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**H**ousing quality is key to the public's health. Translating that simple axiom into action is the topic of this book. In the 30 years since the first edition was published, the nation's understanding of how specific housing conditions are related to disease and injury has matured and deepened. This new edition will enable public health and housing professionals to grasp our shared responsibility to ensure that our housing stock is safe, decent, affordable, and healthy for our citizens, especially those who are particularly vulnerable and who spend more time in the home, such as children and the elderly.

The Centers for Disease Control and Prevention and the U.S. Department of Housing and Urban Development (HUD) have worked together with many others to discover the ways to eliminate substandard housing conditions that harm health. For example, the advances in combating water borne diseases was possible, in part, through standardization of indoor plumbing and sewage, and the institution of federal, state and local regulations and codes. Childhood lead poisoning has been dramatically reduced, in part, through the elimination of residential lead-based paint hazards. Other advances have been made to protect people from carbon monoxide poisoning, falls, safety hazards, electrocution, and many other risks.

However, more must be done to control existing conditions and to understand emerging threats that remain poorly understood. For example, nearly 18 million Americans live with the health threat of contaminated drinking water supplies, especially in rural areas where on-site wastewater systems are prevalent. Despite progress, thousands of children still face the threat of lead poisoning from residential lead paint hazards. The increase in asthma in recent decades and its relationship to housing conditions such as excess moisture, mold, settled dust allergens and ventilation remains the subject of intense research. The impact of energy conservation measures on the home environment is still unfolding. Simple affordable construction techniques and materials that minimize moisture problems and indoor air pollution, improve ventilation, and promote durability and efficiency continue to be uncovered.

A properly constructed and maintained home is nearly timeless in its usefulness. A home is often the biggest single investment people make. This manual will help to ensure that the investment is a sound one that promotes healthy and safe living.

Home rehabilitation has increased significantly in the last few years and HUD has prepared a nine-part series, *The Rehab Guide*, that can assist both residents and contractors in the rehabilitation process. For additional information, go to <http://www.huduser.org/publications/destech/rehabgui.html>.



We acknowledge the suggestions, assistance, and review of numerous individuals and organizations that went into the original and current versions of this manual. The revisions to this manual were made by a team of environmental health, housing, and public health professionals led by Professor Joe Beck, Dr. Darryl Barnett, Dr. Gary Brown, Dr. Carolyn Harvey, Professor Worley Johnson, Dr. Steve Konkel, and Professor Charles Treser.

Individuals from the following organizations were involved in the various drafts of this manual:

- Department of Housing and Urban Development (HUD), Office of Healthy Homes and Lead Hazard Control;
- U.S. Department of Health and Human Services (HHS), Centers for Disease Control and Prevention (CDC), National Center for Environmental Health (NCEH);
- National Healthy Homes Training Center and Network;
- National Association of Housing and Redevelopment Officials;
- Department of Building, Housing and Zoning (Allentown, Pennsylvania);
- Code Enforcement Associates (East Orange, New Jersey);
- Eastern Kentucky University (Richmond, Kentucky);
- University of Washington; Seattle (Washington); and
- Battelle Memorial Institute (Columbus, Ohio).

Specifically, our gratitude goes to the following reviewers:

- Dr. David Jacobs, Martin Nee, and Dr. Peter Ashley, HUD;
- Pat Bohan, East Central University;
- James Larue, The House Mender Inc.;
- Ellen Tohn, ERT Associates;
- Dr. Stephen Margolis, Emory University; and
- Joseph Ponessa and Rebecca Morley, Healthy Homes Training Center.

A special thank-you for assistance from Carolyn Case-Compton, Habitat for Humanity, 123 East Main Street, Morehead, Kentucky. Pictures of a home under construction are courtesy of Habitat for Humanity and John King, home builder and instructor, Rowan County Technical College, Morehead, Kentucky; and Don W. Johnson, building photographer of Habitat for Humanity.

In addition, a special thank you to CAPT Craig Shepherd and CAPT Michael Herring, Commissioned Corps, U.S. Public Health Service, CDC/NCEH/Environmental Health Services Branch for their research and review during the editing of this manual. Special thanks to Pamela S. Wigington and Joey L. Johnson for their hard work preparing this manual for publication and to Teresa M. Sims for Web publication.





# Abbreviations and Acronyms

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ABS	acrylonitrile-butadiene-styrene
ADA	Americans with Disabilities Act
AGA	American Gas Association
ALA	American Lung Association
ANSI	American National Standards Institute
APHA	American Public Health Association
ASME	American Society of Mechanical Engineers
ASSE	American Society of Structural Engineers
ASTM	American Society for Testing Materials
ATSDR	Agency for Toxic Substances and Disease Registry
AWG	American Wire Gauge
AWWA	American Waters Works Association
BTU	British thermal unit
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
CGA	Canadian Gas Association
CO	carbon monoxide
CPR	cardiopulmonary resuscitation
CPSC	Consumer Product Safety Commission
CSIA	Chimney Safety Institute of America
DDT	dichlorodiphenyltrichlorethane
DE	diatomaceous earth
DPD	N,N-diethyl-p-phenylene diamine
DWV	drain, waste, and vent
EIFS	exterior insulation and finish system
EPA	U.S. Environmental Protection Agency
EPDM	ethylene propylene diene terpolymer
ETS	environmental tobacco smoke
FHA	Federal Housing Administration
FM	Factory Mutual
GFCI	ground fault circuit interrupter
HEPA	high-efficiency particulate air
HHS	Health and Human Services, U.S. Department of
HSC	Home Safety Council
HUD	Housing and Urban Development, U.S. Department of
HVAC	heating, ventilating and air conditioning
IAPMO	International Association of Plumbing and Mechanical Officials
ICC	International Code Council
IPM	integrated pest management
ISO	International Standard Organization
kg	kilogram
LPP	low-pressure pipe
MPMH	<i>Military Pest Management Handbook</i>
MSS	Mechanical Standardization Society of the Valve and Fitting Industry
NCEH	National Center for Environmental Health
NCI	National Cancer Institute
NIA	National Institute on Aging
NSF	National Science Foundation
NTU	nephelometric turbidity unit

ODTS	organic dust toxic syndrome
OSHA	Occupational Safety and Health Administration
PEX	cross-formulated polyethylene
POTW	publicly owned treatment works
ppm	parts per million
psi	pound per square inch
PVC	polyvinyl chloride
PW	potable water
RIFA	red imported fire ant
SDWA	Safe Drinking Water Act
SEER	seasonal energy efficiency ratio
T&P	temperature-pressure
TSP	trisodium phosphate
UF	urea-formaldehyde
UL	Underwriters Laboratories
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFA	U.S. Fire Administration
USGS	U.S. Geological Survey
USHA	United States Housing Authority
VA	Veteran's Administration
VOC	volatile organic compound
XRF	X-ray fluorescence

**Accessory building or structure:** a detached building or structure in a secondary or subordinate capacity from the main or principal building or structure on the same premises.

**Appropriate authority/Authority having jurisdiction (AHJ):** a person within the governmental structure of the corporate unit who is charged with the administration of the appropriate code.

**Ashes:** the residue from burning combustible materials.

**Attic:** any story or floor of a building situated wholly or partly within the roof, and so designed, arranged, or built to be used for business, storage, or habitation.

**Basement:** the lowest story of a building, below the main floor and wholly or partially lower than the surface of the ground.

**Building:** a fixed construction with walls, foundation, and roof, such as a house, factory, or garage.

**Bulk container:** any metal garbage, rubbish, or refuse container having a capacity of 2 cubic yards or greater and which is equipped with fittings for hydraulic or mechanical emptying, unloading, or removal.

**Central heating system:** a single system supplying heat to one or more dwelling unit(s) or more than one rooming unit.

**Chimney:** a vertical masonry shaft of reinforced concrete, or other approved noncombustible, heat-resisting material enclosing one or more flues, for the purpose of removing products of combustion from solid, liquid, or gaseous fuel.

**Dilapidated:** in a state of disrepair or ruin and no longer adequate for the purpose or use for which it was originally intended.

**Dormitory:** a building or a group of rooms in a building used for institutional living and sleeping purposes by four or more persons.

**Dwelling:** any enclosed space wholly or partly used or intended to be used for living, sleeping, cooking, and eating. (*Temporary housing*, as hereinafter defined, shall not be classified as a dwelling.) Industrialized housing and modular construction that conform to nationally accepted industry standards and are used or intended for use for living, sleeping, cooking, and eating purposes shall be classified as dwellings.

**Dwelling unit:** a room or group of rooms located within a dwelling forming a single habitable unit with facilities used or intended to be used by a single family for living, sleeping, cooking, and eating.

**Egress:** arrangements and openings to assure a safe means of exit from buildings.

**Extermination:** the control and elimination of insects, rodents, or other pests by eliminating their harborage places; by removing or making inaccessible materials that may serve as their food; by poisoning, spraying, fumigating, trapping, or any other recognized and legal pest elimination methods approved by the local or state authority having such administrative authority. Extermination is one of the components of integrated pest management.

**Fair market value:** a price at which both buyers and sellers will do business.

**Family:** one or more individuals living together and sharing common living, sleeping, cooking, and eating facilities (See also *Household*).

**Flush toilet:** a toilet bowl that can be flushed with water supplied under pressure and that is equipped with a water-sealed trap above the floor level.

**Garbage:** animal and vegetable waste resulting from handling, preparation, cooking, serving, and nonconsumption of food.

**Grade:** the finished ground level adjacent to a required window.

**Guest:** an individual who shares a dwelling unit in a nonpermanent status for not more than 30 days.

**Habitable room:** a room or enclosed floor space used or intended to be used for living, sleeping, cooking or eating purposes, excluding bathrooms, laundries, furnace rooms, pantries, kitchenettes and utility rooms of less than 50 square feet of floor space, foyers, or communicating corridors, stairways, closets, storage spaces, workshops, and hobby and recreation areas.

**Health officer:** the legally designated health authority of the jurisdiction or that person's authorized representative.

**Heated water:** water heated to a temperature of not less than 120°F–130°F (49°C–54°C) at the outlet.

**Heating device:** all furnaces, unit heaters, domestic incinerators, cooking and heating stoves and ranges, and other similar devices.

**Household:** one or more individuals living together in a single dwelling unit and sharing common living, sleeping, cooking, and eating facilities (see also *Family*).

**Infestation:** the presence within or around a dwelling of any insects, rodents, or other pests.

**Integrated pest management:** a coordinated approach to managing roaches, rodents, mosquitoes, and other pests that combines inspection, monitoring, treatment, and evaluation, with special emphasis on the decreased use of toxic agents.

**Kitchen:** any room used for the storage and preparation of foods and containing the following equipment: sink or other device for dishwashing, stove or other device for cooking, refrigerator or other device for cold storage of food, cabinets or shelves for storage of equipment and utensils, and counter or table for food preparation.

**Kitchenette:** a small kitchen or an alcove containing cooking facilities.

**Lead-based paint:** any paint or coating with lead content equal to or greater than 1 milligram per square centimeter, or 0.5% by weight.

**Multiple dwelling:** any dwelling containing more than two dwelling units.

**Occupant:** any individual, over 1 year of age, living, sleeping, cooking, or eating in or having possession of a dwelling unit or a rooming unit; except that in dwelling units a guest shall not be considered an occupant.

**Operator:** any person who has charge, care, control or management of a building, or part thereof, in which dwelling units or rooming units are let.

**Ordinary summer conditions:** a temperature 10°F (-12°C) below the highest recorded temperature in the locality for the prior 10-year period.

**Ordinary winter conditions:** mean a temperature 15°F (-9.4°C) above the lowest recorded temperature in the locality for the prior 10-year period.

**Owner:** any person who alone, jointly, or severally with others (a) shall have legal title to any premises, dwelling, or dwelling unit, with or without accompanying actual possession thereof, or (b) shall have charge, care or control of any premises, dwelling, or dwelling unit, as owner or agent of the owner, or as executor, administrator, trustee, or guardian of the estate of the owner.

**Permissible occupancy:** the maximum number of individuals permitted to reside in a dwelling unit, rooming unit, or dormitory.

**Person:** any individual, firm, corporation, association, partnership, cooperative, or government agency.

**Plumbing:** all of the following supplied facilities and equipment: gas pipes, gas burning equipment, water pipes, garbage disposal units, waste pipes, toilets, sinks, installed dishwashers, bathtubs, shower baths, installed clothes washing machines, catch basins, drains, vents, and similarly supplied fixtures, and the installation thereof, together with all connections to water, sewer, or gas lines.

**Privacy:** the existence of conditions which will permit an individual or individuals to carry out an activity commenced without interruption or interference, either by sight or sound by unwanted individuals.

**Rat harborage:** any conditions or place where rats can live, nest or seek shelter.

**Ratproofing:** a form of construction that will prevent the entry or exit of rats to or from a given space or building, or from gaining access to food, water, or harborage. It consists of the closing and keeping closed of every opening in foundations, basements, cellars, exterior and interior walls, ground or first floors, roofs, sidewalk gratings, sidewalk openings, and other places that may be reached and entered by rats by climbing, burrowing, or other methods, by the use of materials impervious to rat gnawing and other methods approved by the appropriate authority.

**Refuse:** leftover and discarded organic and nonorganic solids (except body wastes), including garbage, rubbish, ashes, and dead animals.

**Refuse container:** a watertight container that is constructed of metal, or other durable material impervious to rodents, that is capable of being serviced without creating unsanitary conditions, or such other containers as have been approved by the appropriate authority (see also *Appropriate Authority*). Openings into the container, such as covers and doors, shall be tight fitting.

**Rooming house:** any dwelling other than a hotel or motel or that part of any dwelling containing one or more rooming units, or one or more dormitory rooms, and in which persons either individually or as families are housed with or without meals being provided.

**Rooming unit:** any room or group of rooms forming a single habitable unit used or intended to be used for living and sleeping, but not for cooking purposes.

**Rubbish:** nonputrescible solid wastes (excluding ashes) consisting of either: (a) combustible wastes such as paper, cardboard, plastic containers, yard clippings and wood; or (b) noncombustible wastes such as cans, glass, and crockery.

**Safety:** the condition of being reasonably free from danger and hazards that may cause accidents or disease.

**Space heater:** a self-contained heating appliance of either the convection type or the radiant type and intended primarily to heat only a limited space or area such as one room or two adjoining rooms.

**Supplied:** paid for, furnished by, provided by, or under the control of the owner, operator or agent.

**System:** the dynamic interrelationship of components designed to enact a vision.

**Systems theory:** The concept proposed to promote the dynamic interrelationship of activities designed to accomplish a unified system.

**Temporary housing:** any tent, trailer, mobile home, or other structure used for human shelter that is designed to be transportable and which is not attached to the ground, to another structure, or to any utility system on the same premises for more than 30 consecutive days.

**Toxic substance:** any chemical product applied on the surface of or incorporated into any structural or decorative material, or any other chemical, biologic, or physical agent in the home environment or its immediate surroundings, which constitutes a potential hazard to human health at acute or chronic exposure levels.

**Variance:** a difference between that which is required or specified and that which is permitted.

# Standards and Organizations

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In addition to the standards and organizations listed in this section, the U.S. Justice Department enforces the requirements of the **Americans with Disabilities Act (ADA)** (<http://www.ada.gov>) and assures that products fully comply with the provisions of the act to ensure equal access for physically challenged users.

- ABPA** The American Backflow Prevention Association, <http://abpa.org>  
Develops cross-connections; ABPA is an organization whose members have a common interest in protecting drinking water from contamination.
- ACI** American Concrete Institute, <http://www.concrete.org/general/home.asp>  
Has produced more than 400 technical documents, reports, guides, specifications, and codes for the best use of concrete. ACI conducts more than 125 educational seminars each year and has 13 certification programs for concrete practitioners, as well as a scholarship program to promote careers in the industry.
- AGA** American Gas Association, <http://www.aga.org>  
Develops standards, tests, and qualifies products used in gas lines and gas appliance installations.
- AGC** Associated General Contractors of America, <http://www.agc.org>  
Is dedicated to improving the construction industry by educating the industry to employ the finest skills, promoting use of the latest technology and advocating building the best quality projects for owners—public and private.
- AMSA** Association of Metropolitan Sewerage Agencies, <http://www.amsa-cleanwater.org>  
Represents the interests of the country's wastewater treatment agencies.
- ANSI** American National Standards Institute, <http://www.ansi.org>  
Coordinates work among U.S. standards writing groups. Works in conjunction with other groups such as ISO, ASME, and ASTM.
- ARI** Air-Conditioning and Refrigeration Institute, <http://www.ari.org>  
Provides information about the 21st Century Research (21-CR) initiative, a private-public sector research collaboration of the heating, ventilation, air-conditioning, and refrigeration industry, with a focus on energy conservation, indoor environmental quality, and environmental protection.
- ASCE** American Society of Civil Engineers, <http://www.asce.org>  
Provides essential value to its members, careers, partners, and the public by developing leadership, advancing technology, advocating lifelong learning, and promoting the profession.
- ASHI** The American Society of Home Inspectors, <http://www.ashi.org>  
Is a source of information about the home inspection profession.
- ASHRAE** American Society of Heating, Refrigerating and Air-Conditioning Engineers, <http://www.ashrae.org>  
Writes standards and guidelines that include uniform methods of testing for rating purposes, describe recommended practices in designing and installing equipment and provide other information to guide the industry. ASHRAE has more than 80 active standards and guideline project committees, addressing such broad areas as indoor air quality, thermal comfort, energy conservation in buildings, reducing refrigerant emissions, and the designation and safety classification of refrigerants.

- ASME** The American Society of Mechanical Engineers, <http://www.asme.org>  
Develops standards for materials and testing as well as finished products.
- ASSE** American Society of Sanitary Engineering, <http://www.asse.org>  
Develops standards and qualifies products for plumbing and sanitary installations.
- ASTM** American Society for Testing and Materials, <http://www.astm.org>  
Is one of the largest voluntary standards development organizations in the world—a trusted source for technical standards for materials, products, systems, and services.
- AWWA** American Water Works Association, <http://www.awwa.org>  
Promotes public health through improvement of the quality of water and develops standards for valves, fittings, and other equipment.
- CGA** Canadian Gas Association, <http://www.cga.ca>  
Develops standards, tests, and qualifies products used in gas lines and gas appliance installations.
- CPSC** U.S. Consumer Product Safety Commission, <http://www.cpsc.gov>  
Protects the public from unreasonable risks for serious injury or death from more than 15,000 types of consumer products. CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard or can injure children.
- CRBT** Center for Resourceful Building Technology, <http://www.crbt.org>  
Contains the online *Guide to Resource-Efficient Building Elements*, which provides information about environmentally efficient construction materials, including foundations, wall systems, panels, insulation, siding, roofing, doors, windows, interior finishing, and floor coverings.
- EPA** U.S. Environmental Protection Agency, <http://www.epa.gov>  
Protects human health and the environment.
- FM** Factory Mutual, <http://fmglobal.com>  
Develops standards and qualifies products for use by the general public and develops standards for materials, products, systems, and services.
- HFHI** Habitat for Humanity International, <http://www.habitat.org>  
Is a nonprofit, ecumenical Christian housing ministry. HFHI seeks to eliminate poverty housing and homelessness from the world, and to make decent shelter a matter of conscience and action.
- HUD** U.S. Department of Housing and Urban Development, <http://www.hud.gov>  
As part of the HUD efforts toward eliminating childhood lead poisoning, the Office of Healthy Homes and Lead Hazard Control is sharing local lead ordinances and regulations that have proven effective in helping communities deal with lead-based paint hazards. Also, the design and construction of manufactured housing are regulated by the federal government and must comply with HUD's Manufactured Home Construction and Safety Standards. Modular and panelized construction must comply with model or local building codes.
- IAPMO** International Association of Plumbing and Mechanical Officials, <http://www.iapmo.org>  
Developed and maintains the Uniform Plumbing Code and the Uniform Mechanical Code.



- ICBO** The Uniform Building Code (UBC)/International Conference of Building Officials, <http://www.iccsafe.org>  
Is the most widely adopted model building code in the world and is a proven document meeting the needs of government units charged with enforcement of building regulation. Published triennially, the UBC provides complete regulations covering all major aspects of building design and construction relating to fire and life safety and structural safety. The requirements reflect the latest technologic advances available in the building and fire- and life-safety industry.
- ICC** International Code Council, <http://www.iccsafe.org>  
Produces the most widely adopted and enforced building safety codes in the United States (I-Codes). International Residential Code (IRC) 2003 has been adopted by many states, jurisdictions, and localities. IRC also references several industry standards such as ACI 318, ASCE 7, ASTM, and ANSI standards that cover specific load, load combinations, design methods, and material specifications.
- ISO** International Standard Organization, <http://www.iso.org>  
Provides internationally recognized certification for manufacturers that comply with high standards of quality control, developed standards ISO-9000 through ISO-9004, and qualifies and lists products suitable for use in plumbing installations.
- MSS** Manufacturers Standardization Society of the Valve and Fittings Industry, Inc., <http://www.mss-hq.com>  
Develops technical codes and standards for the valve and fitting industry.
- NACHI** The National Association of Certified Home Inspectors, <http://www.nachi.org/index.htm>  
Is the world's largest, most elite nonprofit inspection association.
- NAHB** National Association of Home Builders, <http://www.nahb.org>  
Is a trade association representing more than 220,000 residential home building and remodeling industry members. NAHB is affiliated with more than 800 state and local home builders associations around the country. NAHB urges codes and standards development and application that protects public health and safety without cost impacts that decrease affordability and consequently prevent people from moving into new, healthier, safer homes.
- NEC** National Electrical Code, <http://www.nfpa.org>  
Protects public safety by establishing requirements for electrical wiring and equipment in virtually all buildings.
- NESC** National Environmental Services Center, [http://www.nesc.wvu.edu/nesc/nesc\\_about.htm](http://www.nesc.wvu.edu/nesc/nesc_about.htm)  
Is a repository for water, wastewater, solid waste, and environmental training research.
- NFPA** National Fire Protection Association, <http://www.nfpa.org/index.asp>  
Develops, publishes, and disseminates more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks.
- NOWRA** National Onsite Wastewater Recycling Association, <http://www.nowra.org>  
Provides leadership and promotes the onsite wastewater treatment and recycling industry through education, training, communication, and quality tools to support excellence in performance.
- NSF** National Sanitation Foundation, <http://www.nsf.org>  
Develops standards for equipment, products and services; a nonprofit organization now known as NSF International.

- UL** Underwriters Laboratory, <http://www.ul.com>  
Has developed more than 800 Standards for Safety. Millions of products and their components are tested to UL's rigorous safety standards.
- WEF** Water Environment Federation, <http://www.wef.org>  
Is a not-for-profit technical and educational organization with members from varied disciplines who work toward the WEF vision of preservation and enhancement of the global water environment. The WEF network includes water quality professionals from 76 member associations in 30 countries.

The original *Basic Housing Inspection* manual was published in 1976 by the Center for Disease Control (now known as the Centers for Disease Control and Prevention). Its Foreword stated:

*“The growing numbers of new families and the increasing population in the United States have created a pressing demand for additional housing that is conducive to healthful living. These demands are increased by the continuing loss of existing housing through deterioration resulting from age and poor maintenance. Large numbers of communities in the past few years have adopted housing codes and initiated code enforcement programs to prevent further deterioration of existing housing units. This growth in housing activities has caused a serious problem for communities in obtaining qualified personnel to provide the array of housing service needed, such as information, counseling, technical advice, inspections, and enforcement. As a result many agencies throughout the country are conducting comprehensive housing inspection training courses. This publication has been designed to be an integral part of these training sessions.”*

The original *Basic Housing Inspection* manual has been successfully used for several decades by public health and housing personnel across the United States. Although much has changed in the field of housing construction and maintenance, and health and safety issues have expanded, the manual continues to have value, especially as it relates to older housing.

Many housing deficiencies impact on health and safety. For example, lead-based paint and dust may contribute to lead poisoning in children; water leakage and mold may contribute to asthma episodes; improper use and storage of pesticides may result in unintentional poisoning; and lack of working smoke, ionization, and carbon monoxide alarms may cause serious injury and death.

Government agencies have been very responsive to “healthy homes” issues. The U.S. Department of Housing and Urban Development (HUD) created an office with an exclusive focus on healthy homes. In 2003, CDC joined HUD in the effort to improve housing conditions through the training of environmental health practitioners, public health nurses, housing specialists, and others who have interest and responsibility for creating healthy homes.

The revised *Basic Housing Inspection* manual, renamed the *Healthy Housing Reference Manual*, responds to the enormous changes that have occurred in housing construction methods and materials and to new knowledge related to the impact of housing on health and safety. New chapters have been added, making the manual more comprehensive. For example, an entire chapter is devoted to rural water supplies and on-site wastewater treatment. A new chapter was added that discusses issues related to residential swimming pools and spas. At over 230 pages, the comprehensive revised manual is designed primarily as a reference document for public health and housing professionals who work in government and industry.

The *Healthy Housing Reference Manual* contains 14 chapters, each with a specific focus. All chapters contain annotated references and a listing of sources for additional topic information. A summary of the content of each chapter follows:

Chapter One, *Housing History and Purpose*, describes the history of dwellings and urbanization and housing trends during the last century.

Chapter Two, *Basic Principles of Healthy Housing*, describes the basic principles of healthy housing and safety—physiologic needs, psychologic needs, protection against injury and disease—and lays the groundwork for following chapters.

Chapter Three, *Housing Regulations*, reviews the history of housing regulations, followed by a discussion of zoning, housing, and building codes.

Chapter Four, *Disease Vectors and Pests*, provides a detailed analysis of disease vectors that have an impact on residences. It includes information on the management of mice, rats, cockroaches, fleas, flies, termites, and fire ants.

Chapter Five, *Indoor Air Pollution and Toxic Materials*, provides information on indoor air pollution, both biologic and chemical, and to toxic materials in the home, including methods for controlling these hazards. The impact of cockroaches, dust mites, pets, and mold are discussed. Also included is information about the impact of carbon monoxide, ozone, tobacco smoke, volatile organic compounds, radon, and pesticides.

Chapter Six, *Housing Structure*, contains information about “older” housing construction and new construction materials and methods. The chapter also introduces new terminologies and includes information about foundations, vapor barriers, house framing, roof framing, exterior walls, and roofs.

Chapter Seven, *Environmental Barriers*, provides information on roofing, insulation, and siding materials.

Chapter Eight, *Rural Water Supplies and Water-quality Issues*, covers issues related to the drilling and proper maintenance of wells. Research information is provided that indicates that many wells are not properly sealed, allowing for the leakage of contaminated water into wells during hurricanes and periods of significant flooding.

Chapter Nine, *Plumbing*, provides information on plumbing standards and how they can be accessed, followed by a review of the elements of a residential water delivery system, the types of available hot-water heaters, drainage systems, and methods for water conservation. It also includes a visual synthesis of water system components during new residential construction.

Chapter Ten, *On-site Wastewater Treatment*, complements chapter seven by providing information on proper on-site methods for the treatment of human waste.

Chapter Eleven, *Electricity*, expands on information contained in the original manual covering such topics as breaker systems and polarized plugs and connectors. It also provides a format for the inspection of residential electrical systems.

Chapter Twelve, *Heating, Air Conditioning, and Ventilation*, provides information about types of residential fuels and heating systems, including solar heating and minor sources of heating (e.g., coal-fired, oil-fired, gas-fired, and electrical space heaters). Chimney and fireplace safety and the variety of cooling systems are also discussed.

Chapter Thirteen, *Energy Efficiency*, discusses energy efficiency, including R-values and their interpretation, roof ventilation, wall and floor insulation, and door and window energy efficiency systems. It also discusses active and passive solar systems and provides a methodology for conducting a residential energy audit.

Chapter Fourteen, *Residential Swimming Pools and Spas*, provides information about child safety, pool and spa hazards, and diseases. It also provides information on methods for testing and ensuring a safe water system and on methods for spa and pool disinfection. Further, it covers concerns related to unregulated individual residential pools and spas.

The quality of housing plays a decisive role in the health status of its occupants. Substandard housing conditions have been linked to adverse health effects such as childhood lead poisoning, asthma and other respiratory conditions, and unintentional injuries. This new and revised *Healthy Housing Reference Manual* is an important reference for anyone with responsibility and interest in creating and maintaining healthy housing.

The housing design and construction industry has made great progress in recent years through the development of new innovative techniques, materials technologies, and products. The HUD *Rehab Guide* series was developed to inform the design and construction industry about state-of-the-art materials and innovative practices in housing rehabilitation. The series focuses on building technologies, materials, components, and techniques rather than on projects such as adding a new room. The nine volumes each cover a distinct element of housing rehabilitation and feature breakthrough materials, labor-saving tools, and cost-cutting practices. The nine volumes address foundations; exterior walls; roofs; windows and doors; partitions, ceilings, floors, and stairs; kitchen and baths; electrical/electronics; heating, air conditioning, and ventilation; plumbing; and site work.

Additional information about the series can be found at <http://www.huduser.org/publications/destech/rehabgui.html> and <http://www.pathnet.org/sp.asp?id=997>. This series is an excellent adjunct to the *Healthy Housing Reference Manual*.

