solar data center—Data resources and reports,** P. M. Christopher and J. E. Krzewick, 68 pages

(June 1979). Order from NTIS as PB297582.

Key words: automatic data processing; data base; residential buildings; solar data center; solar energy systems; solar heating and cooling.

The Residential Solar Data Center (SDC) is responsible for the establishment and operation of a computerized data base containing non-instrumented residential data collected from the DOE/HUD Solar Heating and Cooling Demonstration Program. This document includes a summary of the history and background of the SDC and it's role in the Demonstration Program, a list of the computer reports which are available and sample pages of representative reports, a description of the data files which comprise the solar data base, a description of the interactive access to the solar data base, a set of figures showing the amount of data on the computer, and a list of other Solar Data Center publications.

NBSIR 79-1766. **Studies on the photodegradation of poly (methyl methacrylate),** M. Abouelezz and P. F. Waters, 52 pages (June 1979). Order from NTIS as PB281828.

Key words: degradation; IR; photodegradation; poly (methyl methacrylate); UV; visible.

When poly (methyl methacrylate), PMMA, is exposed to sunlight, it gradually degrades and, after long-term exposures, may be unable to perform its intended functions. While the photodegradation of PMMA has been studied extensively using radiation sources below 300 nm, natural sunlight at the earth's surface does not extend below 292 nm. This study was performed in order to examine the effect of the radiation from the upper part of the ultraviolet, UV, and the visible regions on PMMA and to identify the mechanism(s) of degradation induced by the radiation.

Thin films of PMMA were irradiated in air with upper UV, upper UV-visible, upper UV-visible-near infrared and 436 and 546 nm radiation. Exposure to either the upper UV or visible radiation caused degradation of the polymer. The data show that both random scission and unzipping of the polymer chain are operative in the degradation. Unzipping becomes increasingly important with incident radiation of increasing wavelength.

NBSIR 79-1781. **Field performance of residential refrigerators and combination refrigerator-freezers,** Y. M. L. Chang and R. A. Grot, 46 pages (July 1979). Order from NTIS as PB299058.

Key words: combination refrigerator-freezer field data; daily load profiles; energy consumption; field measurments; hourly load profiles; refrigerator field data; usage profiles.

Evaluation of the performance of household refrigerators and combination refrigerator-freezers was undertaken in a field experiment to determine the effect of room environment and occupant-usage habits on energy consumption of these appliances. This report presents the results of such an experiment in ten townhouses at Twin Rivers, N.J. One-door manual defrost and two-door frost-free models of various sizes were studied. Energy consumption, kitchen temperature, refrigerator temperature and door openings were measured for each model by data acquisition systems located in the townhouse basements. Both daily and hourly averages and variations about the average for each variable were calculated to determine occupant-usage patterns.

Statistical techniques were utilized to obtain the effect of parameters on energy consumption of these appliances by linear regression of both one- and two-parameter models.

It was found that for a given model the temperature difference between the kitchen and the refrigerator (either main or freezer section) had the most effect on energy consumption, with a lesser, though still important, contribution from the door openings.

In addition, the normalized energy consumption of each model, in different combinations of variables, was calculated from its regression coefficients and the overall average values of parameters from the measurements. The results of these normalized values turned out to be within 5%. Therefore, their mean values could be considered as the typical energy consumption for each refrigerator or combination, under usage conditions.

The linear relationship among the combination refrigerator-freezers according to their physical sizes indicated an increase of about 0.55 kWh per day for each additional cubic foot increase in volume. Energy conservation by using a manual-defrost refrigerator was predicted at approximately 40% from the available measurements and other related laboratory test results.

NBSIR 79-1789. **Economic analysis of insulation in selected masonry and wood-frame walls,** S. R. Petersen, 137 pages (Sept. 1979). Order from NTIS as PB80-101967.

Key words: building economies; energy conservation; insulation; life-cycle cost analysis; masonry construction; space heating and cooling requirements; thermal mass.

This report provides a life-cycle cost-benefit analysis of several alternative methods for insulating 8 in (200 mm) concrete masonry walls in new single-family residences. In addition, a cost-benefit analysis for insulation in wood-frame walls is provided, consistent with the assumptions used in the masonry wall analysis. A dynamic load simulation model, NBSLD, was used to calculate the heating and cooling requirements for a 1176 square foot (110 m^2) house with different levels of thermal resistance for both wall types in eight geographic locations. These data are used to calculate the reduction in annual heating and cooling requirements due to several different types of insulation in the cores and furring spaces of the masonry wall and the cavities of the wood-frame wall.

Economic analysis is applied to determine estimates of life-cycle savings from insulation for different locations and furnace types in order to determine the most cost-effective insulation level. In general it is found that the maximum economically justifiable level of insulation in the masonry wall is considerably lower than for the wood-frame wall because of the significantly higher cost of insulating masonry walls.

NBSIR 79-1796. **Preliminary findings concerning the validity of "BFIRES": A comparison of simulated with actual fire events,** F. I. Stahl, 22 pages (Aug. 1979). Order from NTIS as PB299451.

Key words: architectural research; building fires; computer-aided design; computer simulation; environmental psychology; fire research; fire safety; human performance; modeling technique; simulation.

This report presents preliminary findings regarding the validity of BFIRES/VERSION 1, a computer program developed at the National Bureau of Standards to simulate egress movement by building occupants during fires. A computer simulation experiment was conducted in order to compare outcomes from BFIRES runs with data selected from an archival file summarizing actual fire results. Findings from this experiment suggest that BFIRES is capable of reproducing such important fire outcomes as loss-of-life indices and numbers of persons ultimately escaping. In addition, patterns of egress behavior produced by BFIRES were compared with those found in the literature, with professional opinions, and with impressions gathered from anecdotal accounts. With few exceptions, these comparisons illustrate agreement between simulations and other data sources.

NBSIR 79-1799. **Performance of a packaged solar space-heating system used with a mobile home,** D. E. Jones and J. E. Hill, 44 pages (Sept. 1979). Order from NTIS as PB300890.

Key words: mobile home; packaged solar space-heating system; rating; standards; testing.

As part of a continuing program to develop test methods for solar heating equipment, NBS is now developing a standard test procedure for packaged solar space-heating systems similar to test procedures now used for solar collectors and thermal storage devices, and now under development for packaged solar water-heating systems. As a first step, a mobile home, which was previously tested for thermal performance in an environmental chamber, was equipped with a packaged solar space-heating system using air-heating collectors and pebble-bed storage. The system was fully instrumented and data were collected over the 1977-78 heating season at the NBS site in Gaithersburg, MD. The performance of the system was determined and various methods of correlating performance were explored.

Grant/Contract Reports

Grant/contract reports are prepared by non-NBS persons or organizations working under a grant or contract from the National Bureau of Standards. The contract reports listed below may be ordered, using the indicated order number, directly from the National Technical Information Service (NTIS), Springfield, VA 22161, in paper or microfiche form.

NBS-GCR-78-153. **The architect's access to information,** C. H. Burnette, 97 pages (Mar. 1979). Order from NTIS as PB294855.

Key words: access to information; architect; information format; information sources; technical information; technology application.

The purpose of this report is to provide an overview and some insight into the circumstances which constrain and influence architects when they must obtain information during the course of the design and construction process. It is intended for those outside the profession who wish to understand the conditions which influence the use of the information they provide to architects, and for architects who would consider the nature and context of their difficulties in obtaining information as they need it. While some avenues of progress and change are indicated, this report does not propose detailed solutions and improvements to be sought in the media, forms and channels of access or dissemination nor is it entirely an explanation of the systems which exist. It is, rather, a brief guide to the major features of the problems and to the nature of their effects. A second report in this series will present exemplary formats and guidelines for the successful delivery of information to architects. An extensive bibliography is attached.

NBS-GCR-78-154. **Making information useful to architects,** C. H. Burnette, 101 pages (Dec. 1978). Order from NTIS as PB292782.

Key words: access to information; architect; information format; information sources; technical information; technology application.

The purpose of this report is to present rationales, practical formats and dissemination guidelines to foster the successful delivery of information to practicing architects by those in commerce, government, research organizations and trade or professional associations who produce and supply information useful to them. This report is intended as a complement to "Architect's Access to Information: Constraints on the Architect's Capacity to Seek, Obtain, Translate and Apply Information." It presents a comprehensive spectrum of exemplary practices in such a way as to provide a coordinated basis for both informal and formal actions to improve the delivery of information to architects. It is, therefore, an independent explanatory critique of the state of the art of current practice intended as a useful reference for those considering the structure, content, form and delivery of information services. A bibliography is included.

NBS-GCR-78-156. **Home safety guidelines for architects and builders,** D. Alessi and M. Brill, 126 pages (Dec. 1978). Order from NTIS as PB292928.

Key words: accident avoidance; accidents in the home; door accidents; home accidents; home safety; safety in the home; stair accidents; stair safety; window accidents; window safety.

This document has its goal the analysis, organization and presentation of state-of-the-art information on home accidents and ways to reduce their frequency and/or severity. It is intended to be used in the design and rehabilitation of dwellings and its primary users are intended to be architects, followed by homebuilders, product designers and homeowners.

The National Electronic Injury Surveillance System (NEISS) of the U.S. Consumer Product Safety Commission (CPSC), collects and organizes accident data according to product, frequency, severity of injury and on age and sex of accident victims. These data are statistically representative of accidents occurring nationwide, as are the injury costs associated with each accident type.

Using this substantial and elegant data base, several sophisticated analyses of accidents involving the fixed architectural elements of homes, such as stairs, floors, bathtubs and showers, doors, and windows have recently been undertaken under the sponsorship of various government agencies. This series of analyses has resulted in a much clearer picture of how accidents involving these housing elements occur and of their associated costs to the nation. This document brings together these research findings as a guide to design and construction.

NBS-GCR-79-181. **Snow and ice accumulation at solar collector installations in the Chicago metropolitan area,** R. B. Corotis, C. H. Dowding, and E. C. Rossow, 109 pages (Oct. 1979). Order from NTIS as PB80-113749.

Key words: building; ice; load; roof; roof load; snow; solar collector; structural engineering.

This report presents observations and data concerning snow and ice on eighteen flat plate solar collector installations in the Chicago area. The data was collected in February and March of 1979, following a record snowfall in January. Nearly all of the installations were on the roofs of buildings, and about half were mounted flush with the roof. The remainder were mounted on racks at an angle to the roof. Sketches and photographs of the buildings and snow accumulation, weather data for the entire winter, and comments of the owners are included, as well as a technique for the extraction of linear measurements from the photographs. A significant observation was that the loss of operation of the solar collectors due to snow covering the collector exceeded two months at several sites. This is apparently due to the heavy snowfall, extreme cold, and lack of manual snow removal capability. Other observations and recommendations concerning functional and structural problems are included in the report.

Papers Published in Non-NBS Media 1979

Reprints from the journals listed in this section may often be obtained from the authors. Each entry has been assigned a five-digit number for NBS identification and listing purposes.

18324. Yokel, F. Y., **Guidelines for housing construction in mine subsidence areas,** *Proc. Int. Conf. on Evaluation and Prediction of Subsidence, Pensacola Beach, FL, Jan. 1978*, S. K. Saxena, Ed., pp. 129-139 (American Society of Civil Engineers, New York, NY, 1978).

Key words: foundation design; geotechnical engineering; housing construction; mine subsidence; mining; site development; standards; structural design.

Suggested guidelines for the construction of housing in mine subsidence areas are outlined and discussed. The guidelines deal with site evaluation, site development, and housing construction.

18336. Kusuda, T., **Use of simulation models of buildings in assessing energy conservation strategies,** *Proc. Symp. Energy Conservation Strategies in Buildings: Comfort, Acceptability, and Health, New Haven, CT, Jan. 25, 1978*, J. A. J. Stolwijk, Ed., pp. 143-156 (J. B. Pierce Foundation Laboratories, Hartford, CT, 1978).

Key words: heating and cooling load; hybrid computer; NBSLD; thermal comfort.

A comprehensive treatment of building heat transfer processes is employed by the National Bureau of Standards Heating and Cooling Load Calculation program NBSLD to study the effect of various building parameters upon the resulting heating and cooling load and thermal comfort of occupants, in order to evaluate energy conservation strategies. The basis of the computation is the detailed solution of simultaneous heat balance equations at all of the interior surfaces of a room or space. Transient heat conduction through the exterior walls and in the interior structures is handled by using conduction transfer functions. The use of heat balance equations, although more time consuming than the conventional load calculation procedures, avoids the vagueness and uncertainties inherent in the latter. In addition, it is more accurate for a specific building design. Also mentioned in this paper is use of a hybrid computing system whereby simultaneous transfer of air, moisture and heat in and through the building can be studied more efficiently than by the conventional digital computer.

18339. Peavy, B. A., **A note on response factors and conduction transfer functions,** (Proc. Symp. American Society of Heating and Air-Conditioning Engineers Annual Meeting, Atlanta, GA, Jan. 29-Feb. 2, 1978), *ASHRAE Trans.* **84,** Pt. 1, 688-690 (1978).

Key words: computer time; conduction-transfer functions; dynamic heat transfer; thermal response factors.

The thermal response factor technique for calculating dynamic heat conduction through walls, floors, and roofs is utilized in many computer programs for determining building heating and cooling loads. Considerable computation time and computer memory space are devoted to the use of this technique, and it is advantageous to reduce the time and space required.

Reduction in computation time and computer memory space can be achieved by the use of the zeroth through fifth-order conduction-transfer functions. Computation time can be reduced by about one-half, and it is possible to reduce the memory space to one-fourth of that presently used in the computer program NBSLD.

18351. Biétry, J., Sacré, C., Simiu, E., **Mean wind profiles and change of terrain roughness,** *J. Struct. Div., Am. Soc. Civ. Eng.* **104,** No. ST10, Proc. Paper 14099, 1585-1593 (Oct. 1978).

Key words: aerodynamics; boundary layer; loads (forces); roughness; structural analysis; tall buildings; wind pressure.

Information is presented on the wind structure in established flow over terrains with various roughness characteristics (open water, open terrain, suburban terrain, towns, centers of large cities). Based on recent results of theoretical and experimental meteorological studies a simple procedure is then proposed, enabling the designer to assess the effect upon the mean wind profile of a roughness change upwind of the structure under consideration. The procedure, which is approximate but adequate for structural engineering purposes, is then illustrated in a numerical example.

18363. Holton, J. K., **Interfacing building design and solar energy research and standards,** *Proc. Joint Conf. 1976 of the American Section of the Int. Solar Energy Society and the Solar Energy Society of Canada, Winnipeg, Canada, Aug. 15-20, 1978*, pp. 74-82 (American Section of the Int. Solar Energy Society, Cape Canaveral, FL, 1978).

Key words: building research; NBS solar standards projects; solar energy.

An extensive program of solar energy research and standards development has been undertaken by the National Bureau of Standards in support of the national effort to expedite the introduction of solar usage. The communication between researchers and the building community, who will utilize the products of this research, is of critical importance for effective conduct of this program. This paper examines a number of the programs being conducted at NBS, identifies the intended user groups, and describes some of the paths of communication that are being used. It is hoped that a clearer understanding of the research/user linkage will lead to more effective communication between those working in the field.

18385. Chi, J., Kelly, G. E., **A method for estimating the seasonal performance of residential gas and oil-fired heating systems,** *ASHRAE Trans.* **84,** Part 1, 405-420 (1978).

Key words: boiler; combustion; energy; furnace; gas-fired; heating; oil-fired; rating; space-heating; testing.

An evaluation procedure is described for estimating the seasonal efficiency of a gas or oil-fired furnace which is located in an indoor heated space and uses conditioned air for combustion and draft control. It involves carrying out the following four tasks: 1) measuring the flue gas temperature and CO_2 concentration during steady-state operation; 2) obtaining information on the shape of the flue gas temperature-vs-time curves as a unit cools-down and warms-up from steady-state conditions; 3) assigning appropriate values to various factors which describe the off-period air flow rate through the flue and stack, the degree of furnace oversizing, and the effect of furnace operation on infiltration, and 4) carrying out the calculation procedure described herein to determine the various on-period and off-period losses and the seasonal efficiency of a furnace or boiler operating in any given climatic region. Several examples are worked out to illustrate the nature of this simplified procedure.

18415. Ellingwood, B., Leyendecker, E. V., **Approaches for design against progressive collapse,** *J. Struct. Div., Proc. Am. Soc. Civ. Eng.* **104,** No. ST3, Proc. Paper 13610, 413-423 (Mar. 1978).

Key words: abnormal loads; buildings (codes); probability theory; progressive collapse; reliability; structural engineering.

A progressive collapse is a chain reaction type of failure which follows damage to a relatively small portion of a structure. Progressive collapse constitutes an unacceptable hazard in many buildings, and thus procedures for its control should be incorporated in building standards. Design strategies for reducing the risk of initial failure and for controlling the amount of damage that occurs are presented and their relative advantages are discussed. Design criteria are given for the reduced loads to be carried by a damaged structure.

18425. Hunt, B. J., Richtmyer, T. E., Hill, J. E., Franklin, E. A., **Testing of water tanks for thermal storage according to ASHRAE Standard 94-77,** *ASHRAE Trans.* **85,** Part 1, PH-79-5, No. 1, 20 pages (1979).

Key words: ASHRAE Standards; evaluation of test procedure; solar heating components; standard test procedure; thermal storage tests; water tank thermal storage.

The National Bureau of Standards proposed a standard test procedure for rating thermal storage devices in mid-1975. Early in 1977, the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) adopted ASHRAE Standard 94-77, "Methods of Testing Thermal Storage Devices Based on Thermal Performance," which is based substantially on the NBS procedure. In order to evaluate the Standard, NBS has conducted an experiment in which a 1.9 m^3 (500 gal) water tank, built as part of a residential solar heating and cooling system, was tested in accordance with this Standard. A description of the test apparatus, test procedure, and detailed test results are given. It was found that there were no major problems encountered in using the Standard for this kind of thermal storage device. In addition, suggestions are made for minor modifications in the Standard.

18428. Liu, S. T., Hill, J. E., **A proposed technique for correlating the performance of solar domestic water heating systems,** *ASHRAE Trans.* **85,** Part 1, No. 2516, 13 pages (1979).

Key words: computer; hot water; measurement; rating; solar; standards; testing.

A theoretical study was conducted to determine how experimental data might be collected on solar domestic water heating systems over a short period of time and then used to characterize the performance of the system. The analysis involved stimulating typical state-of-the-art systems using the computer program TRNSYS. The simulations and associated analyses were succesful in indicating a method of correlating the fraction of the hot water load supplied by solar energy with the primary independent variables governing the system performance. Actual test data for a commercially available system were then used to substantiate the value of the correlation.

18429. Raufaste, N. J., Jr., Olmert, K. M., **Case study: NBS' Center for Building Technology,** *Words* **7,** No. 3, 34-37 (Feb.-Mar. 1979).

Key words: Center for Building Technology; manuscripts; word processing center; word processing equipment.

Word Processing Centers (WPC) are more and more being created in business and government as a way of coping with large typing loads. However, making the transition from the idea of a WPC to one that is fully operational is difficult. This paper presents the Center for Building Technology's experience in this transition.

18430. Stahl, F. I., **Exit emergency: A blueprint for design standards research,** *The Construction Specifier*, pp. 65-77 (Feb. 1979).

Key words: architectural barriers; building design; building site planning; environmental psychology; evaluation; fire escape; human research; measurement; pedestrian movement; regulation; safety; standards.

Needs for a more complete and effective technical basis for design standards impacting occupants' access to, movement within, and egress from buildings and building sites are discussed. It is suggested that a major cause of injury and death from fire, and of inconvenience and psychological stigmatization to physically handicapped persons, results (even in code-complying buildings and sites) from adherence to design regulations which are narrowly founded upon physical and engineering principles alone. This paper recommends that psychological aspects of dangerous and stressful situations guide the development of standards for emergency egress facility design, and that such therapeutic objectives as "normalization" guide development of barrier-free design regulations. Finally, this paper outlines particular programmatic themes and research tasks, and discusses the role of the National Bureau of Standards in improving the technical basis for egress and accessibility design regulations.

18493. Milton, H. J., **Our metric future. An analysis of metrication's impact upon construction specifications,** *Constr. Specifier* **32,** No. 2, 36-47 (Feb. 1979).

Key words: construction specifications; conversion approaches; dimensional coordination; metrication; SI; stages in metrication.

The paper examines some of the background considerations in metrication for the construction community, highlights some of the changes that will need to be made, examines different approaches to conversion, and suggests adaptive strategies for the construction specifications sector during the transitional period.

18554. Masters, L. W., Seiler, J. F., Roberts, W. E., **Development of standards for evaluating solar absorptive coatings,** (Proc. Division of Organic Coatings and Plastics Chemistry at the American Chemical Society/Chemical Society of Japan Chemical Congress, Honolulu, Hawaii, Apr. 1-6, 1979), Paper in *Organic Coatings and Plastics Chemistry* **40,** 507-510 (American Chemical Society, Washington, DC, 1979).

Key words: absorptive coatings; accelerated laboratory tests; durability; outdoor exposure; solar collectors; standard test methods.

Absorptive coatings used in solar heating and cooling systems absorb energy from the sun and convert it to thermal energy. It is essential that coatings used for this purpose be durable for extended periods of time. However, the environment in which absorptive coatings are used can cause rapid degradation. For example, the temperature at the coating surface can reach 250 °C or higher under collector stagnation conditions. Likewise, exposure to moisture, ultraviolet (uv) radiation and other factors can also induce degradation. Numerous problems in solar energy systems have clearly shown the need for standards by which solar absorptive coatings can be evaluated. The Center for Building Technology of the National Bureau of Standards is performing research, under Department of Energy sponsorship, to develop draft standards for absorptive coatings. The standards will be submitted to the American Society for Testing and Materials (ASTM) for consideration as consensus standards. Fourteen selective and nonselective absorbers have been evaluated in laboratory and field tests to obtain data needed to prepare the draft standards. The laboratory tests have emphasized thermal stability, moisture stability, uv stability and compatibility with substrates. Field tests, in which coatings are exposed to stagnation conditions in three different climates, are also being performed. Absorptance (α) and emittance (e) are measured before and after the laboratory and field exposures. The data obtained, the test methods used and two interim test method standards prepared as result of the research are discussed.

18587. Kusuda, T., Hunt, C. M., McNall, P. E., **Radioactivity (radon and daughter products) as a potential factor in building ventilation,** *ASHRAE J.* **21,** No. 7, 30-34 (July 1979).

Key words: energy conservation design; indoor radiation; radon in buildings; ventilation and radon concentration.

Awareness has developed in the United States, particularly within the last five years, that traces of radioactive radon gas and its daughter products are present in varying amounts in the indoor air. Some of the existing literature on the subject is briefly reviewed and discussed. It is recommended that further attention be given to quantify radon concentration data pertinent to the environmental health aspects of ventilation requirements from the standpoint of indoor air quality consistent with building energy conservation.

18596. McNall, P. E., Jr., **The relation of thermal comfort to learning and performance: A state-of-the-art report,** (Proc. ASHRAE Semiannual Meeting on HVAC—Human Factors, Philadelphia, PA, Jan. 28-Feb. 2, 1979), Paper PH-79-9, No. 2 in *ASHRAE Trans.* **85,** Pt. 1, 759-767 (June 1979).

Key words: air-conditioning; comfort; education; environment; human factors; research; school.

The results of several research projects are summarized. These projects have attempted to relate thermal comfort, learning and productivity. They show indications of positive correlation (optimal comfort appears to result in maximum learning, etc.) but these are not well supported by commonly accepted experimental statistics. The problem seems to rest in quantifying highly variable individual human motivation as other experimental conditions are varied. This seems particularly true in the usually employed experiments of a few hours duration on many human subjects. On the other hand, investigating long-term effects of fatigue and motivation over many weeks is expensive and time-consuming, and control of the subjects when they are not under the experimental conditions has been minimal in studies of this type up to the present time.

18688. Simiu, E., Scanlan, R. H., **Flutter of a plate-like member in horizontal fluctuating flow,** *Eng. Struct.* **1,** No. 4, 207-210 (July 1979).

Key words: acrodynamic stability; aeroelasticity; fluctuating flow; flutter; suspended-span structures; time-dependent loads.

A procedure is presented for determining the mean flutter velocity of a symmetrical plate with a vertical and a torsional degree of freedom in a flow with periodic horizontal fluctuations. Expressions of the self-excited forces based on a generalized Theodorsen-type model are used. The resulting flutter motion is described by a system of generalized Mathieu-Hill equations to which the stability criteria of the theory of dynamic systems with periodic coefficients are applied. A numerical example is given for a plate with mechanical characteristics comparable to those of a suspension bridge in a flow with fluctuations comparable to those occurring in natural winds. It is found that the effect of such fluctuations upon the value of the mean flutter velocity is negligible. This suggests that in investigating the aerodynamic stability of a suspension bridge with characteristics similar to those dealt with in the paper, it is permissible to neglect the effect of the horizontal fluctuations of the flow. Recently obtained experimental results are quoted which tend to confirm this result.

18703. Didion, D. A., Kelly, G. E., **New testing and rating procedures for seasonal performance of heat pumps,** *ASHRAE J.*, pp. 40-44 (Sept. 1979).

Key words: heat pumps; part-load evaluation; standards for heat pumps; testing procedures for heat pumps.

Current testing and rating procedures for heat pumps have served industry and the consumer well for many years. These steady-state (SS) full-load evaluation procedures allow for the capacity determination needed for sizing the unit to the building loads. They also serve as an efficiency evaluation for comparing the relative merits of various units. However, with the need for energy conservation, and with increasing energy costs, buildings and their equipment have come to require a life-cycle-cost analysis instead of the traditional first-cost approach. In order to provide a better estimate of operational costs, the heat pump industry needs a more comprehensive evaluation technique to obtain data during part-load, cyclic operation. Although the wide variety of types of heat-pump installations and climates makes field performance impractical as a basis for this cost analysis, laboratory part-load simulation can increase the input for a reasonable testing investment.

18705. Brungraber, R. J., Adler, S. C., **Technical support for a slip-resistance standard,** (Proc. American Society for Testing and Materials Symp. on Walkway Surfaces: Measurement of Slip Resistance, Denver, CO, June 30, 1977), *Am. Soc. Test. Mater. Spec. Tech. Publ. 649*, pp. 40-48 (1978).

Key words: ASTM; bathtubs; CPSC; performance test; showers; slip-resistance.

In the spring of 1975, ASTM Subcommittee F15.03.01 on Specifications and Test Methods for Slip Resistance of Bathing Facilities, requested technical assistance from the Building Safety Section (BSS) of the National Bureau of Standards (NBS) in developing a performance test for establishing quantitatively an acceptable level of slip resistance for bathtubs and shower bases. Close cooperation between the subcommittee members and the BSS staff, coupled with financial support from the Consumer Product Safety Commission (CPSC), resulted in the development of a performance test which approximates the conditions that are likely to occur on bathtub or shower base surfaces, is reliable and repeatable, and discriminates adequately between currently available bathtub and shower base materials.

18733. Harrje, D. T., Grot, R. A., **Instrumentation for monitoring energy usage in buildings at twin rivers,** Paper in *Energy and Buildings*, **1,** 293-299 (Elsevier Sequoia S. A., Lausanne—The Netherlands, 1977/1978).

Key words: air infiltration; buildings; data acquisition; energy; instrumentation; measurement; thermography; Twin Rivers Project; weather station.

The measurement systems used at Twin Rivers for determining energy usage are described. These include a weather station, three different systems for the measurement of temperatures and energy-related events in a house, automated devices to measure the air infiltration rate, and infrared thermography. Each of these systems played a role in assessing the actual usage of energy in individual buildings, in identifying the factors that determine energy consumption, and in checking the accuracy of theoretical models for predicting the energy performance of dwellings.

18770. Jenkins, J. P., Hill, J. E., **Testing of water-heating collectors according to ASHRAE Standard 93-77,** (Proc. Int. Solar Energy Society 1978 Meeting, New Delhi, India, Jan. 16-21, 1978), Paper in *SUN: Mankind's Future Source of Energy*, F. deWinter, M. Cox, Eds., **2,** 1021-1028 (Pergamon Press, New York, NY, 1978).

Key words: ASHRAE Standard 93-77; solar collectors; water-heating collectors.

A proposed procedure for testing and rating solar collectors was published by the National Bureau of Standards (NBS) in 1974. In early 1977, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) adopted ASHRAE Standard 93-77 which is a modified version of the NBS procedure. A test facility for water-heating collectors has been built at NBS in accordance with this Standard. The purpose of this paper is to briefly explain the recently adopted test procedure, describe the NBS test facility, and to give typical test results for collectors commercially available in the United States.

18778. Didion, D. A., **New testing and rating procedures for seasonal performance of heat pumps,** *Proc. Carrier Int. Symp. on Heat Pumps and Space Conditioning in the 1990's, Syracuse, NY, Feb. 2-3, 1979*, pp. 37-47 (Carrier Corp., Syracuse, NY, Sept. 1979).

Key words: heat pumps; part-load evaluation; standards for heat pumps; testing procedures for heat pumps.

Current testing and rating procedures for heat pumps have served industry and the consumer well for many years. These steady-state (SS) full-load evaluation procedures allow for the capacity determination needed for sizing the unit to the building loads. They also serve as an efficiency evaluation for comparing the relative merits of various units. However, with the need for energy conservation, and with increasing energy costs, buildings and their equipment have come to require a life-cycle-cost analysis instead of the traditional first-cost approach. In order to provide a better estimate of operational costs, the heat pump industry needs a more comprehensive evaluation technique to obtain data during part-load, cyclic operation. Although the wide variety of types of heat-pump installations and climates makes field performance impractical as a basis for this cost analysis, laboratory part-load simulation can increase the input for a reasonable investment.

Part-load laboratory evaluation offers two added benefits; a more accurate estimate of energy usage on an absolute basis, hence a better comparison between heat pumps and other equipment, needed at least for the heating mode; and encouragement to manufacturers to develop a more efficient product, since they can get more credit for their innovations.

18784. Stahl, F. I., Conway, D., Goglia, M. R., **Human behavioral considerations in the planning and design of passive solar systems for commercial facilities: An exploratory study of the effects of sun and shade,** *Proc. 4th National Passive Solar Conference, Kansas City, MO, Oct. 3-5, 1979*, pp. 26-29 (Oct. 1979).

Key words: environmental psychology; field methodology; passive solar systems; pedestrian behavior; psychology of retailing; retail facilities.

An exploratory study was conducted to determine whether alterations in sun and shade patterns (which may result from certain passive solar retrofit designs) influence window-shopping and other behaviors on retail streets. Pedestrians were observed at two urban locations. The hypothesis that in cool weather pedestrians prefer the sunny (rather than shady) side of retail streets was partially supported by the data. The hypothesis that durations of window-shopping and other relevant behaviors would be greater on the sunny side was not supported.

18829. Grot, R. A., **Field performance of gas and electric water heaters,** *Proc. Major Home Appliance Technology for Energy Conservation, West Lafayette, IN, Feb. 27-Mar. 1, 1978*, pp. 110-120 (Available as CONF-780238 from the National Technical Information Service, Springfield, VA 22161, 1978).

Key words: energy field measurements; hot water heaters; hot water usage; residential water use.

The results of a field experiment for assessing the performance of gas and electric residential storage water heaters are presented. Energy requirements for hot water supply, hot water consumption and usage pattern data are presented and analyzed using statistical techniques in order to obtain average load curves and variations from the average. The effects of various retrofit measures such as wrapping the water heater with additional insulation and reducing the hot water temperature are assessed under actual usage conditions.

18854. Frohnsdorff, G., Clifton, J. R., Brown, P. W., **History and status of standards relating to alkalies in hydraulic cements,** (Proc. American Society for Testing and Materials Symp. on Cement Standards—Evolution and Trends, St. Louis, MO, Dec. 7, 1977), *Am. Soc. Test. Mater. Spec. Tech. Publ. 663*, pp. 16-34 (1978).

Key words: alkalies; cement; history; standards.

The evolution of ASTM standards relating to alkalies, specifically sodium and potassium, in portland and blended hydraulic cements is described. The standards include analytical methods for the determination of alkalies in cements, optional specification limits for alkalies in portland cements for use with aggregates that may be deleteriously reactive, and tests for potential alkali reactivity of aggregates. Some shortcomings of the standards are mentioned, and, where they do not treat portland and blended cements in comparable ways, this fact is pointed out. Finally, changes which might be made in the standards to make them responsive to national needs for conservation of energy and materials are suggested.

18863. Hastings, S. R., **Daylighting—Conflicts and synergies of architectural solutions,** *Proc. 1979 Topical Solar Glazing Conf., Pomona, NJ, June 22-23, 1979*, pp. F-21—F-24 (June 1979).

Key words: daylighting; energy conservation; fenestration; solar energy; windows.

Design solutions which enhance daylighting may enhance or detract from a window's performance of other functions. Five energy control functions and five non-energy functions of windows are defined. The inherent conflicts and synergies between daylighting and other window functions are examined. Various design or hardware solutions to minimize conflict and/or improve overall performance are discussed. Daylighting solutions need not compromise other window functions, given the multitude of design or hardware options available today.

18887. Knab, L. I., Moody, R. C., **Glulam design criteria for temporary structures,** *J. Struct. Div., Am. Soc. Civ. Eng.* **104,** No. ST9, Proc. Paper 14031, 1485-1494 (Sept. 1978).

Key words: bridges; buildings; design criteria; glued-laminated timber; safety; temporary structures; wood.

If temporary structures having lives of 2-5 years are designed using criteria for permanent structures with lives of 50-75 years, overly conservative designs can result. This paper presents a systematic, rational basis for developing criteria for glued-laminated timber temporary bridges and buildings. Second moment reliability theory, which requires estimates of the mean and coefficient of variation of resistance and load, is used to compute measures of safety, called safety index values. These index values are computed for permanent and temporary structural elements. Allowable stresses for temporary structures are determined by choosing corresponding safety index values which will provide adequate safety *relative* to the safety of permanent structures, while reflecting the temporary nature of the structures. Examples of how allowable flexural stresses are developed for bridges and buildings are given.

18888. Marshall, H. E., Petersen, S. R., **Economics and the selection and development of energy standards for buildings,** *Energy and Buildings* **2,** 89-99 (1979).

Key words: buildings; conservation; criteria; design; economics; efficiency; energy; energy budget; equity; life-cycle cost; optimal; standard.

Energy-conservation standards for new buildings will play a major role in federal and state conservation policies in the coming decade. This article discusses economic-efficiency considerations that can be incorporated into the selection and development of such standards. Three types of energy budgets— fixed energy budgets, partially variable energy budgets, and economically efficient energy budgets (EEEB)—are examined for use as standards. Economic-efficiency criteria are presented for use in selecting an appropriate energy budget. An illustrative example shows the potential dollar losses in life-cycle terms from failing to apply an EEEB. Research and operational requirements for developing and implementing an energy budget are described. Three energy-budget standards are evaluated in terms of economic efficiency, administrative feasibility, equity, and consistency in design requirements. An EEEB appears optimal in that it ranks highest overall with respect to the four criteria. Failure to begin research for, and development of, EEEBs now would impose unnecessary social costs in the form of extra expenses to achieve any chosen target levels of energy conservation in buildings.

18890. Knab, L. I., **Numerical aid to reduce construction injury losses,** *J. Constr. Div., Am. Soc. Civ. Eng.* **104,** No. C04, Proc. Paper 14213, 437-445 (Dec. 1978).

Key words: construction; cost effectiveness; hazard; injuries; loss prevention; risk; safety.

In the construction industry, the rate of work-related injuries and deaths is two or more times the national rate for all industries. This paper develops a rational method which quantitatively rates construction risks, using risk scores. The scores, which are computed for each workmen's compensation classification, are based on insurance premiums and injury cause-cost analysis. In addition the method numerically ranks the relative cost effectiveness of corrective actions which are taken to reduce risks. The cost effectiveness ranking is determined from the risk score, the cost and the degree of effectiveness of the corrective action. Use of the method can improve the efficiency of evaluating risks and allocating resources to minimize the risks. The method presented is considered only a first step. The uses, limitations, and further development of the method are presented.

18894. Hastings, S. R., **Passive solar design for urban commercial environments,** (Proc. 4th Nat. Passive Solar Conf., Kansas City, MO, Oct. 3-5, 1979), Paper in *Proceedings of the 4th National Passive Solar Conference*, G. Franta, Ed., **4,** Section 3, 303-306 (American Section of the International Solar Energy Society, Inc., Newark, DE, 1979).

Key words: application; buildings; commercial; daylighting; energy; environments; heating; passive; solar; suburban; urban.

To investigate the passive use of solar energy in urban commercial environments five generic environments and five passive solar configurations have been defined. Common solar energy issues are summarized here. Two of the five generic environments are then examined regarding energy use characteristics, passive solar configurations, and constraints.

18964. Powell, J. W., **Economic evaluation of passive solar designs for urban environments,** *Proc. 4th Nat. Passive Solar Conf., Kansas City, MO, Oct. 3-5, 1979*, pp. 1-5 (American Section of the International Solar Energy Society, Newark, DE, 1979).

Key words: commercial; economics; evaluation; feasibility; passive; rehabilitation; retrofit; solar.

This paper outlines an economic model for evaluating passive solar designs for commercial buildings and applies the model in several case studies of retrofit systems. Taking into account tax effects, incentive programs available to urban rehabilitation projects, and non-thermal as well as thermal benefits of selected passive solar energy systems for space heating, the evaluations show that these systems are cost effective over a wide range of conditions.

18977. Reinhold, T. A., **Wind interaction of neighboring tall buildings,** *Proc. ASCE Third Engineering Mechanics Division Specialty Conf., Sept. 17-19, 1979, Austin, TX*, pp. 179-182 (American Society of Civil Engineers, New York, NY, 1979).

Key words: aerodynamics; boundary layers; dynamic response; interference effects; tall buildings; wind loads; wind tunnels.

A wind-tunnel investigation into the influence of an upstream structure on the dynamic wind loads acting on a square-section tall building is described. The test configurations studied and the types of data obtained are presented. Results are discussed and some important observations are summarized.

The paper contains a listing of reports which contain more detailed information concerning the tests and results.

18986. Jenkins, J. P., Hill, J. E., **A comparison of test results for flat-plate water-heating solar collectors using the BSE and ASHRAE procedures,** *Proc. ASME Winter Ann. Meeting, New York, NY, Dec. 2-7, 1979, 79-Wa/Sol-4*, pp. 1-13 (American Society of Mechanical Engineers, New York, NY, 1979).

Key words: collector efficiency; comparison German BSE vs ASHRAE 93-77 procedures; flat-plate solar collectors; German Bundesverband Solarenergie; solar collector testing; water-heating solar collectors.

The Gernan Bundesverb and Solarenergie (BSE) Working Group recently adopted and published a procedure for testing solar collectors based on thermal performance. Research facilities for testing flat-plate water-heating collectors have been built at NBS in accordance with the BSE procedure and the existing ASHRAE Standard 93-77. The purpose of this paper is to describe the BSE test procedure and compare experimental

test results with those obtained using the existing ASHRAE Standard 93-77. Included is a description of the collector test facilities at NBS and the results obtained from testing five commercially available flat-plate water-heating collectors using both procedures.

19003. Kusuda, T., Bean, J. W., **Comparison between a simplified daylighting calculation procedure and a comprehensive interreflection model calculation procedure,** (Proc. Third Int. Symp. Use of Computers for Environmental Engineering Related to Buildings, Alberta, Canada, May 10-12, 1978), *CNRC Publ. 17376*, pp. 569-578 (National Research Council of Canada, Ottawa K1A OR6, Canada, 1978).

Key words: daylighting; energy calculation; energy consumption; fenestration; heating and cooling load; solar heat gain.

A simplified calculation methodology for daylighting was developed as a subroutine to the annual energy calculation of buildings. Several sets of sample calculations were performed to compare the results of the simplified calculation with those obtained by a rigorous multiple interreflection model called GLIM (General Lighting Interreflection Model) for a sample office module with different ratios of window to exterior wall area.

The simplified daylight calculation procedure then was used to determine the effect of daylight utilization on annual heating and cooling energy consumption on NBSLD, National Bureau of Standards heating and cooling load calculation program. The calculation includes the reduction of light heat gain and electric power demand as a result of daylight utilization.

19016. Weber, S. F., **Tax incentives for historic preservation: An economic analysis,** *J. Real Estate Tax.* 7, No. 1, 31-49 (Fall 1979).

Key words: adaptive reuse; buildings; demolition; economics; historic preservation; life-cycle costing; redevelopment; rehabilitation; tax incentives.

The Tax Reform Act of 1976 contains a number of provisions which affect the financial position of owners of income-producing historic buildings. Prior tax law tended to penalize historic preservation by allowing more rapid acceleration of depreciation schedules for new buildings and by permitting demolition costs to be deducted in the year in which they occur. TRA provided a more favorable tax environment for historic preservation by moving these tax penalties. The effect of the tax changes depends on the type of building (residential versus nonresidential) and on the legal form of ownership. TRA's tax incentives for the preservation of certified historic buildings were expanded by technical corrections enacted as part of the Revenue Act of 1978. This article analyzes the effect of the historic preservation provisions of both tax acts on the after-tax cost of two basic alternatives facing corporate owners of nonresidential historic buildings: (1) Rehabilitate the structure; or (2) demolish it and redevelop the site.

19043. Marshall, H. E., Ruegg, R. T., **Life-cycle costing guide for energy conservation in buildings,** Chapter 9 in *Energy Conservation Through Building Design*, pp. 162-181 (McGraw Hill Book Co., New York, NY, 1979).

Key words: building design; cost; energy conservation; energy standards; fenestration; life-cycle costing; retrofitting; solar.

Architects, engineers, building operators and owners, and others who make decisions about the design and use of buildings need cost information about alternative energy conservation designs for old and new buildings. Specifically, they need to know the cost over time from introducing energy conserving techniques as compared to the cost savings over time from reduced energy bills. Life-cycle costing of energy conservation alternatives in buildings can be applied at the working level to reduce the owning and operating costs of buildings, to reduce energy consumpption, and to encourage the optimal retrofit of old and design of new buildings with respect to rising fuel costs. This article provides practicing architects, architectural students, and others interested in the design process an overview of state-of-the-art methods for estimating the life-cycle cost (LCC) of alternative energy conservation techniques and a description of selected applications of LCC methods to energy conservation in buildings.

Retrofitting existing residential buildings for energy conservation is examined in LCC terms. The design of envelope features and subsystems for energy conservation in new buildings is explored in the context of LCC analysis. Finally, energy standards for buildings are examined in the LCC context to show why varying climates and fuel prices must be considered in developing economically efficient standards.

19044. Weber, S. F., **Cost effectiveness of energy conservation investments in new United States residences,** *Proc. Second Int. CIB Symp. on Energy Conservation in the Built Environment, Copenhagen, Denmark, May 28-June 1, 1979*, pp. 1-10 (May 1979).

Key words: building envelope; cost effectiveness; economics; energy conservation; internal rate of return; life-cycle costing; marginal analysis; optimal design; residential buildings; space cooling; space heating.

This paper assesses the cost effectiveness of selected energy conservation investments in new single-family residences in the U.S. Alternative investment levels in the four major components of the building envelope are evaluated: (1) attics; (2) walls; (3) floors; and (4) windows. The analysis is conducted for five cities of widely diverse climate conditions and for the major forms of energy used for heating and cooling in the U.S. For each investment level the internal rate of return (IRR) is calculated on an incremental basis, that is, in comparison with the next lower level of investment for that component. This marginal IRR is used to rank alternative levels of investment for all four components so that economically optimal envelope designs can be selected for each city and energy type.

19045. Chapman, R. E., **Cost-effective methods for achieving compliance to fire safety codes,** *Fire J.* **73,** No. 5, 30-39, 123 (Sept. 1979).

Key words: applied economics; building codes; building economics; economic analysis; fire safety; health care facilities; hospitals; life safety; mathematical programming; nursing homes; renovation.

The identification of cost-effective levels of fire safety in health care facilities is a major concern to hospital administrators, fire safety engineers and public policy makers. The prohibitive costs of strict compliance to the prescriptive provisions of the Life Safety Code in hospitals and nursing homes has led to the development of an equivalency methodology, the Fire Safety Evaluation System. The equivalency methodology provides a means for identifying how combinations of several widely accepted fire safety systems can be used to produce a level of safety equal to that of the prescriptive provisions of the Life Safety Code. Three topics are described briefly in this paper. They are (1) the Fire Safety Evaluation System; (2) a computerized version of the Fire Safety Evaluation System which permits the least-cost means of achieving compliance to the Life Safety Code to be identified; and (3) an indication of the cost-saving potential of the Fire Safety Evaluation System based on a case study of a typical general hospital.

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Appendices

Appendix A. Depository Libraries in the United States

ALABAMA

Alexander City: Alexander City State Junior College, Thomas D. Russell Library (1967).
Auburn: Auburn University, Ralph Brown Draughon Library (1907).
Birmingham:
- Birmingham Public Library (1895).
- Birmingham-Southern College Library (1932).
- Jefferson State Junior College, James B. Allen Library (1970).
- Samford University, Harwell G. Davis Library (1884).

Enterprise: Enterprise State Junior College, Learning Resource Center (1967).
Florence: University of North Alabama, Collier Library (1932).
Gadsden: Gadsden Public Library (1963).
Huntsville: University of Alabama, Huntsville Campus Library (1964).
Jacksonville: Jacksonville State University, Ramona Wood Library (1929).
Maxwell A.F. Base: Air University Library (1963).
Mobile:
- Mobile Public Library (1963).
- Spring Hill College, Thomas Byrne Memorial Library (1937).
- University of South Alabama Library (1968).

Montgomery:
- Alabama State Department of Archives and History Library (1884).
- Alabama Supreme Court and State Law Library (1884).
- Auburn University at Montgomery Library (1971)-REGIONAL.

Normal: Alabama Agricultural and Mechanical College, Drake Memorial Library (1963).
St. Bernard: St. Bernard College, Herman J. Heidrich Library (1962).
Troy: Troy State University, Lurleen B. Wallace Educational Resources Center (1963).
Tuskegee Institute: Tuskegee Institute, Hollis Burke Frissell Library (1907).
University:
- University of Alabama, School of Law Library (1967).
- University of Alabama Library (1860)-REGIONAL

ALASKA

Anchorage:
- Supreme Court of Alaska Library (1973).
- University of Alaska, Anchorage Library (1961).

College: University of Alaska, Elmer E. Rasmuson Library (1922).
Juneau: Alaska State Library (1964).
Ketchikan: Ketchikan Community College Library (1970).

ARIZONA

Coolidge: Central Arizona College, Instructional Materials Center (1973).
Flagstaff: Northern Arizona University Library (1937).
Phoenix:
- Department of Library and Archives (unknown)-REGIONAL.
- Grand Canyon College, Fleming Library.
- Phoenix Public Library (1917).

Prescott: Yavapai College Library (1976).
Tempe:
- Arizona State University, Matthews Library (1944).
- Arizona State University, College of Law Library (1977).

Thatcher: Eastern Arizona Junior College Library (1963).
Tucson:
- Tucson Public Library (1970).
- University of Arizona Library (1907)-REGIONAL.

Yuma: Yuma City-County Library (1963).

ARKANSAS

Arkadelphia: Ouachita Baptist University, Riley Library (1963).
Batesville: Arkansas College Library (1963).
Clarksville: College of the Ozarks Library (1925).
Conway: Hendrix College, O. C. Bailey Library (1903).
Fayetteville: University of Arkansas Library (1907).
Little Rock:
- Arkansas Supreme Court Library (1962).
- Little Rock Public Library (1953).
- University of Arkansas at Little Rock Library (1973).

Magnolia: Southern Arkansas University, Mogale Library (1956).
Monticello: University of Arkansas at Monticello Library (1956).
Pine Bluff: University of Arkansas at Pine Bluff, Watson Memorial Library (1976).
Russellville: Arkansas Tech University, Tomlinson Library (1925).
Searcy: Harding College, Beaumont Memorial Library (1963).
State College: Arkansas State University, Dean B. Ellis Library (1913).
Walnut Ridge: Southern Baptist College, Felix Goodson Library (1967).

CALIFORNIA

Anaheim: Anaheim Public Library (1963).
Arcadia: Arcadia Public Library (1975).
Arcata: Humboldt State College Library (1963).
Bakersfield:
- California State College, Bakersfield Library (1974).
- Kern County Library System (1943).

Berkeley:
- University of California, General Library (1907).

University of California, Law Library, Earl Warren Legal Center (1963).
Carson:
California State University, Dominguez Hills, Educational Resources Center (1973).
Carson Regional Library (1973).
Chico: Chico State University Library (1962).
Claremont: Pomona College Documents Collection, Honnold Library (1913).
Coalingo: West Hills Community College (1978).
Compton: Compton Library (1972).
Culver City: Culver City Library (1966).
Davis:
University of California at Davis Library (1953).
University of California at Davis, School of Law Library (1972).
Downey: Downey City Library (1963).
Fresno:
California State University Library (1962).
Fresno County Free Library (1920).
Fullerton: California State University, Fullerton Library (1963).
Garden Grove: Garden Grove Regional Library (1963).
Gardena: Gardena Public Library (1966).
Hayward: California State College at Hayward Library (1963).
Huntington Park: Huntington Park Library, San Antonio Region (1970).
Inglewood: Inglewood Public Library (1963).
Irvine: University of California at Irvine Library (1963).
La Jolla: University of California, San Diego, University Library (1963).
Lakewood: Angelo Iacoboni Public Library (1970).
Lancaster: Lancaster Regional Library (1967).
Long Beach:
California State University at Long Beach Library (1962).
Long Beach Public Library (1933).
Los Angeles:
California State College at Los Angeles, John F. Kennedy Memorial Library (1956).
Los Angeles County Law Library (1963).
Los Angeles Public Library (1891).
Loyola University of Los Angeles Library (1933).
Occidental College, Mary Norton Clapp Library (1941).
Pepperdine University Library (1963).
Southwestern University, School of Law Library (1975).
University of California at Los Angeles Library (1932).
University of California at Los Angeles, Law Library (1958).
University of Southern California Library (1933).
Menlo Park: Department of the Interior, Geological Survey Library (1962).
Montebello: Montebello Library (1966).
Monterey: Naval Postgraduate School Library (1963).
Monterey Park: Bruggemeyer Memorial Library (1964).
Northridge: California State University at Northridge, Delmar T. Oviatt Library (1958).
Norwalk: Los Cerritos Regional Library (1973).
Oakland:
Mills College Library (1966).
Oakland Public Library (1923).
Ontario: Ontario City Library (1974).
Pasadena:
California Institute of Technology, Robert A. Millikan Memorial Library (1933).
Pasadena Public Library (1963).
Pleasant Hill: Contra Costa County Library (1964).
Redding: Shasta County Library (1956).
Redlands: University of Redlands, Armacost Library (1933).
Redwood City: Redwood City Public Library (1966).
Reseda: West Valley Regional Branch Library (1966).
Richmond: Richmond Public Library (1943).
Riverside:
Riverside Public Library (1947).
University of California at Riverside Library (1963).
Sacramento:
California State Library (1895)–REGIONAL.
Sacramento City-County Library (1880).
Sacramento County Law Library (1963).
Sacramento State University Library (1963).
San Bernardino: San Bernardino County Free Library (1964).
San Diego:
San Diego State University, Love Library (1962).
San Diego County Law Library (1973).
San Diego County Library (1966).
San Diego Public Library (1895).
University of San Diego Law Library (1967).
San Francisco:
Mechanics' Institute Library (1889).
San Francisco Public Library (1889).
San Francisco State College, Social Science and Business Library (1955).
Supreme Court of California Library (1972).
U.S. Court of Appeals for Ninth Circuit Library (1971).
University of San Francisco, Richard A. Gleeson Library (1963).
San Jose: San Jose State College Library (1962).
San Leandro: San Leandro Community Library Center (1961).
San Luis Obispo: California State Polytechnic University Library (1969).
San Rafael: Marin County Free Library (1975).
Santa Ana:
Orange County Law Library (1975).
Santa Ana Public Library (1959).
Santa Barbara: University of California at Santa Barbara Library (1960).
Santa Clara: University of Santa Clara, Orradre Library (1963).
Santa Cruz: University of California at Santa Cruz Library (1963).
Santa Rosa: Santa Rosa-Sonoma County Public Library (1896).
Stanford: Stanford University Libraries (1895).
Stockton: Public Library of Stockton and San Joaquin County (1884).
Thousand Oaks: California Lutheran College Library (1964).
Torrance: Torrance Civic Center Library (1969).
Turlock: Stanislaus State College Library (1964).
Valencia: Valencia Library (1972).
Ventura: Ventura County Library Services Agency (1975).
Visalia: Tulare County Free Library (1967).
Walnut: Mount San Antonio College Library (1966).
West Covina: West Covina Library (1966).
Whittier: Whittier College, Wardman Library (1963).

CANAL ZONE

Balboa Heights: Canal Zone Library-Museum (1963).

COLORADO

Alamosa: Adams State College, Learning Resources Center (1963).
Boulder: University of Colorado Libraries (1879)–REGIONAL.
Colorado Springs:
Colorado College, Charles Leaming Tutt Library (1880).
University of Colorado, Colorado Springs Library (1974).
Denver:
Auraria Libraries (1978).
Colorado State Library (unknown).
Denver Public Library (1884)–REGIONAL.
Department of Interior, Bureau of Reclamation Library (1962).
Regis College, Dayton Memorial Library (1915).
Supreme Court Library (1978).
University of Denver, Penrose Library (1909).
U.S. Court of Appeals for Tenth Circuit Library (1973).

Fort Collins: Colorado State University Library (1907).
Golden: Colorado School of Mines, Arthur Lakes Library (1939).
Grand Junction: Mesa County Public Library (1975).
Greeley: University of Northern Colorado Library (1966).
Gunnison: Western State College, Leslie J. Savage Library (1932).
La Junta: Otero Junior College, Wheeler Library (1963).
Lakewood: Jefferson County Public Library, Lakewood Regional Library (1968).
Pueblo:
- Pueblo Regional Library (1893).
- University Southern Colorado Library, Learning Resources Center (1965).

U.S. Air Force Academy: Academy Library (1956).

CONNECTICUT

Bridgeport: Bridgeport Public Library (1884).
Danbury: Western Connecticut State College, Ruth A. Haas Library (1967).
Danielson: Quinebaug Valley Community College (1975).
Enfield: Enfield Public Library (1967).
Hartford:
- Connecticut State Library (unknown)-REGIONAL.
- Hartford Public Library (1945).
- Trinity College Library (1895).

Middletown: Wesleyan University Library (1906).
Mystic: Marine Historical Association, Inc., G. W. Blunt White Library (1964).
New Britain: Central Connecticut State College, Elihu Burritt Library (1973).
New Haven:
- Southern Connecticut State College Library (1968).
- Yale University Library (1859).

New London:
- Connecticut College Library (1926).
- U.S. Coast Guard Academy Library (1939).

Stamford: Stamford Public Library (1973).
Storrs: University of Connecticut, Wilbur Cross Library (1907).
Waterbury:
- Post College, Traurig Library (1977).
- Silas Bronson Library (1869).

West Haven: University of New Haven Library (1971).

DELAWARE

Dover:
- Delaware State College, William C. Jason Library (1962).
- State Department of Community Affairs and Economic Development, Division of Libraries (1972).
- State Law Library in Kent County (unknown).

Georgetown:
- Delaware Technical and Community College, Southern Branch Library (1968).
- Sussex County Law Library (1976).

Newark: University of Delaware, Morris Library (1907)
Wilmington:
- Delaware Law School Library (1976).
- New Castle County Law Library (1974).
- Wilmington Institute and New Castle County Library (1861).

DISTRICT OF COLUMBIA

Washington:
- Administrative Conference of U.S. Library (1977).
- Advisory Commission on Intergovernmental Relations Library (1972).
- Civil Aeronautics Board Library (1975).
- Civil Service Commission Library (1963).
- Department of Commerce Library (1955).
- Department of Health, Education, and Welfare Library (1954).
- Department of Housing and Urban Development Library (1969).
- Department of the Interior Central Library (1895).
- Department of Justice Main Library (1895).
- Department of Labor Library (1976).
- Department of State Library (1895).
- Department of State, Office of Legal Advisor, Law Library (1966).
- Department of Transportation, National Highway Traffic Safety Administration Library (1968).
- District of Columbia Public Library (1943).
- Federal City College Library (1970).
- Federal Deposit Insurance Corporation Library (1972).
- Federal Election Commission Library (1975).
- Federal Reserve System Law Library (1976).
- General Accounting Office Library (1975).
- General Services Administration Library (1975).
- Georgetown University Library (1969).
- Indian Claims Commission Library (1968).
- Library of Congress, Gift and Exchange Division (1977).
- National Defense University Library (1895).
- Navy Department Library (1895).
- Navy Department, Office of Judge Advocate General Library (1963).
- Office of Management and Budget Library (1965).
- Office of The Adjutant General, Department of Army Library (1969).
- Postal Service Library (1895).
- Research Library, Board of Governors of the Federal Reserve System (1978).
- Treasury Department Library (1895).
- U.S. Court of Appeals, Judge's Library (1975).
- U.S. Supreme Court Library (1978).
- Veterans' Administration, Central Office Library (1976).

FLORIDA

Boca Raton: Florida Atlantic University Library (1963).
Clearwater: Clearwater Public Library (1972).
Coral Gables: University of Miami Library (1939).
Crestview: Robert F. L. Sikes Public Library (1978).
Daytona Beach: Volusia County Public Libraries (1963).
DeLand: Stetson University, duPont-Ball Library (1887).
Fort Lauderdale:
- Broward County Library System (1967).
- Nova University Law Library (1967).

Fort Pierce: Indian River Community College Library (1975).
Gainesville: University of Florida Libraries (1907)-REGIONAL.
Jacksonville:
- Haydon Burns Library (1914).
- Jacksonville University, Swisher Library (1962).
- University of North Florida Library (1972).

Lakeland: Lakeland Public Library (1928).
Leesburg: Lake-Sumter Community College Library (1963).
Melbourne: Florida Institute of Technology Library (1963).
Miami:
- Florida International University Library (1970).
- Miami Public Library (1952).

North Miami: Florida International University, North Miami Campus Library (1977).
Opa Locka: Biscayne College Library (1966).
Orlando: Florida Technological University Library (1966).
Palatka: St. Johns River Junior College Library (1963).
Pensacola: University of West Florida, John C. Pace Library (1966).

Port Charlotte: Charlotte County Library System (1973).
St. Petersburg:
St. Petersburg Public Library (1965).
Stetson University College Law Library (1975).
Sarasota: Selby Public Library (1970).
Tallahassee:
Florida Agricultural and Mechanical University, Coleman Memorial Library (1936).
Florida State University, R. M. Stozier Library (1941). (1941).
Florida Supreme Court Library (1974).
State Library of Florida (1929).
Tampa:
Tampa Public Library (1965).
University of South Florida Library (1962).
University of Tampa, Merle Kelce Library (1953).
Winter Park: Rollins College, Mills Memorial Library (1909).

GEORGIA

Albany: Albany Public Library (1964).
Americus: Georgia Southwestern College, James Earl Carter Library (1966).
Athens: University of Georgia Libraries (1907)-REGIONAL.
Atlanta:
Atlanta Public Library (1880).
Atlanta University, Trevor Arnett Library (1962).
Emory University, Robert W. Woodruff Library (1928).
Emory University, School of Law Library (1968).
Georgia Institute of Technology, Price Gilbert Memorial Library (1963).
Georgia State Library (unknown).
Georgia State University Library (1970).
Augusta: Augusta College Library (1962).
Brunswick: Brunswick-Glyn County Regional Library (1965).
Carrollton: West Georgia College, Sanford Library (1962).
Columbus: Columbus College, Simon Schwob Memorial Library (1975).
Dahlonega: North Georgia College Library (1939).
Dalton: Dalton Junior College Library (1978).
Decatur: Dekalb Community College-South Campus, Learning Resources Center (1973).
Macon: Mercer University Library (1964).
Marietta: Kennesaw Junior College Library (1968).
Milledgeville: Georgia College at Milledgeville, Ina Dillard Russell Library (1950).
Mount Berry: Berry College, Memorial Library (1970).
Savannah: Savannah Public and Chatham-Effingham Liberty Regional Library (1857).
Statesboro: Georgia Southern College Library (1939).
Valdosta: Valdosta State College, Richard Holmes Powell Library (1956).

GUAM

Agana: Nieves M. Flores Memorial Library (1962).

HAWAII

Hilo: University of Hawaii, Hilo Campus Library (1962).
Honolulu:
Hawaii Medical Library, Inc. (1968).
Hawaii State Library (1929).
Municipal Reference Library of the City and County of Honolulu (1965).
Supreme Court Law Library (1973).
University of Hawaii Library (1907)-REGIONAL.
Laie: Church College of Hawaii, Woolley Library (1964).
Lihue: Kauai Public Library (1967).
Pearl City: Leeward Community College Library (1967).
Wailuku: Maui Public Library (1962).

IDAHO

Boise:
Boise State University Library (1966).
Boise Public Library and Information Center (1929).
Idaho State Law Library (unknown).
Idaho State Library (1971).
Caldwell: College of Idaho, Terteling Library (1930).
Moscow: University of Idaho Library (1907)-REGIONAL.
Pocatello: Idaho State University Library (1908).
Rexburg: Ricks College, David O. McKay Library (1946).
Twin Falls: College of Southern Idaho Library (1970).

ILLINOIS

Bloomington: Illinois Wesleyan University Libraries (1964).
Carbondale: Southern Illinois University Library (1932).
Carlinville: Blackburn College Library (1954).
Carterville: Shawnee Library System (1971).
Champaign: University of Illinois Law Library, College of Law (1965).
Charleston: Eastern Illinois University, Booth Library (1962).
Chicago:
Chicago Public Library (1876).
Chicago State University Library (1954).
DePaul University, Lincoln Park Campus Library (1975).
Field Museum of Natural History Library (1963).
John Crerar Library (1909).
Loyola University of Chicago, E. M. Cudahy Memorial Library (1966).
Northeastern Illinois University Library (1961).
University of Chicago Law Library (1964).
University of Chicago Library (1897).
University of Illinois, Chicago Circle Campus Library (1957).
Decatur: Decatur Public Library (1954).
De Kalb: Northern Illinois University, Swen Franklin Parson Library (1960).
Edwardsville: Southern Illinois University, Lovejoy Memorial Library (1959).
Elsah: Principia College, Marshall Brooks Library (1957).
Evanston: Northwestern University Library (1876).
Freeport: Freeport Public Library (1905).
Galesburg: Galesburg Public Library (1896).
Jacksonville: MacMurray College, Henry Pfeiffer Library (1929).
Kankakee: Olivet Nazarene College, Benner Library and Resource Center (1946).
Lake Forest: Lake Forest College, Donnelley Library (1962).
Lebanon: McKendree College, Holman Library (1968).
Lisle: Illinois Benedictine College, Theodore F. Lownik Library (1911).
Lockport: Lewis University Library (1952).
Macomb: Western Illinois University Memorial Library (1962).
Moline: Black Hawk College, Learning Resources Center (1970).
Monmouth: Monmouth College Library (1860).
Morton Grove: Oakton Community College Library (1976).
Mt. Carmel: Wabash Valley College Library (1975).
Mt. Prospect: Mt. Prospect Public Library (1977).
Normal: Illinois State University, Milner Library (1877).
Oak Park: Oak Park Public Library (1963).
Oglesby: Illinois Valley Community College Library (1976).
Palos Hills: Moraine Valley Community College Library (1972).
Park Forest South: Governors State University Library (1974).

Peoria:
Bradley University, Cullom Davis Library (1963).
Peoria Public Library (1883).
River Forest: Rosary College Library (1966).
Rockford: Rockford Public Library (unknown).
Springfield: Illinois State Library (unknown)–REGIONAL.
Urbana: University of Illinois Library (1907).
Wheaton: Wheaton College Library (1964).
Woodstock: Woodstock Public Library (1963).

INDIANA

Anderson: Anderson College, Charles E. Wilson Library (1959).
Bloomington: Indiana University Library (1881).
Crawfordsville: Wabash College, Lilly Library (1906).
Evansville:
Evansville and Vanderburgh County Public Library (1928).
Indiana State University, Evansville Campus Library (1969).
Fort Wayne:
Indiana-Purdue Universities, Walter E. Helmke Library (1965).
Public Library of Fort Wayne and Allen County (1896).
Franklin: Franklin College Library (1976).
Gary:
Gary Public Library (1943).
Indiana University, Northwest Campus Library (1966).
Greencastle: De Pauw University, Roy O. West Library (1879).
Hammond: Hammond Public Library (1964).
Hanover: Hanover College Library (1892).
Huntington: Huntington College Library (1964).
Indianapolis:
Butler University, Irwin Library (1965).
Indiana State Library (unknown)–REGIONAL.
Indiana Supreme Court Law Library (1975).
Indiana University, Law Library (1967).
Indianapolis-Marion County Public Library (1906).
Kokomo: Indiana University, Kokomo Regional Campus Library (1969).
Lafayette: Purdue University Library (1907).
Muncie:
Ball State University Library (1959).
Muncie Public Library (1906).
New Albany: Indiana University, Southeastern Campus Library (1965).
Notre Dame: University of Notre Dame, Memorial Library (1883).
Rensselaer: St. Joseph's College Library (1964).
Richmond:
Earlham College, Lilly Library (1964).
Morrison-Reeves Library (1906).
South Bend: Indiana University at South Bend Library (1965).
Terre Haute: Indiana State University, Cunningham Memorial Library (1906).
Valparaiso: Valparaiso University, Moellering Memorial Library (1930).

IOWA

Ames: Iowa State University of Science and Technology Library (1907).
Cedar Falls: University of Northern Iowa Library (1946).
Council Bluffs:
Free Public Library (1885).
Iowa Western Community College, Hoover Media Library (1972).
Davenport: Davenport Public Library (1973).
Des Moines:
Drake University, Cowles Library (1966).
Drake University Law Library (1972).
State Library Commission of Iowa (unknown).
Public Library of Des Moines (1888).
Dubuque:
Carnegie-Stout Public Library (unknown).
Loras College, Wahlert Memorial Library (1967).
Fayette: Upper Iowa College, Henderson-Wilder Library (1974).
Grinnell: Grinnell College, Burling Library (1874).
Iowa City:
University of Iowa, Law Library (1968).
University of Iowa Library (1884)–REGIONAL.
Lamoni: Graceland College, Frederick Madison Smith Library (1927).
Mason City: North Iowa Area Community College Library (1976).
Mount Vernon: Cornell College, Russell D. Cole Library (1896).
Orange City: Northwestern University, Ramaker Library (1970).
Sioux City: Sioux City Public Library (1894).

KANSAS

Atchison: Benedictine College Library (1965).
Baldwin City: Baker University Library (1908).
Colby: Colby Community Junior College Library (1968).
Emporia: Emporia State University, William Allen White Library (1909).
Hays: Fort Hays Kansas State College, Forsyth Library (1926).
Hutchinson: Hutchinson Public Library (1963).
Lawrence:
University of Kansas, Watson Library (1869)–REGIONAL.
University of Kansas Law Library (1971).
Manhattan: Kansas State University, Farrell Library (1907).
Pittsburg: Pittsburg State University, Porter Library (1952).
Salina: Kansas Wesleyan University, Memorial Library (1930).
Topeka:
Kansas State Historical Society Library (1877).
Kansas State Library (unknown).
Kansas Supreme Court Law Library (1975).
Washburn University of Topeka, Law Library (1971).
Wichita: Wichita State University Library (1901).

KENTUCKY

Ashland: Ashland Public Library (1946).
Barbourville: Union College, Abigail E. Weeks Memorial Library (1958).
Bowling Green: Western Kentucky University, Cravens Graduate Center and Library (1934).
Covington: Thomas More College Library (1970).
Danville: Centre College, Grace Doherty Library (1884).
Frankfort:
Kentucky Department of Libraries (1967).
Kentucky State University, Blazer Library (1972).
State Law Library (unknown).
Highland Heights: Northern Kentucky University, W. Frank Steely Library (1973).
Hopkinsville: Hopkinsville Community College Library (1976).
Lexington:
University of Kentucky, Law Library (1968).
University of Kentucky, Margaret I. King Library (1907)–REGIONAL.
Louisville:
Louisville Free Public Library (1904).
University of Louisville, Belknap Campus Library (1925).
University of Louisville Law Library (1975).
Morehead: Morehead State University, Johnson Camden Library (1955).
Murray: Murray State University Library (1924).
Owensboro: Kentucky Wesleyan College Library (1966).
Richmond: Eastern Kentucky University, John Grant Crabbe Library (1966).

LOUISIANA

Baton Rouge:
- Louisiana State Library (1976).
- Louisiana State University Law Library (1929).
- Louisiana State University Library (1907)–REGIONAL.
- Southern University Library (1952).

Eunice: Louisiana State University at Eunice, Le Doux Library (1969).
Hammond: Southeastern Louisiana University, Sims Memorial Library (1966).
Lafayette: University of Southwestern Louisiana Library (1938).
Lake Charles: McNeese State University, Frazar Memorial Library (1941).
Monroe: Northeast Louisiana University, Sandel Library (1963).
Natchitoches: Northwestern State University, Watson Memorial Library (1887).
New Orleans:
- Isaac Delgado College, Moss Technical Library (1968).
- Law Library of Louisiana (unknown).
- Loyola University Library (1942).
- New Orleans Public Library (1883).
- Southern University in New Orleans Library (1962).
- Tulane University, Howard-Tilton Memorial Library (1942).
- Tulane University Law Library (1976).
- U.S. Court of Appeals, Fifth Circuit Library (1973).
- University of New Orleans Library (1963).

Pineville: Louisiana College, Richard W. Norton Memorial Library (1969).
Ruston: Louisiana Technical University Library (1896)–REGIONAL.
Shreveport:
- Louisiana State University at Shreveport Library (1967).
- Shreve Memorial Library (1923).

Thibodaux: Francis T. Nicholls State University, Leonidas Polk Library (1962).

MAINE

Augusta:
- Maine Law and Legislative Reference Library (1973).
- Maine State Library (unknown).

Bangor: Bangor Public Library (1884).
Brunswick: Bowdoin College, Hawthorne-Longfellow Library (1884).
Castine: Maine Maritime Academy, Nutting Memorial Library (1969).
Lewiston: Bates College Library (1882).
Orono: University of Maine, Raymond H. Fogler Library (1907)–REGIONAL.
Portland:
- Portland Public Library (1884).
- University of Maine Law Library (1964).

Springvale: Nasson College Library (1961).
Waterville: Colby College Library (1884).

MARYLAND

Annapolis:
- Maryland State Library (unknown).
- U.S. Naval Academy, Nimitz Library (1895).

Baltimore:
- Enoch Pratt Free Library (1887).
- Johns Hopkins University, Milton S. Eisenhower Library (1882).
- Morgan State College, Soper Library (1940).
- University of Baltimore, Langsdale Library (1973).
- University of Maryland, Baltimore County Library (1971).
- University of Maryland, School of Law Library (1969).

Bel Air: Harford Community College Library (1967).
Beltsville: Department of Agriculture, National Agricultural Library (1895).
Bethesda: National Library of Medicine Library (1978).
Chestertown: Washington College, Chester M. Miller Library (1891).
College Park: University of Maryland, McKeldin Library (1925)–REGIONAL.
Cumberland: Allegany Community College Library (1974).
Frostburg: Frostburg State College Library (1967).
Germantown: Energy Research & Development Adm. Library (1963).
Patuxent River: Naval Air Station Library (1968).
Rockville: Montgomery County Department of Public Libraries (1951).
Salisbury: Salisbury State College, Blackwell Library (1965).
Towson: Goucher College, Julia Rogers Library (1966).
Westminster: Western Maryland College Library (1896).

MASSACHUSETTS

Amherst:
- Amherst College Library (1884).
- University of Massachusetts, Godell Library (1907).

Belmont: Belmont Memorial Library (1968).
Boston:
- Boston Athenaeum Library (unknown).
- Boston College, Bapst Library (1963).
- Boston Public Library (1859)–REGIONAL.
- Northeastern University, Dodge Library (1962).
- State Library of Massachusetts (unknown).

Brookline: Public Library of Brookline (1925).
Cambridge:
- Harvard College Library (1860).
- Massachusetts Institute of Technology Libraries (1946).
- Middlesex County Law Library (1978).

Chicopee: Our Lady of the Elms College Library (1969).
Lowell: University of Lowell/North Campus, Alumni/Lydon Library (1952).
Lynn: Lynn Public Library (1953).
Marlborough: Marlborough Public Library (1971).
Medford: Tufts University Library (1899).
Milton: Curry College Library (1972).
New Bedford: New Bedford Free Public Library (1858).
North Dartmouth: Southeastern Massachusetts University Library (1965).
North Easton: Stonehill College, Cushing-Martin Library (1962).
Springfield: Springfield City Library (1966).
Waltham: Brandeis University, Goldfarb Library (1965).
Wellesley: Wellesley College Library (1943).
Wenham: Gordon College, Winn Library (1963).
Williamstown: Williams College Library (unknown).
Worcester:
- American Antiquarian Society Library (1814).
- University of Massachusetts, Medical Center Library (1972).
- Worcester Public Library (1859).

MICHIGAN

Albion: Albion College, Stockwell Memorial Library (1966).
Allendale: Grand Valley State College Library (1963).
Alma: Alma College, Monteith Library (1963).
Ann Arbor:
- Great Lakes Basin Commission Library (1971).
- University of Michigan, Harlan Hatcher Library (1884).

Benton Harbor: Benton Harbor Public Library (1907).
Bloomfield Hills: Cranbrook Institute of Science Library (1940).
Dearborn:
- Henry Ford Centennial Library (1969).
- Henry Ford Community College Library (1957).

Detroit:
- Detroit Public Library (1868)–REGIONAL.

Marygrove College Library (1965).
Mercy College of Detroit Library (1965).
University of Detroit Library (1884).
Wayne State University Law Library (1971).
Wayne State University, G. Flint Purdy Library (1973).
Dowagiac: Southwestern Michigan College Library (1971).
East Lansing:
Michigan State University, Law Library (1971).
Michigan State University Library (1907).
Escanaba: Michigan State Library, Upper Peninsula Branch (1964).
Farmington: Martin Luther King Learning Resources Center, Oakland Community College (1968).
Flint:
Flint Public Library (1967).
University of Michigan, Flint Library (1959).
Grand Rapids:
Calvin College Library (1967).
Grand Rapids Public Library (1876).
Houghton: Michigan Technological University Library (1876).
Jackson: Jackson District Library (1965).
Kalamazoo:
Kalamazoo Library System (1907).
Western Michigan University, Dwight B. Waldo Library (1963).
Lansing: Michigan State Library (unknown)-REGIONAL.
Livonia: Schoolcraft College Library (1962).
Marquette: Northern Michigan University, Olsen Library (1963).
Monroe: Monroe County Library System (1974).
Mt. Clemens: Macomb County Library (1968).
Mt. Pleasant: Central Michigan University Library (1958).
Muskegon: Hackley Public Library (1894).
Olivet: Olivet College Library (1974).
Petoskey: North Central Michigan College Library (1962).
Port Huron: Saint Clair County Library System (1876).
Rochester: Oakland University, Kresge Library (1964).
Saginaw: Hoyt Public Library (1890).
Traverse City: Northwestern Michigan College, Mark Osterlin Library (1964).
University Center: Delta College Library (1963).
Warren: Warren Public Library, Arthur J. Miller Branch (1973).
Wayne: Wayne Oakland Federated Library System (1957).
Ypsilanti: Eastern Michigan University Library (1965).

MINNESOTA

Bemidji: Bemidji State University, A. C. Clark Library (1963).
Collegeville: St. John's University, Alcuin Library (1954).
Duluth: Duluth Public Library (1909).
Mankato: Mankato State University Memorial Library (1962).
Minneapolis:
Anoka County Library (1971).
Hennepin County Libraries (1971).
Minneapolis Public Library (1893).
University of Minnesota, Wilson Library (1907)-REGIONAL.
Moorhead: Moorhead State University Library (1956).
Morris: University of Minnesota at Morris Library (1963).
Northfield:
Carleton College Library (1930).
St. Olaf College, Rolvaag Memorial Library (1930).
St. Cloud: St. Cloud State University Library (1962).
St. Paul:
Minnesota Historical Society Library (1867).
Minnesota State Law Library (unknown).
St. Paul Public Library (1914).
University of Minnesota, St. Paul Campus Library (1974).
Saint Peter: Gustavus Adolphus College Library (1941).
Stillwater: Stillwater Public Library (1893).
Willmar: Crow River Regional Library (1958).
Winona: Winona State University, Maxwell Library (1969).

MISSISSIPPI

Cleveland: Delta State University, W. B. Roberts Library (1975)
Clinton: Mississippi College School of Law Library (1977).
Columbus: Mississippi State University for Women, J. C. Fant Memorial Library (1920).
Hattiesburg: University of Southern Mississippi Library (1935).
Jackson:
Jackson State College Library (1968).
Millsaps College, Millsaps-Wilson Library (1963).
Mississippi Library Commission (1947).
Mississippi State Law Library (unknown).
Lorman: Alcorn Agricultural and Mechanical College Library (1970).
State College: Mississippi State University, Mitchell Memorial Library (1907).
University:
University of Mississippi Library (1833)-REGIONAL.
University of Mississippi, School of Law Library (1967).

MISSOURI

Cape Girardeau: Southeast Missouri State University, Kent Library (1916).
Columbia: University of Missouri Library (1862).
Fayette: Central Methodist College Library (1962).
Fulton: Westminster College, Reeves Library (1875).
Jefferson City:
Lincoln University, Inman E. Page Library (1944).
Missouri State Library (1963).
Missouri Supreme Court Library (unknown).
Joplin: Missouri Southern State College Library (1966).
Kansas City:
Kansas City Public Library (1881).
Rockhurst College Library (1917).
University of Missouri at Kansas City, General Library (1938).
Kirksville: Northeast Missouri State Teachers College, Pickler Memorial Library (1966).
Liberty: William Jewell College Library (1900).
Rolla: University of Missouri at Rolla Library (1907).
St. Charles: Lindenwood College, Margaret Leggat Butler Library (1973).
St. Joseph: St. Joseph Public Library (1891).
St. Louis:
Maryville College Library (1976).
St. Louis County Library (1970).
St. Louis Public Library (1866).
St. Louis University, Law Library (1967).
St. Louis University, Pius XII Memorial Library (1866).
University of Missouri at St. Louis, Thomas Jefferson Library (1966).
U.S. Court of Appeals, Eighth Circuit Library (1972).
Washington University, John M. Olin Library (1906).
Springfield:
Drury College, Walker Library (1874).
Southwest Missouri State College Library (1963).
Warrensburg: Central Missouri State College, Ward Edwards Library (1914).

MONTANA

Billings: Eastern Montana College Library (1924).
Bozeman: Montana State University Library (1907).
Butte: Montana College of Mineral Science and Technology Library (1901).

Helena:
- Carroll College Library (1974).
- Montana Historical Society Library (unknown).
- Montana State Library (1966).
- State Law Library of Montana (1977).

Missoula: University of Montana Library (1909)–REGIONAL.

NEBRASKA

Blair: Dana College, Dana-LIFE Library (1924).
Crete: Doane College, Whitin Library (1944).
Fremont: Midland Lutheran College Library (1924).
Kearney: Kearney State College, Calvin T. Ryan Library (1962).
Lincoln:
- Nebraska Publications Clearinghouse, Nebraska Library Commission (1972)–REGIONAL.
- Nebraska State Library (unknown).
- University of Nebraska, Don L. Love Memorial Library (1907)–JOINT REGIONAL.

Omaha:
- Creighton University, Alumni Library (1964).
- Omaha Public Library (1880).
- University of Nebraska at Omaha, University Library (1939).

Scottsbluff: Scottsbluff Public Library (1925).
Wayne: Wayne State College, U.S. Conn. Library (1970).

NEVADA

Carson City:
- Nevada State Library (unknown).
- Nevada Supreme Court Library (1973).

Las Vegas:
- Clark County District Library (1974).
- University of Nevada at Las Vegas, James R. Dickinson Library (1959).

Reno:
- Nevada State Historical Society Library (1974).
- University of Nevada Library (1907)–REGIONAL

NEW HAMPSHIRE

Concord:
- Franklin Pierce Law Center Library (1973).
- New Hampshire State Library (unknown).

Durham: University of New Hampshire Library (1907).
Franconia: Franconia College Library (1972).
Hanover: Dartmouth College, Baker Library (1884).
Henniker: New England College Library (1966).
Manchester:
- Manchester City Library (1884).
- New Hampshire College, H.A.B. Shapiro Memorial Library (1976).
- St. Anselm's College, Geise Library (1963).

Nashua: Nashua Public Library (1971).

NEW JERSEY

Bayonne: Bayonne Free Public Library (1909).
Bloomfield: Free Public Library of Bloomfield (1965).
Bridgeton: Cumberland County Library (1966).
Camden: Rutgers University-Camden Library (1966).
Convent Station: College of St. Elizabeth, Mahoney Library (1938).
Dover: County College of Morris Library, Learning Resources Center (1975).
East Brunswick: East Brunswick Public Library (1977).
East Orange: East Orange Public Library (1966).
Elizabeth: Free Public Library of Elizabeth (1895).
Glassboro: Glassboro State College, Savitz Learning Resource Center (1963).
Hackensack: Johnson Free Public Library (1966).
Irvington: Free Public Library of Irvington (1966).
Jersey City:
- Free Public Library of Jersey City (1879).
- Jersey City State College, Forrest A. Irwin Library (1963).

Lawrenceville: Rider College Library (1975).
Madison: Drew University, Rose Memorial Library (1939).
Mahwah: Ramapo College Library (1971).
Mount Holly: Burlington County Library (1966).
New Brunswick:
- Free Public Library (1908).
- Rutgers University Library (1907).

Newark:
- Newark Public Library (1906)–REGIONAL.
- Rutgers-The State University, John Cotton Dana Library (1966).

Passaic: Passaic Public Library (1964).
Phillipsburg: Phillipsburg Free Public Library (1976).
Plainfield: Plainfield Public Library (1971).
Pomona: Stockton State College Library (1972).
Princeton: Princeton University Library (1884).
Rutherford: Fairleigh Dickinson University, Messler Library (1953).
Shrewsbury: Monmouth County Library (1968).
South Orange: Seton Hall University Library (1947).
Teaneck: Fairleigh Dickinson University, Teaneck Campus Library (1963).
Toms River: Ocean County College Learning Resources Center (1966).
Trenton:
- New Jersey State Library, Law and Reference Bureau, Department of Education (unknown).
- Trenton Free Public Library (1902).

Union: Kean College of New Jersey, Nancy Thompson Library (1973).
Upper Montclair: Montclair State College, Harry A. Sprague Library (1967).
Wayne: Wayne Public Library (1972).
West Long Branch: Monmouth College, Guggenheim Memorial Library (1963).
Woodbridge: Free Public Library of Woodbridge (1965).

NEW MEXICO

Albuquerque:
- University of New Mexico, Medical Center Library (1973).
- University of New Mexico, School of Law Library (1973).
- University of New Mexico, Zimmerman Library (1896)–REGIONAL.

Hobbs: New Mexico Junior College, Pannell Library (1969).
Las Cruces: New Mexico State University Library (1907).
Las Vegas: New Mexico Highlands University, Donnelly Library (1913).
Portales: Eastern New Mexico University Library (1962).
Santa Fe:
- New Mexico State Library (1960)–REGIONAL.
- Supreme Court Law Library (unknown).

Silver City: Western New Mexico University, Miller Library (1972).

NEW YORK

Albany:
- New York State Library (unknown)–REGIONAL.
- State University of New York at Albany Library (1964).

Auburn: Seymour Library (1972).

Bayside: Queensborough Community College Library (1972).
Binghamton: State University of New York at Binghamton Library (1962).
Brockport: State University of New York, Drake Memorial Library (1967).
Bronx:
- Herbert H. Lehman College Library (1967).
- New York Public Library, Mott Haven Branch (1973).

Bronxville: Sarah Lawrence College Library (1969).
Brooklyn:
- Brooklyn College Library (1936).
- Brooklyn Law School, Law Library (1974).
- Brooklyn Public Library (1908).
- Polytechnic Institute of Brooklyn, Spicer Library (1963).
- Pratt Institute Library (1891).
- State University of New York, Downstate Medical Center Library (1958).

Buffalo:
- Buffalo and Erie County Public Library (1895).
- State University of New York at Buffalo, Lockwood Memorial Library (1963).

Canton: St. Lawrence University, Owen D. Young Library (1920).
Cheektowago: Cheektowago Public Library (1978).
Corning: Corning Community College, Arthur A. Houghton, Jr. Library (1963).
Cortland: State University of New York, College at Cortland, Memorial Library (1964).
Delhi: State University Agricultural and Technical College Library (1970).
Douglaston: Cathedral College Library (1971).
East Islip: East Islip Public Library (1974).
Elmira: Elmira College, Gannett-Tripp Learning Center (1956).
Farmingdale: State University Agricultural and Technical Institute at Farmingdale Library (1917).
Flushing: Queens College, Paul Klapper Library (1939).
Garden City: Adelphi University, Swirbul Library (1966).
Geneseo: State University College, Milne Library (1967).
Greenvale: C. W. Post College, B. Davis Schwartz Memorial Library (1965).
Hamilton: Colgate University Library (1902).
Hempstead: Hofstra University Library (1964).
Ithaca:
- Cornell University Library (1907).
- New York State Colleges of Agriculture and Home Economics, Albert R. Mann Library (1943).

Jamaica:
- Queens Borough Public Library (1926).
- St. John's University Library (1956).

Kings Point: U.S. Merchant Marine Academy Library (1962).
Mount Vernon: Mount Vernon Public Library (1962).
New Paltz: State University College Sojourner Truth Library (1965).
New York City:
- City University of New York, City College Library (1884).
- College of Insurance, Ecker Library (1965).
- Columbia University Libraries (1882).
- Cooper Union Library (1930).
- Fordham University Library (1937).
- Medical Library Center of New York (1976).
- New York Law Institute Library (1909).
- New York Public Library (Astor Branch) (1907).
- New York Public Library (Lenox Branch) (1884).
- New York University Libraries (1967).
- New York University, Law Library (1973).
- State University of New York, Maritime College Library (1947).
- U.S. Court of Appeals Library (1976).

Newburgh: Newburgh Free Library (1909).
Niagara Falls: Niagara Falls Public Library (1976).
Oakdale: Dowling College Library (1965).
Oneonta: State University College, James M. Milne Library (1966).
Oswego: State University College, Penfield Library (1966).
Plattsburgh: State University College, Benjamin F. Feinberg Library (1967).
Potsdam:
- Clarkson College of Technology, Harriet Call Burnap Memorial Library (1938).
- State University College, Frederick W. Crumb Memorial Library (1964).

Poughkeepsie: Vassar College Library (1943).
Purchase: State University of New York, College at Purchase Library (1969).
Rochester:
- Rochester Public Library (1963).
- University of Rochester Library (1880).

St. Bonaventure: St. Bonaventure College, Friedsam Memorial Library (1938).
Saratoga Springs: Skidmore College Library (1964).
Schenectady: Union College, Schaffer Library (1901).
Southampton: Southampton College Library (1973).
Staten Island (Grymes Hill): Wagner College, Horrmann Library (1953).
Stony Brook: State University of New York at Stony Brook Library (1963).
Syracuse: Syracuse University Library (1878).
Troy: Troy Public Library (1869).
Uniondale: Nassau Library System (1965).
Utica:
- Utica Public Library (1885).
- Utica/Rome State University College Library (1977).

West Point: U.S. Military Academy Library (unknown).
Yonkers: Yonkers Public Library (1910).
Yorktown Heights: Mercy College at Fox Meadow Library.

NORTH CAROLINA

Asheville: University of North Carolina at Asheville, D. Hiden Ramsey Library (1965).
Boiling Springs: Gardner-Webb College, Dover Memorial Library (1974).
Boone: Appalachian State University Library (1963).
Buies Creek: Campbell College, Carrie Rich Memorial Library (1965).
Chapel Hill: University of North Carolina Louis Round Wilson Library (1884)–REGIONAL.
Charlotte:
- Public Library of Charlotte and Mecklenburg County (1964).
- Queens College, Everette Library (1927).
- University of North Carolina at Charlotte, Atkins Library (1964).

Cullowhee: Western Carolina University, Hunter Library (1953).
Davidson: Davidson College, Hugh A. & Jane Grey Memorial Library (1893).
Durham:
- Duke University, William R. Perkins Library (1890).
- North Carolina Central University, James E. Shepard Memorial Library (1973).

Elon College: Elon College Library (1971).
Fayetteville: Fayetteville State University, Chesnutt Library (1971).
Greensboro:
- North Carolina Agricultural and Technical State University, F. D. Bluford Library (1937).
- University of North Carolina at Greensboro, Walter Clinton Jackson Library (1963).

Greenville: East Carolina University, J. Y. Joyner Library (1951).
Laurinburg: St. Andrews Presbyterian College, DeTamble Library (1969).
Lexington: Davidson County Public Library System (1971).

Mount Olive: Mount Olive College, Moye Library (1971).
Murfreesboro: Chowan College, Whitaker Library (1963).
Pembroke: Pembroke State University, Mary Livermore Library (1965).
Raleigh:
North Carolina State Library (unknown).
North Carolina State University, D. H. Hill Library (1923).
North Carolina Supreme Court Library (1972).
Wake County Public Libraries (1969).
Rocky Mount: North Carolina Wesleyan College Library (1969).
Salisbury: Catawba College Library (1925).
Wilmington: University of North Carolina at Wilmington, William M. Randall Library (1965).
Wilson: Atlantic Christian College, Clarence L. Hardy Library (1930).
Winston-Salem:
Forsyth County Public Library System (1954).
Wake Forest University, Z. Smith Reynolds Library (1902).

NORTH DAKOTA

Bismarck:
North Dakota State Law Library (unknown).
State Historical Society of North Dakota (1907).
State Library Commission Library (1971).
Veterans Memorial Public Library (1967).
Dickinson: Dickinson State College Library (1968).
Fargo:
Fargo Public Library (1964).
North Dakota State University Library (1907)-REGIONAL, in cooperation with University of North Dakota, Chester Fritz Library at Grand Forks.
Grand Forks: University of North Dakota, Chester Fritz Library (1890).
Minot: Minot State College, Memorial Library (1925).
Valley City: State College Library (1913).

OHIO

Ada: Ohio Northern University, J. P. Taggart Law Library (1965).
Akron:
Akron Public Library (1952).
University of Akron Library (1963).
Alliance: Mount Union College Library (1888).
Ashland: Ashland College Library (1938).
Athens: Ohio University Library (1886).
Batavia: Clermont General and Technical College Library (1973).
Bluffton: Bluffton College, Musselman Library (1951).
Bowling Green: Bowling Green State University Library (1933).
Canton: Malone College, Everett L. Cattell Library (1970).
Chardon: Geauga County Public Library (1971).
Cincinnati:
Public Library of Cincinnati and Hamilton County (1884).
University of Cincinnati Library (1929).
Cleveland:
Case Western Reserve University, Freiberger Library (1913).
Cleveland Heights-University Heights Public Library (1970).
Cleveland Public Library (1886).
Cleveland State University Library (1966).
John Carroll University, Grasselli Library (1963).
Municipal Reference Library (1970).
Columbus:
Capital University Library (1968).
Ohio State Library (unknown)-REGIONAL.
Ohio State University, William Oxley Thompson Memorial Library (1907).
Ohio Supreme Court Law Library (1973).
The Public Library of Columbus and Franklin County (1885).
Dayton:
Dayton and Montgomery County Public Library (1909).
University of Dayton, Albert Emanuel Library (1969).
Wright State University Library (1965).
Delaware: Ohio Wesleyan University, L. A. Beeghly Library (1845).
Elyria: Elyria Public Library (1966).
Findlay: Findlay College, Shafer Library (1969).
Gambier: Kenyon College, Gordon Keith Chalmers Memorial Library (1873).
Granville: Denison University, William Howard Doane Library (1884).
Hiram: Hiram College, Teachout-Price Memorial Library (1874).
Kent: Kent State University Library (1962).
Marietta: Marietta College, Dawes Memorial Library (1884).
Middletown: Miami University at Middletown, Gardner-Harvey Library (1970).
New Concord: Muskingum College Library (1966).
Oberlin: Oberlin College Library (1858).
Oxford: Miami University, Alumni Library (1909).
Portsmouth: Portsmouth Public Library (unknown).
Rio Grande: Rio Grande College, Jeanette Albiez Davis Library (1966).
Springfield: Warder Public Library (1884).
Steubenville:
College of Steubenville, Starvaggi Memorial Library (1971).
Public Library of Steubenville and Jefferson County (1950).
Tiffin: Heidelberg College, Leon A. Beeghly Library (1964).
Toledo:
Toledo-Lucas County Public Library (1884).
University of Toledo Library (1965).
Westerville: Otterbein College (1967).
Wooster: College of Wooster, the Andrews Library (1966).
Youngstown:
Public Library of Youngstown and Mahoning County (1923).
Youngstown State University, William F. Maag Library (1971).

OKLAHOMA

Ada: East Central Oklahoma State University, Linscheid Library (1914).
Alva: Northwestern Oklahoma State University Library (1907).
Bartlesville: United States ERDA-BERC Library (1962).
Bethany: Bethany Nazarene College, R. T. Williams Library (1971).
Durant: Southeastern Oklahoma State University Library (1929).
Edmond: Central State University Library (1934).
Enid: Public Library of Enid and Garfield County (1908).
Langston: Langston University, G. Lamar Harrison Library (1941).
Muskogee: Muskogee Public Library (1971).
Norman: University of Oklahoma Libraries (1893).
Oklahoma City:
Oklahoma County Libraries (1974).
Oklahoma City University Library (1963).
Oklahoma Department of Libraries (1893)-REGIONAL.
Shawnee: Oklahoma Baptist University Library (1933).
Stillwater: Oklahoma State University Library (1907).
Tahlequah: Northeastern Oklahoma State University, John Vaughan Library (1923).
Tulsa:
Tulsa City-County Library Commission (1963).
University of Tulsa, McFarlin Library (1929).
Weatherford: Southwestern Oklahoma State University, Al Harris Library (1958).

OREGON

Ashland: Southern Oregon College Library (1953).
Corvallis: Oregon State University Library (1907).
Eugene: University of Oregon Library (1883).
Forest Grove: Pacific University Library (1897).
La Grande: Eastern Oregon College, Walter M. Pierce Library (1954).
McMinnville: Linfield College, Northup Library (1965).
Monmouth: Oregon College of Education Library (1967).
Portland:
- Department of Energy, Bonneville Power Administration Library (1962).
- Lewis and Clark College, Aubrey R. Watzek Library (1967).
- Library Association of Portland (1884).
- Portland State University Library (1963)–REGIONAL.
- Reed College Library (1912).

Salem:
- Oregon State Library (unknown).
- Oregon Supreme Court Library (1974).
- Willamette University Library (1969).

PENNSYLVANIA

Allentown: Muhlenberg College, Haas Library (1939).
Allegheny: Alleghany County Law Library (1977).
Altoona: Altoona Public Library (1969).
Bethlehem: Lehigh University, Linderman Library (1876).
Blue Bell: Montgomery County Community College, Learning Resources Center (1975).
Carlisle: Dickinson College, Boyd Lee Spahr Library (1947).
Cheyney: Cheyney State College, Leslie Pinckney Hill Library (1947).
Collegeville: Ursinus College, Myrin Library (1963).
Coraopolis: Robert Morris College Library (1978).
Doylestown: Bucks County Free Library, Center County Library (1970).
East Stroudsburg: East Stroudsburg State College, Kemp Library (1966).
Erie: Erie Public Library (1897).
Greenville: Thiel College, Langenheim Memorial Library (1963).
Harrisburg: State Library of Pennsylvania (unknown)–REGIONAL.
Haverford: Haverford College Library (1897).
Hazleton: Hazleton Area Public Library (1964).
Indiana: Indiana University of Pennsylvania, Rhodes R. Stabley Library (1962).
Johnstown: Cambria Public Library (1965).
Lancaster: Franklin and Marshall College, Fackenthal Library (1895).
Lewisburg: Bucknell University, Ellen Clarke Bertrand Library (1963).
Mansfield: Mansfield State College Library (1968).
Meadville: Allegheny College, Reis Library (1907).
Millersville: Millersville State College, Ganser Library (1966).
Monessen: Monessen Public Library (1969).
New Castle: New Castle Free Public Library (1963).
Newtown: Bucks County Community College Library (1968).
Norristown: Montgomery County-Norristown Public Library (1969).
Philadelphia:
- Drexel University Library (1963).
- Free Library of Philadelphia (1897).
- St. Joseph's College Library (1974).
- Temple University, Samuel Paley Library (1947).
- Thomas Jefferson University, Scott Memorial Library (1978).
- U.S. Court of Appeals, Third Circuit (1973).
- University of Pennsylvania, Biddle Law Library (1974).
- University of Pennsylvania Library (1886).

Pittsburgh:
- Bureau of Mines, Pittsburgh Research Center Library (1962).
- Carnegie Library of Pittsburgh, Allegheny Regional Branch (1924).
- Carnegie Library of Pittsburgh (1895).
- La Roche College, John J. Wright Library (1974).
- University of Pittsburgh, Hillman Library (1910).

Pottsville: Pottsville Free Public Library (1967).
Reading: Reading Public Library (1901).
Scranton: Scranton Public Library (1895).
Shippensburg: Shippensburg State College, Ezra Lehman Memorial Library (1973).
Slippery Rock: Slippery Rock State College, Maltby Library (1965).
Swarthmore: Swarthmore College Library (1923).
University Park: Pennsylvania State University Library (1907).
Villanova: Villanova University, School of Law Library (1964).
Warren: Warren Library Association, Warren Public Library (1885).
Washington: Washington and Jefferson College, Memorial Library (1884).
Waynesburg: Waynesburg College Library (1964).
West Chester: West Chester State College, Francis Harvey Green Library (1967).
Wilkes-Barre: King's College, D. Leonard Corgan Library (1949).
Williamsport: Lycoming College Library (1970).
York: York Junior College Library (1963).
Youngwood: Westmoreland County Community College, Learning Resource Center (1972).

PUERTO RICO

Mayaguez: University of Puerto Rico, Mayaguez Campus Library (1928).
Ponce: Catholic University of Puerto Rico Library (1966).
Rio Piedras: University of Puerto Rico General Library (1928).

RHODE ISLAND

Kingston: University of Rhode Island Library (1907).
Newport: Naval War College Library (1963).
Providence:
- Brown University, John D. Rockefeller, Jr. Library (unknown).
- Providence College, Phillips Memorial Library (1969).
- Providence Public Library (1884).
- Rhode Island College Library (1965).
- Rhode Island State Library (before 1895).

Warwick: Warwick Public Library (1966).
Westerly: Westerly Public Library (1909).
Woonsocket: Woonsocket Harris Public Library (1977).

SOUTH CAROLINA

Charleston:
- Baptist College at Charleston Library (1967).
- College of Charleston, Robert Scott Small Library (1869).
- The Citadel Memorial Library (1962).

Clemson: Clemson University Library (1893).
Columbia:
- Benedict College, Learning Resources Center (1969).
- Richland County Public Library (1978).
- South Carolina State Library (before 1895).

University of South Carolina Undergraduate Library (1884).
Conway: University of South Carolina, Coastal Carolina Regional Campus Library (1974).
Due West: Erskine College, McCain Library (1968).
Florence:
Florence County Library (1967).
Francis Marion College, James A. Rogers Library (1970).
Greenville:
Furman University Library (1962).
Greenville County Library (1966).
Greenwood: Lander College Library (1967).
Orangeburg: South Carolina State College, Whittaker Library (1953).
Rock Hill: Winthrop College Library (1896).
Spartanburg: Spartanburg County Public Library (1967).

SOUTH DAKOTA

Aberdeen: Northern State College Library (1963).
Brookings: South Dakota State University, Hilton M. Briggs Library (1889).
Pierre: South Dakota State Library (1973).
Rapid City:
Rapid City Public Library (1963).
South Dakota School of Mines and Technology Library (1963).
Sioux Falls:
Augustana College, Mikkelsen Library and Learning Resources Center (1969).
Sioux Falls Public Library (1903).
Spearfish: Black Hills State College Library (1942).
Vermillion: University of South Dakota, I. D. Weeks Library (1889).
Yankton: Yankton College, Corliss Lay Library (1904).

TENNESSEE

Bristol: King College Library (1970).
Chattanooga:
Chattanooga-Hamilton County Bicentennial Library (1908).
TVA Technical Library (1976).
Clarksville: Austin Peay State University, Felix G. Woodward Library (1945).
Cleveland: Cleveland State Community College Library (1973).
Columbia: Columbia State Community College Library (1973).
Cookeville: Tennessee Technological University, Jere Whitson Memorial Library (1969).
Jackson: Lambuth College, Luther L. Gobbel Library (1967).
Jefferson City: Carson-Newman College Library (1964).
Johnson City: East Tennessee State University, Sherrod Library (1942).
Knoxville:
Public Library of Knoxville and Knox County, Lawson McGhee Library (1973).
University of Tennessee Law Library (1971).
University of Tennessee Library (1907).
Martin: University of Tennessee at Martin Library (1957).
Memphis:
Memphis and Shelby County Public Library and Information Center (1896).
Memphis State University, John W. Brister Library (1966).
Murfreesboro: Middle Tennessee State University, Andrew L. Todd Library (1912).
Nashville:
Fisk University Library (1965).
Joint University Libraries (1884).
Public Library of Nashville and Davidson County (1884).
Tennessee State Law Library (1976).
Tennessee State Library and Archives, State Library Division (unknown).
Tennessee State University, Martha M. Brown Memorial Library (1972).
Vanderbilt University Law Library (1976).
Sewanee: University of the South, Jesse Ball duPont Library (1973).

TEXAS

Abilene: Hardin-Simmons University, Rupert and Pauline Richardson Library (1940).
Arlington:
Arlington Public Library (1970).
University of Texas at Arlington Library (1963).
Austin:
Texas State Law Library (1972).
Texas State Library (unknown)-REGIONAL.
University of Texas at Austin Library (1884).
University of Texas, Lyndon B. Johnson School of Public Affairs Library (1966).
University of Texas, School of Law Library (1965).
Baytown: Lee College Library (1970).
Beaumont: Lamar University Library (1957).
Brownwood: Howard Payne University, Walker Memorial Library (1964).
Canyon: West Texas State University Library (1928).
College Station: Texas Agricultural and Mechanical University Library (1907).
Commerce: East Texas State University Library (1937).
Corpus Christi: Texas A&I University at Corpus Christi Library (1976).
Corsicana: Navarro Junior College Library (1965).
Dallas:
Bishop College, Zale Library (1966).
Dallas Baptist College Library (1967).
Dallas Public Library (1900).
Southern Methodist University, Fondren Library (1925).
University of Texas Health Science Center Library at Dallas (1975).
Denton: North Texas State University Library (1948).
Edinburg: Pan American University Library (1959).
El Paso:
El Paso Public Library (1906).
University of Texas at El Paso Library (1966).
Fort Worth:
Fort Worth Public Library (1905).
Texas Christian University, Mary Couts Burnett Library (1916).
Galveston: Rosenberg Library (1909).
Houston:
Houston Public Library (1884).
North Harris County College, Learning Resource Center (1974).
Rice University, Fondren Library (1967).
University of Houston Library (1957).
Huntsville: Sam Houston State University, Estill Library (1949).
Irving: Irving Municipal Library (1974).
Kingsville: Texas Arts and Industries University Library (1944).
Lake Jackson: Brazosport College Library (1969).
Laredo: Laredo Junior College Library (1970).
Longview: Nicholson Memorial Public Library (1961).
Lubbock: Texas Tech University Library (1935)-REGIONAL
Marshall: Wiley College, Cole Library (1962).
Mesquite: Mesquite Public Library (1975).
Nacogdoches: Stephen F. Austin State University, Steen Library (1965).
Plainview: Wayland Baptist College, Van Howeling Memorial Library (1963).
Richardson: University of Texas at Dallas Library (1972).
San Angelo: Angelo State University, Porter Henderson Library (1964).

San Antonio:
- San Antonio College Library (1972).
- San Antonio Public Library, Business and Science Department (1899).
- St. Mary's University Library (1964).
- Trinity University Library (1964).
- University of Texas at San Antonio Library (1973).

San Marcos: Southwest Texas State University Library (1955).
Seguin: Texas Lutheran College, Blumberg Memorial Library (1970).
Sherman: Austin College, Arthur Hopkins Library (1963).
Texarkana: Texarkana Community College, Palmer Memorial Library (1963).
Victoria: University of Houston, Victoria Campus Library (1973).
Waco: Baylor University Library (1905).
Wichita Falls: Midwestern University, Moffett Library (1963).

UTAH

Cedar City: Southern Utah State College Library (1964).
Ephraim: Snow College, Lucy A. Phillips Library (1963).
Logan: Utah State University, Merrill Library and Learning Resources Center (1907)–REGIONAL.
Ogden: Weber State College Library (1962).
Provo:
- Brigham Young University, Lee Library (1908).
- Brigham Young University Law Library (1972).

Salt Lake City:
- University of Utah, Spencer S. Eccles Medical Sciences Library (1970).
- University of Utah, Law Library (1966).
- University of Utah, Marriott Library (1893).
- Utah State Library Commission, Documents Library (unknown).
- Utah State Supreme Court Law Library (1975).

VERMONT

Burlington: University of Vermont, Bailey Library (1907).
Castleton: Castleton State College, Calvin Coolidge Library (1969).
Johnson: Johnson State College, John Dewey Library (1955).
Lyndonville: Lyndon State College, Samuel Reed Hall Library (1969).
Middlebury: Middlebury College, Egbert Starr Library (1884).
Montpelier: Vermont Department of Libraries (before 1895).
Northfield: Norwich University Library (1908).
Putney: Windham College, Dorothy Culbertson Marvin Memorial Library (1965).

VIRGIN ISLANDS

Charlotte Amalie (St. Thomas):
- College of the Virgin Islands, Ralph M. Paiewonsky Library (1973).
- St. Thomas Public Library (1968).

Christiansted (St. Croix): Florence Augusta Stephens Williams Public Library (1974).

VIRGINIA

Blacksburg: Virginia Polytechnic Institute, Newman Library (1907).
Bridgewater: Bridgewater College, Alexander Mack Memorial Library (1902).
Charlottesville:
- University of Virginia, Alderman Library (1910)–REGIONAL.
- University of Virginia Law Library (1964).

Chesapeake: Chesapeake Public Library System (1970).
Danville: Danville Community College Library (1969).
Emory: Emory and Henry College Library (1884).
Fairfax: George Mason University, Fenwick Library (1960).
Fredericksburg: Mary Washington College, E. Lee Trinkle Library (1940).
Hampden-Sydney: Hampden-Sydney College, Eggleston Library (1891).
Hampton: Hampton Institute, Huntington Memorial Library (1977).
Harrisonburg: James Madison University, Madison Memorial Library (1973).
Hollins College: Hollins College, Fishburn Library (1967).
Lexington:
- Virginia Military Institute, Preston Library (1874).
- Washington and Lee University, Cyrus Hall McCormick Library (1910).

Martinsville: Patrick Henry Community College Library (1971).
Norfolk:
- Armed Forces Staff College Library (1963).
- Norfolk Public Library (1895).
- Old Dominion University Library (1963).

Petersburg: Virginia State College, Johnston Memorial Library (1907).
Quantico:
- Federal Bureau of Investigation Academy Library (1970).
- Marine Corps Schools, James Carson Breckinridge Library (1967).

Reston: Department of the Interior, Geological Survey Library (1962).
Richmond:
- State Law Library (1973).
- University of Richmond, Boatwright Memorial Library (1900).
- U.S. Court of Appeals, Fourth Circuit Library (1973).
- Virginia Commonwealth University, James Branch Cabell Library (1971).
- Virginia State Library (unknown).

Roanoke: Roanoke Public Library (1964).
Salem: Roanoke College Library (1886).
Williamsburg: William and Mary College Library (1936).
Wise: Clinch Valley College, John Cook Wyllie Library (1971).

WASHINGTON

Bellingham: Western Washington State College, Wilson Library (1963).
Cheney: Eastern Washington State College Library (1966).
Ellensburg: Central Washington University Library (1962).
Everett: Everett Public Library (1914).
Olympia:
- Evergreen State College (1972).
- Washington State Library (unknown)–REGIONAL.

Port Angeles: North Olympic Library System (1965).
Pullman: Washington State University Library (1907).
Seattle:
- Seattle Public Library (1908).
- University of Washington Library (1890).
- University of Washington, School of Law Library (1969).

Spokane: Spokane Public Library (1910).
Tacoma:
- Tacoma Public Library (1894).
- University of Puget Sound, Collins Memorial Library (1938).

Vancouver: Fort Vancouver Regional Library (1962).
Walla Walla: Whitman College, Penrose Memorial Library (1890).

WEST VIRGINIA

Athens: Concord College Library (1924).
Bluefield: Bluefield State College Library (1972).
Charleston:
- Kanawha County Public Library (1952).
- West Virginia College Graduate Studies (1977).
- West Virginia Library Commission (unknown).
- West Virginia Supreme Court Law Library (1977).

Elkins: Davis and Elkins College Library (1913).
Fairmont: Fairmont State College Library (1884).
Glenville: Glenville State College, Robert F. Kidd Library (1966).
Huntington: Marshall University Library (1925).
Institute: West Virginia State College Library (1907).
Morgantown: West Virginia University Library (1907)–REGIONAL.
Salem: Salem College Library (1921).
Shepherdstown: Shepherd College Library (1971).
Weirton: Mary H. Weir Public Library (1963).

WISCONSIN

Appleton: Lawrence University, Seeley G. Mudd Library (1869).
Beloit: Beloit College Libraries (1888).
Eau Claire: University of Wisconsin, Eau Claire, William D. McIntyre Library (1951).
Fond du Lac: Fond du Lac Public Library (1966).
Green Bay: University of Wisconsin at Green Bay Library (1968).
La Crosse:
- La Crosse Public Library (1883).
- University of Wisconsin-La Crosse, Murphy Library (1965).

Madison:
- Department of Public Instruction, Division for Library Services, Reference and Loan Library (1965).
- Madison Public Library (1965).
- State Historical Society Library (1870)–REGIONAL, in cooperation with University of Wisconsin, Memorial Library.
- University of Wisconsin, Memorial Library (1939).
- Wisconsin State Law Library (unknown).

Milwaukee:
- Alverno College Library (1971).
- Milwaukee County Law Library (1934).
- Milwaukee Public Library (1861)–REGIONAL.
- Mount Mary College Library (1964).
- University of Wisconsin-Milwaukee Library (1960).

Oshkosh: University of Wisconsin-Oshkosh, Forrest R. Polk Library (1956).
Platteville: University of Wisconsin-Platteville, Elton S. Karrmann Library (1964).
Racine: Racine Public Library (1898).
River Falls: University of Wisconsin-River Falls, Chalmer Davee Library (1962).
Stevens Point: University of Wisconsin-Stevens Point, Learning Resources Center (1951).
Superior:
- Superior Public Library (1908).
- University of Wisconsin-Superior, Jim Dan Hill Library (1935).

Waukesha: Waukesha Public Library (1966).
Wausau: Marathon County Public Library (1971).
Whitewater: University of Wisconsin-Whitewater, Harold Andersen Library (1963).

WYOMING

Casper: Natrona County Public Library (1929).
Cheyenne:
- Wyoming State Law Library (1977).
- Wyoming State Library (unknown)–REGIONAL.

Laramie: University of Wyoming, Coe Library (1907).
Powell: Northwest Community College Library (1967).
Riverton: Central Wyoming College Library (1969).
Rock Springs: Western Wyoming College Library (1969).
Sheridan: Sheridan College, Mary Brown Kooi Library (1963).

Appendix B. District Offices of the U.S. Department of Commerce

ALABAMA

Birmingham—Gayle C. Shelton, Jr., Director, Suite 200-201, 908 South 20th Street, 35205, Area Code 205 Tel 254-1331, FTS 229-1331

ALASKA

Anchorage—Jack C. Wilburn, Director, 701 C Street, P.O. Box 32, 99513, Area Code 907 Tel 271-5041, FTS Dial 8 399-0150, Ask for 271-5041

ARIZONA

Phoenix—Donald W. Fry, Director, Suite 2950 Valley Bank Center, 201 North Central Avenue 85073, Area Code 602 Tel 261-3285, FTS 261-3285

ARKANSAS

••**Little Rock**—Robert E. Kistler, Director, Suite 635, Savers Federal Building, 320 W. Capitol Avenue, 72201, Area Code 501 Tel 378-5794, FTS 740-5794

•**Jonesboro**—P.O. Box 2525, ASU State University, Arkansas 72467, Area Code 501 Tel 792-4760, FTS 277-4760

CALIFORNIA

••**Los Angeles**—Paul W. Leinenbach, Director, Room 800, 11777 San Vicente Boulevard 90049, Area Code 213 Tel 824-7591, FTS 799-7591

•**San Diego**—110 West C Street, 92101, Area Code 714 Tel 293-5395

San Francisco—Betty D. Neuhart, Director, Federal Building, Box 36013, 450 Golden Gate Avenue 94102, Area Code 415 Tele 556-5860, FTS 556-5868

COLORADO

••**Denver**—Thomas F. Maguire, Room 165, New Customhouse, 19th & Stout Street 80202, Area Code 303 Tel 837-3246, FTS 327-3246

CONNECTICUT

Hartford—Richard C. Kilbourn, Director, Room 610-B, Federal Office Building, 450 Main Street 06103, Area Code 203 Tel 244-3530, FTS 244-3530

FLORIDA

Miami—Roger J. LaRoche, Director, Room 821, City National Bank Building, 25 West Flagler Street 33130, Area Code 305 Tel 350-5267, FTS 350-5267

•**Clearwater**—128 North Osceola Avenue 33515, Area Code 813 Tel 461-0011

•**Jacksonville**—815 S. Main Street, Suite 100, 32207, Area Code 904 Tel 791-2796, FTS 946-2796

•**Tallahassee**—Collins Bldg., Rm. G-20 32304, Area Code 904 Tel 488-6469, FTS 946-4320

GEORGIA

Atlanta—Director, (Vacant) Suite 600, 1365 Peachtree Street, N.E. 30309, Area Code 404 Tel 881-7000, FTS 257-7000

Savannah—James W. McIntire, Director, 222 U.S. Courthouse & P.O. Box 9746, 125-29 Bull Street, 31412, Area Code 912 Tel 232-4321, Ext. 204, FTS 248-4204

HAWAII

Honolulu—H. Tucker Gratz, Director, 4106 Federal Building, P.O. Box 50026, 300 Ala Moana Boulevard 96850, Area Code 808 Tel 546-8694, FTS Dial 8, 556-0220, Ask for 546-8694

ILLINOIS

Chicago—Gerald M. Marks, Director, 1406 Mid Continental Plaza Building, 55 East Monroe Street 60603, Area Code 312 Tel 353-4450, FTS 353-4450

•**Commerce Business Daily** Room 1304, 433 West Van Buren Street 60607, Area Code 312 Tel 353-2950

INDIANA

Indianapolis—Mel R. Sherar, Director, 357 U.S. Courthouse & Federal Office Building, 46 East Ohio Street 46204. Area Code 317 Tel 269-6214, FTS 331-6214

IOWA

Des Moines—Jesse N. Durden, Director, 817 Federal Building, 210 Walnut Street 50309, Area Code 515 Tel 284-4222, FTS 862-4222

KENTUCKY

••**Louisville**—Donald R. Henderson, Director, Room 636, U.S. Post Office and Court House Building 40202, Area Code 502 Tel 582-5066, FTS 352-5066

LOUISIANA

New Orleans—Director (Vacant), 432 International Trade Mart, No. 2 Canal Street 70130, Area Code 504 Tel 589-6546, FTS 682-6546

MAINE

•**Augusta (Boston, Massachusetts District)**—1 Memorial Circle, Casco Bank Bldg., Area Code 207 Tel 623-2239, FTS 833-6249

MARYLAND

Baltimore—Carroll F. Hopkins, Director, 415 U.S. Customhouse, Gay and Lombard Streets 21202, Area Code 301 Tel 962-3560, FTS 922-3560

MASSACHUSETTS

Boston—Francis J. O'Connor, Director 10th Floor, 441 Stuart Street 02116, Area Code 617 Tel 223-2312, FTS 223-2312

MICHIGAN

••**Detroit**—Raymond R. Riesgo, Director, 445 Federal Building, 231 West Layfayette 48226, Area Code 313 Tel 226-3650, FTS 226-3650

•**Grand Rapids**—350 Ottawa Street N.W. 49503, Area Code 616 Tel 456-2411/33 FTS 372-2411

MINNESOTA

Minneapolis—Glenn A. Matson, Director, 218 Federal Building, 110 South Fourth Street 55401, Area Code 612 Tel 725-2133, FTS 725-2133

MISSISSIPPI

••**Jackson**—Director (Vacant), Providence Capitol, Suite 550, 200 East Pascagoula 39201, Area Code 601 Tel 969-4388, FTS 490-4388

MISSOURI

St. Louis—Donald R. Loso, Director, 120 South Central Avenue 63105, Area Code 314 Tel 425-3302-4, FTS 279-3302

••**Kansas City**—James D. Cook, Director, Room 1840, 601 East 12th Street 64106, Area Code 816 Tel 374-3142, FTS 758-3142

NEBRASKA

Omaha—George H. Payne, Director, Capitol Plaza, Suite 703A, 1815 Capitol Avenue 68102, Area Code 402 Tel 221-3665, FTS 864-3665

NEVADA

Reno—Joseph J. Jeremy, Director, 777 W. 2nd Street, Room 120, 89503, Area Code 702 Tel 784-5203, FTS 470-5203

NEW JERSEY

Newark—Thomas J. Murray, Director, 4th Floor, Gateway Building, Market Street & Penn Plaza 07102, Area Code 201 Tel 645-6214, FTS 341-6214

NEW MEXICO

Albuquerque—William E. Dwyer, Director, 505 Marquette Ave., NW, Suite 1015, 87102, Area Code 505 Tel 766-2386, FTS 474-2386

NEW YORK

Buffalo—Robert F. Magee, Director. 1312 Federal Building, 111 West Huron Street 14202, Area Code 716 Tel 846-4191, FTS 437-4191

New York—Arthur C. Rutzen, Director, Room 3718, Federal Office Building, 26 Federal Plaza, Foley Square 10007, Area Code 212 Tel 264-0634, FTS 264-0600

NORTH CAROLINA

Greensboro—Joel B. New, Director, 203 Federal Building, West Market Street, P.O. Box 1950 27402, Area Code 919 Tel 378-5345, FTS 699-5345

OHIO

Cincinnati—Gordon B. Thomas, Director, 10504 Federal Office Building, 550 Main Street 45202, Area Code 513 Tel 684-2944, FTS 684-2944

Cleveland—Charles B. Stebbins, Director, Room 600, 686 Euclid Avenue 44114, Area Code 216 Tel 522-4750, FTS 293-4750

OKLAHOMA

•**Oklahoma City (Dallas, Texas District)**—4024 Lincoln Boulevard 73105, Area Code 405 Tel 231-5302, FTS 736-5302

OREGON

Portland — Lloyd R. Porter, Director, Room 618, 1220 S.W. 3rd Avenue 97204, Area Code 503 Tel 221-3001, FTS 423-3001

PENNSYLVANIA

Philadelphia—Patrick P. McCabe, Director, 9448 Federal Building, 600 Arch Street 19106, Area Code 215 Tel 597-2850, FTS 597-2866

Pittsburgh—William M. Bradley, Director, 2002 Federal Building, 1000 Liberty Avenue 15222, Area Code 412 Tel 644-2850, FTS 722-2850

PUERTO RICO

San Juan (Hato Rey)—Enrique Vilella, Director, Room 659-Federal Building 00918, Area Code 809 Tel 753-4555, Ext. 555, FTS Dial 9 472-6620, Ask for 753-4555

RHODE ISLAND

•**Providence (Boston, Massachusetts District)**—7 Jackson Walkway 02903, Area Code 401 Tel 277-2605, ext. 22, FTS 838-4482

SOUTH CAROLINA

Columbia—Margaret A. Patrick Director, Strom Thurmond Fed. Bldg., Suite 571, 1835 Assembly Street 29201 Area Code 803 Tel 765-5345 FTS 677-5345

•**Charleston**—505 Federal Building, 334 Meeting Street 29403, Area Code 803 Tel 677-4361, FTS 677-4361

TENNESSEE

Memphis—Bradford H. Rice, Director, Room 710, 147 Jefferson Avenue 38103, Area Code 901 Tel 521-3213, FTS 222-3213

•**Nashville**—Room 1020, Andrew Jackson Office Building 37219, Area Code 615 Tel 251-5161 FTS 852-5161

UTAH

Salt Lake City—Director (Vacant), 1201 Federal Building, 125 South State Street 84138, Area Code 801 Tel 524-5116, FTS 588-5116

VIRGINIA

Richmond—Philip A. Ouzts, Director, 8010 Federal Bldg., 400 North 8th Street, 23240, Area Code 804 Tel 771-2246, FTS 925-2246

•**Fairfax**—8550 Arlington Blvd., 22031, Area Code 703 Tel 560-6460, FTS 235-1519

WASHINGTON

Seattle—Judson S. Wonderly, Director, Room 706, Lake Union Building, 1700 Westlake Avenue North 98109, Area Code 206 Tel 442-5615, FTS 399-5615, FOMC 399-5910/11

WEST VIRGINIA

Charleston—Roger L. Fortner, Director, 3000 New Federal Building, 500 Quarrier Street 25301, Area Code 304 Tel 343-6181, ext. 375, FTS 924-1375

WISCONSIN

Milwaukee—Russell H. Leitch, Director, Federal Bldg/U.S. Courthouse, 517 East Wisconsin Avenue 53202, Area Code 414 Tel. 291-3473, FTS 362-3473

WYOMING

Cheyenne—Lowell O. Burns, Director, 6022 O'Mahoney Federal Center, 2120 Capitol Avenue 82001, Area Code 307 Tel 778-2220, ext. 2151, FTS 328-2151

TEXAS

Dallas—C. Carmon Stiles, Director, Room 7A5, 1100 Commerce Street 75242 Area Code 214 Tel 767-0542 FTS 729-0542

Houston—Felicito C. Guerrero, Director, 2625 Federal Bldg., Courthouse, 515 Rusk Street 77002, Area Code 713 Tel 226-4231, FTS 527-4231

Appendix C. CBT Publication Order Numbers and Price List

The National Bureau of Standards, Center for Building Technology (CBT) publications are available from the Government Printing Office, (GPO) or the National Technical Information Service (NTIS). The following table lists the CBT publication numbers, the SD Catalog No. (if available from GPO) or the Order No. (if available from NTIS,) and the most recent price of each document. Page iv provides complete instruction on how to obtain publications.

BUILDING SCIENCE SERIES

	Government Printing Office		National Technical Information Service			Government Printing Office		National Technical Information Service	
Publication Number	SD Catalog No.	Price	Order No.	Price	Publication Number	SD Catalog No.	Price	Order No.	Price
75	SN 003-003-02029-0	$3.00			117	SN 003-003-02008-7	$3.00		
95	SN 003-003-01697-7	$3.00			118	SN 003-003-02041-9	$5.25		
107	SN 003-003-02121-1	$4.75			119	SN 003-003-02042-7	$3.00		
108	SN 003-003-02026-5	$3.00			120	SN 003-003-02063-0	$3.25		
115	SN 003-003-02016-8	$2.30							

TECHNICAL NOTES

971	SN 003-003-02014-1	$ 2.75			996	SN 003-003-02066-4	$ 2.25		
979	SN 003-003-02022-2	$ 3.25			998	SN 003-003-02062-1	$ 2.30		
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☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report presents NBS' Center for Building Technology (CBT) publications for 1979. It is the fourth supplement to NBS Special Publication 457, Building Technology Publications 1965-1975, and lists CBT documents issued or recorded during January 1 - December 31, 1979. It includes titles and abstracts of each NBS publication and each paper published in non-NBS media, key word and author indexes, and general information and instructions on how to order CBT publications.

This document is divided into three main sections. The first, Titles and Abstracts, provides the report title, author(s), date of publication, selected key words, and an abstract of each NBS publication and each paper published in an outside source. The Author Index cites each CBT author and gives the publication number which references documents listed in this supplement. The Key Word Index is a subject index, listing word summaries of the building research topics for each publication and paper. By selecting a main word or subject, which are listed alphabetically, the user is able to locate reports of interest through the subject-related words found in the key word index.

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